دانشگاه صنعتی امیرکبیر
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Signals and Systems

Assignment 1

Fall 2019 - Group 1

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Question 1

For the signal $x(t)$ shown in the figure, compute the following:

(a) $g_1(t) = x(-t)$, (describe)

(b) $g_2(t) = x(2t)$, (describe)

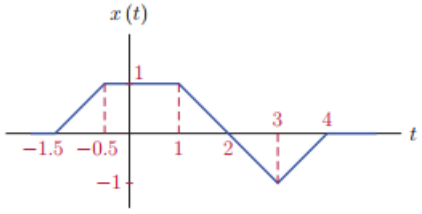
(c) $g_3(t) = x(\frac{t}{2})$, (describe)

(d) $g_4(t) = x(-t+3)$, (step-by-step sketch)

(e) $g_5(t) = x(\frac{t-1}{3})$, , (step-by-step sketch)

(f) $g_6(t) = x(4t-3)$, (step-by-step sketch)

(g) $g_7(t) = x(1-\frac{t}{3})$, (step-by-step sketch)



Question 2

For each of the signals listed below, find the even and odd components $Ev\{x(t)\}$ and $Od\{x(t)\}$.

(a) $x(t) = e^{-5t}sin(t)u(t)$

(b) $x(t) = e^{-3|t|}cos(t)$

(c) $x(t) = \Pi(t + \frac{1}{2})$, (Solve by sketching)

Hint:

$$\Pi(t) = rect(t) = \text{unit pulse} = u(t + \frac{1}{2}) - u(t - \frac{1}{2})$$

Question 3

Determine if each signal below is periodic or not. If the signal is periodic, determine the fundamental period and the fundamental frequency,

(a) $x(t) = cos^2(3t - \frac{\pi}{3})$

(b) $x(t) = e^{-|t|}cos(5t)$

(c) $x(t) = e^{j(2t+\frac{\pi}{10})}$

(d) $x(t) = sin^3(2t)$

(e) $x[n] = 5cos(3\pi n)$

(f) $x[n] = 5cos(3n)$

(g) $x[n] = e^{j\frac{n}{2}} + e^{j\frac{n}{3}}$

(h) $x[n] = e^{j\frac{n\pi}{2}} + e^{j\frac{n\pi}{3}}$

(i) $x(t) = Ev\{sin(4\pi t)u(t)\}$

(j) $x(t) = Ev\{cos(4\pi t)u(t)\}$

Question 4

Determine whether these systems have memory or are memoryless, are causal or noncausal, are time-invariant or time-varying, are stable or unstable, are linear or nonlinear.

(a) $y(t) = e^{x(t)}$

(b) $y(t) = x(sin(t))$

(c) $y(t) = \frac{dx(t)}{dt}$

(d) $y(t) = \int_{-\infty}^{2t} x(\tau)d\tau$

(e) $y[n] = (n-1)x[n]$

(f) $y[n] = x[3n+2]$

(g) $y[n] = Od\{x[n-1]\}$

Hint: first determine whether $Od\{x[n-n_0]\}$ is equal to $\frac{x[n-n_0]-x[-n-n_0]}{2}$ or $\frac{x[n-n_0]-x[-(n-n_0)]}{2}$

(h) $y[n] = x[n]\sum_{k=-\infty}^{\infty}\delta[n-2k]$, (Under what circumstances might this system be wrongly considered time-invariant?)

Question 5

Determine if each of the following systems is invertible. If it is, construct the inverse system. if it is not, find two input signals to the system that have the same output.

(a) $y[n] = x[2n]$

(b) $y[n] = \begin{cases} x[\frac{n}{2}], \text{n even} \\ 0, \text{otherwise} \end{cases}$

(c) $y(t) = \frac{dx(t)}{dt}$

(d) $y(t) = Ev\{x(t)\}$

Question 6

Determine the values of P_∞ and E_∞ for each of the following signals.

(a) $x(t) = e^{-4t}u(t)$

(b) $x(t) = e^{j(2t+\frac{\pi}{4})}$

(c) $x[n] = (\frac{1}{2})^n u[n]$

(d) $x[n] = e^{j(\frac{\pi}{2}n+\frac{\pi}{8})}$

Matlab Question 1

Plot the following continuous-time signals for $t = -5$ to $t = 5$ with 0.001 time steps:

(a) $x(t) = e^{-4t}u(t)$

(b) $x(t) = e^{-t}u(t) + cos(t-2)$

(c) $\begin{cases} e^{-3t} - e^{-6t} & t \geq 0 \\ 0 & t < 0 \end{cases}$

- Use matlab *heaviside*() function for step functions.
- In order to solve the part *c*, use matlab loops and conditionals. Do not use the *heaviside*() function :)
- Matlab introduction tutorials will be sent in the course telegram channel.

Matlab Question 2

Plot the following discrete-time signals for $n = -10$ to $n = 10$:

(a) $x[n] = u[n] - u[n-5]$

(b) $(1 - e^{0.5n})u[-n+4] + 3u[n-5]$

(c) $x[n] = 5cos(3\pi n)$

(d) $x[n] = 5cos(3n)$

Matlab Question 3

Plot the following signal within the interval $-10 < t < 10$, then, using matlab *awgn*() function (see the documentation at *mathworks.com*) add white gaussian noise to it and plot again.

$$x(t) = u(t+2) - u(t-2)$$