2207/302
TELECOMMUNICATION PRINCIPLES
Oct./Nov. 2017
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING AVIONICS (COMMUNICATION AND NAVIGATION OPTION)

TELECOMMUNICATION PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Mathematical tables/Non-programmable scientific calculator;
Smith chart;
Drawing instruments.
*Answer **FIVE** of the **EIGHT** questions 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.

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) (i) Define the following with respect to silicon controlled rectifiers (SCRs):

I. holding current;
II. forward breakover voltage.

(ii) With the aid of a circuit diagram, describe the operation of a unijunction transistor oscillator used to trigger an SCR.

(8 marks)

(b) (i) State **two** advantages of thermistors over resistance thermometers when used for temperature measurements.

(ii) Figure 1 shows a diagram of a pressure measurement system using a photo detector. Describe its operation.

(6 marks)

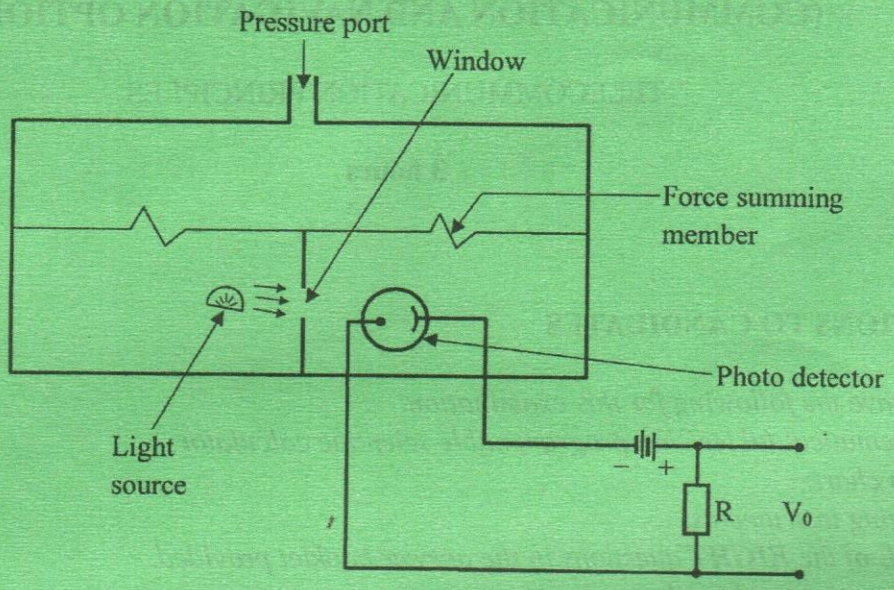


Fig. 1

(c) Figure 2 shows circuit diagram of an astable multivibrator. Determine the:

(i) period of output pulse;
(ii) pulse repetition frequency;
(iii) mark-to-space ratio. (6 marks)

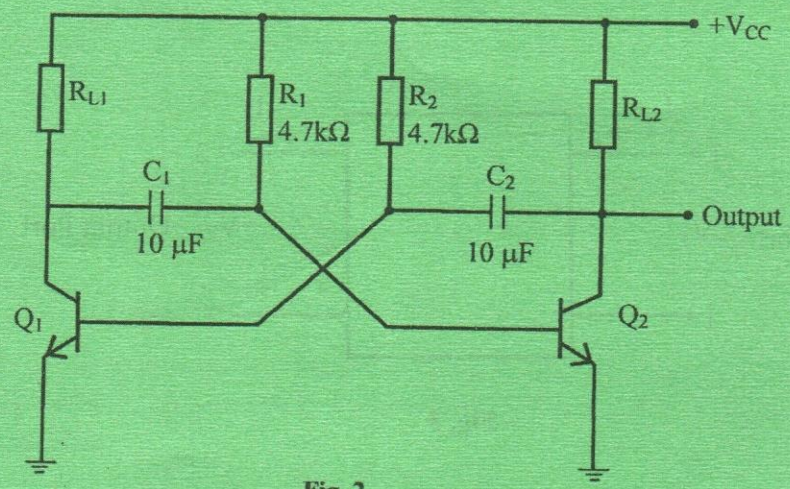


Fig. 2

2. (a) (i) State **three** ways in which interference occur in radio waves.

(ii) With the aid of ray diagram, describe the following modes of radio wave propagation:

I. ground wave;
II. sky wave;
III. space wave.

(9 marks)

(b) Sketch the waveforms for the following pulse amplitude modulated waves, assuming sinusoidal modulating signal:

(i) double-polarity PAM;

(ii) single-polarity PAM.

(4 marks)

(c) A wave travelling in free space enters an ionospheric layer having electron density of 4×10^{11} electrons/m^3. If the angle of incidence is 45°, angle of refraction is 37° and the velocity in free space in 3×10^8 m/s, determine the:

(i) maximum frequency that can be returned to earth;
(ii) optimum working frequency;
(iii) velocity of the wave in the ionospheric layer.

