2207/302
TELECOMMUNICATION PRINCIPLES
Oct./Nov. 2011
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:
Answer booklet;
Mathematical table/scientific calculator.

*Answer any **FIVE** of the **EIGHT** questions in this paper.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.

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.

1. (a) (i) State how the following line parameters arise in a transmission line:
   I. inductance , L;
   II. capacitance, C;
   III. conductance, G.

   (ii) Describe how a $\frac{\lambda}{4}$ transformer may be used to match a load to a transmission line. (7 marks)

   (b) A lossless transmission line having a characteristic impedance $Z_o = 75\Omega$ is terminated in a resistive load of impedance $Z_L = 250\Omega$. If the voltage across the terminating load is 15V, determine the:

   (i) reflection coefficient for the line;
   (ii) incident current;
   (iii) reflected voltage. (13 marks)

2. (a) (i) State the frequency band for each of the following radio waves:

   I. low frequency (l.f.)
   II. supper high frequency (s.h.f)

   (ii) With the aid of a labelled diagram describe space wave communication. (7 marks)

   (b) Explain the importance of maximum usable frequency (m.u.f) in the propagation of radio waves. (5 marks)

   (c) An electromagnetic wave is refracted when it enters an ionospheric layer having a maximum electron density of 2×10^{10} electrons/m^3. If the angle of incidence is 60^0 and the refractive index is 1.5, determine the:

   (i) angle of refraction;
   (ii) maximum frequency that can be returned to earth;
   (iii) critical frequency. (8 marks)

3. (a) (i) State any **two** advantages of single sideband (SSB) over double sideband (DSB) systems.

   (ii) With the aid of a labelled block diagram describe the phase shift method of generating an SSB signal. (8 marks)

   (b) With the aid of waveforms explain how a pulse position modulated (PPM) signal is obtained from a pulse width modulated (PWM) signal. (7 marks)

(c) A carrier wave is amplitude modulated (AM) to a depth of 50%. If the carrier and one sideband are suppressed in the AM wave, determine the percentage saving in the transmitted power. (5 marks)

4. (a) (i) State the **two** conditions that are necessary for oscillation to be sustained in an oscillator.

(ii) With the aid of a circuit diagram describe the operation of a tuned-collector sinusoidal oscillator. (8 marks)

(b) Figure 1 shows the circuit diagram of the frequency determining network of a colpitts oscillator. Derive the expression for the oscillation frequency. (6 marks)

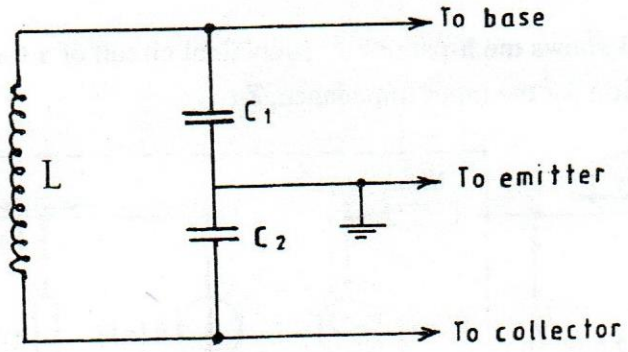

Fig. 1

(c) Figure 2 shows the circuit diagram of a Schmitt trigger. Determine the value of the hysteresis voltage. (6 marks)

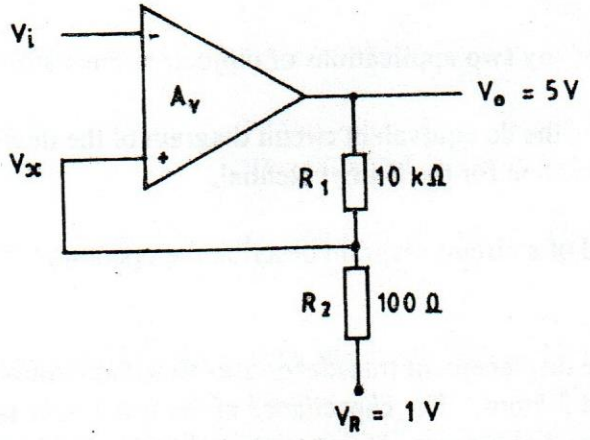

Fig. 2

5. (a) (i) Distinguish between class A and class B biasing of power amplifiers.

