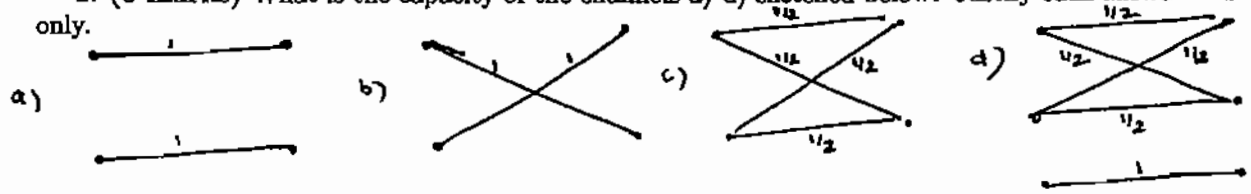
EEL762 Digital Communications, Semester I, 2006-2007
Major Examination - PART A

Name:_____ Entry No._____
45 marks, 120 minutes
Note:

1. Answers to PART A (Q1-Q8) are to be written only in the space provided after each question.
2. Answers should be *very brief*, to the point, and legible.
3. Answers without reasoning will not be given any credit.

1. (3 marks) A random process is defined by: $X(t) = N(t) + Acos(2\pi f_0 t + \Theta)$ where Θ is a random variable that is uniformly distributed, f_0 and A are constants, and $N(t)$ is a white process independent of Θ. What is the autocorrelation of $X(t)$? How will you find A from it? Is there any ambiguity in this estimate?

2. (5 marks) What is the capacity of the channels a)-d) sketched below? Justify each answer in 1-2 lines only.



3. (2 marks) An anitpodal signal which is $\pm 1V$ is transmitted (equiprobable symbols). It is contaminated by additive white Gaussian noise $n(t)$ with PSD $N_0/2$. A very simple receiver is used that simply samples the received wavefrom in the middle of the symbol interval, and makes a decision that the transmitted symbol is 1 if the sample is positive and -1 otherwise. Will such a receiver work? If so, what is its probability of bit error? If not, justify.

4. **(2 marks)** A transmitter transmits one of two wavefroms $s_1(t)$ and $s_2(t)$ in a symbol interval. The signal is contaminated by noise. A receiver computes $K_1 = \int |y(t) - s_1(t)|^2 dt$ and $K_2 = \int |y(t) - s_2(t)|^2 dt$ and decides that the symbol transmitted is $s_1(t)$ is K_1 is smaller than K_2, and $s_2(t)$ otherwise. Is such a receiver optimal? If so justify. If not, how does it perform compared to an optimal recciver?

5. **(2 marks)** For an FSK modem we wish to use two frequencies: 177750 and 177850 Hz as the two tones. Is it possible to have symbol rate of 150 bits/second with these tones using a) coherent and h) non-coherent receivers? Justify.

6. **(2 marks)** The P(e) performance of a hinary-FSK system can be decreased when the separation hetween two tones is inereased appropriately beyond $1/2T$. Qualify.

7. **(2 marks)** Let $s_i(t) = \sum_{k=1}^{N} c_{i,k} p(t - kT)$, $i = 1, 2$ and let $\sum_{k=1}^{N} c_{1,k} c_{2,k}^{*} = 0$. Under what conditions will $s_1(t)$ and $s_2(t)$ be orthogonal to each other over the interval $0 \leq t \leq NT$?

8. **(2 marks)** Consider the two waveforms $s_1(t)$ and $s_2(t)$ as choices for the waveform used in an binary antipodal signalling scheme. The BER performance (assuming an optimal receiver) of b) is superior to that of a). True/False? Justify.