BITS, Pilani-Dubai
Dubai International Academic City

BE (Hons.) EEE, IV Year, Second Semester, 2008-09
Comprehensive Examination

Course Title: Digital Communication (Elective) **Course No.: EEE C416**
Maximum Marks: 80 Weightage: 40 % Duration: 3 Hours

Note:- *Answer all questions. Appropriate assumptions may be made where necessary.*

1. With the aid of block diagrams explain how a digital communication system differs from an analog communication system. (5 marks)
2. Explain the Gaussian density function and why it occurs so frequently in the real world. What do you understand by the term Q-function? (4 + 2 = 6 marks)
3. A received signal is made up of two components: signal and noise. That is, $r(t) = s(t) + n(t)$. The signal may be considered as a sample of a random process with autocorrelation $R_s(\tau) = 2e^{-|\tau|}$. The noise is a sample of a random process with autocorrelation $R_n(\tau) = e^{-2|\tau|}$. Both processes have zero mean value, and they are independent of each other. Find the autocorrelation and total power of $r(t)$. (5 + 3 = 8 marks)
4. Establish the equivalence of a matched filter output and a correlator output when sampled at $t = T$, where T is the symbol interval. (5 marks)
5. A (7, 4) systematic cyclic code is specified by the generating polynomial $g(X) = 1 + X + X^3$. Find the code word corresponding to u = 1011. (6 marks)
6. Explain briefly the Viterbi decoding algorithm taking an appropriate (2, 1, 3) convolutional encoder of your choice. (10 marks)
7. Explain briefly the phenomenon of inter symbol interference and how it is minimized. For a telephone line with bandwidth 3.5 kHz, find the data rate in bits per second (b/s) that can be transmitted if we use binary signaling with raised-cosine pulses and a roll-off factor $\alpha = 0.5$. (5 + 4 = 10 marks)
8. Give the principle and working of an early-late gate synchronizer with the aid of illustrations. (8 marks)
9. What is Continuous Phase FSK and why is it preferred to conventional FSK? Write a brief note on Minimum Shift Keying. (3 + 4 = 7 marks)
10. What is CDMA? With appropriate mathematical analysis, show how CDMA allows asynchronous transmission and reception of N DSSS signals over the same frequency band without any noticeable interference or cross talk among receivers. (2 + 8 = 10 marks)
11. With the aid of a block diagram, explain the working principle of the RAKE receiver. (5 marks)

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B.E. (Hons.) EEE, IV Year, II Semester, 2008-2009
Test #2 (Open Book)
Course No. / Course Name: **EEE C416 / Digital Communication (Elective)**
Date: 12/04/2009 Duration: 50 min Weightage: 20% Max. Marks: 40

Note: Answer all questions. Appropriate assumptions may be made, where necessary. Q-function table is given on the reverse page.

1. Three messages are to be transmitted over a AWGN channel with zero mean and two-sided noise power spectral density $\eta/2$. The messages are transmitted as waveforms $s_1(t)$, $s_2(t)$, and $s_3(t)$ as described below:

$$s_1(t) = \begin{cases} 1, & 0 \le t \le 1 \\ 0, & otherwise \end{cases};$$

$$s_2(t) = \begin{cases} \cos(2\pi t), & 0 \le t \le 1 \\ 0, & otherwise \end{cases};$$

$$s_3(t) = \begin{cases} \cos^2(\pi t), & 0 \le t \le 1 \\ 0, & otherwise \end{cases}.$$

Using the Gram-Schmidt orthogonalization procedure, find an appropriate basis for the signal space. What is the dimensionality of the signal space (justify!)? Draw the signal constellation. (6+2+4)

2. Binary information is transmitted using basebend signals of the form shown in Fig. 1 below. Design a ***simplified*** matched filter detector, and find the probability of bit error, assuming that the additive noise in the channel has a two-sided power spectral density of 0.5×10^{-3} Watt/Hz. (8+4)

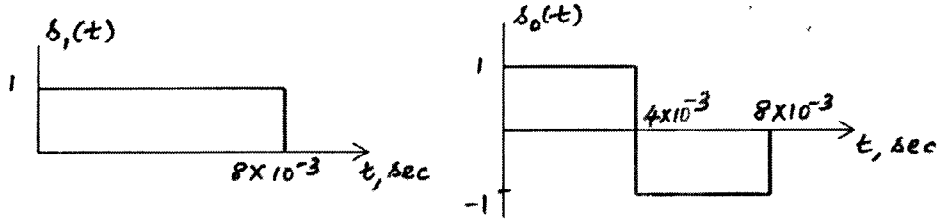

Fig. 1: Baseband waveforms for Q 2.

