



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)
MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR
FOURTH YEAR FIRST SEMESTER EXAMINATIONS
FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL AND
COMMUNICATIONS ENGINEERING**

COURSE CODE: ECE 416

COURSE TITLE: DIGITAL COMMUNICATION SYSTEMS

DATE: WEDNESDAY 13/12/2023 TIME: 12.00 PM–2.00 PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over. 

QUESTION ONE (30 MARKS)

(a) (i) What are the main differences between source coding and channel coding?

(ii) Given a binary sequence [0101010111] draw the corresponding waveforms for unipolar NRZ and polar quaternary NRZ.

(iii) Draw a flow-chart and write the corresponding Matlab code to generate and display Unipolar NRZ and polar quaternary NRZ signals for a bit stream given [1 1 0 1 1 0 0 1 1 1]

(8 marks)

(b) Assume a signal with 6 MHz bandwidth is to be transmitted using a binary PCM system of 256 quantization levels. Determine the following:

(i) the PCM code word length,

(ii) Transmission bandwidth,

(iii) the PCM stream bit rate,

(iv) Signal to Quantization Noise Ratio (SQRN).

(8 marks)

(c) (i) Name and discuss THREE types of quantization noise found in a PCM system.

(ii) An analog signal is band-limited at 8KHz and is quantized in 8 levels $\{x_1, x_2, x_3, \dots, x_8\}$ with probabilities $P(x_1) = \frac{1}{4}$, $P(x_2) = \frac{1}{5}$, $P(x_3) = \frac{1}{5}$, $P(x_4) = \frac{1}{5}$, $P(x_5) = \frac{1}{10}$, $P(x_6) = \frac{1}{10}$, $P(x_7) = \frac{1}{20}$ and $P(x_8) = \frac{1}{20}$. If the signal is sampled at 20 Kbps, find the entropy and the rate of information.

(6 marks)

(d) (i) Describe the causes and effects of intersymbol interference in communication systems.

(ii) Describe a commonly used method for analysing intersymbol interference in the laboratory.

(iii) A Delta modulator operates at five times the Nyquist rate in a transmission channel whose bandwidth is 3 KHz. If the delta modulation step size is set at 250mV, calculate the maximum amplitude of a sinusoidal signal of 2 KHz that ensures that there is no slope distortion. Derive the formula that you use.

(8 marks)

QUESTION TWO (20 MARKS)

(a) A Discrete memoryless system is encoded as shown below. Calculate:

- (I) Code efficiency
- (II) Code redundancy

a_i	P(a_i)	Code
a ₁	0.71	0
a ₂	0.20	10
a ₃	0.05	110
a ₄	0.04	111

(6 marks)

(b) (i) Describe the principle of operation of the DTMF telephone

(ii) What are the advantages of DTMF phone over the dial pulse phone?

(6 marks)

(c) A discrete memoryless Source (DMS) has five equally likely symbols.

(i) Construct the Shannon-Fano code in tabular form;

(ii) Calculate the efficiency of the code.

(8 marks)

QUESTION THREE (20 MARKS)

3(a) (i) Discuss TWO conditions that must be fulfilled for a communication system to be called spread spectrum.

(ii) With the aid of a drawing, discuss how frequency hopping spread spectrum system works.

(iii) Define the term spreading factor when used in communication engineering.

(6 marks)

(b) (i) What are that factors that motivated the development Asymmetrical Digital Subscriber Line (ADSL) systems?

(ii) An ADSL system was designed to deliver telephone and internet traffic to an office. Answer the following:

(I) Using a block diagram, describe the various components in such a system.

(II) What is the maximum up-link speed that can be supported on the ADSL system?

(iii) Give FOUR reasons why one would choose to use fibre optic cables to copper cables in a digital communication systems.

(8 marks)

- (c) With the aid of a diagram describe a Plesiochronous Digital Hierarchy (PDH) system that can carry over 7,000 telephone voice channels.

(6 marks)

QUESTION FOUR (20 MARKS)

- (a) (i) What is GPON?

- (ii) With the aid a block diagram, describe the various elements in a GPON.

(8 marks)

- (b) The Global System for Mobile Communication (GSM) 1800 MHz band occupies the frequency range 1710 – 1785 MHz (uplink) and 1805–1880 MHz(Downlink).

- (I) What is the duplex frequency?

- (II) How many ARFCNs does the system support?

- (III) Where is GSM 1800 MHz band used in a mobile communication system like Safaricom? Explain your answer.

(6 marks)

- (c) (i) With the aid of a block diagram, describe the various elements that constitute a SONET network.

- (ii) What is the duration of a ST-3 frame in a SONET network?

(6 marks)