2602/205
TELECOMMUNICATION PRINCIPLES
AND INDUSTRIAL MEASUREMENTS
March/April 2024
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (TELECOMMUNICATION OPTION) MODULE II

TELECOMMUNICATION PRINCIPLES AND INDUSTRIAL MEASUREMENTS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Mathematical tables/non programmable scientific calculator;
Drawing instruments.
*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.*
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

Take: ***Speed of light,*** $c = 3 \times 10^8\ m/s$
Boltzman's constant, $k = 1.38 \times 10^{-23}\ J/K$
Permitivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}\ F/m$
Permeability of free space, $\mu o = 4\pi \times 10^{-7}\ H/m$
Radius of earth R= 6400 km

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

SECTION A: TELECOMMUNICATION PRINCIPLES

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

1. (a) State:

(i) **two** types of multimedia signals used in telecommunication;
(ii) **three** components of a telecommunication system. (5 marks)

(b) Figure 1 shows a double side band amplitude modulator. Describe its operation. (7marks)

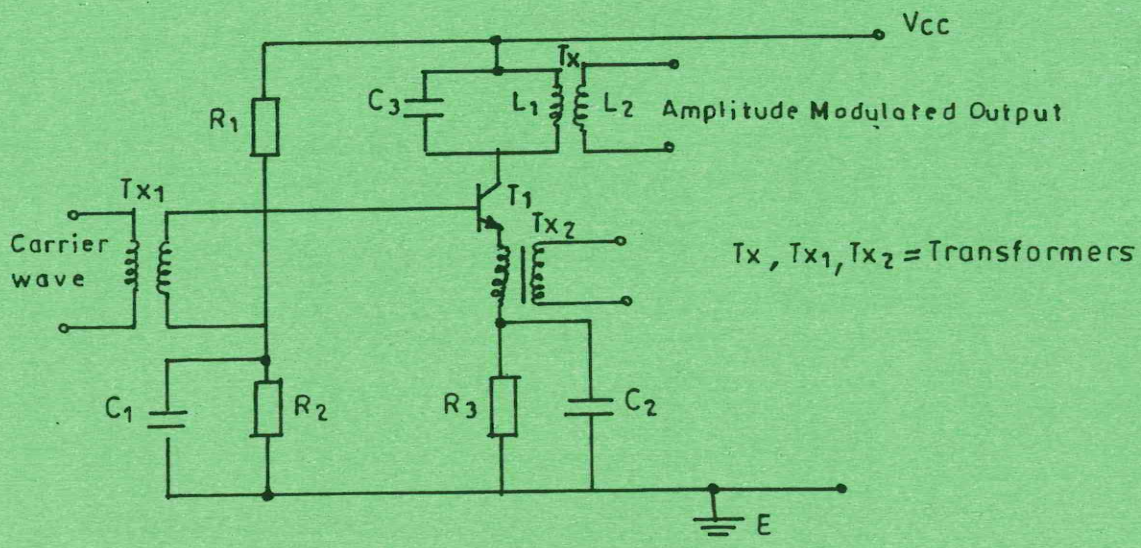

Fig 1

(c) A sinusoidal signal of amplitude 100 V is amplitude modulated by a carrier signal to a depth of 25%. Determine the:

(i) I. maximum and minimum voltage of the wave;
II. modulating signal voltage;
III. amplitude of the lower side frequency component..

(ii) Sketch the resulting waveform of the carrier wave. (8 marks)

2. (a) List **three** roles played by International Telecommunication Union (ITU). (3 marks)

(b) State **three** advantages of frequency modulation over amplitude modulation. (3 marks)

(c) With the aid of a labelled schematic diagram, describe the operation of a horn loud speaker. (7 marks)

(d) A 6 V, 15 kHz, carrier wave is frequency modulated to have a rated frequency deviation of 51 kHz. During its transmission it has an interfering signal of 0.25 V at 99.985 MHz superimposed upon it. Determine it:

(i) frequency deviation due to interfering signal;
(ii) frequency deviation due to modulation;
(iii) carrier-to-noise ratio at the detector input;
(iv) signal-to-noise ratio at the detector output. (7 marks)

3. (a) State **four** advantages of superheterodyne receiver over tuned radio frequency (TRF) receivers. (4 marks)

(b) List **four** tasks performed by digital signal processor (dsp) in medium frequency/ High Frequency (MF/HF) radio receiver. (4 marks)

(c) A superheterodyne radio receiver has an intermediate frequency of 470 kHz and is tuned to 1065 kHz. Determine the:

(i) frequency of the local oscillator;
(ii) image frequency. (4 marks)

(d) A land line cable has a resistance of $20\,\Omega$ a capacitance of $0.5\,\mu$F per kilometre and negligible distributed inductance and conductance. Loading coils each having an inductance of 80 mH and a resistance of $10\,\Omega$ are inserted at intervals of 0.7 kilometres (km). At a frequency of $5{,}000 / 2\pi$ Hz, determine the:

(i) loading inductance per km;
(ii) load resistance per km;
(iii) line resistance per km;
(iv) attenuation constant, α;
(v) cut-off frequency, fc. (8 marks)

4. (a) Explain critical angle with reference to wave propagation. (2 marks)

(b) With the aid of a labelled diagram, describe the propagation paths of electromagnetic waves. (8 marks)

(c) With the aid of a labelled ray diagram, show that the range of a space wave, d, is given by:

