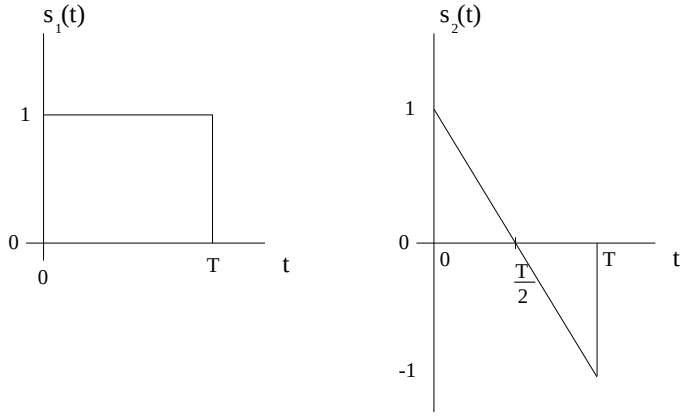
GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
Quiz II - Fall, 2014
EE 4601: Communication Systems

Aids Allowed: Text, $8\frac{1}{2} \times 11$ crib sheet (one side),
math tables, calculator
Attempt all 3 questions
Questions are of equal value

DATE: Tuesday November 18, 2014.
TIME: 12:05 - 1:25
INSTRUCTOR: G.L. Stüber

1) Signal Space: Suppose that the two waveforms $s_1(t)$ and $s_2(t)$ shown below are used for binary signaling on an additive white Gaussian noise channel.



a) 2 marks: Obtain a complete set of orthonormal basis functions, $\{f_i(t)\}_{i=1}^{N}$, for the signal set $\{s_1(t), s_2(t)\}$.

b) 3 marks: Sketch the signal-space diagram and specify the signal vectors $\mathbf{s}_1$ and $\mathbf{s}_2$.

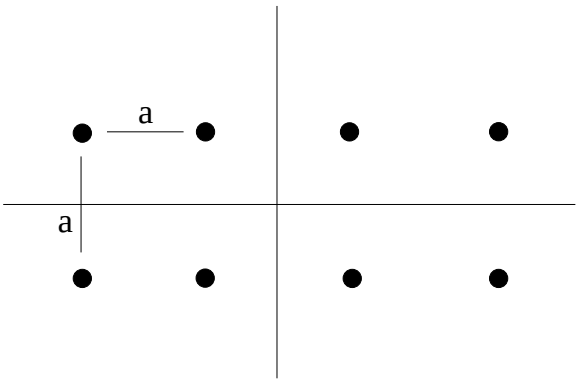
c) 5 marks: Obtain an expression for the probability of *bit* error, P_b, in terms of the received *bit* energy-to-noise ratio, E_b/N_o.

2) Pulse Shaping: An available wireless channel passes the frequencies in the band from 3450 MHz to 3480 MHz. It is desired to design a modem that transmits information at a symbol rate of 20 Mbaud (20×10^6 symbols/second) and a bit rate of 80 Mbps (80×10^6 bits/second).

a) 6 marks: Select an appropriate QAM signal constellation size M, carrier frequency f_c, and roll-off factor β of a spectral raised cosine pulse that uses the entire frequency band.

b) 4 marks: Based on your results in part a) what are the *complex-valued* frequency responses of the transmit filter and receiver matched filters that you would implement?

3) Signal Space: A 8-PAM signal constellation is shown in the figure below. Assume the symbols are used with equal probability and the receiver makes minimum distance decisions.



a) 2 marks: Determine and sketch the decision boundaries and identify the Voronoi regions, R_i.

b) 6 marks: Find the *exact* probability of 8-PAM *symbol* error, P_M, in terms of the received *bit* energy-to-noise ratio E_b/N_o.

c) 2 marks: By using the minimum distance, $d_{\min}$, between signal vectors in the signal constellation, and relating $d_{\min}$ to the energy per bit, E_b, obtain a simple upper bound on the probability of *symbol* error, P_M, in terms of the received *bit* energy-to-noise ratio, E_b/N_o.