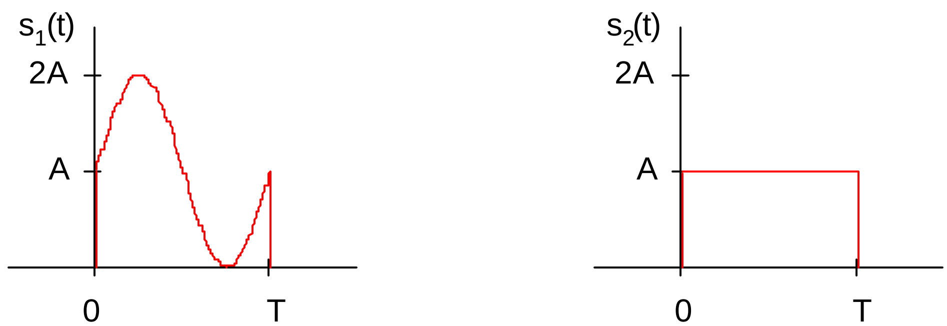
SIMON FRASER UNIVERSITY
School of Engineering Science

ENSC 428 Data Communications

Midterm Examination **2001 03 01**

This is a closed book exam of 55 minutes duration. Remember to write your name on your answer sheets.

1. (20 marks) The signals $s_1(t)$ and $s_2(t)$ shown below are proposed for use in a digital transmission system.



(a) Give a non-orthonormal basis for the signal space.

(b) Give an orthonormal basis for the space.

(c) Draw the signal constellation.

(d) Sketch a receiver structure based on two correlators.

(e) Sketch a receiver structure based on a single correlator.

(f) Give an expression for the probability of bit error, assuming the signals are received in white noise with PSD $N_o/2$ watt/Hz.

2. (10 marks). Reinterpret the two waveforms above as impulse responses of a pair of filters, and give them the same input, a white noise process with PSD $N_o/2$ watt/Hz. If you sample them simultaneously at time $100T$, you have a pair of random variables. What are the values of the two variances and the correlation coefficient?

3. (10 marks). Is MAP detection equivalent to $\underset{i}{\operatorname{argmax}}\, p_{\mathbf{r},\mathbf{s}}(\mathbf{r}, \mathbf{s}_i)$?

4. (10 marks) Two correlated zero-mean random variables X_1 and X_2 have variances and correlation coefficient σ_1^2, σ_2^2 and ρ. You are unable to observe X_2 directly, so you must make an estimate $\hat{X}_2$ of its value based on the value of X_1, which you can observe.

(a) What is the minimum mean squared error estimate? [I would prefer that you use a spatial reasoning shortcut here, but explicit minimization using the random variables is acceptable, too.]

(b) Does your answer depend on the variables having a Gaussian distribution?