UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT NAME	:	DIGITAL COMMUNICATIONS
SUBJECT CODE	:	BEP 4113
COURSE	:	4 BET / BEP
EXAMINATION DATE	:	APRIL 2009
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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Q1 (a) Calculate the average information in bits/character for the alphabetic characters occur with the following probabilities :

p = 0.21;	for the letters a,e,o,t
p = 0.13;	for the letters h,i,n,r,s
p = 0.09;	for the letters c,d,f,l,m,p,u,y
p = 0.05;	for the letters b,g,j,k,q,v,w,x,z

(5 marks)

(b) A high-resolution black-and-white TV picture consists of about $2x10^6$ picture elements and 16 different brightness levels. Pictures are repeated at the rate of 32 per second. All picture elements are assumed to be independent, and all levels have equal likelihood of occurrence. Calculate the average rate of information conveyed by this TV picture source.

(8 marks)

(c) A discrete memoryless channel have five symbols m_1, m_2, m_3, m_4 dan m_5 with probabilities 0.4, 0.19, 0.16, 0.15 and 0.1 respectively.

(i) Construct a Shannon-Fano code for the channel.

(4 marks)

(ii) Calculate the efficiency of the code.

(3 marks)

Q2 (a) Define Pulse Code Modulation (PCM).

(2 marks)

(b) Figure Q2(b) shows an analog signal, *x(t)*, together with the natural sample value (in voltage) of that analog signal. With the aid of Figure Q2(b), explain the process of getting the PCM sequence.

(8 marks)

(c) By using the common voice communication as an example, discuss the advantages of non-uniform quantization over uniform quantization.

(4 marks)

(d) Given a pulse waveform in the format of Nonreturn to Zero-Space (NRZ-S) as shown in Figure Q2(d). Construct the waveform in the format of:

(i) Unipolar Return to Zero (Unipolar RZ)

(2 marks)

(ii) Bipolar Return to Zero (Bipolar RZ)

(2 marks)

(iii) Return to Zero Alternate Mark Inversion (RZ-AMI)

(2 marks)

Q3 (a) Design a Binary Phase Shift Keying (BPSK) match filter detector and explain its operation by using appropriate mathematical expressions.

(5 marks)

(b) In digital communication system, the performance of the detector can be known by calculating the bit error probability, P_B. By assuming that $s_1(t)$ is for the transmission of binary 1 and $s_0(t)$ for binary 0, show that:

$$P_B = Q\left(\sqrt{\frac{E_d}{2N_o}}\right) = Q\left(\sqrt{\frac{E_b(1-\rho)}{N_o}}\right)$$

given that

$$\rho = \frac{1}{E_b}\int_0^T s_1(t)s_0(t)dt \quad \text{where } -1 \le \rho \le 1$$

and

$$E_b = \frac{E_1 + E_0}{2}$$

(7 marks)

(c) Some binary information are being transmitted over the baseband signals in the Pulse Code Modulation (PCM) waveform as shown in Figure Q3(c). Find the probability of error, P_B by using the Q-function table. Assume that adaptive noise has a power of 10^{-3} watt/Hz.

(8 marks)

Q4 (a) Identify TWO (2) factors that influence the performance of a M-ary Frequency Shift Keying (MFSK) system.

(2 marks)

(b) Draw the modulated signals of the following digital modulation schemes if the data bits represented by a bipolar Non Return to Zero waveform is given as 101001.

(i) Amplitude Shift Keying (ASK)

(2 marks)

(ii) Frequency Shift Keying (FSK)

(2 marks)

(iii) Phase Shift Keying (PSK)

(2 marks)

(c) Among the following digital-to-analog conversion techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK), which technique is the most susceptible to noise? Defend your answer.

(4 marks)

(d) Binary information is transmitted at 200 kbps using on/off keying (OOK). The carrier frequency is 10 MHz and the received carrier amplitude is 10^{-3} V. The additive noise power is No = 10^{-12} W/Hz.

(i) Design a coherent detector and find the bit error rate.

(ii) Design an incoherent detector and find the bit error rate.

(8 marks)

Q5 (a) A constellation diagram consists of eight equally spaced points on a circle. If the bit rate is 4800 bps, determine its baud rate.

(3 marks)

(b) Draw the constellation diagrams for On-Off Keying (OOK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK) signals.

(6 marks)

(c) Discuss the generation of Quadrature Phase Shift Keying (QPSK) modulation and demodulation scheme.

(5 marks)

(d) Compare a 32-Phase Shift Keying (32-PSK) and a Binary Phase Shift Keying (BPSK) in terms of bandwidth occupancy and transmission rate.

(6 marks)

Q6 For a (6,3) systematic linear block code, the codeword comprises $I_1\ I_2\ I_3\ P_1\ P_2\ P_3$ where the three parity check bits P_1, P_2 and P_3 are formed from the information bits as follows:

$$P_1 = I_1 \oplus I_2$$
$$P_2 = I_1 \oplus I_3$$
$$P_3 = I_2 \oplus I_3$$

(a) Find the parity check matrix.

