ECE4304 Homework Assignment Number 4

Due by 4:50pm on Thursday 8-Feb-2006

1 Required Reading

- Haykin Chapter 5. You may also want to read the parts in Chapter 6 about PSK and QAM digital communication systems.

2 Problems

80 points total. You must show all of your work and your work must be neat to receive credit for a problem. Complete the following problems:

1. 10 points. Haykin 5.3.
2. 10 points. Haykin 5.7.
3. 10 points. Haykin 5.13.
4. 30 points total. In this problem, use the standard assumptions that each symbol is equally likely, the noise is AWGN with PSD equal to $\frac{N_0}{2}$, and the noise and data are independent.
   (a) 5 points. Carefully draw the thresholds of the optimum decision regions for a the communication system (shown in its geometric representation) in Figure 1 below.

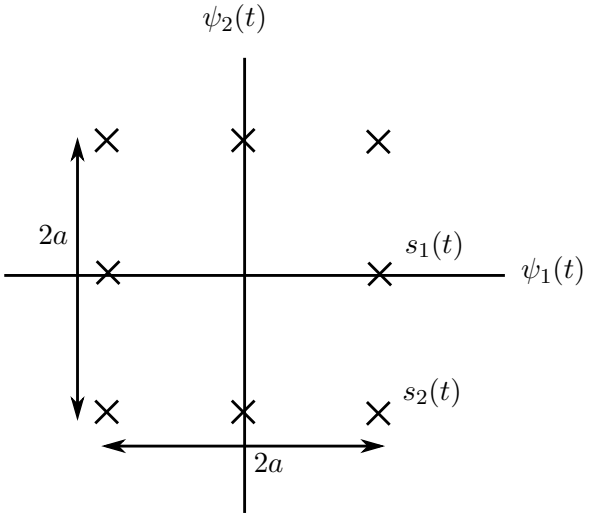

Figure 1: Two dimensional geometric representation of communication system with eight possible equiprobable signal waveforms. Draw the optimum decision regions.

(b) 5 points. Compute the average energy per bit ($\mathcal{E}_{b-av}$) of this communication system as a function of a.

(c) 5 points. Compute the probability of a *correct symbol decision* conditioned on the event that $s_1(t)$ was transmitted, i.e. $P(\text{correct} \,|\, s_1(t) \text{ transmitted})$. Express your answer in terms of Q-functions and $\frac{\mathcal{E}_{b-av}}{N_0}$.

(d) 5 points. Compute the probability of a *correct symbol decision* conditioned on the event that $s_2(t)$ was transmitted, i.e. $P(\text{correct} \,|\, s_1(2) \text{ transmitted})$. Express your answer in terms of Q-functions and $\frac{\mathcal{E}_{b-av}}{N_0}$.

(e) 5 points. Use your results from parts (c) and (d) to write an overall expression for the probability of symbol error of this communication system. Express your answer in terms of Q-functions and $\frac{\mathcal{E}_{b-av}}{N_0}$.

(f) 5 points. Assign bits to each symbol in order to minimize the probability of **bit** error. Can you estimate the probability of bit error as a function of the probability of symbol error with your bit assignments?

5. 10 points. Haykin 6.16.

6. 10 points. Haykin 6.21 part (a).