2507/206
COMMUNICATION AND
TELECOMMUNICATION SYSTEMS
Oct./Nov. 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;
Smith chart.
*This paper consists of **EIGHT** questions in **TWO** section; **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 spacewave velocity, c = $3 \times 10^8\ m/s$
Earth radius R = 6400 km

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.

1. (a) State the function of each of the following in a TV system:

(i) synchronisation pulse;
(ii) burst signal.

(2 marks)

(b) (i) Explain the function of a prism in a colour TV camera.

(ii) Draw a labelled composite colour TV picture waveform for one line scan and describe it.

(9 marks)

(c) Figure 1 shows a block diagram of the components of a sync separator used in a TV receiver.

(i) Describe its operation.

(ii) Sketch the waveforms at points 1, 2 and 3.

(9 marks)

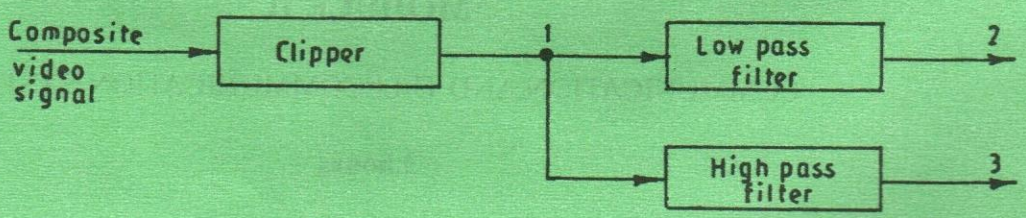


Fig. 1

2. (a) (i) List **two** reasons why the single sideband suppressed carrier (SSBSC) amplitude modulation system is preferred in point-to-point communications.

(ii) Draw a labelled block diagram of the phase-shift method of generating an SSB signal and describe its operation.

(8 marks)

(b) (i) An independent sideband transmitter has a carrier signal of 60 MHz and is used to transmit a.f. signals in the range 0.3 kHz to 20 kHz. Determine the:

(I) frequencies of the lower sideband;
(II) frequencies of the upper sideband;

(ii) Sketch the transmission spectrum.

(8 marks)

(c) A frequency modulation system with a modulation index of 12, transmits an a.f. signal of 16 kHz. Determine the:

(i) frequency deviation;
(ii) required bandwidth.

(4 marks)

3. (a) Explain each of the following with respect to satellite communication:

(i) latency;
(ii) medium-altitude orbit.

(6 marks)

(b) An 800 MHz microwave radio link uses an antenna whose transmit gain is 30 dB to radiate 5 kW power towards a similar antenna located 25 km away. Determine the:

(i) received power, in watts;
(ii) free space pathloss in dB.

(8 marks)

(c) With the aid of a labelled block diagram, describe the operation of a 6/4 GHz satellite transponder. (6 marks)

4. (a) Figure 2 shows the transmit (Tx) and receive (Rx) waveforms of a pulsed radar system.

(i) Identify the durations labelled A, B and C;

(ii) Determine the duty cycle when A is 6 μS, B is 15 μS and C is 30 μS.

(5 marks)

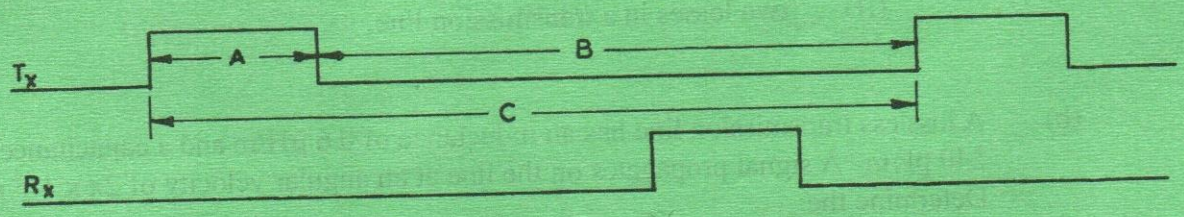


Fig. 2

(b) (i) Explain Doppler effect with respect to radar systems.

