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 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 indicated.
Candidates should answer the questions in English.

Take: Free space wave velocity, $c = 3 \times 10^8$ m/s
         Free space impedance, $Z_o = 377\Omega$

SECTION A: COMMUNICATION SYSTEMS

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

1. (a) (i)   List **three** challenges faced when migrating from analog to digital TV transmission.

    (ii) A closed circuit TV system consists of four TV cameras, a video mixer, a video recorder and a video monitor. Draw a labelled sketch for the arrangement of the system and describe its operation.

    (11 marks)

    (b) With the aid of frequency spectra, describe the colour video signal sidebands.

    (9 marks)

2. (a) Define each of the following as applied to satellite communications:

    (i)   footprint;
    (ii)   station-keeping.

    (2 marks)

    (b) (i)   Figure 1 shows a block diagram of an earth satellite station. Describe its operation.
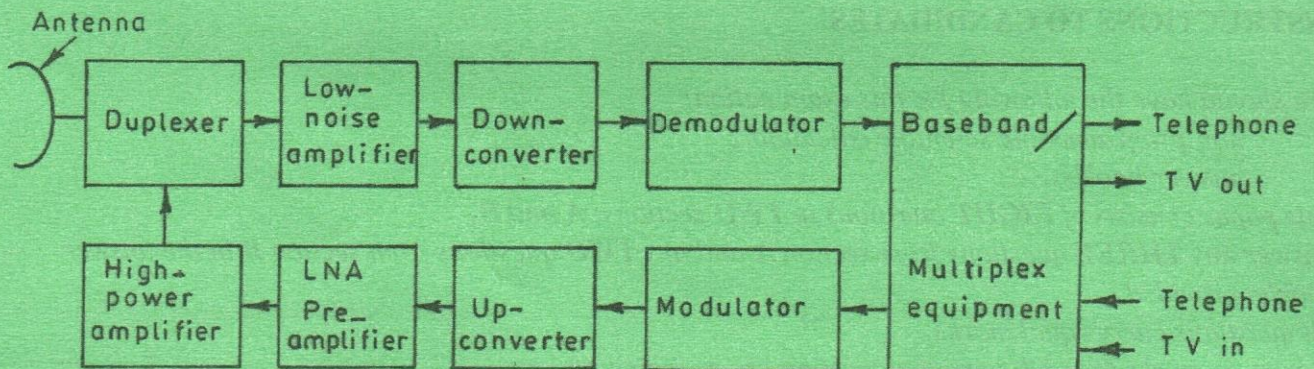

Fig.1

    (ii) Draw a labelled block diagram of the power sub-system of a satellite and describe its operation.

    (13 marks)

(c) An earth station operating at 6 GHz radiates 6 W towards a space satellite located 36,000 km away. It uses an antenna whose gain is 16 dB and effective aperture of 12 m. Determine the:

(i) power flux density at the receiving point;
(ii) received power.

(5 marks)

3: (a) (i) List **two** applications of the continuous wave radar.

(ii) Figure 2 shows a simplified block diagram of a pulsed radar system. Describe its operation.
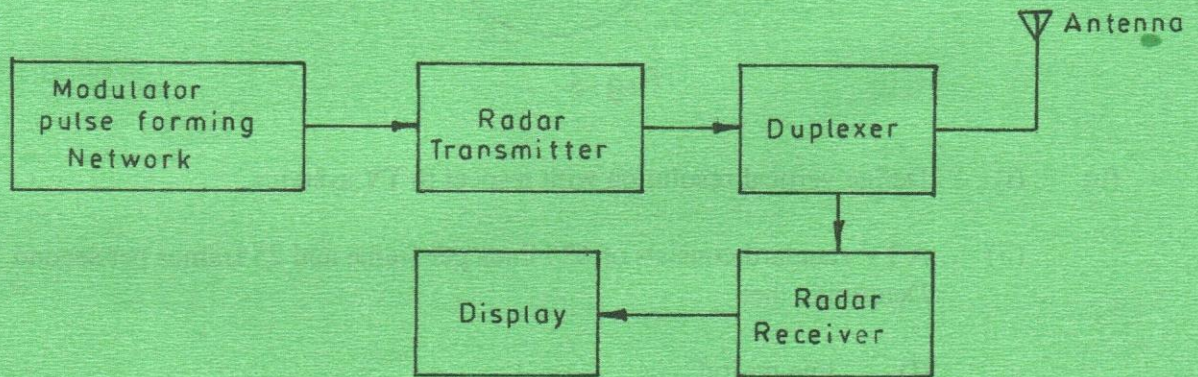
(6 marks)

Fig. 2

(b) An 8 GHz radar system scans a target over a range of 900 km in 25 secs. Determine the:

(i) doppler frequency shift;
(ii) target relative velocity.

(5 marks)

(c) (i) With the aid of a labelled diagram, describe the operation of the A scope radar system display.

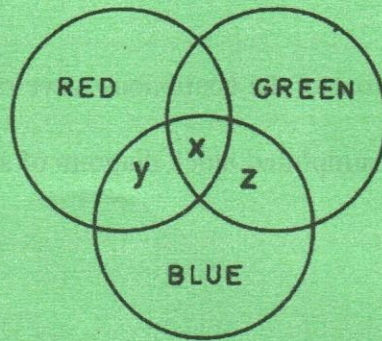(ii) Define each of the following with respect to radar systems:

(I) clutter;
(II) angle resolution.

