2203/302
DATA COMMUNICATION
Oct./Nov. 2011
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;
Non-programmable calculator.

*Answer any **FIVE** of the **EIGHT** questions in this paper.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.

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) State any **two** features of each of the following networks:
   (i) Local Area Network;
   (ii) Metropolitan Area Network. (4 marks)

   (b) Describe the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access protocol. (6 marks)

   (c) A CSMA/CD system has a transmission rate on the bus of 10Mbps. The bus is 2Km long and propagation delay is 5μs/Km. Packets are 1000 bits long. Determine the:

   (i) end to end delay, τ_d;

   (ii) packet duration τ_p;

   (iii) maximum utilization on the bus;

   (iv) maximum bit-rate. (10 marks)

2. (a) Explain the need for considering the following in the choice of line encoding schemes:

   (i) differential enconding;
   (ii) noise immunity. (4 marks)

   (b) (i) Figure 1 shows a Manchester encoded waveform. Decode the bit pattern.

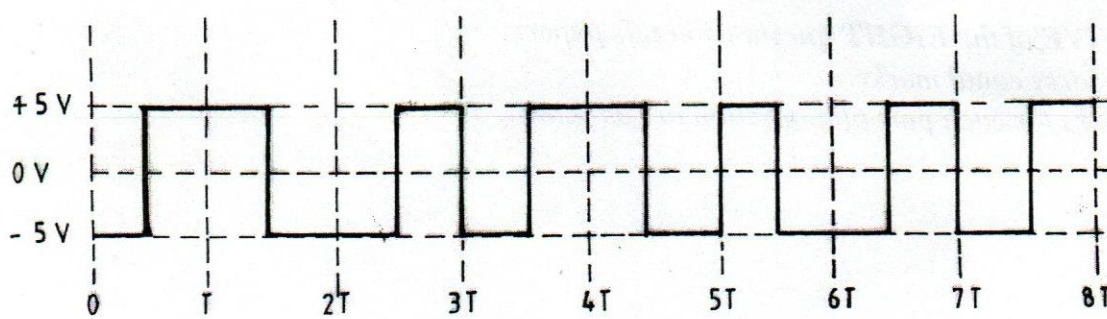

Fig.1

   (ii) For the Bipolar Alternate Mark Inversion line encoding scheme:

   I. sketch the resulting waveform for the message sequence 1001101;
   II. determine it efficiency. (7 marks)

(c) (i) A phase modulation system transmits the modulated signal $A\cos(2\pi f_c t + \phi)$ where the phase ϕ , , is determined by the two information bits transmitted as indicated in Table 1.

Phase (ϕ)	bit-pattern
0	0 0
$\frac{\pi}{2}$	0 1
π	1 0
$\frac{3\pi}{2}$	1 1

I. sketch the signal constellation diagram for this modulation scheme;

II. state **two** ways of modifying the modulation scheme in (I) to obtain an eight-point constellation diagram.

(ii) Stereo audio signals are to be transmitted using a digital modem. Each audio is signal is sampled at a rate of 40 Kilosamples/second and quantized into one of the possible 65,536 quantization levels. For this system determine the:

I. bit-rate produced by each stereo audio signal;
II. number of points required in the signal constellation. (9 marks)

3. (a) Explain the need for non-uniform quantization of voice signals. (3 marks)

(b) (i) With the aid of a labelled diagram illustrate how the eye-diagram is used to determine the extent of intersymbol interference and sensitivity to timing error.

(ii) An audio signal with spectral components limited to the frequency band to 3300Hz is to be sampled at 1.5 times the Nyquist rate and transmitted through a pulse coded Modulation System. The ratio of the peak signal power to the average quantization noise power at the output needs to be 30dB. Determine the:

I. minimum number of bits per sample;
II. minimum number of uniform quantization levels;
III. bit-rate;
IV. minimum system bandwidth. (17 marks)

4. (a) Define the following as applied to error control.
   (i) code weight;
   (ii) code redundancy. (2 marks)

   (b) (i) The generator-matrix of a (7, 4) code is given by:

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

   For this code, determine the:
   I. codeword corresponding to the message 1110;
   II. parity check matrix, H;
   III. syndrome for the received vector 1101101 and comment on the answer.

   (ii) For the code matrix in b(i), determine the error detecting capability. (12 marks)

   (c) A series of information frames with a mean length of 1000 bits is to be transmitted across a data link 4000 Km long at a data rate of 2Mbps. If the link has a velocity of propagation of 2×10^8 m/s and a bit error rate (BER) of 10^{-4}, determine the link utilization efficiency assuming Stop and Wait ARQ protocal. (6 marks)

5. (a) (i) describe the **three** High Level Data Link Control (HDLC) protocal data transfer modes;
   (ii) state the **three** different types of frames used in the Link Access procedure balanced protocal. (9 marks)

   (b) Draw a labelled frame format of the IEEE 802.3 Medium Access Control frame and state the function of each field. (8 marks)

   (c) With reference to the X.25 protocal, describe the function of the Packet Assembler/ Disassembler. (3 marks)

6. (a) (i) Describe any **three** disadvantages of circuit switching as a mode of transmitting data.
   (ii) A circuit switched network has the following characteristics:

length between any pair of stations	=	1000Km.
number of nodes across the network	=	100 nodes.
data rate	=	1×10^4 bits/sec.
propagation velocity	=	2×10^8m/s
set up time by each node	=	30ms

   For a message of length 5×10^6 bits, determine the:
   I. transmission time;
   II. transmission efficiency.

   (iii) Comment on the efficiency of the system in a(ii) II if the length of the message is increased. (16 marks)

(b) Describe the following Integrated Services Digital Network interfaces:
(i) basic rate interface;
(ii) primary rate interfaces. (4 marks)

7. (a) Describe the use of the following passive devices in optical transmission:
(i) attenuators;
(ii) isolators. (4 marks)

(b) From the fiber-optic installation plan of a campus, the following information is available.

Total fibre optic link length = 3Km
Number of required optical splices = 2
Number of connections = 2
Loss per splice/connection = 0.1dB
Design margin estimate = 2 dB
Optical loss due to any other component in the system is negligible.

Table 1 shows the specifications of the two sets of equipment available from the manufacturer.

SET	EQUIPMENT SPECIFICATIONS
1	Fibre diameter = 62.5/125μM Fibre attenuation = 2.5dB/km Transmitter power = -25dBm Receiver sensitivity = -35dBm
2	Fibre diameter = 62.5/125μM Fibre attenuation = 1.5dB/km Transmitter power = -8dBm Receiver sensitivity = -18dBm

(i) Determine the total link loss if the installation is implemented with equipment from:
I. set I;
II. set 2.

(ii) Determine with reasons the most suitable set of equipment for the implementation.
(10 marks)

(c) Describe the following forms of dispersion in optical fibre cables, stating how they can be minimised:

(i) medal;
(ii) material. (6 marks)

8. (a) (i) With the aid of a diagram describe the 20mA current loop interface.

(ii) State **one** advantage of the interface in (a) (i) over the EAI -RS 232 interface. (8 marks)

(b) (i) Define the following as used in Time Division Multiplaxing (TDM).
I. channel;
II. frame.

(ii) For a 3 - channel TDM system describe its operation under the following headings:
I. transmitter;
II. channel;
III. receiver. (12 marks)