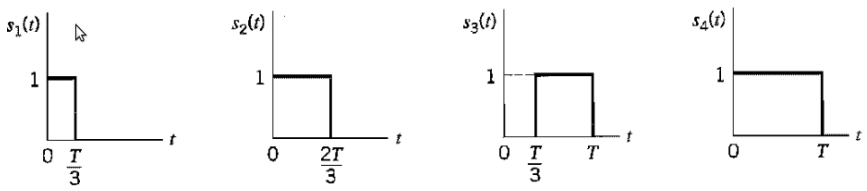
Assignment 1
Advanced Communications Systems Design

CTEN 522

Dr I. M. Ngebani

Due Date Mar 15, 2023

Problem 1-(20Marks)

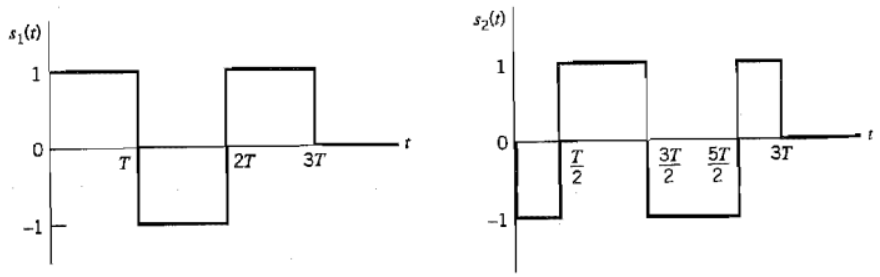


The figure above displays waveforms of four signals $s_1(t)$,$s_2(t)$,$s_3(t)$ and $s_4(t)$.

(a) Using the Gram-Schmidt orthogonalization procedure, find an orthonormal basis for this set of signals

(b) Construct the corresponding signal-space diagram

Problem 2-(20 Marks)



The figure above shows a pair of signals, $s_1(t)$ and $s_2(t)$ that are orthogonal to each other over the observation interval $0 \leq t \leq 3T$. The received signal is defined by

$$x(t) = s_k(t) + w(t); \quad \begin{matrix} 0 \leq t \leq 3T \\ k = 1, 2 \end{matrix}$$

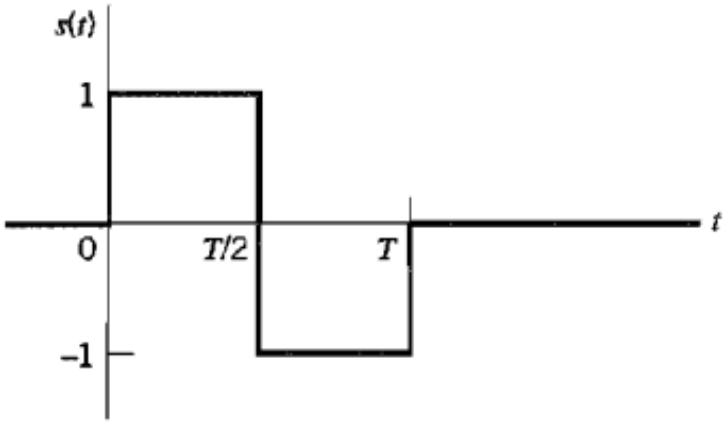
where $w(t)$ is white Gaussian noise of zero mean and power spectral density $\frac{N_0}{2}$

(a) Design a receiver that decides in favor of signals $s_1(t)$ or $s_2(t)$ assuming that these two signals are equiprobable.
(b) Calculate the average probability of symbol error incurred by this receiver for $\frac{E}{N_0} = 4$, where E is the signal energy.

Problem 3-(20 Marks)

Formulate the signal constellation for the following line codes
(a) Unipolar nonreturn-to-zero code
(b) Polar nonreturn to zero code
(c) Unipolar return-to-zero
(d) Manchester code

Problem 4



In the Manchestor code, binary symbol 1 is represented by the doublet pulse $s(t)$ shown in the figure above and binary symbol 0 is represented by the negatie of this pulse. Derive the formula for the probability of error incurred by the Maximum Likelihood detection procdure applied to this form of signaling over an AWGN channel.

Problem 5

Explain differentiate between the MAP (Maximum Aposteriori Probability) and ML (Maximumding Likelihood) decoding decision rules.