3. Sketch the state diagram and the trellis diagram for the convolutional encoder shown in Fig. 2. (5+5)
4. Calculate the capacity of an AWGN channel with a bandwidth of 1 MHz and an *S/N* ratio of 30 dB. (6)

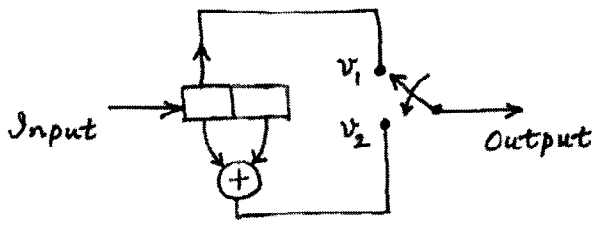

Fig. 2: Encoder for Q. 3

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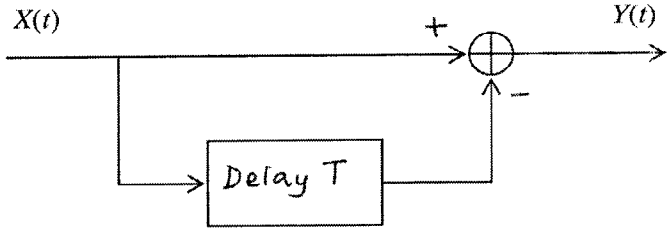
BE (Hons.) EEE, IV year, II Semester, 2008-2009
Test # 1
Course No./Course Title: **EEE C416 / Digital Communication (Elective)**
Duration: 50 minutes Weightage: 25% Max. Marks: 50

Answer all questions. Appropriate assumptions may be made, where necessary.

1. A random variable X takes the values 0 and 1 with probabilities α and $\beta = 1 - \alpha$, respectively. Find the mean and variance of X. (3 + 3 = 6 marks)
2. The noise level produced by a noisy resistor at a certain time instant is known to be a Gaussian random variable, say X, with zero mean and variance σ^2. Compute the probability that $|X| > k\sigma$ for $k = 1, 2, 3$. A table of the Q function is given on the next page. (8 marks)
3. A WSS random process $X(t)$ with power spectral density $G_x(\omega)$ is applied at the input to the filter shown below. Show that the power spectral density of the output process is $G_y(\omega) = 2(1 - \cos \omega T) G_x(\omega)$. (10 marks)



4. Consider a binary channel with channel capacity 36 kb/s that is available for PCM transmission of voice signals. Find appropriate values of the: (a) sampling rate f_s, (b) number of quantizing levels L, and (c) number of binary digits per sample n, assuming that the message signal is bandlimited to 3.2 kHz. (3 + 4 + 3 = 10 marks)
5. Write short notes on the following: (a) Equivalence of matched filter and correlator, (b) Average information content in the English language, (c) Ergodic process, and (d) Channel capacity of an AWGN channel. (4 + 4 + 4 + 4 = 16 marks)

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EEE C416 Digital Communication
Surprise Quiz #3
Duration : 20 min Max. Marks : 10 Weightage : 5%

Name: _____

ID No: _____

1. In a four-stage shift register used to generate a PN sequence, feedback taps [4, 1] are connected through a modulo-2 adder and the initial state of the register is 1000. Determine the output sequence of the shift register. (6 marks)
2. What are the requirements to be satisfied for a system to be described as a spread spectrum system? (4 marks)

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B.E. (Hons.), EEE IV Year, II Semester, 2008-2009
Course No. / Course Name: EEE C416 / Digital Communication
SURPRISE QUIZ #2
Duration: 20 min Marks: 10 Weightage: 5%

Name: _____

ID No.: _____

1. A matched filter has the frequency response $H(f)=\frac{1-e^{-j2\pi fT}}{j2\pi f}$. Determine the impulse response $h(t)$. Also determine and plot the signal waveform to which the filter characteristic is matched. (3+3 = 6 marks)
2. Show that if $\mathbf{c}_i$ and $\mathbf{c}_j$ are two code vectors in an (n, k) linear block code, then their sum is also a code vector. (4 marks)

SOLUTIONS

1. Given $H(f) = \frac{1-e^{-j2\pi fT}}{j2\pi f}$

Inverse transform yields

$h(t) = sgn(t) -$

$= 2\,rect$

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BE (Hons.) EEE, IV year, II Semester, 2008-2009
Surprise Quiz # 1
Course No./Course Title: **EEE C416 / Digital Communication (Elective)**
Duration: 15 minutes Weightage: 5% Max. Marks: 10

Name: _____

ID No.: _____

A communication system consists of three possible messages A, B, and C. The probability of message A is p, and the probability of message B is also p. Find and plot the entropy as a function of p. What are your inferences from the plot?