2507/206
COMMUNICATION AND
TELECOMMUNICATION SYSTEMS
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS OPTION)

MODULE II

COMMUNICATION AND TELECOMMUNICATION SYSTEMS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non programmable scientific calculator.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing any **THREE** questions from section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.
***Take:** **Velocity of light** $C = 3.0 \times 10^8$ m/s*

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.

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Turn over

SECTION A: COMMUNICATION SYSTEMS

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

1. (a) (i) List **three** services provided by satellite communication systems.

(ii) With the aid of a labelled diagram, explain an elliptical orbit with respect to satellite communication. (9 marks)

(b) Describe the following components of a satellite in orbit:

(i) power supply;

(ii) attitude and orbit control. (6 marks)

(c) An 800 MHz radio link uses an antenna whose transmit gain is 35 dB while the receive antenna gain is 28 dB. The signals are received 50 km away. Determine the overall pathloss in dB. (5 marks)

2. (a) (i) List **two** advantages of the continuous wave radar over the pulsed radar system.

(ii) With the aid of a labelled diagram, describe monopulse tracking as applied to radar systems. (9 marks)

(b) (i) A radar system, operating at 950 MHz, uses an antenna whose capture area is $4\ m^2$ to radiate 20 kW towards a target. The target cross-sectional area is $12\ m^2$ and the received power is 400 pW. Determine the radar range.

(ii) A moving target indication radar operates at 6 GHz with a pulse repetition frequency of 900 pulses per second. Determine the first blind speed. (7 marks)

(c) With the aid of a labelled diagram, describe conical antenna scanning as applied to radar systems. (4 marks)

3. (a) State the function of each of the following in a colour TV receiver:

(i) sync separator;

(ii) chroma detector. (2 marks)

(b) Figure 1 shows a simplified block diagram of a monochrome TV transmitter.

(i) Describe its operation;

(ii) Sketch the waveform at point 1 and response curves at points 2 and 3.

(12 marks)

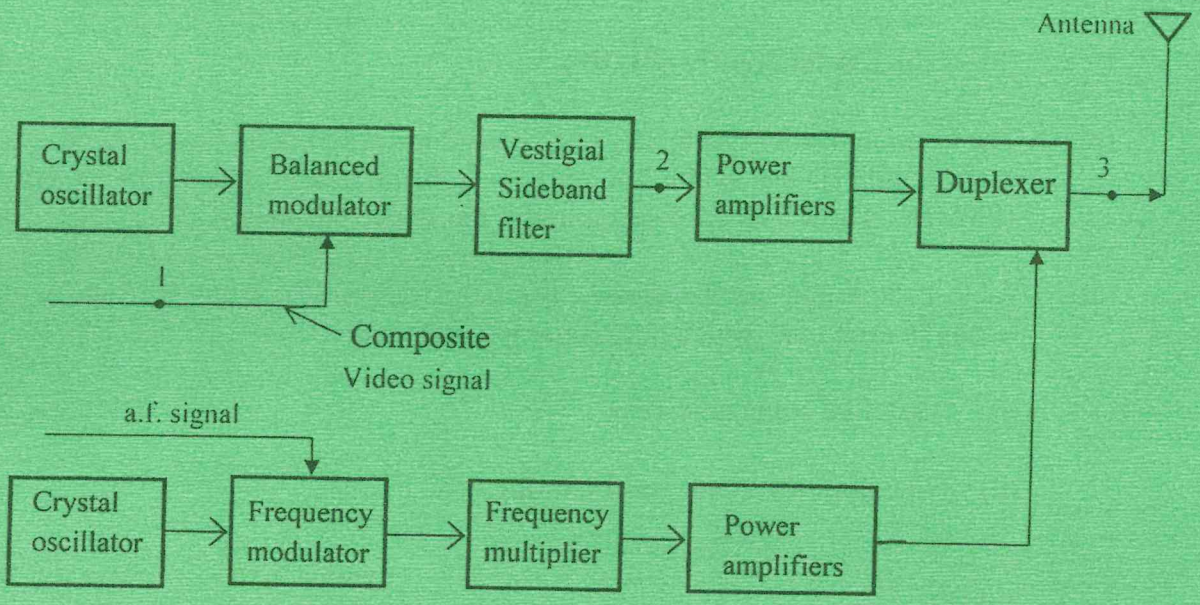

Fig. 1

(c) (i) Explain sub carrier as applied to a colour TV receiver.

