2507/206
COMMUNICATION AND TELECOMMUNICATION SYSTEMS
Oct./Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS OPTION)

MODULE II

COMMUNICATION AND TELECOMMUNICATION SYSTEMS

72

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Mathematical tables;
Non-programmable scientific calculator;
Drawing instruments.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing any **THREE** questions from section **A** and **TWO** questions form section **B** 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.

Take: Free space wave velocity, $c = 3 \times 10^8$ m/s
Earth radius, R = 6400 km
Characteristic impedance of free space, $Z_o = 120\pi\ \Omega$
Bolt Zamman's constant $K = 1.38 \times 10^{-23} J/K$

This paper consists of 5 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: COMMUNICATION SYSTEMS

*Answer **THREE** questions from this section.*

1. (a) State **three** desirable characteristics of a radio transmitter. (3 marks)

(b) With the aid of a labelled block diagram, describe the filter method of generating single band (SSB) signals. (8 marks)

(c) A frequency modulator has an output voltage wave given by:
$v(t) = 16\cos\{6 \times 10^8 t + 3\sin 1250t\}$

Determine the:

(i) carrier signal frequency;
(ii) modulating signal frequency;
(iii) modulating index;
(iv) maximum frequency deviation;
(v) power dissipated in a $20\,\Omega$ resistor. (9 marks)

72 2. (a) State **three** demerits of amplitude modulation systems. (3 marks)

(b) Show that the power transmitted in an A.M wave is given by:

$$P_t = P_c(1 + \frac{m^2}{2})$$

Where:

P_t = power transmitted
P_c = power of the carrier
m = modulation index (6 marks)

(c) A carrier wave of frequency 10 MHz and peak value of 10 V is amplitude modulated by a 5 kHz sine wave of amplitude 6 V:

(i) Determine the:

I. modulation factor;
II. lower side band frequency;
III. upper side band frequency;
IV. draw the frequency spectrum. (8 marks)

(d) State the **three** primary colours used in TV systems. (3 marks)

3. (a) List **three** roles of the Communication Authority of Kenya (C.A.K). (3 marks)
(b) Draw the frequency spectrum of a PAL TV system. (4 marks)

(c) A coloured TV standard using interlaced scanning consists of 1250 lines per frame and 25 frames per second:

Determine the:

(i) line scan frequency;
(ii) field scan period;
(iii) field scan frequency. (7 marks)

(d) (i) State **two** advantages of optic fibre cable over satellite communication.
(ii) An optical fibre cable is made up of glass with core and cladding refractive indices of 1.48 and 1.45 respectively:

Determine the:

(i) numerical aperture;
(ii) acceptance angle. (6 marks)

4. (a) Define each of the following with respect to RADAR systems:

(i) duty cycle;
(ii) range resolution;
(iii) maximum unambiguous range. (3 marks)

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(b) With the aid of a labelled diagram, describe the operation of a Continuous Wave (CW) RADAR system. (7 marks)

(c) A RADAR system operates at 7.5 GHz with a pulse repetition frequency of 900 pulses per second. Determine the **two** lowest blind speed in, km/h. (6 marks)

(d) Table 1 shows different frequency bands in a fixed satellite communication. Complete the table by specifying the range frequencies. (4 marks)

Table 1

S/No.	Frequency Band	Range in GHz
1.	*C*	———
2.	K_u	———

5. (a) State **three** advantages of 3G over 2G mobile technology. (3 marks)

(b) Describe each of the following technologies:

(i) 4G systems;
(ii) interactive TV. (6 marks)

(c) Table 2 shows different types of cellular technologies and their corresponding generations. Complete the table. (4 marks)

Table 2

Technology Characteristics	Mobile Network generation
FDMA	———
TDMA	———
WCDMA	———
EDGE	———

(d) A GSM 1800 MHz digital cellular network has the following characteristics:

- One way frequency range: 18020-1840 MHz
- RF channel spacing = 200 kHz
- Number of users per channel = 8

Determine the:

(i) two way channel bandwidth;
(ii) number of R.F channels;
(iii) total number of TDM channel. (7 marks)

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SECTION B: TELECOMMUNICATION PRINCIPLES

*Answer **TWO** questions from this section.*

6. (a) Distinguish between TE and TM modes with respect to waveguide propagation. (2 marks)

(b) With the aid of a labelled diagram, explain the operation of a two-cavity klystron amplifier. (8 marks)

(c) A rectangular waveguide measures $2 \times 3.5\,cm$ internally and has a 12 GHz signal propagating in it. For the $TE_{1,1}$ mode, determine the:

(i) cut-off wavelength;
(ii) group velocity;
(iii) phase velocity;
(iv) characteristic impedance. (10 marks)

7. (a) Describe each of the following types of noise in communication systems:

(i) shot noise;
(ii) flicker noise;
(iii) Johnson noise. (6 marks)

(b) Two resistors of 20 kΩ and 50 kΩ are at room temperature of 290 K. For a bandwidth of 100 kHz, determine the thermal noise voltage generated by the two resistors in :

(i) series;
(ii) parallel. (5 marks)

(c) Draw a labelled diagram of unshield twisted pair cable. (2 marks)

(d) (i) State **three** merits of using Tropospheric Scatter radio links.
(ii) With the aid of a labelled diagram, describe multi-hop mode of sky wave propagation. (7 marks)

8. (a) Define each of the following with respect to antennas:

(i) beam width;
(ii) polarization;
(iii) directivity. (3 marks)

(b) (i) Draw a construction diagram of a Rhombic Antenna and describe its operation.
(ii) State **three** merits of the antenna in (b)(i). (9 marks)

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(c) A television transmitting antenna mounted at a height of 120 m radiates 15 kW of power equally in all directions. A receiving antenna of height 16 m is located at the radio horizon. Taking equivalent earth's radius factor due to atmosphere condition $K = \frac{4}{3}$ determine the maximum line of sight range for the antenna. (4 marks)

(d) **Figure 1** shows a diagram of Broadside array antenna. Describe its operation. (4 marks)

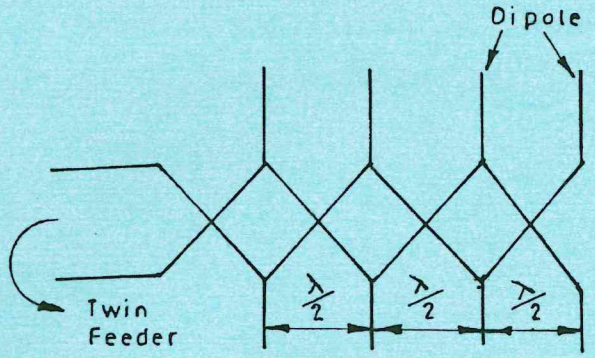

Fig. 1

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