2203/302
DATA COMMUNICATION
Oct./Nov. 2009
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN TELECOMMUNICATION ENGINEERING

DATA COMMUNICATION

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet
Electronic Calculator

*Answer any **FIVE** of the **EIGHT** questions in this paper.*
All questions carry equal marks.

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.

1. (a) (i) Explain any **two** causes of absorption loss in optical fibres.
(ii) With the aid of a diagram describe the operation of a PIN diode optical detector.
(8 marks)

(b) The refractive indices of the core and cladding of an optical fibre are 1.5 and 1.44 respectively. Determine the:

(i) numerical arpeture;
(ii) acceptance angle;
(iii) critical angle of incidence.

(6 marks)

(c) A speech signal is sampled at a rate of 8 Khz and then encoded. The signal to quantization noise ratio is required to be 40 dB. Determine the:

(i) number of bits per sample;
(ii) minimum storage capacity needed to accommodate the digitized speech if its duration is 10 seconds.

(6 marks)

2. (a) (i) For synchronous transmission state how the following are achieved:
I bit synchronization;
II character synchronization.

(ii) Asynchronous data is transmitted in the form of characters made up as follows: five information bits of duration 20 ms, a start bit of same duration as the information bits and a stop bit of 30 ms. Determine the:
I transmission rate in bits/sec;
II signalling rate in bauds.

(7 marks)

(b) (i) Describe coherent phase-shift keying modulation method.
(ii) State **one** disadvantage of the modulation scheme in b(i).
(iii) A differential phase shift keying system advances the phase shift by 90° for a binary 0 and 270° for a binary 1. Given that the previous bit had a phase shift of -90°, determine the phase shift in the last bit of the data stream 10110.

(8 marks)

(c) (i) For line codes, explain why the following properties are desirable:
I self-clocking;
II lack of d.c component.

(ii) On the same axis sketch the waveform for the bit stream 10101101 using the following line codes:
I polar NRZ;
II Manchester.

(5 marks)

3. (a) Given that the approximate voice spectrum is 0 - 4 khz and Nyquist sampling rate is applied:

(i) show that the resulting bit rate for the first hierarchy of an E_1 system is 2.048 Mbps;

(ii) determine the duration of the time slot for:
I character/byte interleaving;
II bit interleaving.

(8 marks)

(b) (i) Describe the principle of operation of Frequency Division Multiplexing (FDM) system.

(ii) Table 1 shows a FDM hierarchy

Table 1

Hierarchy	Voice channels
Group	12
Supergroup	60
Master group	600

Given that voice signal occupies a bandwidth of 4 Khz, determine:

I the number of groups making a master group;
II highest supergroup frequency given that the lowest is 312 khz.

(8 marks)

(c) A channel has a bandwidth of 4 Khz and a signal to noise ratio of 30dB. Determine:

(i) the channel capacity;
(ii) whether the channel can support a transmission system using combined FDM/TDM scheme with 124 FDM channels where 8 time slots at 16 kbps is mapped on each frequency.

(4 marks)

4. (a) State:

(i) any **two** differences between the EIA RS 232 and EIA RS 422 interfaces;

(ii) the use of the following in network installation:
I crimping tool;
II tester

(8 marks)

(b) A host in a network is assigned an IP address 150.100.12.176.
For the IP address identify the:
I class;
II default mask.

(2 marks)

(c) (i) State any **two** advantages of coaxial cable over twisted pair transmission line.

(ii) Table 1 shows three optical transmitters and their respective specifications.

Table 1

Transmitter no.	Power
1	-16 dBm
2	-12 dBm
3	-8 dBm

A network is to be designed which meets the following criteria.

- Receiver sensitivity = -20 dBm
- Cable loss = 0.2 dB/km
- Cable length = 10 km
- System Design margin = 5 dB

I Determine the required transmit power.

II Identify the appropriate transmitter from table 1 for use in (I). (10 marks)

5. (a) Distinguish between virtual and datagram packet switching. (2 marks)

(b) (i) Figure 1 shows a packet switched network with three switching nodes and two end nodes. A virtual path between nodes A and B is identified by Virtual Channel Identifiers (VCI's), VCI(1), VCI(3) and VCI(4).

