Signal Analysis (802321)

Dr. Mouaaz Nahas

Second Exam – Group (1)
First Semester, 15-01-1432 H

الرقم الجامعي: الاسم:

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Q1. Choose the correct answer: **(13 *marks*)**

1) The continuous-time unit impulse function $\delta(t)$:
   a. Equals 1 at $t = 0$
   b. Equals 0 only if $t < 0$
   c. Is undefined at $t = 0$
   d. Equals ∞ at $t = 0$

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2) The continuous-time unit step function $u(t)$:
   a. Equals zero at $t > 0$
   b. Equals zero at $t < 0$
   c. Equals 1 only at $t > 0$
   d. b and c

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3) The relationship between the unit impulse and unit step functions is:
   a. $u(t) = d\delta / dt$
   b. $\delta(t) = du / dt$
   c. $u(t)$ is the area under $\delta(t)$ from $-\infty$ to ∞
   d. b and c

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4) The sampling property of the unit impulse function means that:
   a. $g(t)\ \delta(t + 5) = g(0)\ \delta(t + 5)$
   b. $g(t)\ \delta(t + 5) = g(5)\ \delta(t - 5)$
   c. $g(t)\ \delta(t + 5) = g(-5)\ \delta(t + 5)$
   d. $g(t)\ \delta(t + 5) = g(-5)\ \delta(t - 5)$

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5) Which one of the following signals is not real:
   a. $x(t) = \cos \omega t$
   b. $x(t) = \sin \omega t$
   c. $x(t) = e^{j\omega t}$
   d. $x(t) = e^{\omega t}$

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6) Which one of the following relations is correct:
   a. $f = 2\pi\ \omega$
   b. $\omega = 2\pi f$
   c. $\omega = 2\pi\ T$
   d. $\omega = 1 / T$

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7) The unit of the angular frequency ω is:
   a. Hertz
   b. Radians
   c. Radians per second
   d. Hertz per second

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8) In the signal $g(t) = C \sin(\omega t + \theta)$, θ is:
   a. The phase angle in degrees.
   b. The radial frequency in radians.
   c. The radial frequency in radians per second.
   d. The phase angle in radians.

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9) Which one of the following equations is correct:
   a. $j = -j$
   b. $1/j = j$
   c. $1/j = -j$
   d. $j^2 = -(1/j)^2$

10) If the complex exponential signals $x_1(t)$ and $x_2(t)$ are harmonically related, then their frequencies ω_1 and ω_2 can have the relationship:
   a. $\omega_1 = \omega_2$
   b. $\omega_1 = 4\,\omega_2$
   c. $\omega_1 = \frac{1}{2}\,\omega_2$
   d. $\omega_1 = 2.5\,\omega_2$

11) The complex number $e^{j5\pi/2}$ equals:
   a. j
   b. $-j$
   c. $e^{j\pi/2}$
   d. a and c

12) The complex number $\sqrt{2}\,e^{-j\pi/4}$ equals:
   a. $1 + j$
   b. $1 - j$
   c. $2 + j2$
   d. $2 - j2$

13) The complex number $(1 - j) / (1 + j)$ equals:
   a. $e^{j\pi/2}$
   b. $e^{-j\pi/2}$
   c. $e^{j\pi/4}$
   d. $e^{-j\pi/4}$

Q2. Given the signal: $x(t) = e^{-j\omega t}$ **(3 *marks*)**

a. Using Eular's relation, $x(t)$ can be expressed in terms of sinusoidal signals as:
   $x(t) = \cos \omega t - j \sin \omega t$ (1 *mark*)

b. Given x and y values for a complex number, the magnitude r and the angle θ are calculated as:
   $r = \sqrt{x^2 + y^2}$ $\theta = \tan^{-1}(y/x)$ (1 *mark*)

c. Given r and θ for a complex number, the values of x and y are calculated as:
   $x = r \cos\theta$ $y = r \sin\theta$ (1 *mark*)

Q3. For the signals $g(t)$ and $x(t)$ shown in the figure: **(11 *marks*)**

1) Define $g(t)$ mathematically. (1 *mark*)
2) Define $x(t)$ mathematically. (1 *mark*)
3) Find E_x (the energy of the signal $x(t)$). (2 *marks*)
4) Find the inner product of the two signals $g(t)$ and $x(t)$. (2 *marks*)
5) Are $g(t)$ and $x(t)$ orthogonal? Why? (1 *marks*)
6) Find the optimum value of c in the approximation $g(t) \approx c\,x(t)$ so that the error signal energy is minimum. (2 *marks*)
7) Sketch $x(t)\,u(t)$. (1 *mark*)
8) Sketch $x(t)\,\delta(t - ½)$. (1 *mark*)

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1) $g(t) = t$ ($\frac{1}{2}$), $0 \leq t \leq 1$ ($\frac{1}{2}$)

2) $x(t) = 1$ ($\frac{1}{2}$), $0 \leq t \leq 1$ ($\frac{1}{2}$)

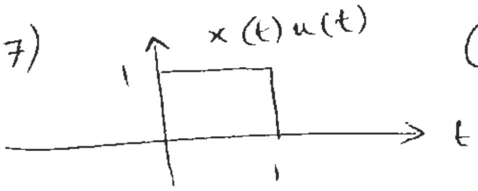
3) $E_x = \int_{-\infty}^{\infty} x^2(t)\,dt$ (1) $= \int_0^1 (1)^2\,dt = [t]_0^1 = 1$ (1)

4) Inner product $= \int_{-\infty}^{\infty} g(t)\,x(t)\,dt$ (1) $= \int_0^1 t\,dt = \left[\frac{t^2}{2}\right]_0^1 = \frac{1}{2}$ (1)

5) No, because the inner product is not zero. (1)

6) $c = \frac{1}{E_x}\int_{-\infty}^{\infty} g(t)\,x(t)\,dt$ (1) $= \frac{1}{1}\left(\frac{1}{2}\right) = \frac{1}{2}$ (1)

7) (1)



8) (1)