**ECS 332: Principles of Communications** **2016/1**

# HW 10 — Due: Not Due

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**Problem 1.** In a digital PAM system, equally-likely message symbols are selected from an alphabet set $\mathcal{A} = \{-5, 5\}$. The pulse used in the transmitted signal is a Nyquist pulse. The additive white noise at each particular time instant is Gaussian with mean 0 and standard deviation $\sigma_N = 3$. The noise and the message are independent.

As described in class, a simple receiver samples the received signal (the transmitted signal combined with the noise) and then compare the value to the thresholding level. If the sampled value is greater than the threshold, the decoded value of the message will be "5". Otherwise, the decoded value of the message will be "-5". Here, assume that 0 is used as the threshold level for the decoding decision at the receiver.

(a) Suppose the message selected was "-5". What is the probability that the decoded value is "5"?

(b) Suppose the message selected was "5". What is the probability that the decoded value is also "5"?

(c) Suppose the message selected was "-5". What is the probability that the decoded value is also "-5"?

(d) Suppose the message selected was "5". What is the probability that the decoded value is "-5"?

(e) Find the symbol error probability.

(f) Suppose the alphabet set is $\mathcal{A} = \{-5, 5, 15\}$. How would you perform the decoding from the sampled received signal value?

**Problem 2.** Suppose we are using a digital PAM system to transmit a string: "`I love ECS332.`".

(a) Suppose each character is converted into real number using MATLAB command real(). For example, the character "I" gives `real('I') = 73`. The sequence of number is then transmitted using digital PAM. (Each number is a symbol.) Suppose the decoded string at the receiver is "`I like ECS332.`" Estimate the symbol error rate.

(b) Suppose each character was converted to 7-bit binary before transmission. We can perform this operation on the whole string in `MATLAB` via the expression

```
dec2bin('I love ECS332.')
```

The resulting binary string was then transmitted with digital PAM. At the receiver, suppose the decoded string is "`I like ECS332.`". Estimate the bit error rate.