UCI EECS
EECS141B
Spring 2007

MIDTERM EXAMINATION

Name:	
Student ID #:	

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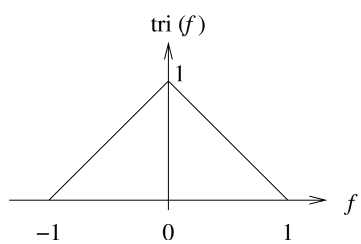
Useful identities

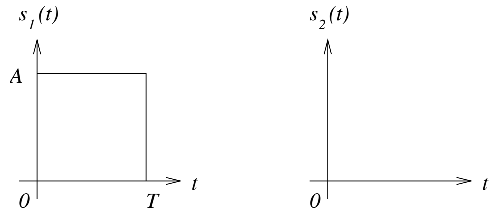


$$\text{tri}(f) = \begin{cases} 1 - |f| & |f| \le 1, \\ 0 & |f| > 1. \end{cases}$$

$$\text{sinc}^2(t) \longleftrightarrow \text{tri}(f)$$

$$\text{sinc}(t) = \frac{\sin(\pi t)}{\pi t}$$

1. *(20 points)*

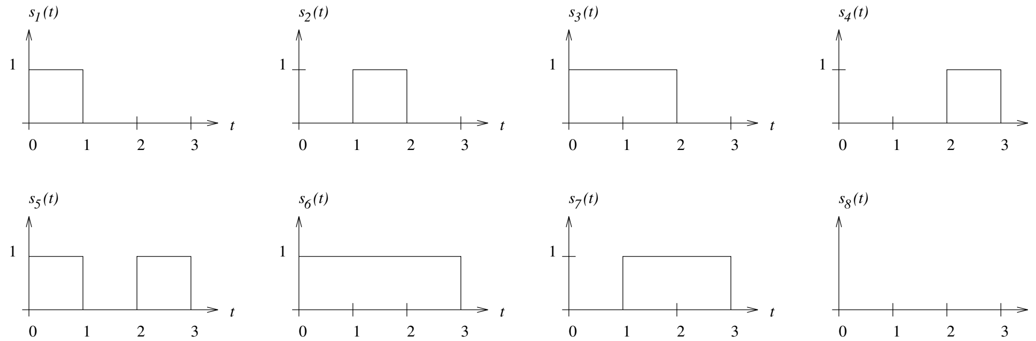


In a binary communication system, $s_1(t)$ is as shown above and $s_2(t) = 0$ for $0 \leq t \leq T$ where T is the binary symbol period. The a priori probabilities are $P(m_1) = p_1$ and $P(m_2) = p_2$. The transmitted signal is corrupted by additive white Gaussian noise with zero mean and power spectral density $N_0/2$.

(a) Draw the optimum receiver.

(b) Calculate the optimum decision rule.

2. *(20 points)*



Let the eight signals shown in the figure above be used to transmit one of $M = 8$ equally likely messages m during $0 \leq t \leq T = 3$. The transmitted signal $s_m(t)$ is corrupted by additive white Gaussian noise with zero mean and two-sided power spectral density $N_0/2$.

(a) Draw the signal constellation.

(b) Calculate the exact probability of symbol error.

(c) Calculate the nearest neighbor bound for the probability of symbol error.

3. *(20 points)* A ternary communication system uses three message signals $s_1(t)$, $s_2(t)$, $s_3(t)$, where

$$s_1(t) = A_c \cos(2\pi f_c t),$$

$s_2(t) = -s_1(t)$, and $s_3(t) = 0$ for $0 \le t \le T$, $T = n/f_c$ where n is a positive integer. All signals are equal to 0 outside $0 \le t \le T$. The transmitted signal is corrupted by additive white Gaussian noise with zero mean and power spectral density $N_0/2$.

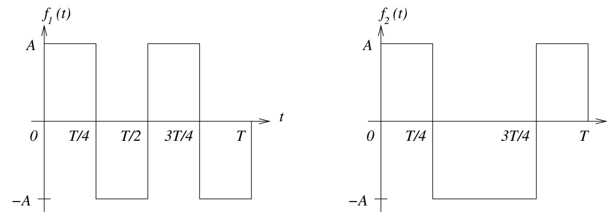
(a) Draw the optimum receiver.

(b) Draw the signal constellation.

(c) Show the optimum decision regions.

(d) Calculate the probability of symbol error incurred by the optimum receiver.

4. *(20 points)*

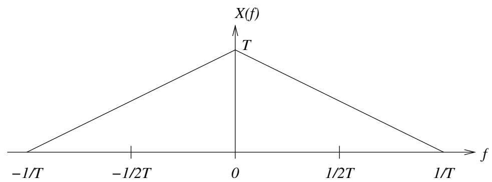


Consider the signals $s_1(t)$ and $s_2(t)$ shown above. Let

$$s_i(t) = s_{i1} f_1(t) + s_{i2} f_2(t)$$

where s_{ik} take values from $\{\pm 1, \pm 3, \pm 5, \pm 7, \pm 9\}$ for $i = 1, 2, \ldots, 100$, $k = 1, 2$. There is a one-to-one correspondence between each i and the pair s_{i1}, s_{i2}. The transmitted signal goes through an additive white Gaussian noise channel with zero mean and power spectral density $N_0/2$. Calculate the exact probability of symbol error.

5. *(20 points)*



Consider the channel frequency response $X(f)$ in the figure above.

(a) Does this channel satisfy the Nyquist criterion? Why?

(b) Calculate the impulse response $x(t)$. What are $x(kT)$?

(c) Compare this $x(t)$ with that of raised cosine. Which one would you prefer? Why?