$d = 3578(\sqrt{h_t} + \sqrt{h_r})$, meters: where:

h_t = height of the transmitting antenna

h_r = height of the receiving antenna. (7 marks)

(d) A TV transmitter antenna is located at a height of 155 m above the ground level. Determine the distance over which direct ray coverage is possible if the receiving antenna height is 10 m. (3 marks)

5. (a) Describe telephony as used in telecommunication systems. (2 marks)

(b) Draw a labelled block diagram of the phase shift method of generating single side band suppressed carrier (SSB/SC) signals. (4 marks)

(c) A 20 V, 150 MHz carrier wave is frequency modulated by a 2000 Hz tone when the frequency deviation is 1050 Hz. Determine the:

(i) modulation index;
(ii) carrier amplitude. (4 marks)

(d) A 4-element folded dipole Yagi array operates at 750 MHz.

(i) Determine the:

I. length of the dipole;
II. length of the reflector;
III. length of the director;
IV. distance between reflector and dipole;
V. distance between dipole and director;
VI. distance between the directors.

(ii) Sketch the resulting antenna array. (10 marks)

SECTION B: INDUSTRIAL MEASUREMENTS

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

6. (a) With reference to speed measuring devices, list **two**:

(i) types of routine maintenance activities carried out on the devices;
(ii) features considered when selecting a speed measuring device.
(4 marks)

(b) With the aid of a labelled schematic diagram, describe speed measurement using inductive tachometer. (8 marks)

(c) A gas thermometer was calibrated by placing the bulb in melting ice at 0°C and the difference in height of the mercury column was 85 cm. The bulb was then placed in steam at 100°C and the mercury column was 165 cm. The bulb was then placed in a fluid of unknown temperature and after adjustment, the difference in height of the mercury column was 95 cm. Determine the:

(i) change of pressure per 100°C, α;

(ii) temperature of the fluid, given atmospheric pressure to be 76 cm of Hg at 0°C. (8 marks)

7. (a) List **two** categories of liquid level measurement techniques. (2 marks)

(b) Figure 2 shows hook's gauge.

(i) Describe its operation.
(ii) Name the parts marked A, B and C. (7 marks)

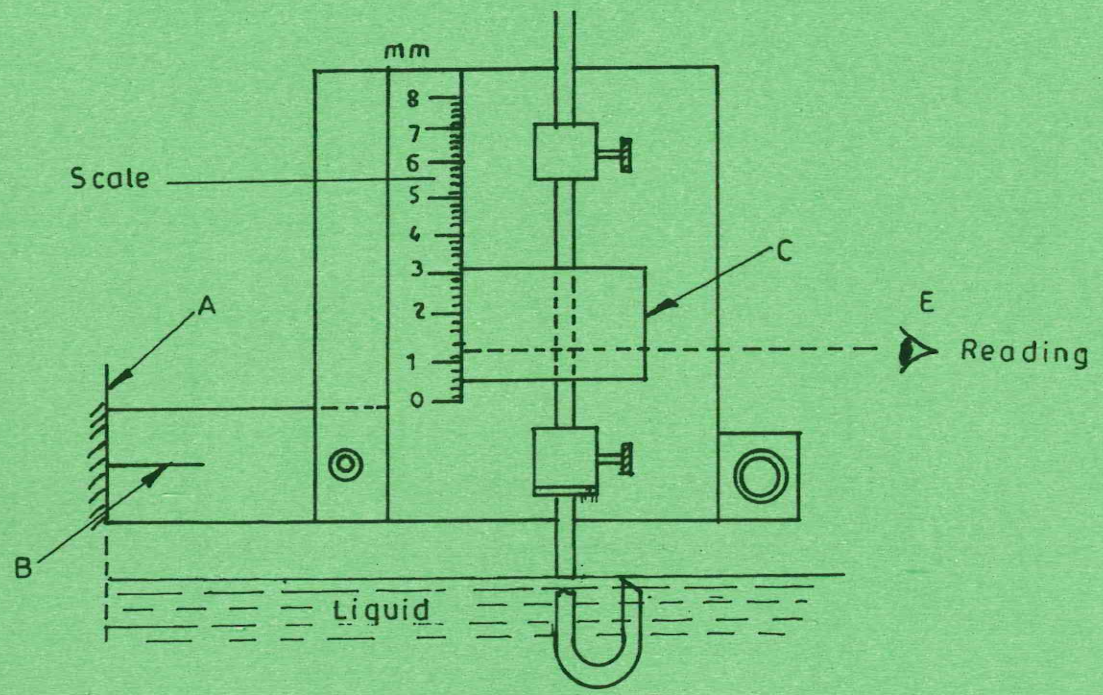

Fig.2

(c) (i) With the aid of a labelled diagram, describe the working principles of a bi-metallic strip thermometer.
(ii) State **two** areas where the principle of bimetallic strip is used. (9 marks)

(d) A strain gauge having a resistance of 300 Ω and a gauge factor 4 is bonded onto a member of structure under tensile stress. Determine the percentage strain suffered by the member if the change in resistance of the gauge is 1.2 Ω. (2 marks)

8. (a) Draw a labelled diagram of a mercury barometer. (4 marks)

(b) With the aid of a diagram, explain pressure measurement using piezo-electric effect. (5 marks)

(c) With the aid of a labelled diagram, describe viscocity measurement using a viscometer. (7 marks)

(d) List **four** main types of pressure transmitters. (4 marks)

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