(ii) A 600 MHz radar system radiates 20 kW using an antenna whose capture area is 6 m^2. The target cross-sectional area is 15 m^2 and the range is 80 km. Determine the minimum receivable power. (7 marks)

(c) (i) With the aid of a labelled diagram, describe lobe-switching antenna tracking as applied to radar systems.

(ii) A 9 GHz radar system operates with a pulse repetition frequency of 1200 pulses per second. Determine its lowest blind speed. (8 marks)

5. (a) Describe each of the following emerging technologies:

(i) GPRS in GSM;
(ii) multi-media systems.

(6 marks)

(b) With the aid of a labelled diagram, describe the operation of a VSAT network. (7 marks)

(c) (i) Explain link budget as applied to satellite communications.

(ii) List any **two** disadvantages of satellite communications over terestrial radio communication.

(7 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

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

6. (a) (i) List:

(I) **three** applications of a transmission line.

(II) **two** losses in a transmission line.

(5 marks)

(b) A lossless transmission line has an inductance of 0.6 μH/m and a capacitance of 240 pF/m. A signal propagates on the line at an angular velocity of $2\pi \times 10^8$ rads/sec. Determine the:

(i) characteristic impedance of the line;

(ii) phase change coefficient of the signal.

(4 marks)

(c) (i) A DSB amplitude modulation system has a carrier whose amplitude is 10 V and a modulating signal whose amplitude is 6 V. The carrier power is 120 kW. Determine the:

(I) modulation index;
(II) transmission efficiency;
(III) total radiated power;
(IV) power of each sideband.

(ii) Sketch the AM waveform.

(11 marks)

7. (a) Define each of the following as applied to antennas:

(i) front-to-back ratio;
(ii) polar diagram.

(2 marks)

(b) A transmission line, whose characteristic impedance is 600 Ω, is terminated by a load impedance of 390 + j570 Ω. Using the Smith chart provided, determine the:

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

(6 marks)

(c) An ionospheric layer has electron density of 2.2×10^{12} electrons/m^3 at a virtual height of 180 km. Determine the:

(i) critical frequency;
(ii) maximum usable frequency;
(iii) skip distance.

(8 marks)

(d) Explain thermal noise with respect to a communication system. (4 marks)

8. (a) (i) Define each of the following with respect to waveguides:

(I) phase velocity;
(II) cut-off wavelength.

(ii) Figure 3 shows the construction diagram of a light emitting diode. Describe its operation. (5 marks)

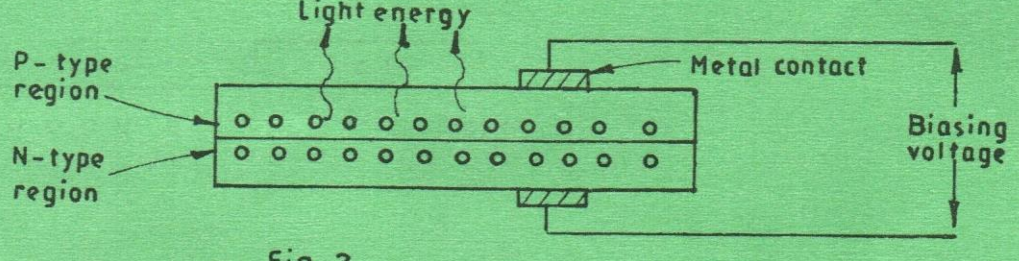


Fig. 3

(b) With the aid of a labelled diagram, describe the use of a capacitive iris in impedance matching in a waveguide. (6 marks)

(c) Figure 4 shows a rectangular waveguide. If the $TE_{2,0}$ mode is launched in the guide, describe with the aid of field patterns the:

(i) electric field along plane YY;
(ii) magnetic field along plane ZZ.

