Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	DIGITAL COMMUNICATION
COURSE CODE	:	BEJ 41103
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 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 **FIVE (5)** PAGES

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Q1 (a) Describe the figure of merit for the performance of analog and digital communication system.

(4 marks)

(b) Illustrate the eye patterns of distorted polar non-return to zero (NRZ) waveform for the sequence 011001 under:

(i) Ideal channel filtering

(2.5 marks)

(ii) Filtering that produces inter-symbol interference (ISI).

(2.5 marks)

(c) 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) Verify the validity of the received vector 1101101.

(4 marks)

(ii) Determine the error-correcting capability of the code.

(2 marks)

(d) Coordinated Multipoint (CoMP) technology in LTE-Advanced allows multiple cell to cooperate and can be seen as a network Multiple Input Multiple Output (MIMO) system. Compare 8X8 conventional MIMO and 8X8 CoMP systems. Provide appropriate block diagrams where needed.

(10 marks)

Q2 (a) The Non-Orthogonal Multiple Access (NOMA) is a multiple access technique applied in Fifth Generation (5G) cellular wireless network. NOMA offers massive connectivity compared to Orthogonal Multiple Access (OMA) technique. Give your explanation.

(4 marks)

(b) Interleaving is a method used to obtain time diversity in wireless communication system. If the sequence of 1011011000101100 is the input to a 4×4 block interleaver, demonstrate the interleaving procedure and determine the interleaver output. Then, show how the transmitted data being recovered at the receiver.

(6 marks)

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(c) Consider the convolutional encoder shown in **Figure Q2 (c).**

(i) Draw the state diagram.

(10 marks)

(ii) Draw the trellis diagram.

(2 marks)

(iii) Given the input to the encoder is 101. Analyze the output sequence and verify by using the generator polynomials.

(3 marks)

Q3 (a) Assume that a 120 kbps data stream is to be transmitted on a voice-grade telephone circuit with a bandwidth of 3 kHz.

(i) Determine the possibility of acquiring error-free transmission with a signal-to- noise ratio (SNR) of 10 dB.

(2 marks)

(ii) If it is not possible, suggest **THREE (3)** system modifications that could be made.

(3 marks)

(b) Discuss the concept of redundancy in error detection and error correction.

(4 marks)

(c) The users in Long Term Evolution (LTE) networks need to know frame synchronization to be able to decode the downlink radio frame. With the aid of LTE frame structure, explain Primary Synchronization Channel (PSS) and Secondary Synchronization Channel (SSS).

(8 marks)

(d) Feedback diversity and Maximal Ratio Combining (MRC) are two classes of space diversity reception methods. As an system engineer in a telecommunication company, you are required to choose only **ONE (1)** of the methods that gives significant benefits to the company. Justify your choice of method in terms of the implementation complexity and resulting fading statistics.

(8 marks)

Q4 (a) Define the following bandwidth criteria:

(i) Half-power bandwidth

(2 marks)

(ii) Power bandwidth

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(2 marks)

(iii) Absolute bandwidth

(2 marks)

(b) A binary noncoherent Frequency Shift Keying (FSK) link has a maximum data rate of 2.4 kbps without inter-symbol interference (ISI) over a channel whose nominal bandwidth is 2.4 kHz. Propose strategies to increase the data rate under the following system constraints:

(i) The system is power limited

(2 marks)

(ii) The system is bandwidth limited

(2 marks)

(iii) The system is both power and bandwidth limited

(3 marks)

(c) Timing error occurs in synchronization as a result of frequency difference of two physically oscillators (transmitter and receiver). Analyze the effects of frequency difference in asynchronous character transmission with data rate of 10 kbps shown in **Figure Q4 (c)**.

(8 marks)

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

(4 marks)

-END OF QUESTIONS –

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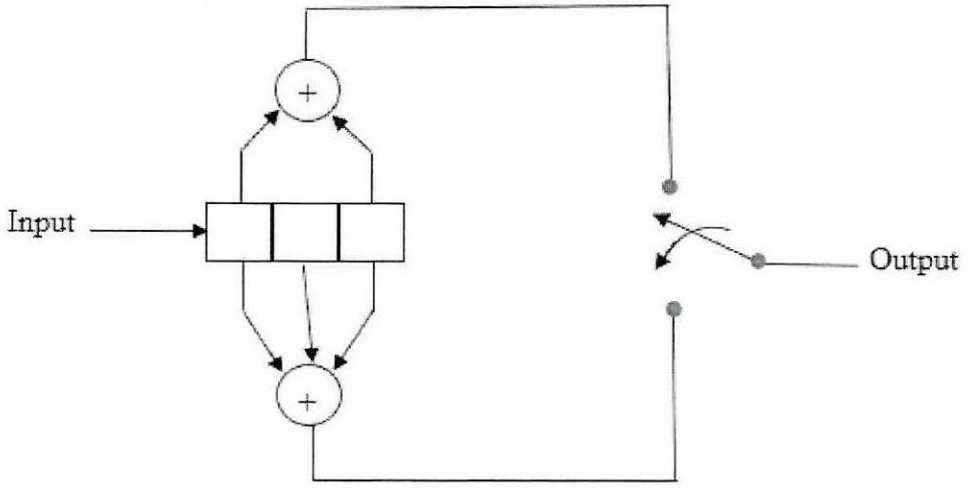

Figure Q2 (c)

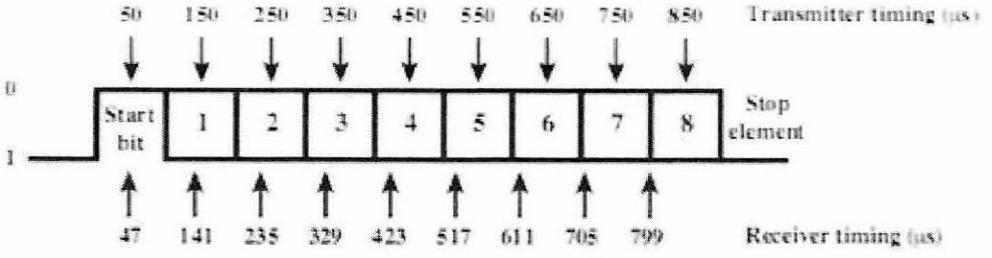

Figure Q4 (c)

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