2507/206
COMMUNICATION AND
TELECOMMUNICATION SYSTEMS
Oct./Nov. 2016
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:
Non-programmable scientific calculator;
Answer booklet.
*This paper consists of **EIGHT** questions in **TWO** sections A and B.*
*Answer any **THREE** questions in section A and any **TWO** questions in 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.

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.

Turn over

SECTION A: COMMUNICATION SYSTEMS

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

1. (a) With the aid of a labelled block diagram, explain the operation of an AM Radio transmitter. (6 marks)

   (b) Sketch wave diagrams to show how an information signal and a carrier wave can be combined to form an AM signal. (6 marks)

   (c) An information signal has a maximum frequency of 15 kHz, the maximum frequency deviation of the carrier is ±75 kHz.
   Determine the:

   (i) practical bandwidth of the resultant FM signal;

   (ii) number of available channels; if the channel spacing is 200 kHz on the 88 - 108 MHz VHF band;

   (iii) length required for a half-wave dipole if the carrier signal frequency is 90 MHz. (8 marks)

2. (a) Explain the principle of operation of a TV camera. (4 marks)

   (b) With the aid of a labelled block diagram, describe the operation of a monochrome TV receiver. (10 marks)

   (c) For a video signal, H_R is the number of lines scanned within a given time and t is the time in seconds taken to scan the lines. If $H_R = 533$ and $t = 52\ \mu s$.
   Determine the video bandwidth for the system. (6 marks)

3. (a) Distinguish between fixed service and broadcast service categories of communication satellites, stating an example in each case. (4 marks)

   (b) Explain the functions of the following components of a geostationary satellite communication system:

   (i) antenna;
   (ii) transponder;
   (iii) command and telemetry subsystem.

   (6 marks)

   (c) With the aid of a labelled diagram, describe how VSATs connected in a star topology communicate. (10 marks)

4. (a) Define each of the following types of wireless technologies:

(i) Wi-Fi;
(ii) Wimax.

(2 marks)

(b) Explain each of the following trends in communication systems.

(i) 3G systems;
(ii) 4G systems.

(4 marks)

(c) With the aid of a block diagram, describe the operation of a digital TV receiver.

(8 marks)

(d) Draw a block diagram of an audio/video streaming architecture components and explain how streaming is achieved over the web. (6 marks)

5. (a) Define the following terms as used in Radar communication:

(i) Pulse repetition (PRT);
(ii) Maximum unambiguous range (Mur);
(iii) Maximum range.

(3 marks)

(b) With the aid of a block diagram, explain the principle of operation of a tracking Radar.

(8 marks)

(c) A low-power, short range Radar is solid-state throughout, including a low-noise RF amplifier which gives it an overall noise figure of 4.77 dB. If the antenna diameter is 1 m, the IF bandwidth is 500 kHz, the operating frequency is 8 GHz and the radar set is capable of detecting targets of 5 m^2 cross sectional area at maximum distance of 12 km. Determine the value of the peak transmitted pulse power. (7 marks)

(d) State any **two** data display methods used in radar technology. (2 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

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

6. (a) (i) Define the term "noise" as applied in telecommunications.

(ii) Differentiate between modulation noise and thermal noise as applied to transistor devices in telecommunication systems.

(5 marks)

(b) A receiver connected to an antenna whose resistance is 50 Ω has an equivalent noise resistance of 30 Ω.
Determine the:

(i) receiver's noise figure, decibels (dB);

(ii) equivalent noise temperature.

(6 marks)

(c) With the aid of a circuit diagram, derive the expression for equivalent noise voltage (Vn) of a resistor R, at a temperature T, kelvin. (7 marks)

(d) State any **two** advantages of waveguides over transmission lines. (2 marks)

7. (a) (i) Distinguish between linear polarisation and random polarisation as applied to electromagnetic waves. (2 marks)

(ii) With the aid of a diagram, explain the multipath sky-wave propagation in relation to the ionosphere. (6 marks)

(b) (i) Define the term "standing wave ratio".

(ii) A (200 + j75)Ω load is to be matched to a line to give SWR = 1.

Determine the:

(I) reactance of the stub, connected directly to the load;

(II) characteristic impendence of the quarter-wave transformer connected directly to the load.

(12 marks)

8. (a) (i) Define the term "antenna".

(ii) State with reasons the application of each of the following types of antennae:

(I) Wideband antennae;

(II) Helical antennae.

(5 marks)

(b) A parabolic reflector is used at 6 GHz, for nulls of 2 m. Determine the:

(i) bandwidth between nulls;

(ii) gain of the Antenna.

(6 marks)

(c) The antenna current of an AM transmitter is 8 A when only the carrier is sent, but it increases to 8.93 A when the carrier is modulated by a single sine wave. Determine the:

(i) percentage modulation;

(ii) antenna current when the modulation changes to 0.8%.

(9 marks)

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