

2602/305  
DATA COMMUNICATION  
AND NETWORKING  
June/July 2023  
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL  
DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING  
(TELECOMMUNICATION OPTION)

MODULE III

DATA COMMUNICATION AND NETWORKING

3 hours

**INSTRUCTIONS TO CANDIDATES**

*You should have the following for this examination:*

*Answer booklet;*

*Non-programmable scientific calculator;*

*Drawing instruments.*

*This paper consists of EIGHT questions in TWO sections; A and B.*

*Answer FIVE questions, choosing at least TWO questions from each section in the answer booklet provided.*

*All questions carry equal marks.*

*Maximum marks for each part of a question are as indicated.*

*Candidates should answer the questions in English.*

**This paper consists of 6 printed pages.**

**Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.**

## SECTION A: DATA COMMUNICATION

Answer at least *TWO* questions from this section.

1. (a) Define each of the following with respect to error control:

- (i) redundancy;
- (ii) code distance;
- (iii) code weight.

(3 marks)

(b) With the aid of a time flow diagram, describe the stop and wait ARQ error control technique in data communication.

(7 marks)

(c) Table 1 shows a code word of 7-bits each to be transmitted using the longitudinal redundancy check (LRC).

Table 1

1	0	0	1	0	1	0
0	1	1	1	1	0	0
1	1	1	0	0	0	1
1	1	1	1	0	1	0

Using even parity, determine the:

- (i) frame check sequence;
- (ii) transmitted code word.

(6 marks)

(d) An optical fibre cable with a core and cladding refractive indices of 1.62 and 1.52 respectively is used to transmit data. Launching takes place in the air. Determine the:

- (i) numerical aperture;
- (ii) critical angle.

(4 marks)

2. (a) Differentiate between half-duplex and full-duplex data communication modes. (2 marks)
- (b) With the aid of a block diagram, describe the components of a data communication system. (6 marks)
- (c) Explain each of the following data transmission impairments:
- (i) thermal noise;
  - (ii) jitter. (4 marks)
- (d) A channel transmits data asynchronously using bits of 20 mS duration. The receiver clock is operating at 48 Hz.
- Determine the:
- (i) receiver clock period;
  - (ii) slip in receiver clock on each successive bit;
  - (iii) number of slips for the receiver to slide beyond half of the received bit period. (8 marks)
3. (a) Differentiate between switching and routing as used in data networks. (2 marks)
- (b) Describe the phases in circuit switching technique in data communication. (5 marks)
- (c) (i) Draw a labelled block diagram of the Bisynchronous (BI SYNC) frame format.  
(ii) State how transparency is achieved in the frame in c (i). (5 marks)
- (d) 8 data terminals each transmitting at 6600 bps are to be multiplexed using the time division multiplexing (TDM) technique.
- (i) Determine the total capacity required for synchronous TDM.
  - (ii) If the link utilization is 0.6, using statistical TDM, determine the:
    - (I) data rate that can be supported;
    - (II) number of terminals that can be supported. (8 marks)

4. (a) Distinguish between data rate and baud rate with respect to data transmission. (2 marks)
- (b) State **three** merits of scrambling in data encoding. (3 marks)
- (c) The data sequence, 1011101001, is to be encoded. Draw the resultant waveforms for each of the following encoding schemes:
- (i) unipolar NRZ;
  - (ii) bipolar AMI;
  - (iii) polar NRZ. (9 marks)
- (d) A modem transmits 60,671 bits per second using signalling elements chosen from a 8192 constellation. Determine the:
- (i) modulation scheme used;
  - (ii) number of bits which may be encoded in each signalling element;
  - (iii) modulation rate of the modem. (6 marks)

### SECTION B: NETWORKING

*Answer at least TWO questions from this section.*

5. (a) (i) Describe the voice over internet protocol (VOIP);
- (ii) State **three** merits of using the VOIP phone service. (5 marks)
- (b) Outline the steps in carrier sense multiple access with collision detection (CSMA/CD) medium access control protocol. (5 marks)
- (c) Table 2 shows devices owned by a certain organization and are to be connected to a ISDN network. Determine the required number of basic rate interfaces required. (7 marks)

Table 2

Device	Bit rate
PABX	384 kbps
Computer	564 kbps
Security camera	800 kbps

- (d) State **three** merits of ISDN networks. (3 marks)
6. (a) State **three** functions of the asynchronous transfer mode (ATM) physical layer. (3 marks)
- (b) With the aid of diagrams, describe each of the following LAN topologies:
- (i) bus topology;
  - (ii) ring topology.
- (8 marks)
- (c) Table 3 shows devices used in computer networks and the corresponding layer of the OSI model on which they operate. Complete the table. (4 marks)

Table 3

Network Devices	OSI Layer
Bridge	
Hub	
Gateway	
Router	

- (d) Draw the X.25 data link layer frame. (5 marks)
7. (a) Describe each of the following cellular technologies:
- (i) frequency division multiple access (FDMA);
  - (ii) Time division multiple access (TDMA).
- (4 marks)
- (b) State **three** features of wide area networks that distinguish them from local area networks. (3 marks)
- (c) Draw a labelled diagram of a structured cabling system from the work area upto the ISP. Indicate the PCs, patch panel, switch and routes. (7 marks)

- (d) Table 4 shows modulation schemes used in wireless networks, and their data rates. Complete the table. (6 marks)

Table 4

Modulation Scheme	Code bits per sub-carrier	Data Rate	Baud Rate
BPSK	-	54	-
QPSK	-	108	-
16 - QAM	-	216	-

8. (a) Identify **three** types of keys used in an encryption scheme. (3 marks)
- (b) With the aid of a block diagram, describe the digital signature technique in relation to network security. (6 marks)
- (c) Describe each of the following routing techniques:
- (i) static routing;
  - (ii) dynamic routing.
- (d) An organization with an IP address 196. 22. 50. 0 has a sub-net mask of 255. 255. 255. 248.

Determine the:

- (i) class of the network;
- (ii) number of sub-nets;
- (iii) host addresses of the first sub-nets.

(7 marks)

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