Assignment - 1

EEC201 - Signals, Systems, and Networks (Monsoon 2024)

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Due: 22.08.2024

1. Determine the energy and power for each of the following signals:

(a) $x_1(t) = \cos^2(4t)$

(b) $x_2(t) = e^{-2t}u(t)$

(c) $x_3(t) = e^{j(2t+\pi/4)}$

(d) $x_4(t) = \dfrac{u(t) - u(t-3)}{3}$

2. Let $x(t)$ represent the signal shown below. Plot the following:

(a) $x_1(t) = x(4-t)$

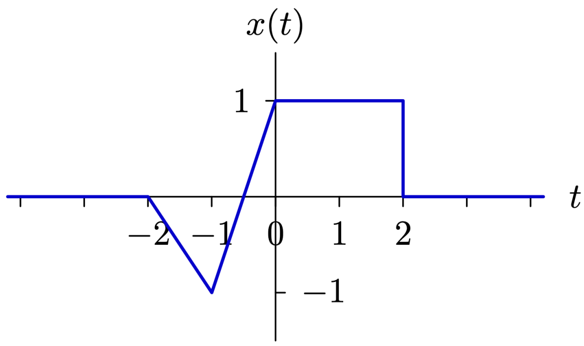
(b) $x_2(t) = x(3t+2)$

(c) $x_3(t) = 2 + x(t/2)$

(d) $x_4(t) = x(t)[\delta(t+3/2) - \delta(t-3/2)]$

(e) $x_5(t) = x_e(t) = \dfrac{x(t) + x(-t)}{2}$

(f) $x_6(t) = x_o(t) = \dfrac{x(t) - x(-t)}{2}$



3. Let $x(t)$ be a signal with $x(t) = 0$ for $t < 3$. For each signal given below, determine the values of t for which the signal is guaranteed to be zero:

(a) $x_1(t) = x(-t)$

(b) $x_2(t) = x(1-t) + x(2-t)$

(c) $x_3(t) = x(1-t)\ x(2-t)$

4. Simplify and/or evaluate the following expressions:

(a) $\dfrac{(x^2+1)\ \delta(x-1)}{x^2+7}$

(b) $\cos(2\pi t)\big(\dot{u}(t) + \delta(t+1/4)\big)$

(c) $\dfrac{(x^4 - x^2 + 6)\ \delta(2x+3)}{e^{x^2} + 5x}$

(d) $\displaystyle\int_{-\infty}^{\infty} (\tau^2+1)\ \delta(\tau-2)\ d\tau$

(e) $\displaystyle\int_{-\infty}^{\infty} e^{t-1} \cos\left(\frac{\pi(t-5)}{2}\right)\ \delta(t-3)\ dt$

(f) $\displaystyle\int_{-\infty}^{\infty} \sin(\pi t)\ \delta(2t-3)\ dt$

(g) $\displaystyle\int_{-\infty}^{\infty} \sin(2\pi t)\ \delta(4t-1)\ dt$

5. Determine if each system given below is linear. Explain your reasoning.

(a) $y(t) = t u(t) x(t)$

(b) $y(t) = \dfrac{x(t) - 2}{3}$

(c) $y(t) = 3\big[x(4t+3)\big]$

(d) $y(t) = \dfrac{x^2(t)}{1 + x(t)}$

(e) $y(t) = x(t-10)$

(f) $y(t) = x(t) + t$

6. Determine if each system given below is time-invariant. Explain your reasoning.

(a) $y(t) = tu(t)x(t)$ (b) $y(t) = \dfrac{d^5x(t)}{dt^5}$ (c) $y(t) = x(2t+5)$

(d) $y(t) = e^{4x(t)}$ (e) $y(t) = \dfrac{x(t)}{1+x(t)}$ (f) $y(t) = \ln(x(t)) + 4$

7. Determine if each system given below is memoryless and/or causal. Explain your reasoning.

(a) $y(t) = x(t^2)$ (b) $y(t) = 30$ (c) $y(t) = x(u(t))$

(d) $y(t) = \dfrac{x^7(t) + x^6(t) + x^5(t)}{1 + x^2(t) + x^9(t)}$ (e) $y(t) = \dfrac{dx(t)}{dt} + x^2(t)$

8. Determine if each system given below is BIBO stable. Explain your reasoning.

(a) $y(t) = u(t)x(t)$ (b) $y(t) = e^{x(t)}$ (c) $y(t) = \dfrac{x^2(t) + x^4(t)}{1 + x(t)}$

(d) $y(t) = \ln(x(t))$ (e) $y(t) = |x(t) - 4|$

9. Find the zero-input response of the following LTIC systems with their initial conditions described below. Furthermore, investigate the asymptotic (internal) and BIBO (external) stabilities of the systems.

(a) $(D+5)y(t) = x(t)$ with the initial condition $y(0) = 5$.

(b) $(D^2 + 2D)y(t) = (5D+2)x(t)$ with the initial conditions $y(0) = 1$ and $\dot{y}(0) = 4$.

(c) $(D^2 + 6D + 9)y(t) = (3D+5)x(t)$ with the initial conditions $y(0) = 3$ and $\dot{y}(0) = -7$.

(d) $(D+1)(D^2 + 5D + 6)y(t) = Dx(t)$ with the initial conditions $y(0) = 2$, $\dot{y}(0) = -1$, and $\ddot{y}(0) = 5$.

10. Find the zero-state response of the following LTIC systems with the unit impulse response and input described below. Essentially, compute the convolution $x(t) * h(t)$.

(a) $h(t) = u(t) - u(t-1)$ and $x(t) = u(t) - u(t-1)$

(b) $h(t) = e^{-3t}u(t)$ and $x(t) = (e^{-3t} - e^{-4t})u(t)$

(c) $h(t) = -\delta(t) + 2e^{-t}u(t)$ and $x(t) = e^{t}u(-t)$

(d) $h(t) = e^{-t}u(t)$ and $x(t) = \begin{cases} 1 & |t| \le 1 \\ 0 & \text{else} \end{cases}$

(e) $h(t) = e^{-t}u(t)$ and $x(t) = 4e^{-2t}\cos(3t)u(t)$

(f) $h(t) = u(t)$ and $x(t) = \begin{cases} 2 - |t| & |t| \le 2 \\ 0 & \text{else} \end{cases}$