(9 marks)

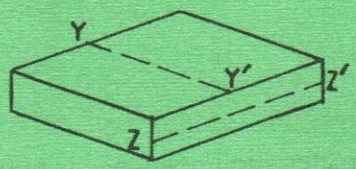
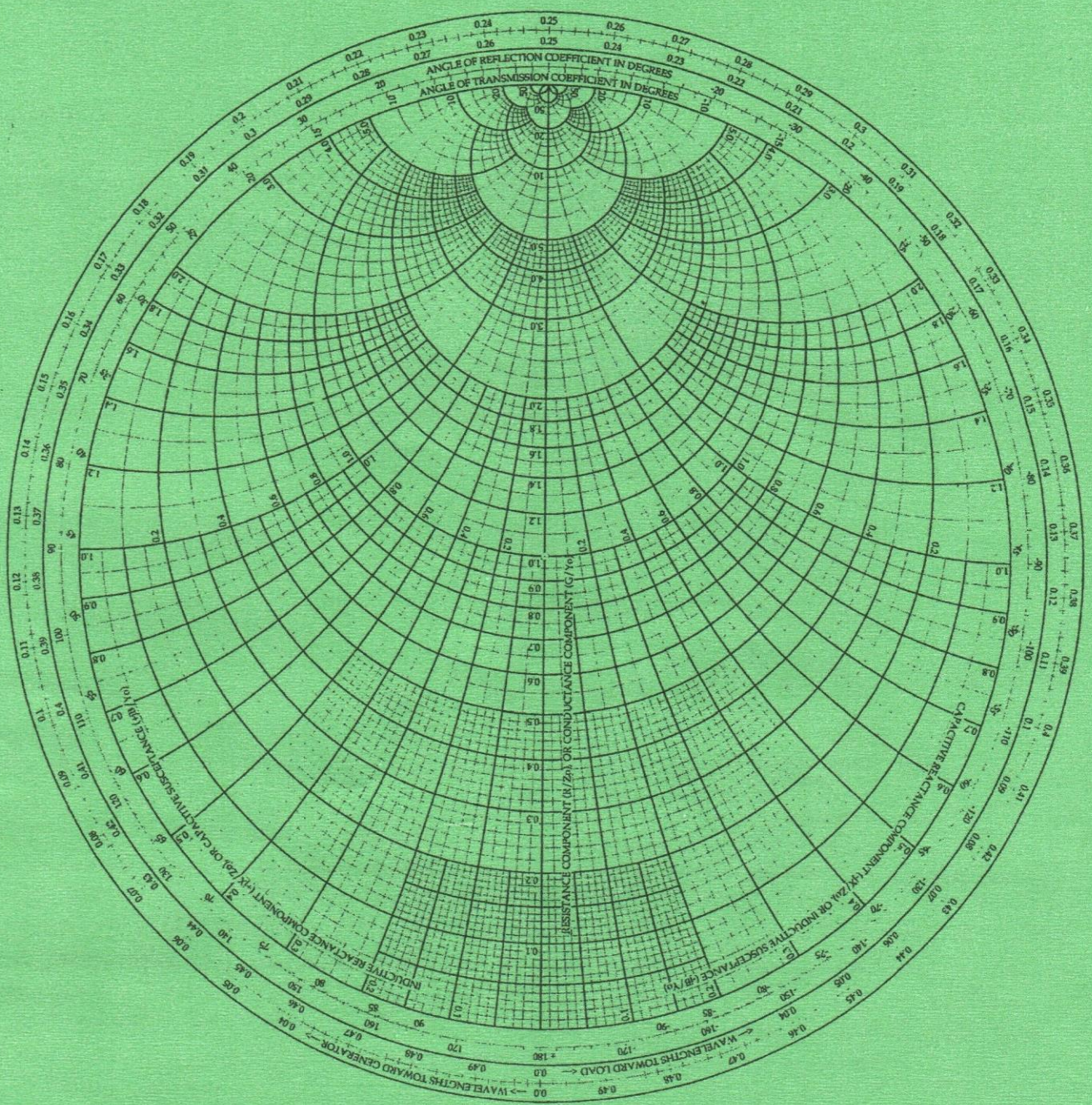


Fig. 4

NAME: _____ INDEX NO: _____



THIS IS THE LAST PRINTED PAGE.