Mansoura University
Faculty of Engineering
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Final exam
Grade 100

Advanced Digital Communications.Systems
Dept. of Electronics and Comm.
M.Sc preliminary
3 hours
COM6743

Answer the following questions. **Two pages exam**
Questions are not allowed, assume any missing data, **just do your best**

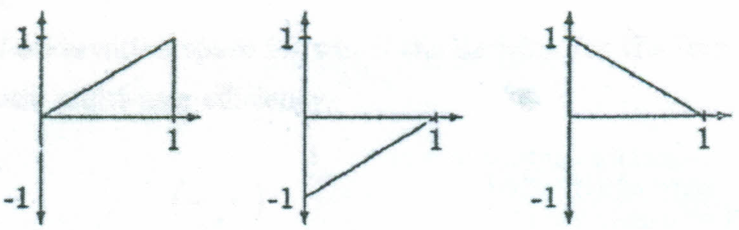
This is an open books, open notes exam

يسمح للطلاب بإصطحاب أى مراجع أو مذكرات

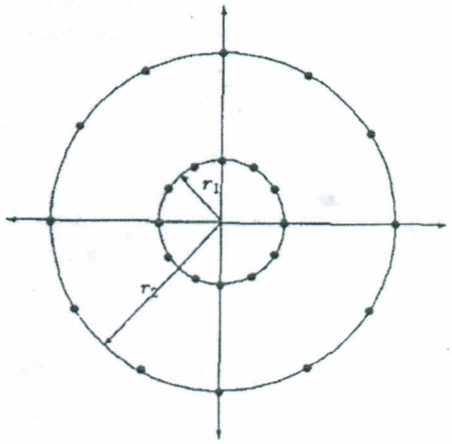
غير مسموح بتداول المذكرات بين الممتحنين

Q1) Consider the three signal set shown below (25 points)

(a) Find a set of ortho-normal basis functions capable of representing these signals
(b) Plot the signal constellation in signal space, and sketch the decision regions
(c) Suppose the observation X(t)=-0.1 for $0 \leq t \leq 1$. What is the MAP decision for this observation?
(d) For AWGN channel with PSD $N_o/2$ what is the system probability of error.



Q2) For the dual-PSK signal set pictured below, what is the best choice of the ratio r_2/r_1? You may assume high SNR (20 points)



Q3) a BFSK transmitter sends one of two orthogonal signals

$$S_i(t) = \sqrt{2E/T}cos(w_i t + \theta)$$

For $0 \leq t \leq T$. where θ is a uniformly distributed random variable, and the receiver knows E, T, and No exactly. (20 points)

(a) Sketch the optimum waveform receiver.

(b) What is the message error probability, and the energy per bit required if E_b/No=2 dB and T_e=290 Kelvin.

Q4) Assume a source that transmits 3 symbols (A,B, and C). Assume the following:

- Probabilities of the first transmitted symbol are P(A)=1/2, P(B)=1/4, and P(C)=1/4
- Probability of symbol error = 0.1
- Probability that two consecutive symbols are different = 0.75

If the received sequence Y= ABBABCC what is the MAP estimate of the transmitted sequence X (Use Viterbi algorithm) (10 points)

Q5) A coder sends the following symbols with the following probabilities of occurrence

Symbol	A	B	C	D	E	F	G	H
Probability	.05	.05	.3	.3	.1	.05	.1	.05

a- Find the Huffman code for each symbol.

b- What is the bit rate if the symbol rate is 1M symbol/s. (10 points)

Q6) Consider a channel with impulse response

$$h(t) = \alpha 0\delta(t) + \alpha 1\delta(t - T1) + \alpha 2\delta(t - T2).$$

Assume that T1 = 10 μsecs and T2 = 20 μsecs. You want to design a multicarrier system for the channel with subchannel bandwidth $B_N = Bc/2$. If raised cosine pulses with $\beta = 1$ are used, and the subcarriers are separated by the minimum bandwidth necessary to remain orthogonal, then what is the total bandwidth occupied by a multicarrier system with 8 subcarriers? Assuming a constant SNR on each subchannel of 20 dB, what is the maximum constellation size for MQAM modulation that can be sent over each subchannel with a target BER of 10^{-3}, assuming M is restricted to be a power of 2. Also find the corresponding total data rate of the system. What would be the bit error rate for BPSK if the SNR is uniformly distributed from 1 to 100. (20 points)

(7) When a periodic pseudorandom sequence of length N is used to adjust the coefficients of an N-tap linear equalizer, the computations can be performed efficiently in the frequency domain by use of the discrete Fourier transform (DFT). Suppose that {yn}is a sequence of N received samples(taken at the symbol rate) at the equalizer input. Then the computation of the equalizer coefficients is performed as follows.

a. Compute the DFT of one period of the equalizer input sequence{yn}

b. Compute the desired equalizer spectrum $C_k = \frac{|X_k Y_k^*|}{|Y_k|}$

where{Xi}is the pre-computed DFT of the training sequence.

c . Compute the inverse DFT of{C_k}to obtain the equalizer coefficients{c_n}. Show that this procedure in the absence of noise yields an equalizer whose frequency response is equal to the frequency response of the inverse folded channel spectrum at the N uniformly spaced frequencies $f_k = k/NT$, k = 0,1,...,N −1. (15 points)

Good Luck
Sherif Kishk