

2602/205
 TELECOMMUNICATION PRINCIPLES
 AND INDUSTRIAL MEASUREMENTS
 Oct. / Nov. 2022
 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;

non-programmable scientific calculator/ mathematical tables;

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.

All questions carry equal marks.

Maximum marks for each part of a question are as indicated.

Candidates should answer the questions in **English**.

Take: Boltzman's constant, $k = 1.38 \times 10^{-23} \text{ J/K}$

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

Speed of light in free space, $c = 3 \times 10^8 \text{ m/s}$

Radius of the Earth, $R = 6400 \text{ km}$

This paper consists of 8 printed pages.



Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: TELECOMMUNICATION PRINCIPLES

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

1. (a) State:
- four roles of Communications Authority of Kenya (CAK);
 - the frequency ranges of each of the following frequency bands:
 - UHF; *300 MHz - 3000 MHz*
 - HF. *3 - 30 MHz*
- (8 marks)
- (b) With the aid of a labelled block diagram, describe the phase shift method of single sideband (SSB) signal production. (7 marks)
- (c) A 107 MHz carrier wave is frequency modulated by a 20 V, 10 kHz sinusoidal voltage using a linear modulator. The instantaneous carrier frequency varies between 106.95 MHz and 107.05 MHz. Determine the:
- sensitivity of the modulator;
 - modulation index;
 - peak phase deviation of the carrier. (5 marks)
2. (a) Define each of the following with respect to radio wave propagation:
- maximum usable frequency (m.u.f);
 - polarization. (2 marks)
- (b) Figure 1 shows a ray diagram of different modes of radio wave propagation. Identify the waves labelled Q, R and N. (3 marks)

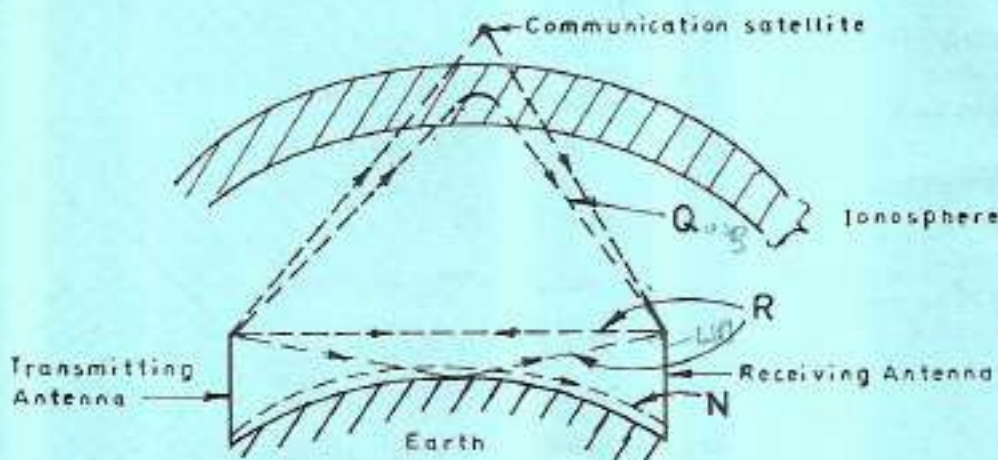


Fig. 1



- (c) With the aid of a sketch show that the service range of a sky wave, d , is given by the expression: $d = 2R \left[\left(\frac{\pi}{2} - \beta \right) - \sin^{-1} \left(\frac{R}{R+h} \right) \cos \beta \right]$ where;

R = radius of the earth
 β = the take-off angle
 h = virtual height

(10 marks)

- (d) An ionospheric layer has an electron density of 6×10^{11} electron/m³ at a height of 500 km. The take-off angle from the earth is 30° and a refractive index of 0.5. Determine the:

- (i) critical frequency of the layer;
 (ii) skip distance.

(5 marks)

3. (a) State **three** ways of minimizing industrial noise in electronic communication.

(3 marks)

- (b) Figure 2 shows a diagram of a Ribbon microphone. Explain its operation.

