1204/315
ELECTRONICS TECHNOLOGY
June/July 2011
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

ELECTRONICS CRAFT COURSE

ELECTRONICS TECHNOLOGY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;
Mathematical tables/ 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.

Take free space wave velocity, c = 3 x10 ^{8} m/s.

This paper consists of 6 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

1. (a) (i) Define the following as applied to propagation of radio waves:

   (I)   skip distance;

   (II) fading.

   (ii) With the aid of a labelled diagram, describe multi-hop propagation as applied to medium frequency (MF) radio waves.   (9 marks)

   (b) A skywave communication signal, at a critical frequency of 6MHz, enters the ionosphere at an angle of incidence of 40°. If the refractive index of the ionosphere is 0.8, determine the:

   (i)   angle of refraction of the signal;

   (ii) maximum electron density of the ionosphere.   (8 marks)

   (c) Describe how surface duct enables radio waves to be received beyond the optical horizon.   (3 marks)

2. (a) Define the following terms with respect to radio receivers:

   (i)   selectivity;

   (ii) sensitivity.   (4 marks)

   (b) (i) With the aid of a response curve, describe "amplitude limiting" as applied to Frequency Modulated systems.

   (ii) Explain the operation of the radio receiver tuning circuit in figure 1.

                                                                                (11 marks)

Fig. 1
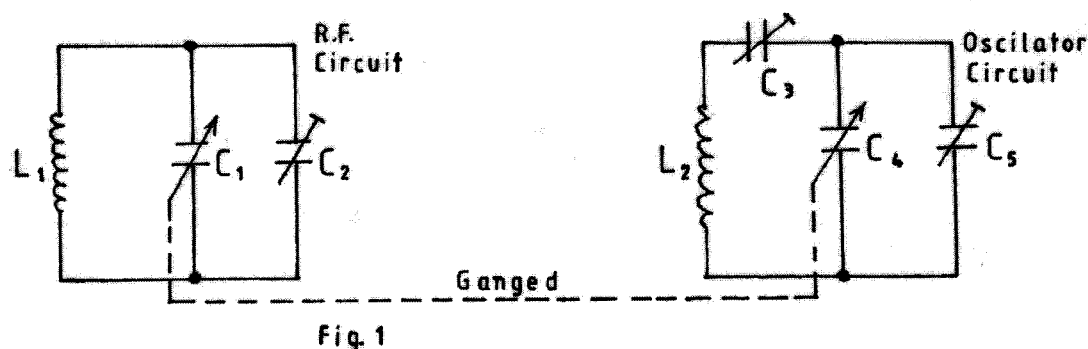
   (c) (i) The tuning range of an FM radio receiver is from 88MHz to 108MHz when the i.f. is 10.7MHz. Determine the frequency range of the image signal.

        (ii)   An AM radio receiver has an output signal of 250mV while the adjacent frequency signal output is 0.85mV. Determine the adjacent channel ratio in dB.

                                                           (5 marks)

3.   (a)   (i)   List any **three** factors that determine the power received by a very high frequency (VHF) antenna.

             (ii)   Draw a labeled diagram of a 5-element end-fire array and describe its operation.

                                                         (9 marks)

    (b)   A VHF antenna has an input power of 2kW at an efficiency of 75%. If the loss resistance is 25Ω, determine the:

            (i)   radiation resistance;

            (ii)   input current;

            (iii)   radiated power.   (7 marks)

    (c)   A 2-element folded dipole Yagi array operates at 900MHz. Determine the electrical length of the reflector.   (4 marks)

4.   (a)   (i)   Explain how changes in the modulation index affect power distribution in an FM wave.

             (ii)   Draw the frequency spectrum for the wave in (a)(i) up to the 3rd side frequency components.   (6 marks)

    (b)   Figure 2 shows a double sideband amplitude modulated waveform. If the carrier power is 55kW, determine the:

            (i)   modulation depth;

            (ii)   radiated power;

