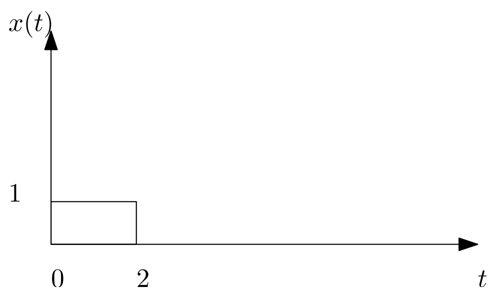
EE4440 HW#1 Assignment

January 13, 2011

1. Given a signal the signal x(t) shown below in (a), plot or sketch(b-e):

   (a) 

   (b) $x(t-4)$

   (c) $x(4t)$

   (d) $x(-t)$

   (e) $x(2-2t)$

2. Answer the following

   (a) What is the primary advantage of digital communications over analog?

   (b) What two properties of channels prevent error free communication at an unlimited data rate?

3. Draw a labeled block diagram for two people communicating over a tin can telephone system. Show communication going in one direction only. If you don't know what that is look it up in Wikipedia, but don't tell me because you'll make me feel old.

   (a) Be sure to label the transmitter, receiver, source, destination, and channel.

   (b) What kinds of noise or interference might impede communication using this system?

   (c) By what physical mechanism is communication accomplished using this system(i.e. what physical phenomenon)?

4. Assume that you have now purchased a modem for your tin can telephone. If the system has 20kHz of available bandwidth what is the channel capacity if the SNR is:

   (a) 0dB

   (b) 3dB

   (c) 100dB

   (d) 1000dB

   (e) If you continue to increase the SNR by increasing transmit power what physical system failure will eventually come into play?

5. Given three signals $x(t)$,$y_1(t)$, and $y_2(t)$ defined as :

$$x(t) = \begin{cases} t & |t| \leq \pi \\ 0 & |t| > \pi \end{cases}$$

$$y_1(t) = \begin{cases} cos(t) & |t| \leq \pi \\ 0 & |t| > \pi \end{cases}$$

$$y_2(t) = \begin{cases} sin(t) & |t| \leq \pi \\ 0 & |t| > \pi \end{cases}$$

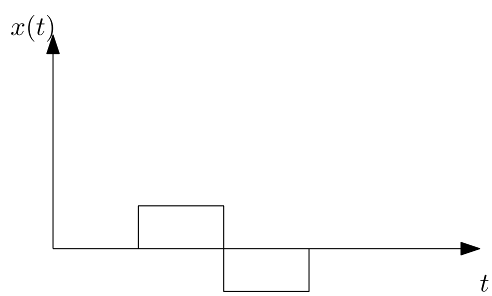
Find the dot products $< x, y_1 >$ and $< x, y_2 >$. That's right, you need to remember integration by parts. Or maybe a table would be easier? Mathematica? Anything but copying is OK, if you don't work it out by hand, please note your source or method. If you know the identity, lie and tell me some table or Calculus book where you found it.

6. Show that $e^{jn\omega_0 t}$ and $e^{jm\omega_0 t}$are orthogonal for $n \neq m$ for an inner product defined as:

$$< f, g >= \frac{1}{T}\int_0^T f(t)g^*(t)$$

where $\omega_0 = \frac{2\pi}{T}$. Recall that $e^{j2\pi k} = 1$. A hint, this is a trivial integration so don't make this harder than it needs to be!

7. For the signal x(t) shown below in (a) complete (b-d):



(a)

(b) Sketch a best friend (signal with ρ=1)

(c) Sketch a complete stranger (signal with ρ=0)

(d) Sketch a worst enemy (signal with ρ=-1)

8. In example 2.12 we showed that the Fourier series coeffecients for a pulse train $g(t) = \sum_{n=-\infty}^{\infty} \delta(t-nT_0)$ are $D_n = \frac{1}{T_0}$. That means that we can express $g(t)$as $g(t) = \frac{1}{T_0}\sum_{n=-\infty}^{\infty} e^{j2\pi n f_0 t}$ with $f_0 = \frac{1}{T_0}$. Use Euler's identity to write this function as a sum of real functions $\{y_0(t) + y_1(t) + y_2(t) + ... + y_N(t), ...\}$of time. Plot this expression for $N = \{3, 10, 15\}$ in MATLAB. Include your MATLAB code with your homework.