UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

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

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

Q1 (a) 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.

(i) Calculate the average rate of information conveyed by this TV picture source.
(6 marks)

(ii) For color TV, this system additionally provides for 64 different shades of color. Determine and the system capacity required for a color system compared to the black and white system.
(5 marks)

(iii) Determine the required capacity if 100 of the possible brightness-color combinations occur with a probability of 0.003 each, 300 of the combinations occur with a probability of 0.001, and 624 of the combinations occur with a probability of 0.00064.
(4 marks)

(b) 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.
(5 marks)

Q2 (a) Define a Direct Current (DC) component and discuss its effect on digital transmission.
(5 marks)

(b) The input stream to a block encoder is 0100 0000 0000 0001. 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)

(c) Compare and contrast Pulse Code Modulation (PCM) and Delta Modulation (DM).
(6 marks)

(d) In a digital transmission, the receiver clock is 0.1 percent faster than the sender clock. Determine the number of extra bits per second the receiver receive if the data rate is:

(i) 1 kbps

(ii) 1 Mbps

(3 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, prove 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) On-Off Keying (OOK)

(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? Justify 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 the following signals:

(i) On-Off Keying (OOK)

(ii) Binary Phase Shift Keying (BPSK)

(iii) Quadrature Phase Shift Keying (QPSK)

(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 (a) For a (8,4) systematic linear block code whose parity-check equation as follows:

$$p_1 = m_1 + m_2 + m_4$$
$$p_2 = m_1 + m_3 + m_4$$
$$p_3 = m_1 + m_2 + m_3$$
$$p_4 = m_2 + m_3 + m_4$$

where m_i are message digits and p_i are check digits.

(i) Find the generator matrix for this code.

(2 marks)

(ii) Find the parity-check matrix.

(2 marks)

(iii) Determine if the vector 10101010 is a codeword.

(3 marks)

(iv) Determine if the vector 01011100 is a codeword.

(3 marks)

(b) Construct a subset consisting 6 codewords of vector space, V_4 that forms a subspace.

(6 marks)

(c) Design a (3,1) code that will correct all single error patterns.

(4 marks)

Q7 (a) Discuss the goal of multiple access.

(5 marks)

(b) As a telecommunication engineer, design an appropriate configuration to combine five voice channels into a link with a bandwidth of 20 kHz, from 20 to 40 kHz. Assume that a voice channel occupies a bandwidth of 4 kHz. Show the configuration, using the frequency domain. Assume there are no guard bands.

(5 marks)

(c) Explain the reasons for employing spread spectrum modulation.

(5 marks)

(d) Discuss the near far problem in CDMA multiple access interference system.

(5 marks)

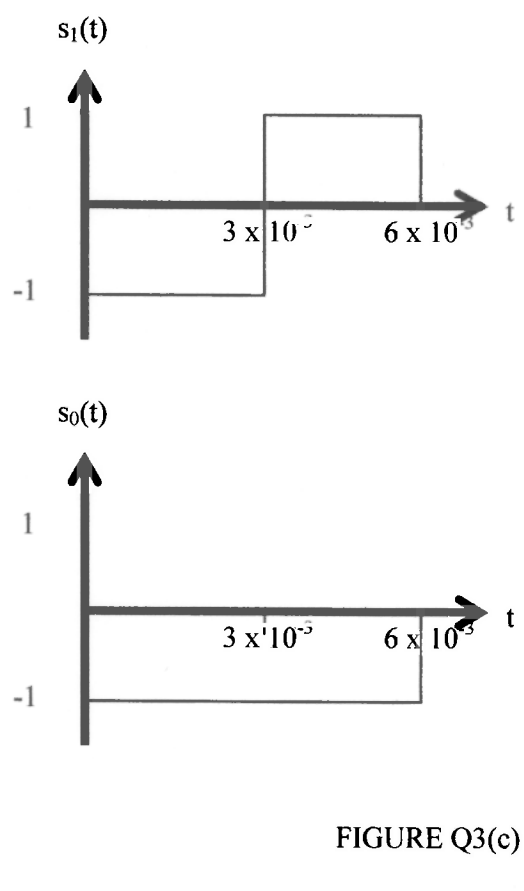

FIGURE Q3(c)

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