(5 marks)

Ribbon Microphone

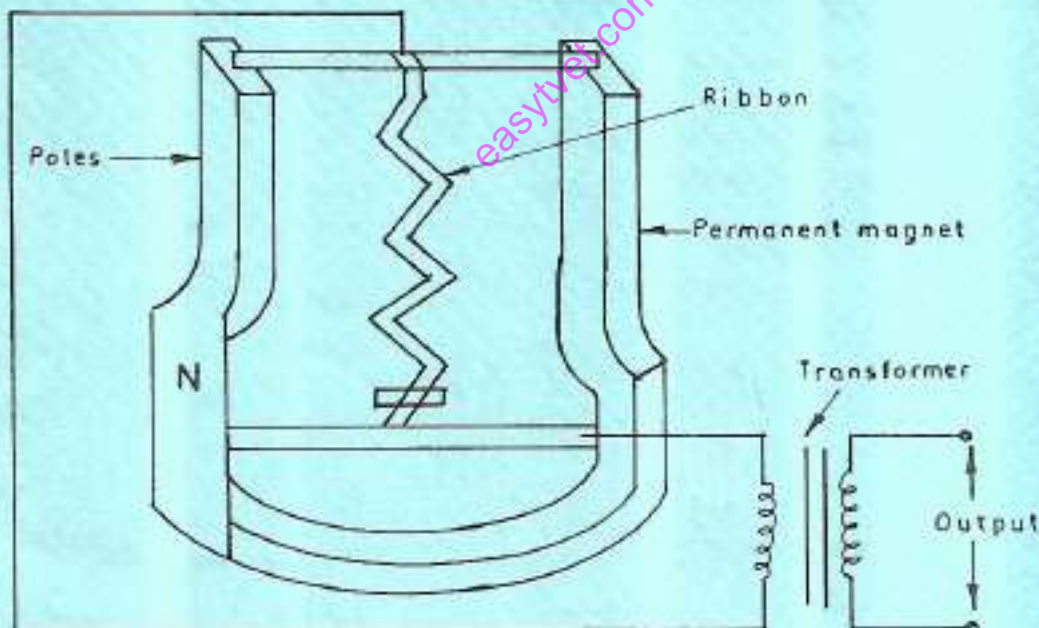


Fig. 2



- (c) Figure 3 shows a block diagram of a three-stage noiseless amplifier system with a 3-dB bandwidth of 200 kHz determined by an LC-tuned circuit at its input and operates at 22°C. The input noise is generated by a 10 kΩ resistor, with an output load of 300 Ω. Determine the:

- (i) effective noise power;
- (ii) noise power at the input;
- (iii) input noise voltage;
- (iv) total power gain of the amplifier;
- (v) output noise power;
- (vi) output noise voltage.

(12 marks)

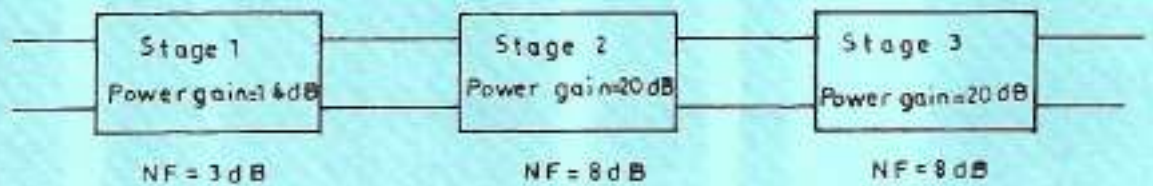


Fig.3

4. (a) State four applications of a spectrum analyzer. (4 marks)

- (b) Figure 4 shows the block diagram of a frequency counter.

- (i) Identify the parts marked x, y and z.
- (ii) Outline the functions of:

- (I) display;
- (II) gate flip flop;
- (III) gate.

(6 marks)