(2 marks)

(b) Find the generator matrix.

(2 marks)

(c) Find all possible codewords.

(8 marks)

(d) Determine the error detecting and correcting capability of this code.

(4 marks)

(e) If the received sequence is 101000, calculate the syndrome and decode the received sequence.

(4 marks)

Q7 A special class of modulation technique is referred to as spread-spectrum modulation spreads the bandwidth of the modulated signal well beyond the bandwidth of the modulating signal.

(a) Discuss the reasons for employing spread spectrum modulation.

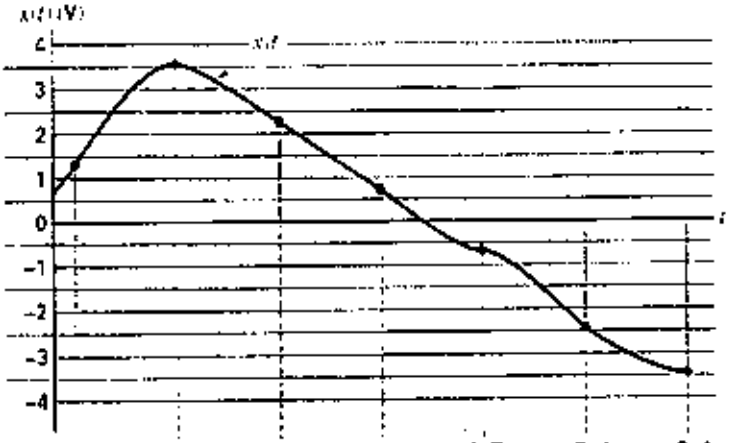
(5 marks)

(b) A spread spectrum technology with Pseudonoise (PN)-generator and Binary Phase Shift Keying (BPSK) modulation is to be employed for Code Division Multiple Access (CDMA) interference system. Draw a suitable block diagram for the system and explain the function of each of the sub-block in the block diagram and state their mathematical expressions.

(10 marks)

(c) Describe the near far problem in CDMA multiple access interference system.

(5 marks)



Natural sample value 1.3 3.6 2.3 0.7 -0.7 -2.4 -3.4

FIGURE Q2(b)

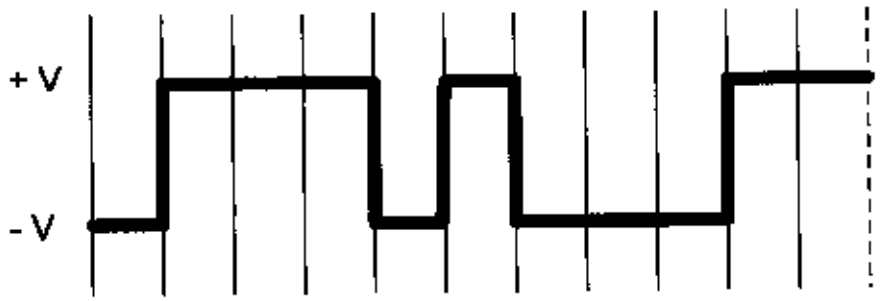


FIGURE Q2(d)

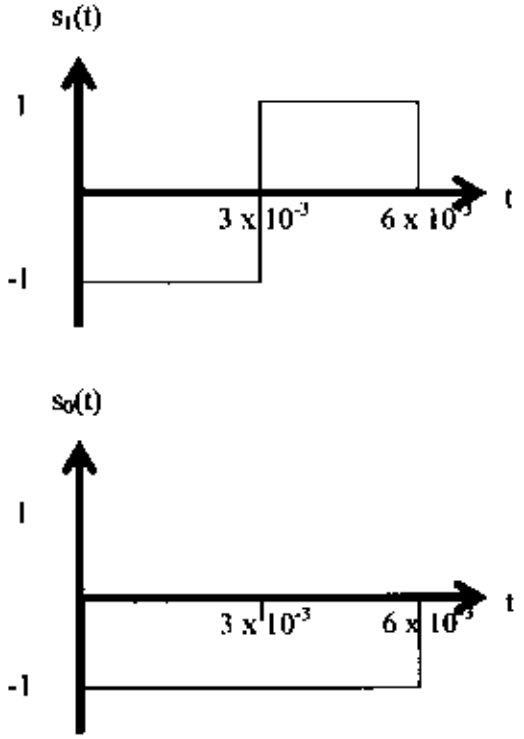


FIGURE Q3(c)

Table 1: Q-function Table

z	Q(z)
2.00	0.0228
2.05	0.0202
2.10	0.0179
2.15	0.0158
2.20	0.0139
2.25	0.0122
2.30	0.0107
2.35	0.0094
2.40	0.0082
2.45	0.0071
2.50	0.0062
2.56	0.0054