UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	:	DIGITAL COMMUNICATION
COURSE CODE	:	BEP 4113
COURSE PROGRAMME	:	BEE
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE** (5) QUESTIONS ONLY

THIS PAPER CONSISTS OF **SEVEN** (7) PAGES

Q1 (a) Define Pulse Code Modulation (PCM).

(2 marks)

(b) Figure Q1(b) shows an analog signal, *x(t)*, together with the natural sample value (in voltage) of that analog signal. 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-Level (NRZ-L) as shown in Figure Q1(d). Construct the waveform in the format of:

(i) Unipolar Return to Zero (Unipolar RZ)
(ii) Bipolar Return to Zero (Bipolar RZ)
(iii) Return to Zero Alternate Mark Inversion (RZ-AMI)

(6 marks)

Q2 (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) Consider an adaptive white gaussian noise (AWGN) channel with 4 kHz bandwidth and the noise power spectral density $N_O/2=10^{-12}$ W/Hz. The signal power required at the receiver is 0.1 mW. Calculate the capacity of this channel.

(5 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.
(ii) Calculate the efficiency of the code.

(10 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_e. 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_e by using the Q-function table. Assume that adaptive noise has a power of 10^{-3} watt/Hz.

(8 marks)

Q4 (a) Identify TWO 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)
(ii) Frequency Shift Keying (FSK)
(iii) Phase Shift Keying (PSK)

(6 marks)

(c) 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 $N_o = 10^{-12}$ W/Hz.

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

(12 marks)

Q5 (a) Configure a (4,3) even-parity error-detection code such that the parity symbol appears as the leftmost symbol of the codeword.

(i) Which error patterns can the code detect?
(ii) Compute the probability of an undetected message error, assuming that all symbol errors are independent events and that the probability of a channel symbol error is $p=10^{-3}$.

(6 marks)

(b) Consider a (7,4) code whose generator matrix is

$$G = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

(i) Find the codewords of 0111, 1001 and 1011 codes.
(6 marks)

(ii) Find H, the parity-check matrix for this code.
(2 marks)

(iii) Compute the syndrome for the received vector 1101101. Is this a valid code vector?
(2 marks)

(iv) What is the error-correcting capability of the 1101101 code?
(2 marks)

(v) What is the error-detecting capability of the 1101101 code?
(2 marks)

Q6 (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 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)

Q7 (a) With the aid of suitable diagram, states THREE classes of multiple access techniques in communication systems.
(6 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.

(4 marks)

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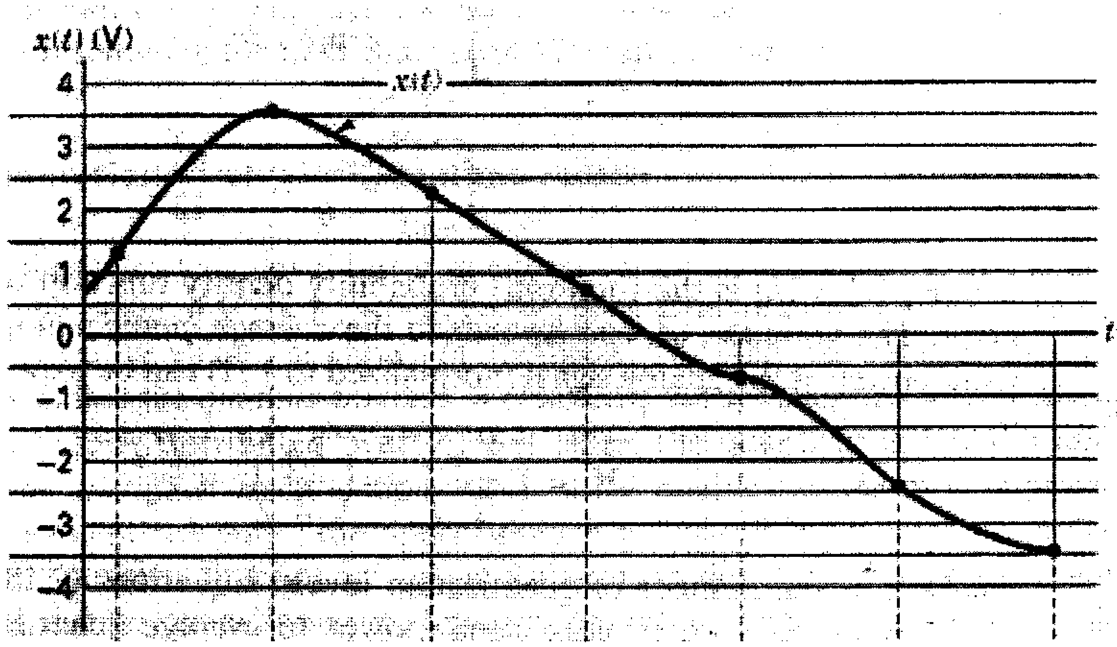

