

2602/205

**TELECOMMUNICATION PRINCIPLES
AND INDUSTRIAL MEASUREMENTS**

June / July 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;

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, $k = 1.38 \times 10^{-23}$ J/K

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

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

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

Radius of the Earth, $R = 6400$ km

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.

SECTION A: TELECOMMUNICATION PRINCIPLES

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

1. (a) (i) Define demodulation in telecommunication.
- (ii) State the frequency bands of the following:
- (I) MF (Medium Frequency);
- (II) SHF (Super High Frequency) .
- (5 marks)
- (b) With the aid of a labelled schematic diagram, describe the operation of a moving coil microphone.
- (7 marks)
- (c) An FM system has a rated system deviation of 51 kHz and a maximum modulating signal frequency of 6.8 kHz. A 4 V, 2 kHz test tone produces a frequency deviation of 16 kHz. Determine the:
- (i) modulation index produced by the test tone;
- (ii) deviation ratio;
- (iii) frequency deviation produced by a 6 V, 2.5 kHz input signal.
- (iv) voltage at 5 kHz needed to give the rated system deviation.
- (8 marks)
2. (a) State **three** factors that determine the rating of a loud speaker.
- (3 marks)
- (b) Draw a labelled block diagram of a Bit Error Rate Tester (BERT)
- (5 marks)

- (c) (i) Figure 1 shows a Quadrature Phase Shift Keying (QPSK) demodulator block diagram. Identify the blocks labelled E, F and G.

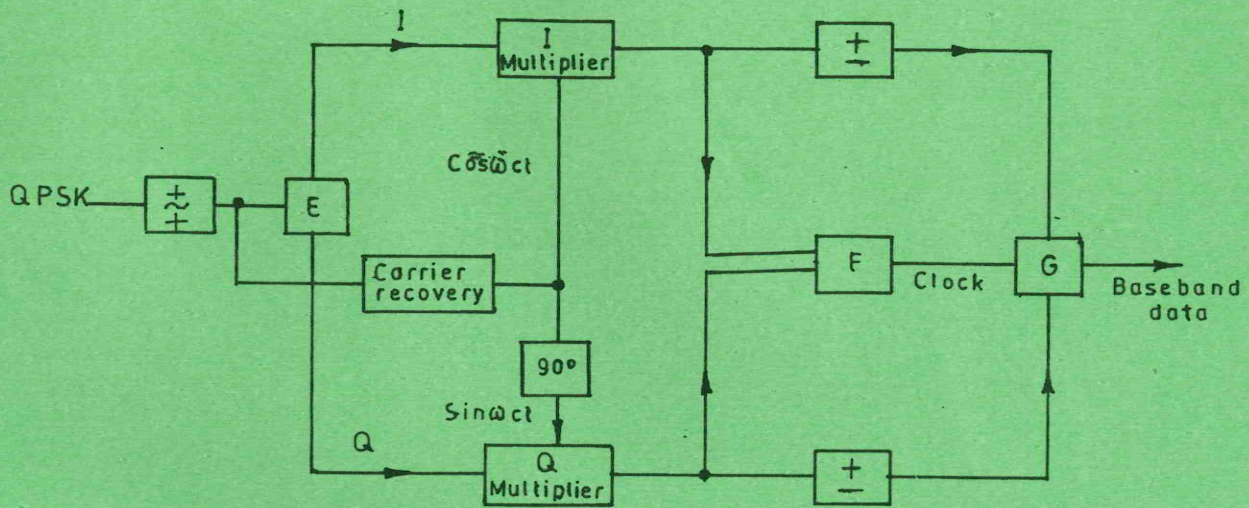


Fig.1

- (ii) List **three** types of measuring instruments used in telecommunication systems. (6 marks)

- (d) A Bi-polar phase shift keying (BPSK) modulator with rectangular pulses has a carrier frequency of 70 MHz and input bit rate of 5 Mb/s. Determine the:

- (i) output voltage;
(ii) theoretical minimum bandwidth;
(iii) null-to-null bandwidth.

(6 marks)

3. (a) List **three** primary line constants with reference to transmission lines. (3 marks)

- (b) Draw a labelled diagram of a shielded-pair cable. (4 marks)

- (c) Determine the overall noise figure of a three stage cascaded amplifier, each stage having a power gain of 10 dB and a noise figure of 6 dB. (4 marks)

- (d) A lossless transmission line has distributed inductance of 1.2 mH/km and a distributed capacitance of 0.08 μ F/km.

Determine the:

- (i) characteristic impedance, Z_0 ;
(ii) propagation constant, γ ;
(iii) frequency at which the line is equivalent to one wavelength for a section of 0.6 km.
(iv) Velocity of propagation.