(7 marks)

3. (a) Figure 3 shows a block diagram of a two-port network. Taking I_1 and V_2 as independent variables:

(i) derive the expressions for the h-parameters of the network;

(ii) draw the h-parameter equivalent circuit of the network.

(10 marks)

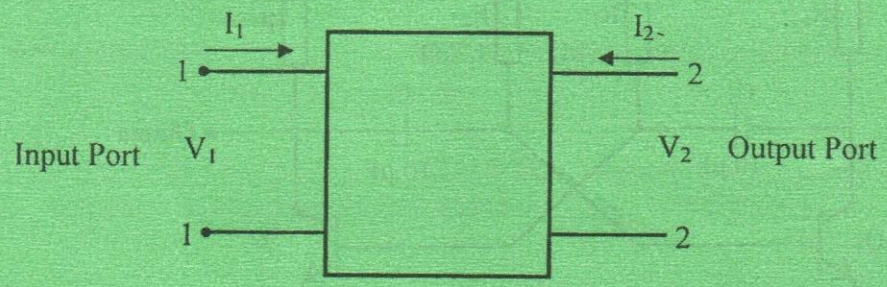


Fig. 3

(b) A transformer-coupled class A audio power amplifier is supplied from a 10 V supply and drives as 8 Ω loudspeaker. The coupling transformer has a turns ratio $N_1:N_2 = 3:1$, the quiescent base bias current = 6 mA and the output voltage varies between $V_{ce\ min}$ = 1.7 V and $V_{ce\ max}$ = 18.3 V. Determine the:

(i) ac resistance on the collector;

(ii) rms value of voltage across the primary winding;

(iii) rms value of voltage across the load;

(iv) ac load power;

(v) second harmonic distortion.

(10 marks)

4. (a) (i) State **two** effects of each of the following on the performance of a single-tuned amplifier:

I. low Q;
II. high Q.

(ii) With the aid of response curves, describe stagger tuning in tuned amplifiers.

(10 marks)

(b) Figure 4 shows the circuit diagram of the frequency determining network of a Hartley oscillator. Derive the expression for the oscillating frequency. (4 marks)

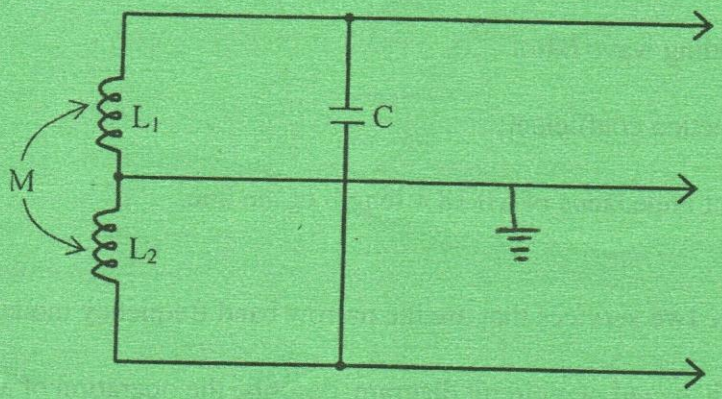


Fig. 4

(c) An LC oscillator tunes over the frequency range 500 Hz to 2,000 Hz.. The coil has a self inductance of 150 μH. Determine the maximum and minimum values of the tuning capacitor. (6 marks)

5. (a) With the aid of a circuit diagram, describe the operation of a diode detector used to demodulate an amplitude modulated (AM) wave. (6 marks)

(b) Derive the expression for the total power, p_t, contained in an AM wave in terms of the carrier power, P_c, and modulation index, m. (5 marks)

(c) The envelope of an AM wave varies between a maximum of 10 V and a minimum of 4 V. Determine the amplitude of the:

(i) carrier;

(ii) modulating signal;

(iii) side frequency components.

(9 marks)

6. (a) (i) Define the following with respect to transmission lines:

I. standing wave ratio;
II. wavelength.

(ii) Sketch the standing wave pattern for both voltage and current in a lossless transmission line terminated in:

I. short circuit;
II. open circuit.

(10 marks)

(b) A transmission line having a characteristic impedance of 50 Ω is terminated by a load of (40 - j50) Ω. Using a Smith chart, determine the:

(i) standing wave ratio;

(ii) reflection coefficient;

(iii) input impedance of a 0.18 λ length of the line.

(10 marks)

7. (a) (i) State **two** services that use the narrow band frequency modulation (FM).

(ii) With the aid of a circuit diagram, describe the operation of an FM balanced slope detector and sketch its response curve.

