ESE 471 Spring 2021: Homework 1

1. For each of the following signals, state whether they are waveforms or power signals. No proof is required, and no partial credit is given.

   (a) $x(t) = (-1)^{\lceil t \rceil}$, where $\lceil x \rceil$ is the ceil function, that is, the "round up" function.

   (b) $x(t) = \begin{cases} t, & -1 \le t \le 1 \\ 0, & o.w. \end{cases}$.

   (c) $x(t) = \frac{\sin t}{t}$, that is, the "sinc" function.

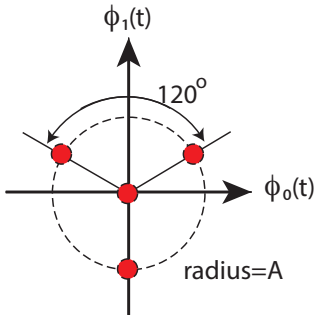
2. Rice Exercise 5.6. Copied here: Consider the two basis functions:

$$\phi_0(t) = \begin{cases} 1, & 0 \le t < 1 \\ 0, & o.w. \end{cases}$$

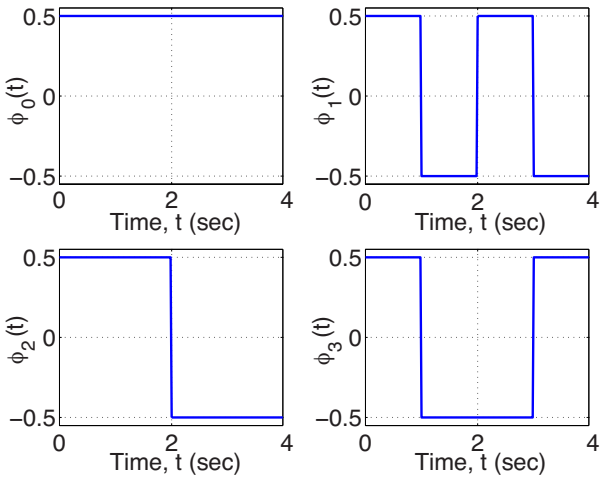
$$\phi_1(t) = \begin{cases} 1, & 0 \le t < 0.5 \\ -1, & 0.5 \le t < 1 \\ 0, & o.w. \end{cases}$$

   Sketch the waveforms corresponding to the constellation diagram with symbol 0 at $(-A, 0)$ and symbol 1 at $(A, 0)$. (Neal's note: In the constellations drawn in the book for these Rice problems, the horizontal axis always corresponds to the a_0 element (corresponding to $\phi_0(t)$), and the vertical axis corresponds to a_1 (corresponding to $\phi_1(t)$).

3. Rice Exercise 5.10. Copied here: Using the basis functions of Exercise 5.6 (your problem 2), sketch the waveforms corresponding to the points in the constellation shown below.



4. Consider the waveforms below, which are also known as the Walsh-Hadamard basis, which are non-zero for $0 \le t < 4$ seconds, and zero otherwise. (A *basis* is a set of mutually orthogonal waveforms). Answer the questions below using these waveforms $\phi_0(t), \ldots, \phi_3(t)$.



(a) Draw the symbol $s_0(t) = 0.5\phi_0(t) - 0.5\phi_2(t)$.

(b) Find a linear combination a_0, a_1, a_2, a_3 such that the symbol $s(t) = a_0\phi_0(t) + a_1\phi_1(t) + a_2\phi_2(t) + a_3\phi_3(t)$ is equal to 1 for $0 \leq t < 1$, and zero otherwise.