

EE 703: Digital Message Transmission

Instructor: Saravanan Vijayakumaran

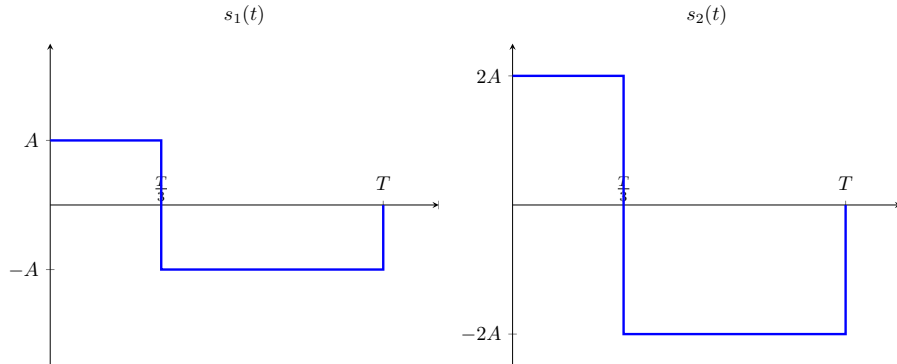
Indian Institute of Technology Bombay

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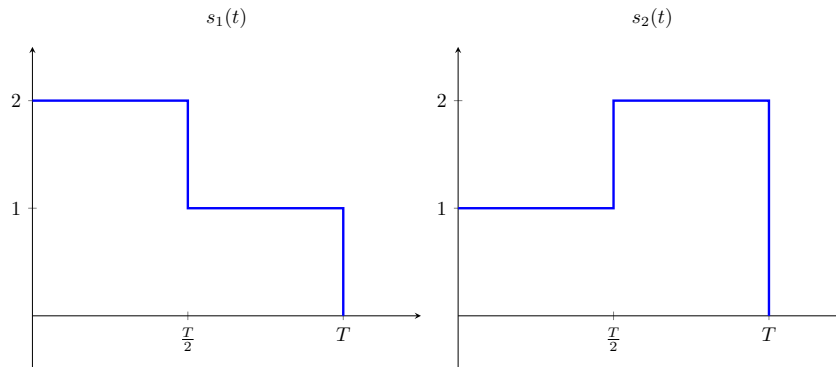
Quiz 2: 12 points

Date: October 17, 2013

1. [4 points] A communication system transmits one of three messages m_1, m_2 , and m_3 using signals $s_1(t)$, $s_2(t)$, and $s_3(t)$. The signal $s_3(t) = 0$ and the signals $s_1(t)$ and $s_2(t)$ are shown below. The channel is AWGN channel with noise PSD $\frac{N_0}{2}$.



- (a) Determine an orthonormal basis for this signal set, and depict the signal constellation.
 (b) If the three messages are equiprobable, what is the optimal decision rule?
 (c) What is the average decision error probability of the optimal decision rule in terms of E_b and N_0 ?
2. [4 points] A binary signaling scheme over an AWGN channel with noise PSD $\frac{N_0}{2}$ is equally likely to transmit the following two signals. One of the two signals is transmitted every T seconds.



- (a) What is the E_b for this system in terms of T ?
 (b) What is the optimal decision rule?
 (c) What is the average decision error probability of the optimal decision rule in terms of E_b and N_0 ?
 (d) By how many decibels does this system underperform a binary antipodal signaling system with the same $\frac{E_b}{N_0}$?
3. [4 points] Show that for equiprobable binary signaling over an AWGN channel **any** pair of antipodal signals represents the optimal choice of signal pair. Assume E_b is fixed.