Homework #1, ECE 340, Fall 2011
Due Tuesday, Sept 6 at the beginning of class

- Textbook 1.1-3
- Textbook 1.1-5 (b) and (d)
- Textbook 1.1-7 (a) and (b)
- Textbook 1.2-2
- Textbook 1.3-3 (a)
- Textbook 1.4-2 (hint: use step functions)
- Textbook 1.4-4 (a), (c), (e), (g)
- Textbook 1.4-10
- Textbook 1.5-11
- Textbook 1.7-1 (a), (c), and (e)
- Textbook 1.7-2
- Textbook 1.7-7
- If the energy in $x(t)$ is E_x, show that the energy in $x(at)$ is E_x/a.
- Use Matlab to plot the function shown in Figure P1.4-2(b).

- (a) First, show that a signal of the form $\phi(t) = \sqrt{\frac{2}{T}} \cos\left(2\pi\left(\frac{k}{T}\right)t\right)$ is "normalized" (in other words, show that the energy = 1) if k is a non-zero integer and the signal exists only over the interval from 0 to T.

  (b) Next, define $\phi_1(t) = \sqrt{\frac{2}{T}} \cos\left(2\pi\left(\frac{1}{T}\right)t\right)$ and $\phi_2(t) = \sqrt{\frac{2}{T}} \cos\left(2\pi\left(\frac{2}{T}\right)t\right)$. Show that $\phi_1(t)$ and $\phi_2(t)$ are orthogonal over the interval from 0 to T (in other words, show that $\int_0^T \phi_1(t)\phi_2(t)\,dt = 0$).

  (c) Since $\phi_1(t)$ and $\phi_2(t)$ are orthogonal and normalized, they are said to form an orthonormal basis for any signals of the form $a\phi_1(t) + b\phi_2(t)$. If a signal is given by

  $$x(t) = A\cos\left(2\pi\left(\frac{1}{T}\right)t\right) + B\cos\left(2\pi\left(\frac{2}{T}\right)t\right) \text{ for } 0 \le t < T$$

  re-write $x(t)$ to be in the form $a\phi_1(t) + b\phi_2(t)$.

  (d) Finally, calculate the projection of $x(t)$ onto the basis function $\phi_1(t)$ (i.e., calculate $\int_0^T x(t)\phi_1(t)\,dt$). Compare the result to the coefficient a that you just found in part (c) above.