ECE315 - Signals and Systems, Spring 2017

Homework 2, Due 02/01/17

Note that $x(t)$ or $g(t)$ denotes a continuous-time signal and $x[n]$ or $g[n]$ denotes a discrete-time signal.

1. (18 pt) Provide the numerical value of the following expressions. (Hint: make usage of the important properties of the unit impulse function.)

   (a) $\int_{-\infty}^{+\infty} \delta(t - 1) \cos(48\pi t) dt$
   
   (b) $\sum_{n=-\infty}^{+\infty} \delta[n - 1] \cos(48\pi n)$
   
   (c) $\int_{-\infty}^{+\infty} \delta(t + 2)(0.9)^{0.5t} dt$
   
   (d) $\sum_{n=-\infty}^{+\infty} \delta[t + 2](0.9)^{0.5n}$
   
   (e) $\int_{-\infty}^{+\infty} \delta(5t) \cos(\pi t) dt$
   
   (f) $\sum_{n=-\infty}^{+\infty} \delta[5n] \cos(\pi n)$

2. On evenness/oddness of signals:

   (a) (5 pt) Any signal $x(t)$ can be expressed as a sum of two signals, $x_e(t)$ which is an even signal and $x_o(t)$ which is an odd signal. That is, $x(t) = x_e(t) + x_o(t)$. And

   $x_e(t) = \frac{1}{2}[x(t) + x(-t)] \quad (1)$
   
   $x_o(t) = \frac{1}{2}[x(t) - x(-t)] \quad (2)$

   The same holds for discrete-time signals. Prove the above property.

   (b) (9 pt) Find and graph the even and odd parts of the signals shown in Fig. 1. What can you observe from these exercises?

3. On signal transformations (scaling and shifting).

   (a) (10 pt) Given the graphical definition of a function $g[n]$ as shown in Fig. 2, graph the function $h_1[n] = g[2n - 4]$ and $h_2[n] = g[-\frac{n}{2}]$. 

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(b) (10 pt) Given the original signal \( g_1(t) \) and the transformed signal \( g_2(t) \) as shown in Fig. 3,

i. If \( g_2(t) = Ag_1(t - t_0) \), what are \( A \), \( t_0 \), and \( w \)?

ii. If \( g_2(t) = Ag_1(wt - t_0) \), what are \( A \), \( t_0 \), and \( w \)?

4. (48 pt) On signal energy and power. From the following signals, identify energy signals and power signals. For energy signals, calculate their energy. For power signals, calculate their average signal power.

(a) \( x(t) = 3rect(t/4) \)
(b) \( x[n] = 3rect(n/4) \)
(c) \( x(t) = 2 \sin(200\pi t) \)
(d) \( x[n] = 2 \sin(200\pi n) \)
(e) \( x(t) = \delta(t) \)
(f) \( x[n] = 2\delta[n] + 5\delta[n - 3] \)
(g) \( x(t) = \frac{d}{dt}(rect(t)) \)
(h) \( x(t) = \int_{-\infty}^{t} rect(\lambda) d\lambda \)
(i) \( x(t) = e^{(-1-j8\pi)t}u(t) \)
(j) $x[n] = (-1/3)^n u[n]$

(k) $x(t) = e^{-j\pi t/2}$

(l) $x[n] = e^{-j\pi n/2}$