Electrical Engineering Department

Signal Analysis (802321) – G1

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First Term (1436-1437), Second Exam

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Solution

Accredited ABET Engineering Accreditation Commission

الاسم:

الرقم الجامعي:

Start from here →

Q 1. Choose the correct answer: Total 26 *Marks*

Part A – CLO 2: Apply some time operations to signals and analyze the unit impulse, unit step, exponential and sinusoidal functions.

1. Which statement is correct? 1 *Mark*

   a) All signals observed in real life are energy signals
   b) Both energy and power signals exist in real life.
   c) All signals observed in real life are power signals
   d) A power signal must necessarily have finite duration.

2. In communication systems, message signal and noise signals are classified as: 1 *Mark*

   a) Message is random but noise is deterministic
   b) Noise is random but message is either random or deterministic.
   c) Noise is random but message is deterministic
   d) Both message and noise are probabilistic

3. If $g_2(t) = -g_1(-\frac{1}{2}t + 3)$, the energy of the signal $g_2(t)$ equals: 1 *Mark*

   a) The energy of $g_1(t)$ multiplied by – 2
   b) The energy of $g_1(t)$ divided by 2
   c) The energy of $g_1(t)$ multiplied by 2
   d) The energy of $g_1(t)$ multiplied by – ½

   Expansion by 2

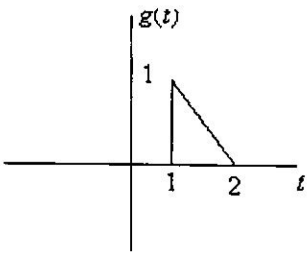
4. The signal $g(-2t + 3)$ is: $= g[-2(t - 3/2)]$ 1 *Mark*

   a) $g(t)$ delayed by 2, then time-inverted, then compressed by 3
   b) $g(t)$ left-shifted by 3, then time-inverted, then expanded by 2
   c) $g(t)$ time-inverted, then compressed by 2, then right-shifted by 3/2
   d) $g(t)$ time-inverted, then compressed by 2, then left-shifted by 3

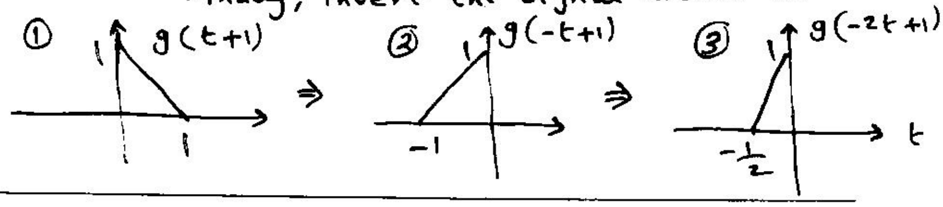
5. If a signal is time-shifted, scaled and inverted, which order can be followed? 1 *Mark*

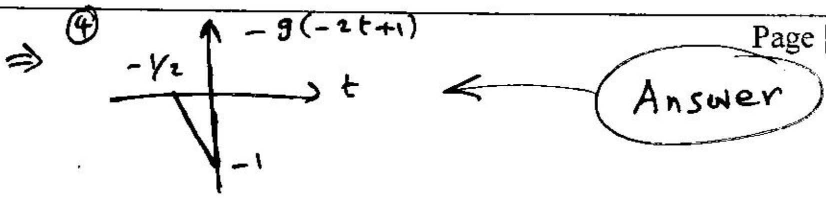
   a) Scaling → inversion → shifting
   b) Shifting → inversion → scaling
   c) Inversion → scaling → shifting
   d) All the above (as long as shifting is not in the middle).

6. Given the signal $g(t)$ shown in the figure. Sketch the signal $-g(1-2t)$. 2 *Marks*



Method (2): ① Left-shift by 1.
② Invert.
③ Compress by 2.
Finally, invert the signal around the t-axis.