(ii) A class B push-pull power amplifier takes a mean current of 2.2A from a 30V supply. The output transformer has a turns ratio of 5:1 and feeds a load of 10Ω. The current gain of each transistor is 50. If a sinusoidal signal of 8.5mA(rms) is applied to the base of each transistor determine the:

I. optimum load resistance for each transistor;
II. total power output;
III. efficiency of the amplifier.

(14 marks)

(b) Figure 3 shows the h-parameter equivalent circuit of a transistor. Derive the expression for the input impedance, Z_i. (6 marks)

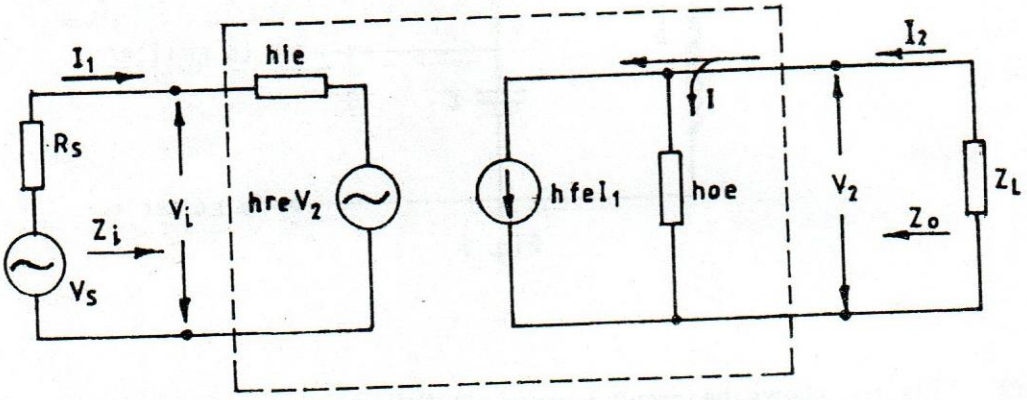

Fig. 3

6. (a) (i) State any **two** applications of unijuction transistor (UJT).

(ii) Draw the dc equivalent circuit diagram of the device in a(i) hence obtain the expression for the firing potential. (7 marks)

(b) With the aid of a circuit diagram describe the operation of the repulsion type induction motor. (6 marks)

(c) A capacitive displacement transducer uses two diaphragms of area 750mm^2 separated by a distance of 3.5mm. The capacitance of the transducer is 370pF with no pressure applied to the diaphragms. If a pressure of 900KN/m^2 is applied to the top diaphragm determine the:

(i) new capacitance;
(ii) sensitivity of the transducer. (7 marks)

7. (a) (i) State any **two** disadvantages of frequency modulation (FM) as compared to amptitude modulation (AM) systems.

(ii) With the aid of a circuit diagram describe the operation of a varactor diode FM modulator.

(7 marks)

(b) Explain how changes in the amplitude of the modulating signal affect the bandwidth of an FM signal. (4 marks)

(c) An FM wave is represented by the expression:
$v = 4 \sin (1.57 \times 10^8 t + 25 \sin 2513t)$ volts. Determine the:
(i) carrier frequency;
(ii) modulating signal frequency;
(iii) maximum deviation;
(iv) bandwidth. (9 marks)

8. (a) (i) State any **two** effects of a high value of Q in a parallel resonant circuit.

(ii) Explain the need for a damping resistor in a tuned circuit. (6 marks)

(b) The winding of a double-tuned transformer are identical, each having a self inductance of 720μH and tuned to resonance by a loss free capacitor of 100pF. If the 3B bandwidth of the transformer is 10kHz and the mutual inductance between the two windings is 8.5μH, determine the:

(i) resonant frequency;
(ii) Q - factor;
(iii) coefficient of coupling. (7 marks)

(c) An amplifier has a gain of 1000 and 0.1 of the output voltage is applied as negative feed back. Determine the change in:

(i) bandwidth;
(ii) distortion;
(iii) gain due to a temperature change of 20%. (7 marks)