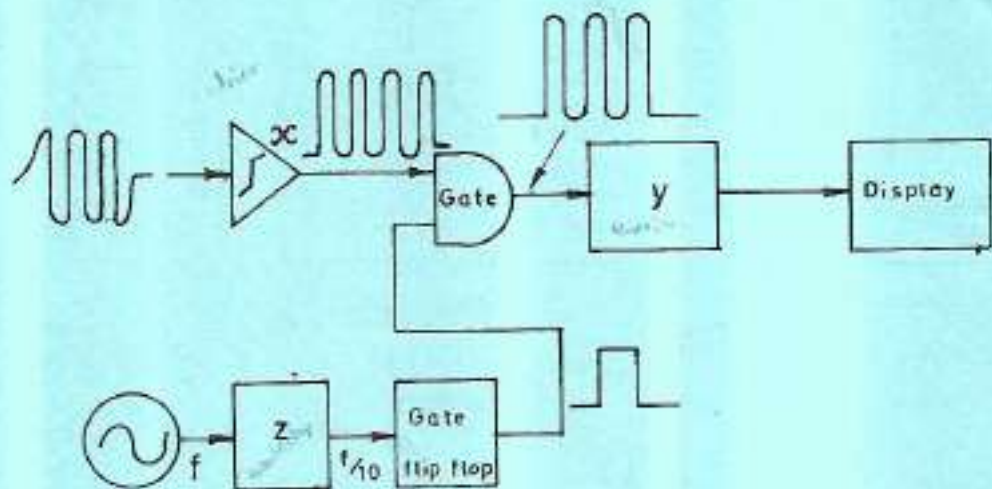


Fig.4



(c) A radio receiver has four stages having their voltage gains controlled by a simple automatic gain control (a.g.c) system. Each stage has an a.g.c characteristic of 4 dB/V. A change in the input voltage to the r.f stage from 20 μ V to 100 mV causes the a.f output level to increase by 6 dB. Determine the change in the a.g.c voltage per stage. (6 marks)

(d) Describe each of the following parts of a telephone handset.

- (i) ringer;
- (ii) dialer.

(4 marks)

5. (a) (i) State **two** merits of open wire telecommunication lines.

(ii) A loss less transmission line has distributed inductance of 1.2 mH/km and distributed capacitance of 0.5 μ F/km. Determine the:

- (I) characteristic impedance;
- (II) propagation constant of the line for a 10 MHz signal;
- (III) frequency at which the line length is equivalent to one wavelength for a 0.4 km section of the line;
- (IV) velocity of propagation.

(9 marks)

(b) (i) State **four** causes of antenna losses;

(ii) An antenna driven by a sinusoidal current of 15 amperes has an efficiency of 80%. If the radiation resistance is 1600 Ω , determine the:

- (i) loss resistance;
- (ii) input power;
- (iii) radiated power.

(11 marks)



SECTION B: INDUSTRIAL MEASUREMENTS

Answer any TWO questions from this section.

6. (a) (i) With the aid of a labelled diagram, describe the operation of a Linear Variable Differential Transformer (LVDT) accelerometer in speed measurement. (9 marks)
- (ii) State two merits of the instrument in a(i). (3 marks)
- (b) State three effects of humidity in strain gauges. (3 marks)
- (c) Figure 5 shows the float method of liquid level measurement.
- (i) identify the parts labelled E, F, G and H; (8 marks)
- (ii) describe its operation.

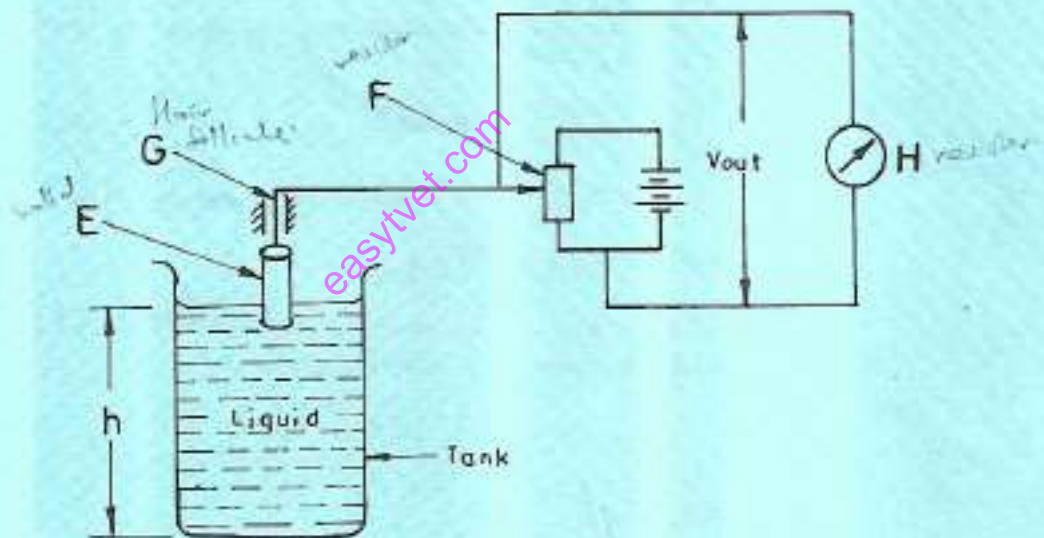


Fig 5

7. (a) State two demerits of:
- (i) liquid manometers. (4 marks)
- (ii) bourdon pressure gauge.