7. Which definition is correct for the unit impulse function $\delta(t)$? *1 Mark*

a) $\delta(t) = 1$ at $t = 0$
$\delta(t)$ is undefined at $t = 0$

b) $\delta(t) = \overset{0}{\cancel{1}}$ at $t \neq 0$
$\int_{-\infty}^{\infty} \delta(t)dt = 1$

c) $\delta(t) = 1$ at $t = 0$
$= 0$ at $t \neq 0$

d) $\delta(t) = 1$ for $t \geq 0$
$= 0$ for $t < 0$

$\delta(t) = 0 \, , \; t \neq 0$

$\int_{-\infty}^{\infty} \delta(t)\,dt = 1$

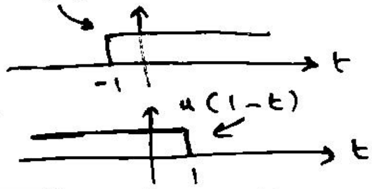
8. The definition of the unit step function $u(1-t)$ is: *1 Mark*

a) $u(1-t) = 1$ for $t \leq 1$
$= 0$ for $t > 1$

b) $u(1-t) = 0$ for $t < 1$
$= 1$ for $t \geq 1$

c) $u(1-t) = 1$ for $t \leq -1$
$= 0$ for $t > -1$

d) $u(1-t) = 0$ for $t < -1$
$= 1$ for $t \geq -1$



9. Simplify the following expression: $\left[\frac{\cos \pi(t-2)}{t^2+4t}\right]\delta(t+1) = \frac{\cos\pi(-1-2)}{(-1)^2+4(-1)}\,\delta(t+1)$ *1 Mark*

$= \frac{\cos(-3\pi)}{1-4}\,\delta(t+1)$

$= \frac{\cos(3\pi)}{-3}\,\delta(t+1) = \frac{1}{3}\,\delta(t+1)$

a) $-1/3$

b) $-(1/3)\,\delta(t+1)$

c) $(1/3)\,\delta(t+1)$

d) 0

10. Which relation is correct? *1 Mark*

← should be t

a) $\int_{-\infty}^{\infty} \delta(t)dt = u(t)$

b) $\frac{du(t)}{dt} = \delta(t)$

c) $\frac{d\delta(t)}{dt} = u(t)$

d) a) and b)

11. The unit step signal is classified as: *1 Mark*

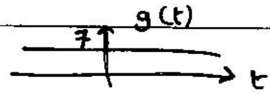
a) Energy signal

b) Neither energy nor power signal

c) Power signal

d) Cannot decide

12. The energy and power of the signal $g(t) = 7$ equal to: *1 Mark*



a) $E_g = 49, P_g = 0$

b) $E_g = \infty, P_g = 49$

c) $E_g = 7, P_g = 0$

d) $E_g = \infty, P_g = 7$

$E_g = \infty \, , \; P_g = 7^2 = 49$

13. The period-energy and power of the periodic complex exponential signal $g(t) = e^{j\omega_0 t}$ are: *1 Mark*

$E_{g\,period} = \int_0^{T_0} |g(t)|^2\,dt = T_0$

$P_g = E_{g\,period}/T_0$

a) $E_{g\,period} = \infty, P_g = 1$

b) $E_{g\,period} = \infty, P_g = T_0$

c) $E_{g\,period} = T_0, P_g = 1$

d) $E_{g\,period} = \omega_0, P_g = 1$

14. Which formula is correct? *1 Mark*

a) $f_0 = 2\pi T_0$

b) $T_0 = 2\pi|\omega_0|$

c) $|\omega_0| = 2\pi T_0$

d) $T_0 = 2\pi/|\omega_0|$

ω_0 can be +ve or −ve.
T_0 can only be positive.

15. The frequencies of a set of harmonically-related complex exponential signals, with the fundamental frequency $\omega_0 = 100\pi$ (rad/s), can be: (integer multiple of 100π) *1 Mark*

a) 100π, 150π, 350π, and 550π

b) 100π, 150π, 200π, and 250π

c) 100π, 300π, 500π, and 700π

d) 100π, 50π, 200π, and 300π

16. Which formula is correct? *1 Mark*

a) $e^{j\omega_0 t} = \cos\omega_0 t + \sin\omega_0 t$

b) $e^{j\omega_0 t} = \sin\omega_0 t + j\cos\omega_0 t$

c) $e^{-j\omega_0 t} = \cos\omega_0 t - j\sin\omega_0 t$

d) $e^{-j\omega_0 t} = \sin\omega_0 t - j\cos\omega_0 t$

17.	The signal $\underline{\sin\omega_0 t}$ can be expressed in terms of complex exponential signal as:	1 *Mark*

a) $\frac{1}{2}[e^{j\omega_0 t} - e^{-j\omega_0 t}]$
b) $\frac{1}{j2}[e^{j\omega_0 t} - e^{-j\omega_0 t}]$
c) $\frac{1}{2}[e^{j\omega_0 t} + e^{-j\omega_0 t}]$
d) $\frac{1}{j2}[e^{j\omega_0 t} + e^{-j\omega_0 t}]$