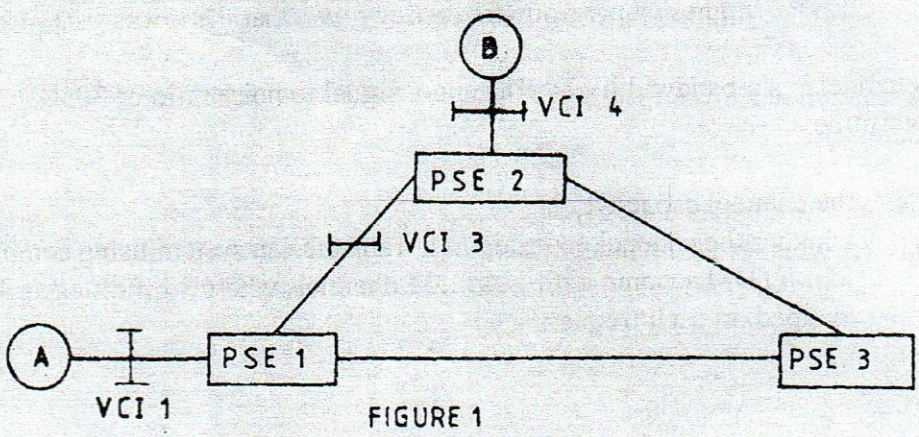

Figure 1

I. Fill the routing tables 2(a) and 2(b) for the packet switching exchanges PSE1 and PSE2 respectively.

Table 2(a)

incoming Port	Incoming VCI	Outgoing Port	Outgoing VCI

Table 2(b)

incoming Port	incoming VCI	Outgoing Port	Outgoing VCI

II. Using the tables constructed in (I), describe the information transfer between A and B.

(ii) Explain any **three** sources of delay in virtual circuit networks. (14 marks)

(c) Explain any **two** areas of application of flooding routing. (4 marks)

6. (a) Define the following as used in block error codes:

(i) code efficiency;
(ii) code distance.

(2 marks)

(b) (i) Distinguish between vertical and longitudinal redundancy check.

(ii) Table 3 shows part of ASCII code

Table 3

			7	0	0	0	0	1	1	1	1
			6	0	0	1	1	0	0	1	1
			5	0	1	0	1	0	1	0	1
4	3	2	1								
0	0	0	0	NUL	DLE	SP	0	@	p	\	p
0	0	0	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	STX	DC2	"	2	B	R	b	r
0	0	1	1								

Given that the character sequence STX A, B is to be transmitted using even parity. Determine the vertical redundancy check (VRC) and longitudinal redundancy check for the block.

(7 marks)

(c) A (7,4) Hamming code generator matrix is given by:

$$G = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

(i) Determine the parity check matrix H.

(ii) For the message word 0010 determine the corresponding code-word.

(iii) The code-word in (ii) is transmitted and an error occurs in the third position from the MSB. Determine the syndrome.

(11 marks)

7. (a) State any **three** characteristics of Local Area Networks (LANs). (3 marks)

(b) (i) Describe the token ring LAN access protocol.

(ii) A token ring network has the following characteristics:

Speed of operation, R = 4 Mbps
Number of stations, M = 20
Distances of separation of stations, d = 100 m
Delay introduced by each station interface, b = 2.5 bits
Length of the frame, L = 400 bits.

Given that token insertion strategy is to reinsert the token after the frame transmission is completed but not until the last bit of the frame returns to the sending station, determine the:

I duration in μs for a bit to go round the ring;
II duration in μs for the last bit in a transmitted frame to return;
III ring efficiency.

(14 marks)

(c) State **three** reasons for the use of Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) in wireless LANs over Carrier Sense Multiple Access with Collision Detection (CSMA/CD). (3 marks)

8. (a) (i) Draw a labelled diagram of Binary Synchronous (BISYN) control frame.

(ii) Explain how transparent transmission is achieved in b(i).

(iii) Describe the **two** modes of operation of the BISYN channel.

(iv) For the High level data link control protocol, perform bit destuffing for the sequence 111011111011111101111110

(10 marks)

(b) With the aid of a labelled diagram describe the Integrated Services Digital Network (ISDN) architecture showing the functional groups and the reference points.

(10 marks)