(b) Figure 6 shows a diagram of a gas thermometer.

- (i) Describe its operation.
 (ii) State **three** applications of the instrument in b(i).

(7 marks)

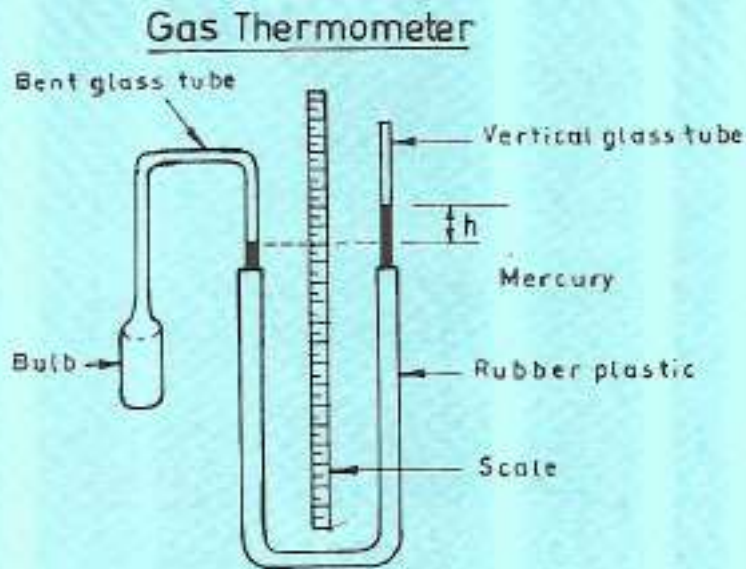


Fig.6

(c) The temperature of a hot body, when measured by radiation pyrometer, is found to be $2,350^{\circ}\text{C}$ for a surface emissivity of 0.85. Later on, it was found that the true surface emissivity is 0.78. Determine the:

- (i) actual temperature;
 (ii) error in temperature measurement.

(9 marks)

8. (a) State **three** parameter changes used in temperature measurement.

(3 marks)

(b) State **three** physical principles on which viscosity measuring instruments work.

(3 marks)

(c) (i) With the aid of a labelled diagram, describe the operation of a pneumatic load cell.

(ii) List **three** merits of the cell in c(i).

(9 marks)



(d) Figure 7 shows the basic components of a pneumatic system.

(i) Identify the parts marked K, L and M;

(ii) State the function of the:

- I. cooler;
- II. receiver tank.

(5 marks)

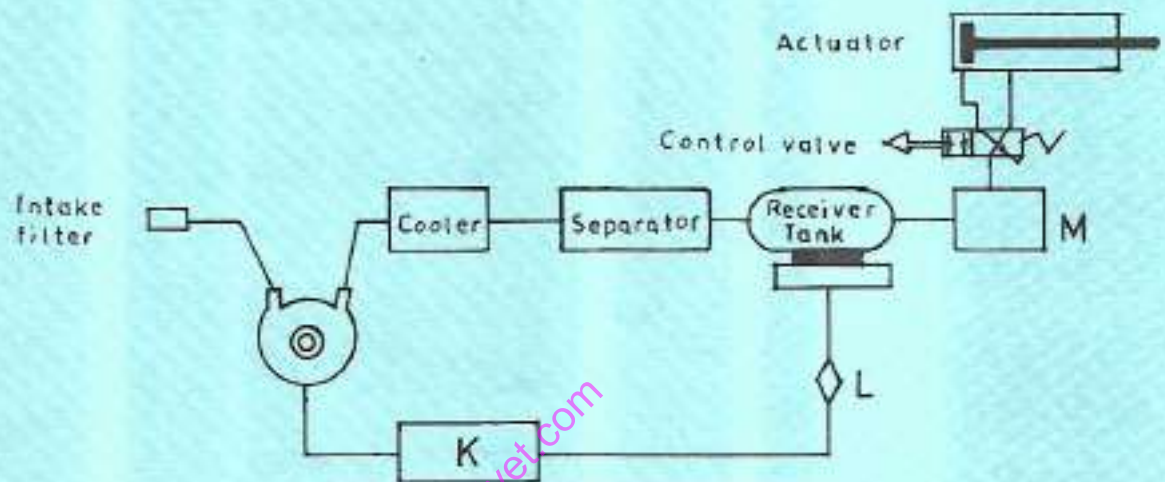


Fig.7

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