

2507/206  
COMMUNICATION AND  
TELECOMMUNICATION SYSTEMS  
Oct. /Nov. 2019  
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 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,  $Z_0 = 377\Omega$

**This paper consists of 7 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 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.

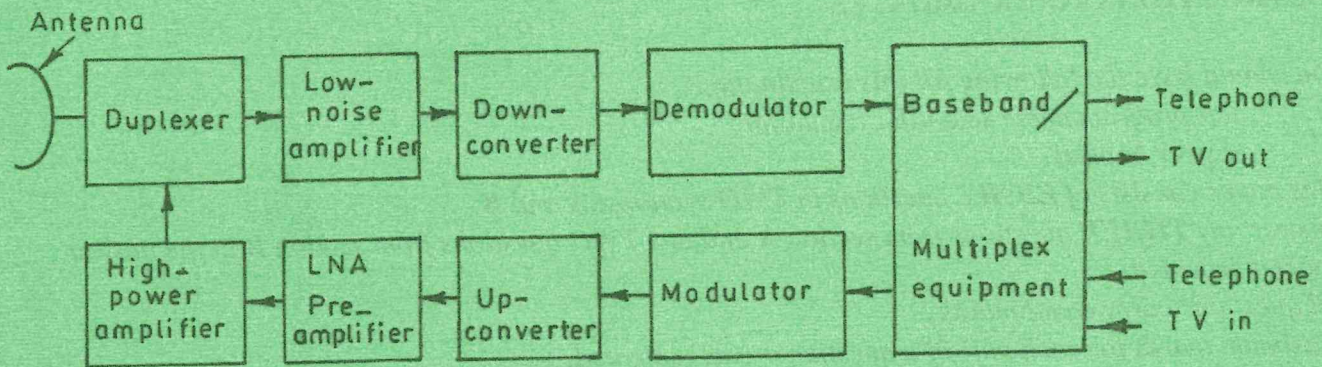


Fig.1

- (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)

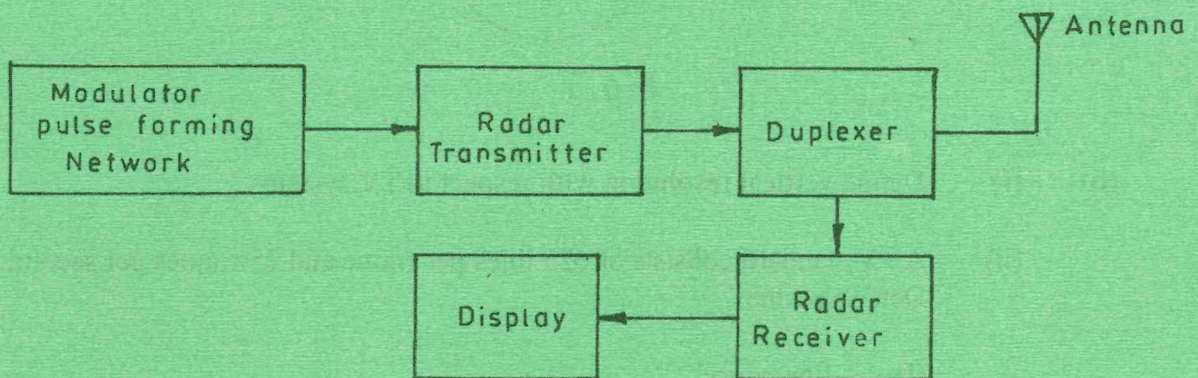


Fig. 2

(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)

*[Handwritten signature and scribbles]*



4. (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)

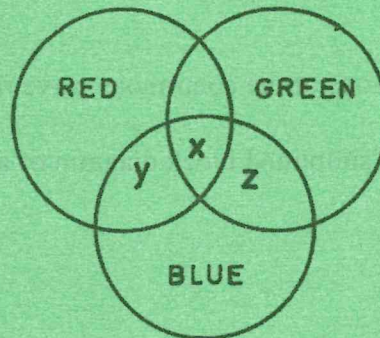


Fig.3

- (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.
- Describe its operation.
  - Sketch the pre-emphasis response curve.
  - Determine the circuit time constant,  $\tau$ , when  $R_L$  is  $3\text{ k}\Omega$  and  $L$  is  $150\text{ mH}$ .
- (9 marks)

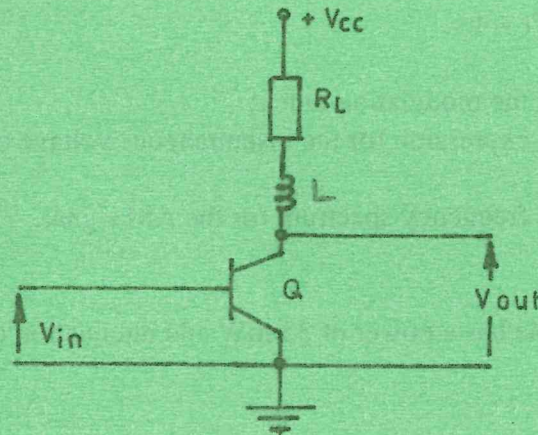


Fig. 4

- (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  $5\text{ cm}$  has a signal whose frequency is  $10\text{ GHz}$  propagating in it in the  $TE_{1,1}$  mode. Determine the:
- cut-off wavelength;
  - characteristic wave impedance. (Take  $K_r = 1.84$ )
- (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)

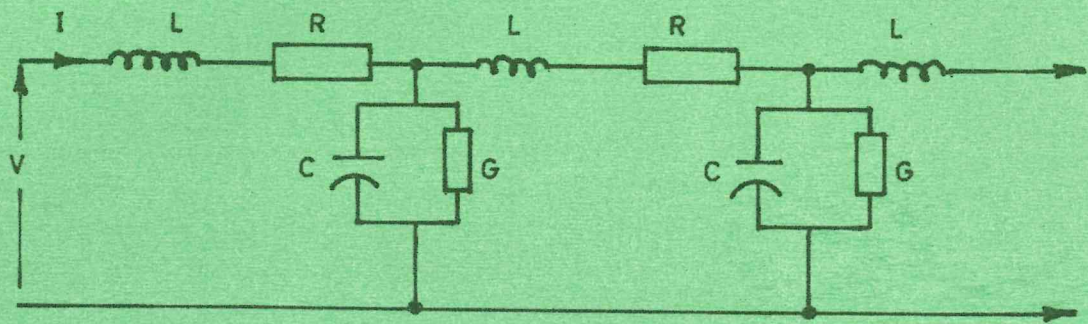


Fig. 5

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