University of Toronto
Faculty of Applied Science and Engineering

Final

Date - Dec. 15, 1998
Duration: 2.0 Hr.

ECE1392S — Integrated Circuit for Digital Communications
Examiner - D.A. Johns

ANSWER QUESTIONS ON THESE SHEETS USING BACKS IF NECESSARY

1. Calculator type unrestricted.
2. Grading indicated by [ ]. Attempt all questions since a blank answer will certainly get 0.
3. Part marks are given. Clarity and neatness will be appreciated.

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Last Name: _________________________
First Name: _________________________
Student #: _________________________

(max grade =40)
[10] **Question 1:**

(a) Consider a 4-level PAM receiver where additive noise is Gaussian and independent from sample-to-sample. Assuming the noise level is 1 uV rms, estimate the signal levels that should be received so that a symbol error rate of $10^{-8}$ is achieved. (For the estimate, ignore the fact that large noise spikes of the correct signs at the two outside levels do not cause a symbol error).
Question 1: (cont’d)

(b) Repeat part (a) but consider a 8-level signal and estimate the signal levels. (For the estimate, ignore the fact that large noise spikes of the correct signs at the two outside levels do not cause a symbol error).

(c) How much extra (or less) power is required to achieve the same symbol-error-rate for the answers of parts (a) and (b). Give your answer in dB.
[10] Question 2:

Consider a partial-response system which can be modelled as $1+D$ (or $1+z^{-1}$) encoded.

(a) Draw the transmit trellis for such a system when the input signal is +1 or -1.

(b) Show the receive trellis and all the state and branch metrics assuming the initial state value is -1 and the receive signal is: -0.1 0.2 -1.9 -2.1 1.1 0.1 0.1 1.8
[10] Question 2: (cont’d)

(c) Discuss how the difference metric algorithm would operate in this 1+D case.
[10] Question 3:
(a) It is desired to transmit at a rate of 100Mb/s. Assuming that a CAP-16 signal is used with 20 percent extra bandwidth (using a raised-cosine response), find the symbol-rate. Also, sketch the resulting transmit spectrum.

(b) What frequency should be used for the modulating sine and cosine carriers?

(c) Explain what practical advantages are obtained in this CAP system over a PAM system if the channel is AC coupled at a very low frequency (say 1kHz).
[10] **Question 4:**

Consider the following adaptive filter configuration

![Diagram of the adaptive filter configuration](image)

a) Find the correlation matrix relating $x_1$ and $x_2$.

b) Find the optimum weight vector $[w_1 \ w_2]$ to minimize the error signal, $e(n)$. 

(white noise) (variance=1)