(9 marks)

4. (a) Explain each of the following with respect to wave propagation:
- (i) frequency diversity;
 - (ii) space diversity;
 - (iii) phase angle diversity.
- (3 marks)
- (b) With the aid of a ray diagram, describe multipath space wave propagation between a transmitter and a receiver located on the Earth's surface. (6 marks)
- (c) (i) Describe temperature inversion with respect to ground wave propagation.
- (ii) Outline **three** causes of temperature inversion. (5 marks)
- (d) An ionospheric layer has a maximum electron density of 6×10^{11} electrons/m³. Determine the:
- (i) critical frequency;
 - (ii) maximum usable frequency when the angle of incidence is 60° .
 - (iii) optimum working frequency (OWF).
- (6 marks)
5. (a) Define each of the following with respect to radio reception:
- (i) co-channel interference;
 - (ii) blocking.
- (2 marks)
- (b) A sinusoidal modulated signal has a carrier modulated equation:
- $$v_c = V_c \sin \omega_c t + \left(\frac{V_m}{2} \right) \cos(\omega_c - \omega_m)t - \left(\frac{V_m}{2} \right) \cos(\omega_c + \omega_m)t$$
- Draw its frequency spectrum diagram. (3 marks)
- (c) (i) Describe the procedure for an outgoing call on a GSM system.
- (ii) With the aid of a labelled diagram, describe the construction of a monopole antenna. (7 marks)

(d) A 30 m high monopole antenna is supplied with 100 amperes at 3000 kHz. Determine the:

- (i) wavelength of radiated signal;
- (ii) effective antenna height;
- (iii) radiated power;
- (iv) electric field strength at a point 120 km away.

(8 marks)

SECTION B: INDUSTRIAL MEASUREMENTS

Answer any TWO questions from this section.

6. (a) State **four** types of speed measuring devices. (4 marks)
- (b) With the aid of a labelled diagram, describe the operation of an Eddy current Tachometer. (6 marks)
- (c) List **two** merits of stroboscopic method of speed measurement. (2 marks)
- (d) A disc having 12 pattern points is mounted on a motor shaft. The number of flashes projected on the disc by a stroboscope is 6000 per minute. Determine the:
- (i) prime speed of the machine.
 - (ii) speed of the machine when the disc appears:
 - (I) stationary;
 - (II) to rotate in the forward direction at 25 rpm.
 - (III) to rotate in the backward direction at 16 rpm.

(8 marks)

7. (a) With reference to pressure measurement, define:
- (i) gauge pressure. (2 marks)
 - (ii) absolute pressure. (8 marks)
- (b) With the aid of a labelled diagram, describe the chain float level measuring instrument. (8 marks)
- (c) A resistance strain gauge is used to measure stress on steel. The steel is stressed to 1400 N/m^2 and Young's modulus of steel is $2.1 \times 10^6 \text{ N/m}^2$. Determine the percentage change of resistance of the strain gauge assuming gauge factor of 2. (7 marks)
- (d) State **three** areas of application of pressure gauges. (3 marks)
8. (a) State the **three** units used for temperature measurement. (3 marks)
- (b) Explain each of the following methods of soil moisture measurement:
- (i) oven drying method;
 - (ii) volumetric method. (6 marks)
- (c) (i) Describe the working principle of a pressure transmitter;
- (ii) Explain **two** merits of pneumatic load cell in weight measurement. (8 marks)

- (d) Figure 2 shows a C-shaped Bourdon tube. Identify the parts labelled X, Y and Z. (3 marks)

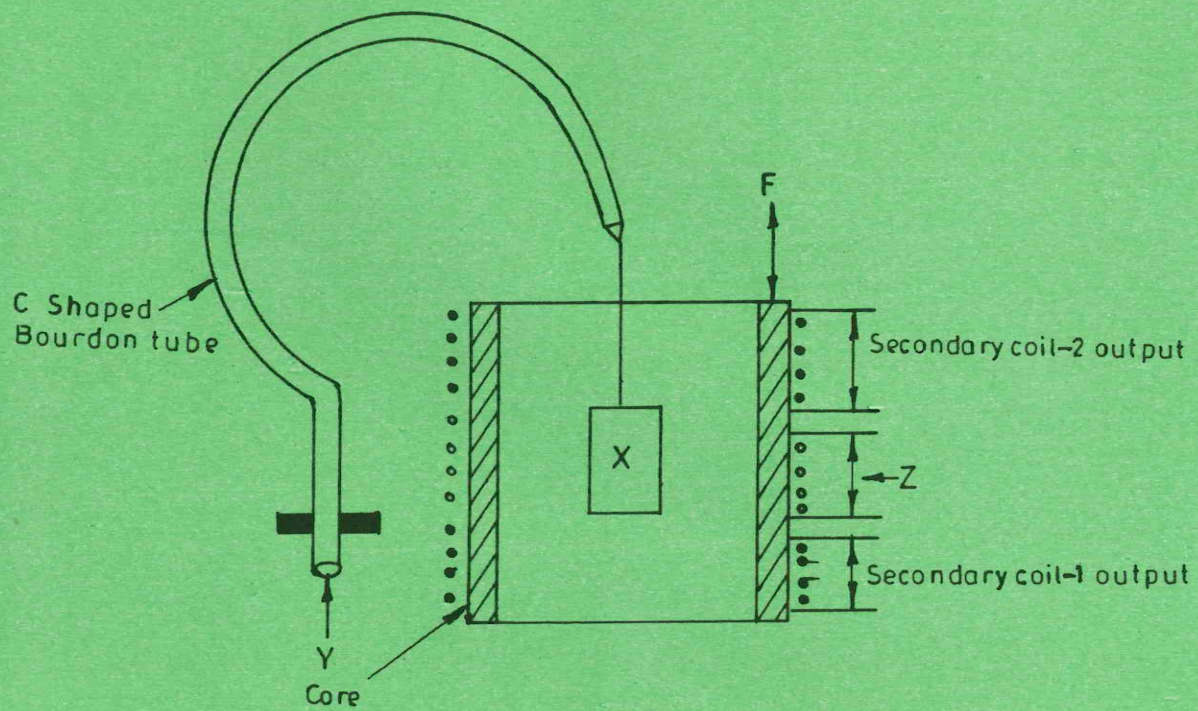


Fig. 2

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