(ii) The primary colours red, green and blue have picture colour amplitudes of 0.3 V, 0.59 V and 0.11 V respectively. Determine the amplitude of the:

I. yellow colour;
II. magenta colour.

(6 marks)

4. (a) (i) List **two** areas of application of a varactor diode.

(ii) Draw a labelled block diagram of a low-level modulation AM transmitter and describe its operation.

(8 marks)

(b) An FM system with a modulation index of 8, transmits an a.f. signal of 3 kHz. Determine the:

I. transmission bandwidth;
II. new bandwidth when the modulation index is reduced to 5.

(ii) A frequency modular has a carrier of 90 MHz at an amplitude of 10 V. When the modulating signal of 4 sin 6280 t volts is applied, the frequency deviation is 12 kHz. Derive the expression for the FM signal wave.

(12 marks)

5. (a) Explain the following emerging technologies:

(i) interactive TV;

(ii) high definition TV (HDTV). (6 marks)

(b) The Communications Authority of Kenya allocates FM radio broadcast channels, each of 180 kHz bandwidth and 5 kHz guardband, to subscribers from 88 MHz to 108 MHz. Draw a labelled spectrum for the 1st two channels. (8 marks)

(c) Table 1 shows the specifications of two radio transmitters, A and B. State, with a reason in each case, which transmitter is suitable for:

(i) satellite communication;

(ii) medium wave radio broadcasting. (4 marks)

Table 1

Transmitter	Radiated power (kW)	Operating Frequency (MHz)
A	5	2000
B	300	0.8

(d) List **two** functions of a transmitter matching network. (2 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

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

6. (a) List **two** areas of application of optical fibres in communication. (2 marks)

(b) Table 2 shows data for an optical detector.

(i) Plot the response curve.

(ii) Determine the:

I. transmission bandwidth;
II. frequencies at which the output power is 35 μW;
III. frequency for the highest conversion. (8 marks)

Table 2

Frequency (THz)	0	50	100	150	200	250	300	350	400	450
Output power (μW)	0	12	30	60	90	64	40	20	8	0

(c) (i) With the aid of a labelled construction diagram, describe the operation of a light emitting diode.

(ii) An optical fibre has a core of refractive index of 1.84 and cladding of refractive index of 1.69. The wavelength of the signal propagating through the fibre is 0.9 μm. Determine the:

(I) numerical aperture;
(II) signal frequency. (10 marks)

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

I. gain;
II. efficiency.

(ii) With the aid of a labelled diagram, describe the cassegrain feed method for a parabolic dish antenna. (8 marks)

(b) A parabolic dish antenna has a capture area of $A_o\ m^2$, an actual area of A m^2 and 65% efficiency. It operates at a frequency f Hz and the mouth diameter is D meters. Derive the expression for the power gain. (5 marks)

(c) A parabolic dish antenna operates at 6 GHz and has a mouth diameter of 45 m. Determine the:

(i) 3 dB beamwidth;

(ii) beamwidth at the nulls;

(iii) power gain, in dB. (7 marks)

8. (a) Define each of the following as applied to noise in communication systems:

(i) signal-to-noise ratio;

(ii) noise figure. (2 marks)

(b) (i) With the aid of a voltage - wavelength response curve, describe standing waves in a mismatched transmission line.

(ii) A transmission line has a forward voltage of 250 mV and a reflected voltage of 15 mV. Determine the:

I. voltage standing wave ratio (VSWR);
II. voltage reflection coefficient. (9 marks)

(c) (i) Figure 2 shows a two-stage amplifier interconnected by line links. Determine the overall gain of the amplifier.

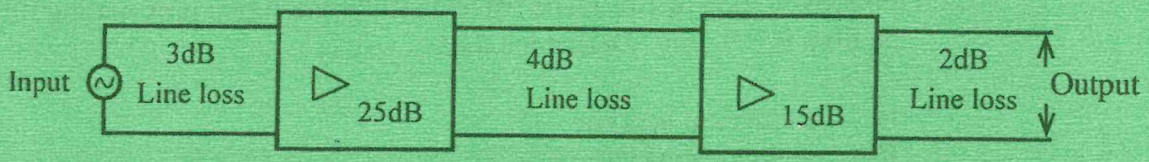

Fig. 2

(ii) A DSB-AM system has a carrier of 800 kHz and an a.f. signal of the range 0.3 kHz to 15 kHz. Determine the:

I. frequencies of the lower side band;
II. frequencies of the upper side band;
III. transmission bandwidth. (9 marks)

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