18.	Given an exponential signal $x(t)$. If the exponent equals $j2000\pi t$, the <u>fundamental frequency</u> and <u>period-energy</u> equal to: $\omega_o = 2000\pi$ (rad/s) $\Rightarrow f_o = \frac{2000\pi}{2\pi} = 1000$ Hz $\Rightarrow E_{xperiod} = T_o = \frac{1}{f_o} = 1$ m	1 *Mark*

a) $f_0 = 1000$ Hz, $E_{x\,period} = \infty$
b) $f_0 = 2000\pi$ Hz, $E_{x\,period} = \infty$
c) $f_0 = 1000$ Hz, $E_{x\,period} = 1$ m
d) $f_0 = 2000\pi$ Hz, $E_{x\,period} = 1$ m

19.	For the exponential signal $e^{-j500\pi t}$, the <u>fundamental frequency</u> and <u>period</u> equal to:	1 *Mark*

a) $\omega_0 = 500\pi$, $T_0 = 4$ ms.
b) $\omega_0 = 500\pi$, $T_0 = -4$ ms.
c) $\omega_0 = -500\pi$, $T_0 = 4$ ms.
d) $\omega_0 = -500\pi$, $T_0 = -4$ ms.

$\omega_o = -500\pi$ (rad/s)
$T_o = \frac{2\pi}{|\omega_o|} = \frac{2\pi}{500\pi} =$

20.	Which one of the following signals is <u>complex</u>?	1 *Mark*

a) $|7e^{-j5000\pi t}| = 7$ (real)
b) $j^2\left(\frac{1}{j}t + jt^2\right) = jt + j^3t^2 = jt - jt^2 = j(t-t^2)$
c) $\frac{1}{j2}[e^{j50\pi t} - e^{-j50\pi t}] = \sin 50\pi t$ (real)
d) $\frac{1}{2}[e^{j50\pi t} + e^{-j50\pi t}] = \frac{1}{2}e^{j0} = \frac{1}{2}$ (real)

21.	For the complex variable $z = \frac{1}{5-j3}$, the magnitude of z is calculated as:	1 *Mark*

a) $[(1/5)^2 + (-1/3)^2]^{-1/2}$
b) $(25+9)^{-1/2}$
c) $(5^2 - 3^2)^{-1/2}$
d) $(5^2 + 3^2)^{1/2}$

$|z| = \frac{1}{\sqrt{5^2 + (-3)^2}}$

22.	If the polar form of a complex number is $\sqrt{2}e^{j\frac{9\pi}{4}}$, its Cartesian form is:	1 *Mark*

a) $\frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}$
b) $1 - j$
c) $\frac{1}{\sqrt{2}} - j\frac{1}{\sqrt{2}}$
d) $1 + j$

$\sqrt{2}e^{j\frac{9\pi}{4}} = \sqrt{2}\left[\cos\left(\frac{9\pi}{4}\right) + j\sin\left(\frac{9\pi}{4}\right)\right]$
$= \sqrt{2}\left(\frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}\right) = 1 + j$

<u>Part B – CLO 3: demonstrate the understanding of the orthogonal signals.</u>

23.	The signals $g(t)$ and $x(t)$ and are said to be <u>orthogonal</u> over the period $[t_1: t_2]$ if:	1 *Mark*

a) $\int_{t_1}^{t_2} x(t)g(t)dt = 0$
b) $\int_{t_1}^{t_2} g(t)x(t)dt = 0$
c) Their inner product equals to zero.
d) All the above

24.	Which two signals are <u>not orthogonal</u>? (See Note 8)	1 *Mark*

a) sin t and cos t over the interval $[0, ½\,\pi]$
b) sin t and cos t over the interval $[0, \pi]$
c) sin t and cos t over the interval $[0, 2\pi]$
d) sin t and cos t over the interval $[-\pi/2, 3\pi/2]$

25.	The <u>inner product</u> of the two real signals $g(t)$ and $x(t)$ is defined as:	1 *Mark*

a) $\int x(t)dt \int x(t)dt$
b) $g(t)\,x(t)$
c) The area under the curve $g(t) + x(t)$
d) The area under the curve $g(t)\,x(t)$

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