2507/206
COMMUNICATION AND
TELECOMMUNICATION SYSTEMS
June/July 2020
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING
(AVIONICS OPTION)
MODULE II

COMMUNICATION AND TELECOMMUNICATIONS SYSTEMS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Mathematical tables/Non programmable scientific calculator;
Answer booklet.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **THREE** questions in Section **A** and **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 **THREE** questions from this section.*

1. (a) (i) State **two** applications of continuous wave Doppler radar.

(ii) Explain blind speed as applied to radar systems and state its significance. (5 marks)

(b) (i) **Figure 1** shows a block diagram of a continuous wave Doppler radar. Describe its operation.

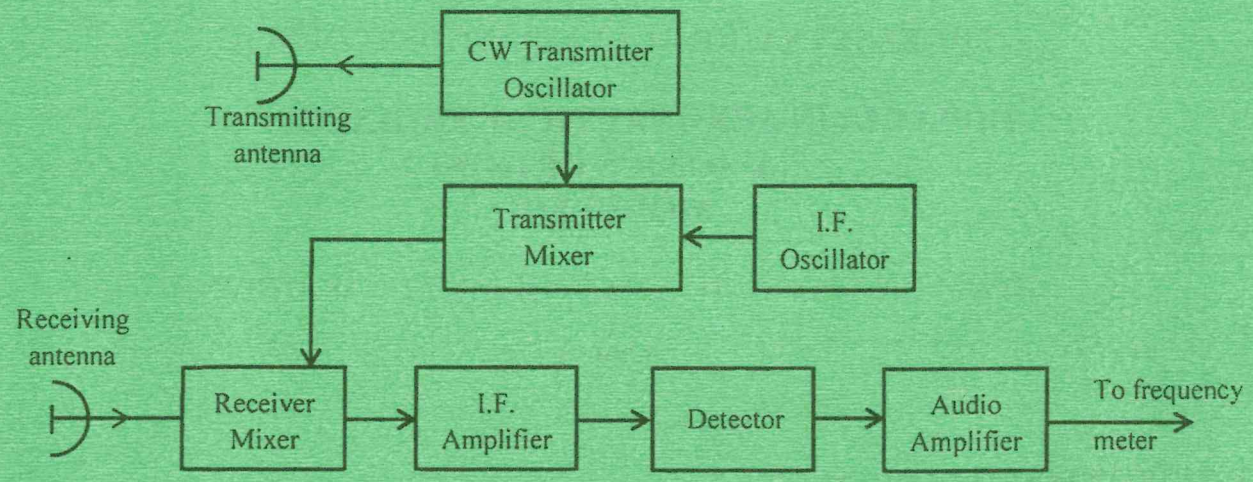

Fig. 1

(ii) A radar system, operating at 900 MHz over a 60 km range uses an antenna whose capture area is $8m^2$. The target cross-sectional area is $12\ m^2$ and the peak pulsed power radiated is 12 kW. Determine the minimum receivable power. (9 marks)

(c) Table 1 shows characteristics of tracking and search radars

(i) Identify each type.

(ii) State, with reason, one application area of each radar. (6 marks)

Table 1

Radar	A	B
Range (km)	1500	15
Antenna Beamwidth(°)	80	2

2. (a) (i) List **three** merits of single sideband amplitude modulation radio systems.

(ii) With the aid of a circuit diagram, describe pre-emphasis with respect to frequency modulation (FM). (8 marks)

(b) An FM modulator has a sensitivity of 4 kHz/V and produces a frequency deviation of 30 kHz when a modulating signal of 10 kHz is applied.
Determine the:

(i) modulation index;

(ii) required bandwidth;

(iii) amplitude of the modulating signal. (6 marks)

(c) (i) The power, P_t, radiated by a double sideband amplitude modulation system is given by:

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

where:

P_c = carrier power, W.
m = modulation index.

Derive the expression for the transmission efficiency from the above expression.

(ii) Determine the modulation index for an AM system in which the carrier wave is modulated by two signals whose modulation indices are 0.45 and 0.55. (6 marks)

3. (a) (i) State **three** merits of satellite communication.

(ii) With the aid of a labelled block diagram, describe the operation of the power subsystem of a space satellite. (10 marks)

(b) (i) An AM modulator is fed with a modulating signal of $E_m \sin \omega_m t$ and a carrier signal whose amplitude is E_c. Derive the expression for the double sidedband AM signal.

(ii) A TV standard specifies 1050 lines per frame and 25 frames per second. Determine the number of active lines. (10 marks)

4. (a) (i) Explain interlaced scanning in TV system.

(ii) With the aid of a spectrum diagram, explain vestigial sideband transmission in black and white TV systems. (9 marks)

(b) Twelve TV stations, each of 6 MHz bandwidth, are allocated channels from 360 MHz. The channels are separated by 50 kHz guard bands.

