CSE 4214 :: Lab 2

Issued October 25, 2007; due November 8, 2007

Part 1

Consider QPSK modulation with the following pair of signal sets:

$$r_0(t) = \begin{matrix} A\cos 2\pi t, & 0 \le t \le 1, \\ 0, & t < 0, t > 1 \end{matrix} \qquad s_0(t) = \begin{matrix} A\sin 2\pi t, & 0 \le t \le 1, \\ 0, & t < 0, t > 1 \end{matrix}$$

where $r_1(t) = -r_0(t)$, and where $s_1(t) = -s_0(t)$. Let $N_0 = 1$.

a) Determine the matched filters for this pair of signal sets. Verify that the output of the filter matched to $r_0(t)$ results in zero when $s_0(t)$ is the input, and vice versa.
b) For each matched filter, calculate the signal means and noise variances. Sketch the two-dimensional signal space and decision regions.
c) Show that at the sampling point (t=1), the noise at the output of the filter matched to $r_0(t)$ and the noise at the output of the filter matched to $s_0(t)$ are independent random variables.
d) Repeat part b) for 16-QAPSK, where four levels are used on both I and Q. That is, we use $r_1(t) = -r_0(t)$, $r_2(t) = 3r_0(t)$, and $r_3(t) = -3r_0(t)$, and similarly $s_1(t) = -s_0(t)$, $s_2(t) = 3s_0(t)$, and $s_3(t) = -3r_0(t)$.

Part 2

Similarly to lab 1, we will be simulating this system in MATLAB. However, unlike lab 1, the simulation will generate only the outputs of the two matched filters at the sampling point (t=1). It is not necessary to simulate the operation of the matched filter. The output of the matched filter is merely the signal mean corresponding to the transmitted symbol, plus Gaussian noise with the variance you found in Part 1.

For both the QPSK and the 16-QAPSK signal sets, simulate the matched filter outputs for 1000 symbols, making a decision on these outputs, and mapping the outputs to bits. For both signal sets, plot *symbol error rate* and *bit error rate* versus *energy per bit* (not versus A) on the range of energy per bit from 1 to 3 "joules" (the units are abstract here).

Deliverables

Your deliverables for this lab are:
- Answers for the four parts in part 1;
- Your MATLAB code for part 2; and
- Plots from part 2.