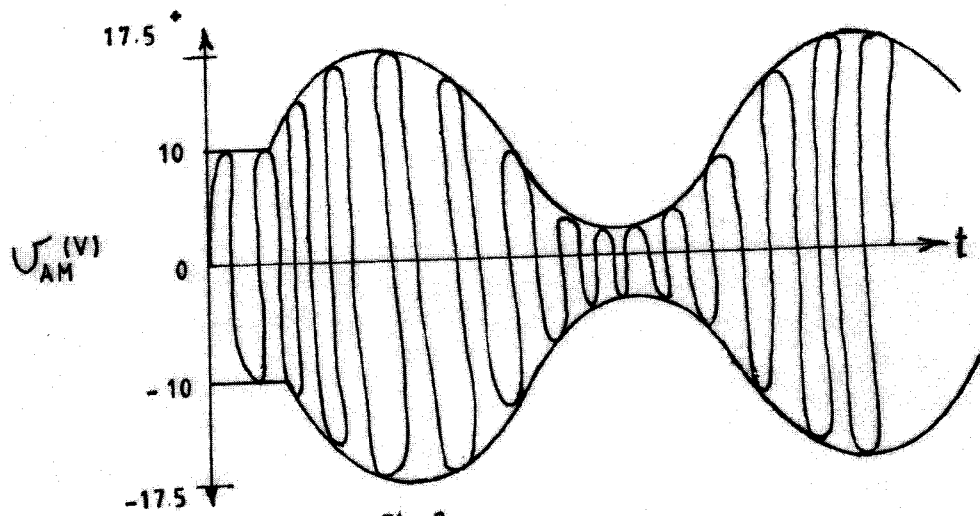   (iii)   power of each sideband.   (6 marks)

Fig. 2

(c) When a carrier voltage of $6\sin(28\pi \times 10^6t)$ is frequency modulated by an audio signal of $4\sin(2\pi \times 10^3t)$, the peak frequency deviation is 24kHz. Determine the:

(i) modulation index;

(ii) frequency of the carrier wave;

(iii) required bandwidth.   (8marks)

5. (a) Define the following terms with respect to television (T.V) systems:

(i) aspect ratio;

(ii) interleaving.   (4 marks)

(b) Describe:

(i) television standards in TV systems;

(ii) the need for a synchronizing pulse generator in a TV system.

(8 marks)

(c) (i) A colour TV mixing process has the primary colours RED, GREEN and BLUE of amplitudes of 0.3V, 0.59V and 0.11V respectively. Determine the amplitudes of the following secondary colours:

(I) white colour;

(II) magenta colour.

(ii)   State the primary colours that produce yellow colour.   (8 marks)

6.   (a)   List any **three** factors that determine the linearity of a resistive potentiometer.

(3 marks)

(b)   A capacitive transducer controls an oscillator whose resonant frequency is 90MHz. If the oscillator has an inductance of 20nH, determine the:

(i)   value of the capacitor;

(ii)   oscillator frequency if the value of the capacitor increases by 10%.

(6 marks)

(c)   (i)   With the aid of a labelled diagram, describe the operation of a resistance thermometer.

(ii)   A platinum wire has a resistance of $R\Omega$ at 15°C and this increases to 250Ω when it is mounted in an oven. If the temperature coefficient of resistance of platinum is 0.0039/ °C, determine the platinum resistance, R, if the oven temperature is 485°C.   (11 marks)

7.   (a)   (i)   List any **two** advantages of the single sideband over the double sideband amplitude modulation system.

(ii)   Draw a labeled block diagram of a low-level modulation radio transmitter and describe its operation.   (9 marks)

(b)   A carrier wave of 800kHz is amplitude modulated by a sinusoidal signal of frequency range 300Hz to 16kHz:

(i)   determine the frequency range of the:

    I   lower sideband;

    II   upper sideband.

(ii)   obtain the system bandwidth;

(iii)   sketch the frequency spectrum of the waveform in (b)(i);

(iv)   explain "erect" as applied to the spectrum in (b)(iii).   (11 marks)

8.   (a)   (i)   State any **two** areas of application of a strain gauge.

(ii)   With the aid of a block schematic diagram, describe the operation of an optoelectronic street light controller.   (8 marks)

(b)   An A.C. motor has an input power of 16kW and develops a driving power of 12kW. If the output power is 10kW, determine the:

    (i)   copper losses;

    (ii)   iron and friction losses;

    (iii)   mechanical efficiency;

    (iv)   electrical efficiency.   (8 marks)

(c)   A d.c. shunt motor, driven from a 220V supply, runs at 1200revs/min on no load at an armature current of 2 amperes. If the armature resistance is 5Ω, determine the armature current which will produce a motor speed of 1000revs/min on load.

                                                                                            (4 marks)