Natural sample value: 1.3, 3.6, 2.3, 0.7, -0.7, -2.4, -3.4

Figure Q1(b)

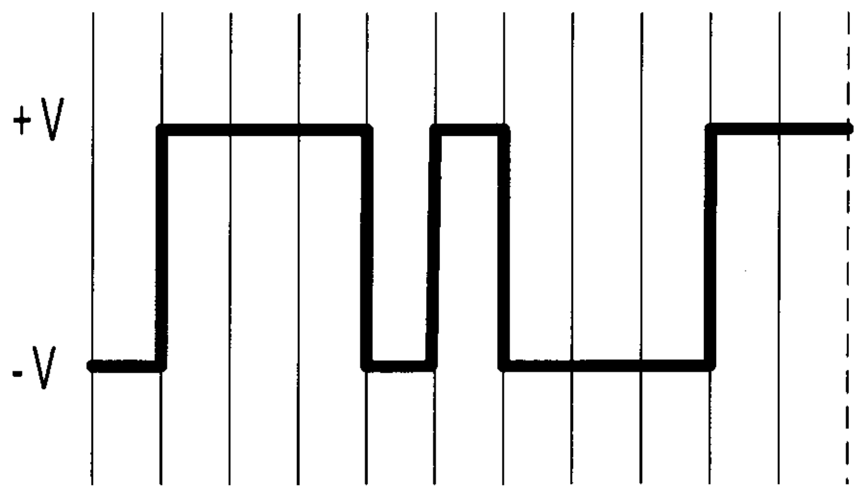

Figure Q1(d)

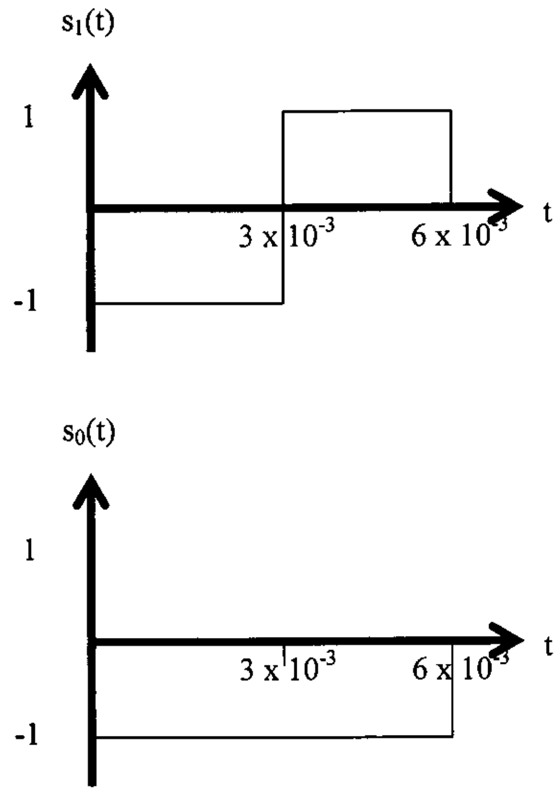

Figure Q3(c)

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
2.55	0.0054