(9 marks)

4.ʼ   (a)   (i)   Outline **three** key features of the 4 G mobile communication system.

      (ii)   Figure 3 shows a diagram for mixing primary colours. Identify the colours marked x, y and z.

(6 marks)

Fig.3

(b)   (i)   Define vertical resolution with respect to TV systems.

      (ii)   A TV standard consists of 625 lines per frame and 25 frames per second. Determine the:

            (I)   line period;
            (II)   field frequency;
            (III)   vertical resolution if the active lines are 575.

(7 marks)

(c)   With the aid of a circuit diagram, describe the operation of a varactor diode frequency modulator. (7 marks)

5.   (a)   Draw a labelled block diagram of an indirect FM transmitter and describe its operation.

(8 marks)

(b)   Figure 4 shows a circuit diagram of a pre-emphasis network used in an FM transmitter.

      (i)   Describe its operation.
      (ii)   Sketch the pre-emphasis response curve.
      (iii)   Determine the circuit time constant, τ, when R_L is 3 kΩ and L is 150 mH.

                                                                    (9 marks)

Fig. 4

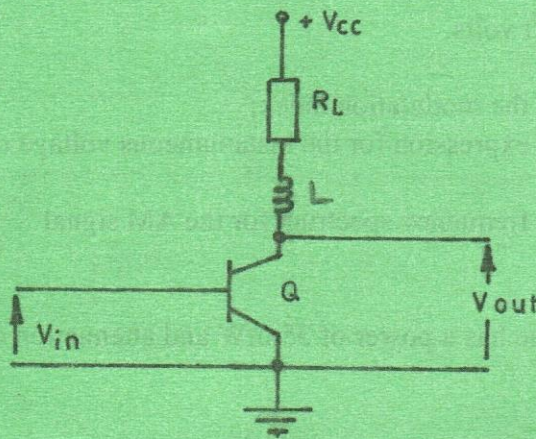(c)   List **three** advantages of the single sideband AM over the double sideband AM system.

                                                                    (3 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

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

6.   (a)   (i)   List **three** losses that occur in optical fibers.

          (ii)   With the aid of a labelled raypath diagram, describe light propagation in a single mode optic fiber.

                                                                   (8 marks)

(b)   With the aid of a labelled diagram, describe the coupling of a signal from a coaxial line to a circular waveguide using a taper section.

                                                                     (6 marks)

(c)   A circular waveguide whose internal diameter is 5 cm has a signal whose frequency is 10 GHz propagating in it in the $TE_{1,1}$ mode. Determine the:

      (i)   cut-off wavelength;
      (ii)   characteristic wave impedance. (Take Kr = 1.84)

                                                                        (6 marks)

7. (a) Define each of the following with respect to propagation of sky radio waves:

  (i)   maximum usable frequency;
  (ii) critical angle.

  (2 marks)

  (b) An amplitude modulated signal has a carrier of 10 V, 800 kHz and a modulating signal of $4 \sin 30\pi \times 10^3 t$ volts.

  (i)   determine the modulation index;
  (ii) derive the expression for the instantaneous voltage of the double sideband AM signal;
  (iii) sketch the frequency spectrum for the AM signal.

  (11 marks)

  (c) A transmission line has a power of 35 mW and attenuation of 6 Nepers at a point. Determine the:

  (i)   absolute power, in dBm;
  (ii) voltage at that point.

  (4 marks)

  (d) A binary phase shift keying modulator has an input of 10101010_2. Sketch the input and output waveforms of the modulator.   (3 marks)

8. (a) (i)   List **three** sources of losses in an antenna.

  (ii) With the aid of a labelled diagram, describe the operation of a 5-element log-periodic antenna.

  (11 marks)

  (b) A mismatched transmission line has a signal of 600 mV at its input and the reflected signal is 80 mV. Determine the:

  (i)   voltage reflection coefficient;
  (ii) voltage standing wave ratio.

  (4 marks)

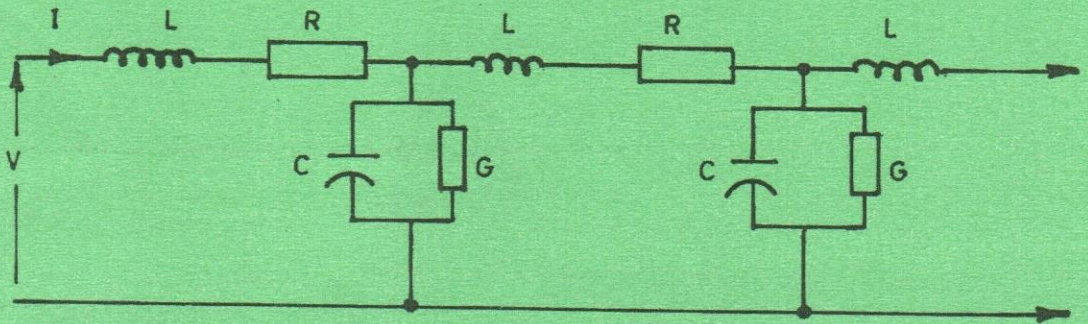(c) Figure 5 shows the equivalent circuit diagram of a transmission line. Explain the primary constants. (5 marks)

Fig. 5

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