

2203/302  
DATA COMMUNICATION  
Oct/Nov. 2004  
Time: 3 hours

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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  
Mathematical table/calculator

Answer any **FIVE** of the following **EIGHT** questions.  
All questions carry equal marks.  
Maximum marks for each part of a question are indicated.

1. (a) (i) State THREE ways in which reduction of modes can be achieved in fiber optic cable transmission.  
(ii) With the aid of a diagram describe the construction and operation of a pin diode. (7 marks)
- (b) (i) Describe the TWO light absorption mechanisms in an optical fiber.  
(ii) State any ONE remedy in each case in (b) (i). (6 marks)
- (c) Explain any TWO advantages and any TWO disadvantages of laser diodes over LEDs. (4 marks)
- (d) Determine the number of modes in a step index fiber given that:
- |                           |   |                      |           |
|---------------------------|---|----------------------|-----------|
| Numerical aperture        | = | 0.23                 |           |
| Core diameter             | = | 50 $\mu\text{m}$     |           |
| Wavelength of input light | = | 0.82 $\mu\text{m}$ . | (3 marks) |
2. (a) (i) With the aid of a block diagram describe the essential components of an analogue to digital data communication system.  
(ii) Explain any FOUR reasons why digital transmission is better than analogue transmission. (14 marks)
- (b) Define the following terms as applied to digital transmission:
- (i) Attenuation
  - (ii) Distortion
  - (iii) Noise. (3 marks)
- (c) A signal having a range from 0-5V is sampled and digitized to an accuracy of 8 bits. Determine the:
- (i) Quantizing rms error.
  - (ii) Signal-to-quantizing noise ratio. (3 marks)
3. (a) Define and explain the need for the following signal conversion processes:
- (i) Digital-to-digital
  - (ii) Analogue-to-digital
  - (iii) Digital-to-analogue. (6 marks)
- (b) Describe with suitable sketches the following digital-to-digital signal encoding formats:
- (i) Unipolar
  - (ii) Polar
  - (iii) Bipolar. (6 marks)

(c) Explain any FOUR factors to be considered when selecting line encoding schemes. (8 marks)

4. (a) (i) Define coding.  
(ii) State any THREE reasons why coding is undertaken. (4 marks)

(b) Given the generator matrix for a (6,3) block, determine any three code words of this code.

$$H = \begin{bmatrix} 011100 \\ 101010 \\ 110001 \end{bmatrix}$$

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(6 marks)

(c) (i) Describe Shannon's theorem as applied to transmission in a noisy channel.  
(ii) A 3 bit message is transmitted via PSK. Compute the probability of 2 bits being in error with BER =  $10^{-5}$ .  
(iii) The message is next encoded so that the word length is increased to 5 bits. Compute the probability of 2 bits being in error with a BER of  $5 \times 10^{-4}$ .  
(iv) Calculate the ratio of the message error without coding over message error with coding.

10 marks)

5. (a) (i) Explain the need for error control in data transmission.  
(ii) Explain the following approaches to error control:

- I. Forward error control
- II. Backward error control.

(7 marks)

(b) Describe the THREE features of sliding window automatic repeat request (ARQ) method of error control. (7 marks)

(c) (i) By means of a sketch explain the stop-and-wait flow control method.  
(ii) State any ONE advantage and ONE disadvantage of the method in (c) (i). (6 marks)

6. (a) List any TWO functions for any THREE layers of the OSI. (6 marks)

(b) (i) Describe the X.25 network interface.  
(ii) With reference to the X.25 network, describe the functions of the:

- I. Frame layer
- II. Packet layer

(10 marks)

- (c) Explain any FOUR considerations in choosing network cabling. (4 marks)
7. (a) Explain any THREE features of the following:
- (i) Circuit switching
  - (ii) Time division switching. (6 marks)
- (b) With the aid of sketches describe the operation of a Time Slot Interchange (TSI) switch. (6 marks)
- (c) (i) State any THREE benefits of packet switching over circuit switching.  
(ii) With the aid of sketches, illustrate the datagram approach to packet switching. (8 marks)
8. (a) (i) Explain why a modem is necessary in data transmission.  
(ii) A 16-QAM modem has a frequency bandwidth ranging from 600 -3000Hz and a carrier frequency of 1800Hz. Determine the:
- I. Band rate
  - II. Bit rate (3 marks)
- (b) By means of a diagram explain the principle of operation of 56 K modems when:
- (i) Uploading
  - (ii) Downloading. (11 marks)
- (c) Describe the following terms:
- (i) WAN
  - (ii) Bandwidth on demand
  - (iii) E1 (6 marks)