(i) Determine the frequencies of the 1st four channels.

(ii) Draw the transmission spectrum for the 1st four channels.

(7 marks)

(c) Describe picture elements with respect to a colour TV picture tube. (4 marks)

5. (a) Explain each of the following:

(i) 4G mobile networks;
(ii) MPEG. (6 marks)

(b) **Figure 2** shows the waveform of a double sideband amplitude modulated signal in which the carrier power is 100 kW. Determine the:

(i) modulation index;
(ii) radiated power;
(iii) power of each sideband;
(iv) transmission efficiency. (8 marks)

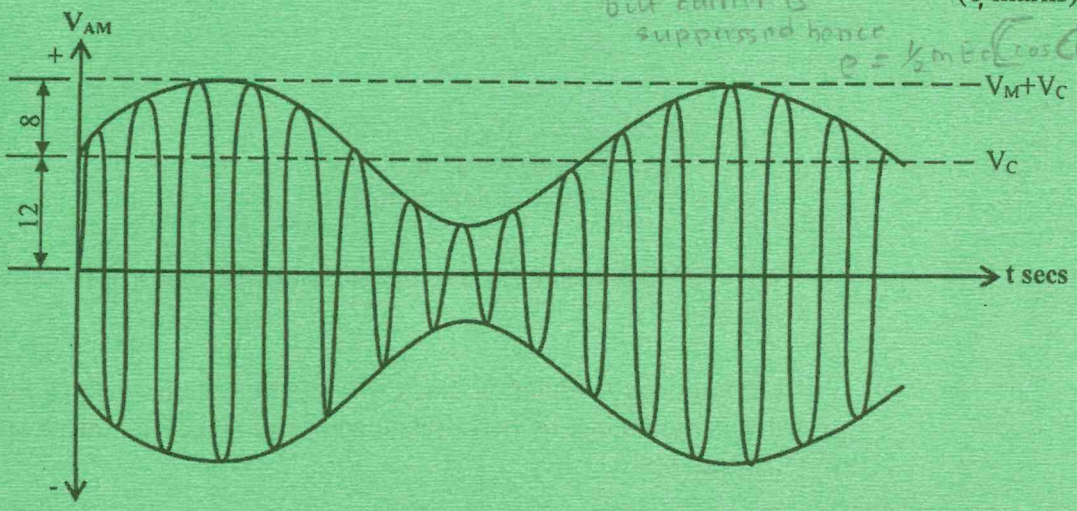

Fig. 2

(c) The production unit for an independent sideband (i.s.b) signal consists of two filters, an oscillator whose signal frequency is 24 MHz, an adder unit, two balanced modulators and two modulating signals of frequency range 3 kHz to 15 kHz.

(i) Determine the sideband frequencies.
(ii) Draw a labelled block diagram of the unit. (6 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

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

6. (a) (i) List **three** services provided by the UHF band.
(ii) With the aid of a ray diagram, describe multi-hop communication in sky wave radio propagation. (9 marks)

(b) (i) An electronic system has an input signal of 40 mV and an output signal of 0.8 volts. The noise signals at its input and output are 800 μV and 100mV respectively. Determine the system noise figure.
(ii) A communication system has an output power of 35 mW. Determine the relative power in dBm. (6 marks)

(c) A sky wave radio communication occurs via an ionospheric layer whose electron density is 2.6×10^{12} electrons/m^3 at a virtual height of 200 km. Determine the:

(i) critical frequency;
(ii) maximum usable frequency. (5 marks)

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

(i) efficiency;
(ii) beam width. (2 marks)

(b) (i) Table 2 shows characteristics of two antennas, A and B. State with reason **one** application of each antenna.

Table 2

Antenna	3dB Beamwidth	Output power (kW)
A	0.2°	5
B	360°	150

(ii) Sketch a response curve of a resonant antenna and explain its shape. (10 marks)

(c) An antenna has a loss resistance of 0.75 Ω and radiation resistance of 50 Ω. It is driven by a current of 5 Amps. Determine the:

(i) input resistance
(ii) input power;
(iii) radiated power;
(iv) power loss. (8 marks)

8. (a) (i) State **two** reasons why standing waves are undesirable on transmission lines.
(ii) With the aid of a labelled diagram, describe the use of a tapered terminating vane in waveguides. (8 marks)

(b) With the aid of a labelled diagram, describe the single stub method of impedance matching in a transmission line. (6 marks)

(c) A lossless transmission line has an inductance, L, of 0.6 μH/m and capacitance, C, of 240 pF/m. It is terminated by a load resistance of 300 Ω and the phase change coefficient, $\beta = 2\pi$ radians.
Determine the:

(i) Characteristic impedance;
(ii) Voltage reflection coefficient;
(iii) Wavelength. (6 marks)

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