Homework 6

Assigned: Wednesday, May 10, 2006
Due: Wednesday, May 17, 2006

Reading Assignment: Chapter 7 (7.6) and Chapter 8 (8.1 to 8.3)

1. Consider the signal space depicted below:

Assume that each symbol has transmitted energy $E$ and that $\varphi_1(t)$ and $\varphi_2(t)$ are given by

$$
\varphi_1(t) = \begin{cases} 
\sqrt{2/T} \cos 2\pi f_s t, & 0 \leq t < T \\
0, & \text{elsewhere}
\end{cases}
$$

$$
\varphi_2(t) = \begin{cases} 
\sqrt{2/T} \sin 2\pi f_s t, & 0 \leq t < T \\
0, & \text{elsewhere}
\end{cases}
$$

(a) Find the time domain expressions for the 8 signals $s_i(t)$, $i = 1, \ldots, 8$.
(b) Determine the bit error probability (as a function of $E_b/N_0$), considering only the nearest neighbors.
(c) Provide a labeling using Gray coding.

2. Consider an 8-PSK system and a 16-PSK system.
(a) Find an expression for the probability of symbol (not bit) error for the 8-PSK system, as a function of $E$ and $N_0$, where $E$ is the transmitted symbol energy.
(b) Give an expression for the BER, as a function of $E_b$ and $N_0$.
(c) Find the $E_b/N_0$ (in dB) for which the BER will be $10^{-5}$.
(d) Now consider the 16-PSK system. Assume that the energy per transmitted symbol is $4E/3$ (this will ensure that bit energy comparisons with the 8-PSK system are fair). Find an expression for the BER of the 16-PSK system in terms of $E_b/N_0$.
(e) Using the same value of $E_b/N_0$ found in part (c) above; calculate the BER for the 16-PSK system.
(f) For the 16-PSK system, find the $E_b/N_0$ for which the BER will be $10^{-5}$.

3. Suppose that you want to transmit bits at the rate of 1 kbit/sec.
(a) Sketch the PSD at passband, assuming that BPSK is used, and that the carrier frequency is 100 KHz. What is the bandwidth (to first nulls) of this transmission?
(b) Sketch the PSD at passband, assuming that QPSK is used, and that the carrier frequency is 100 KHz. What is the bandwidth (to first nulls) of this transmission?
4. **Self-learning/use of resources to find an answer in the scientific literature**

Find, using whatever combination of research tools you find most appropriate, the original publications that first proposed OFDM. For your answer, provide a full citation of at least one of the original papers, including author names, title of publication, journal name, page numbers, and dates.