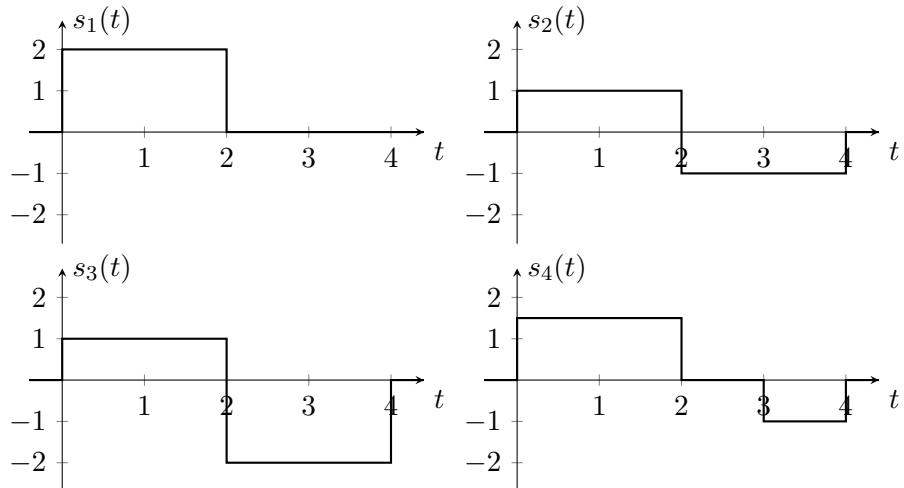


Homework 2: Digital Data Transmission

University of Windsor
Department of Electrical and Computer Engineering
ELEC 4190 - Digital Communications

Submission: Submissions should be through Brightspace. There is a 24-hour grace period after the due date without a penalty. Late submissions and email submissions will not be accepted.

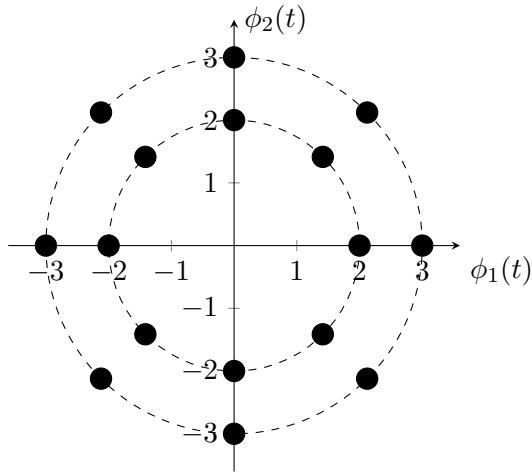
1. (5 points) Consider the four signal waveforms shown below:
 - (a) Determine the dimensionality of the waveforms and a set of basis functions.
 - (b) Use the basis functions to represent the four waveforms by vectors and plot the signal space representation.
 - (c) Determine the minimum distance d_{\min} between any pair of vectors.



2. (5 points) For the signal point constellation shown below:

- (a) Find the minimum distance between the constellation points d_{\min} .
 - (b) Determine the average symbol energy.

(c) Sketch the optimum decision boundaries for the detector..



3. (4 points) Consider the QPSK and 8-PSK signal constellations with radii A_1 and A_2 , respectively. Determine the radii of the circles so that both schemes have the same minimum distance d_{\min} . Which scheme is more power efficient in this case?
4. (4 points) For a 16-QAM with $d_{\min} = 4$ and pulse shaping $g(t) = \sqrt{2/T_s}, 0 \leq t < T_s$,
 - (a) Sketch the signal space representation.
 - (b) Find a Gray code mapping such that adjacent symbols differ by a single bit.
 - (c) Sketch the decision regions Z_i that minimize error probability assuming AWGN.
 - (d) What is the additional energy to increase the number of bits per symbol by one while keeping the same bit error probability?
5. (4 points) Assume a 16-PAM communication system with a unit-energy HS pulse shaping filter. If the desired average bit error probability is 1.1×10^{-5} , determine the SNR per bit in dB.
6. (4 points) You need to design a modem that transmits over a bandpass channel with a bandwidth of 25 kHz at a symbol rate of 4800 symbols/sec, and desired data rate of 19200 bits/sec. Select an appropriate FSK signal constellation and the roll-off factor of a pulse with a raised cosine spectrum that utilizes the entire frequency band.