Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	DIGITAL COMMUNICATION
COURSE CODE	:	BEJ 41103
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY/ AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) A signal can be classified as *deterministic*, meaning that there is no uncertainty with respect to its value at any time, or *random*, meaning that there is some degree of uncertainty before the signal actually occurs. Based on your understanding, why random processes are important in communication systems.

(3 marks)

(b) Explain how does the auto correlation function give us bandwidth information of a signal. Assists your explanation with suitable diagram(s).

(4 marks)

(c) **Figure Q1(c)** demonstrates the bandwidth of digital data. State the type of bandwidth for (i), (ii) and (iii) shown in the figure.

(3 marks)

(d) Discuss **TWO (2)** factors that contribute to the choice of suitable link margin of a communication link.

(4 marks)

(e) A proposal for a direct broadcast satellite (DBS) states an effective isotropic radiated power (EIRP) of 60 dBW and a downlink transmission frequency of 15.5 GHz for a downlink information consisting of a digital signal with a data rate of 10×10^8 bits/s. The required E_b/N_0 is 10 dB, the system temperature at the home receiver is 600 K, the rooftop dish has an efficiency of 0.55, and the link margin is 0 dB. Assume that the only loss is the downlink space loss which is 206.1 dB. Evaluate if the size of the receiver dish will be objected by the neighbors. Support your answer by first finding the diameter of the antenna. (Botlzmann's constant $\kappa = 1.38 \times 10^{-23}$ J/K)

(6 marks)

Q2 (a) Discuss **TWO (2)** advantages of biorthogonal codes over the orthogonal codes.

(4 marks)

(b) Compare the working principles between stop-and-wait ARQ and continuous ARQ with selective repeat schemes.

(6 marks)

(c) Linear block codes transform a block of k message digits into a longer block of n codeword digits and can be characterized by the (n, k) notation.

(i) Describe the process of error correction of a block coding.

(4 marks)

(ii) Encode the message 1 0 1 in systematic form from the $(7, 3)$ codeword set using polynomial division and the generator $\mathbf{g}(x) = 1 + X^4$.

(4 marks)

(iii) State the maximum number of detectable error if given that the minimum distance $d_{\min} = 8$.

(2 marks)

Q3 **Figure Q3** demonstrates a rate $1/2$ convolutional encoder with constraint length, $K = 3$.

(a) Find the codeword of the convolutional encoder in **Figure Q3** for message $\mathbf{m} = (110)$ by using polinomial representation.

(4 marks)

(b) Verify the resulting output codeword in **Q3(a)** by using impulse response technique.

(4 marks)

(c) Complete the table in **Figure Q3(c)** to show the state changes and the resulting output u_1 and u_2 of the convolutional encoder in **Figure Q3**. Given the states are $S_0 = [0\ 0]$, $S_1 = [0\ 1]$, $S_2 = [1\ 0]$, and $S_3 = [1\ 1]$.

(5 marks)

(d) By using hard-decision Viterbi, find message of the received codeword

$$Z = (11\ 01\ 10\ 00\ 01)$$

(7 marks)

Q4 (a) Describe **TWO (2)** situations in which it may be appropriate to require a transmitter to synchronize itself to the expectations of the receiver.

(4 marks)

(b) Differentiate between receiver and network synchronization.

(4 marks)

(c) State **FOUR (4)** goals of the communication system designer.

(4 marks)

(d) A given source alphabet consists of 300 words, of which 15 occur with probability 0.06 each and the remaining 285 words occur with probability 0.00035 each. If 1000 words are transmitted each second, what is the average rate of information transmission.

(5 marks)

(e) Compute the equivocation or message uncertainty in bits per character for a textual transmission using 7-bit ASCII coding. Assume each character is equally likely and that noise on the channel results in a bit error probability of 0.01.

(3 marks)

Q5 (a) Explain the operation of basic form of scanning diversity shown in **Figure Q5(a)**. State the advantages of implementing this technique in terms of the implementation complexity and resulting fading statistics.

(5 marks)

(b) State the key difference between the term multiplexing and multiple access.

(4 marks)

(c) With the aid of diagrams, differentiate the operation of Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access (OFDMA) and Non-Orthogonal Multiple Access (NOMA).

(11 marks)

-END OF QUESTIONS –

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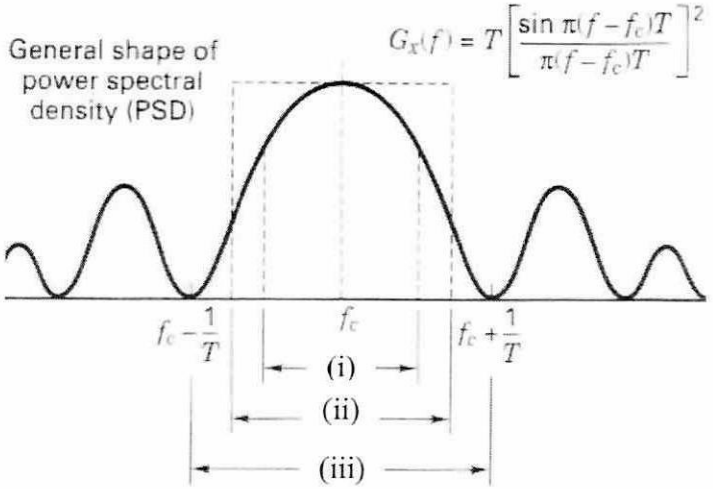

Figure Q1(c)

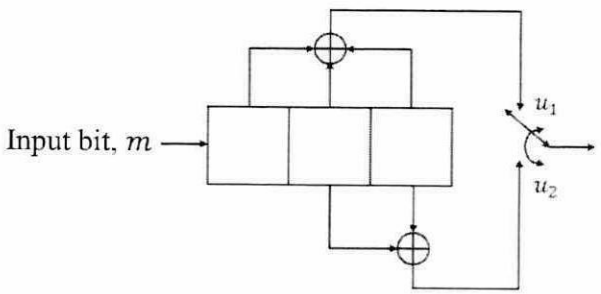

Figure Q3

Input bit, m	Current state	Next state	Output	
			u_1	u_2
0	S_0			
1	S_0			
0	S_1			
1	S_1			
0	S_2			
1	S_2			
0	S_3			
1	S_3			

Figure Q3(c)

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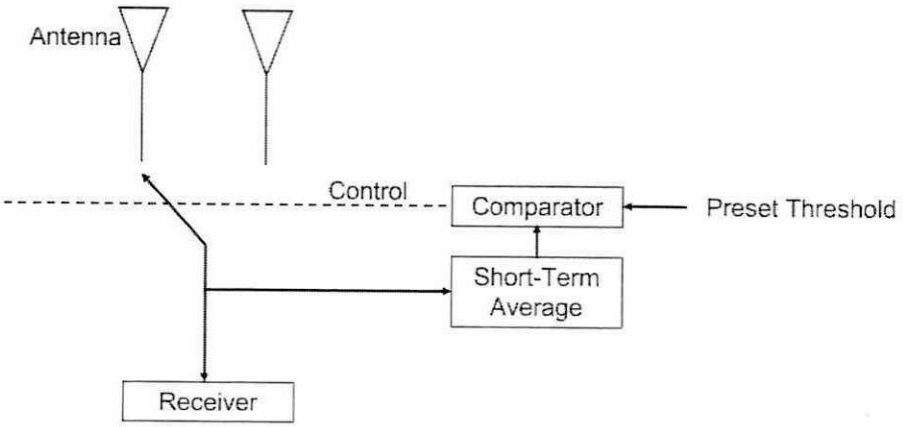

Figure Q5(a)