(12 marks)

(b) An FM wave is represented by the expression $v = 10 \sin (7.45 \times 10^8 t + 4 \sin 1180t)$ volts. Determine the:

(i) carrier frequency in Hz;

(ii) modulating signal frequency in Hz;

(iii) frequency deviation;

(iv) power the wave will dissipate in a 12 Ω resistor.

(8 marks)

8. (a) With the aid of a circuit diagram, describe the operation of a synchro error-detecting system. (6 marks)

(b) (i) State the reasons for including protective devices on the dc motor starters.

(ii) Sketch, on the same axis, speed characteristic curves for shunt, series and compound dc motors respectively.

(5 marks)

(c) (i) Draw labelled block diagrams illustrating the following negative feedback amplifier connections:

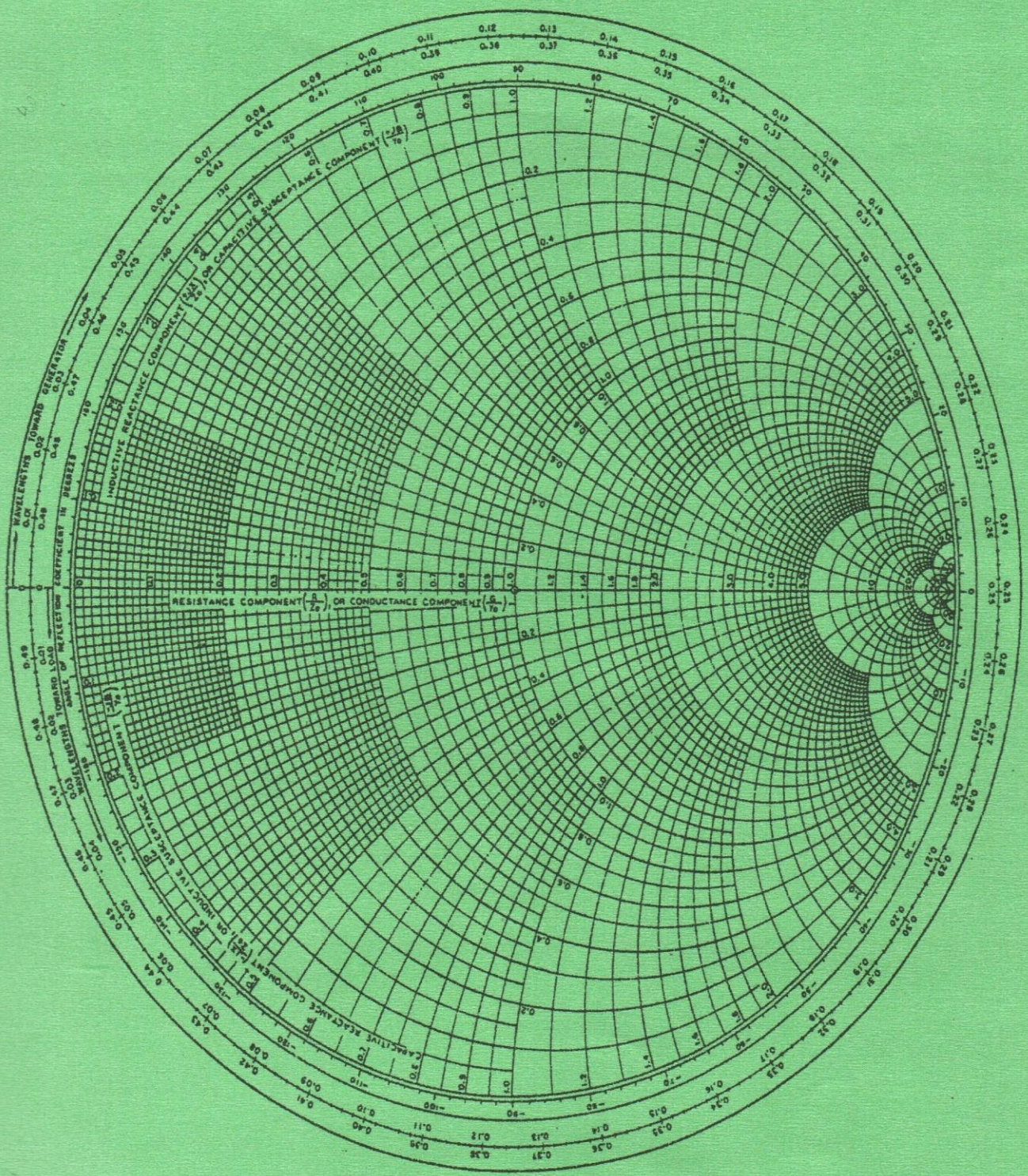
I. voltage series;
II. current series.

(ii) An amplifier has a gain of 1000 before feedback is applied. Determine the percentage change in gain if 0.01 of the output is fed back as negative feedback.

(9 marks)

Name: _____ Index No. _____

IMPEDANCE OR ADMITTANCE COORDINATES



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