2521/105 2602/106
2601/106 2603/106
ELECTRICAL MEASUREMENTS AND ANALOGUE ELECTRONICS I
June/July 2019
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)

MODULE I

ELECTRICAL MEASUREMENTS AND ANALOGUE ELECTRONICS I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable Scientific calculator.
*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 the question are as indicated.
Candidates should answer questions in English.

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.

Turn over

SECTION A: ELECTRICAL MEASUREMENTS

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

1. (a) (i) State **two** precautions to observe when using analogue multi range multi-meters.

(ii) With the aid of a labelled block diagram, describe the zero-beat method of frequency measurement.

(8 marks)

(b) Figure 1 shows the circuit diagram of De Sauty's capacitor bridge. Derive the expressions for R_1 and C_1 at balance. (6 marks)

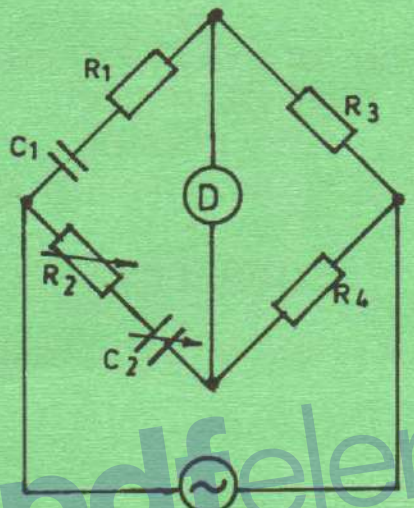

Fig.1

(c) In the two-wattmeter method of power measurement to a three-phase load, the readings were $P_1 = 6.3$ kW and $P_2 = 3.1$ kW. The line voltage is 415 V. Determine the:

(i) total load power;
(ii) load power factor;
(iii) line current.

(6 marks)

2. (a) (i) Distinguish between primary fundamental units and auxillary fundamental units.

(ii) Figure 2 shows a laboratory standard for e.m.f. Describe its operation.

(5 marks)

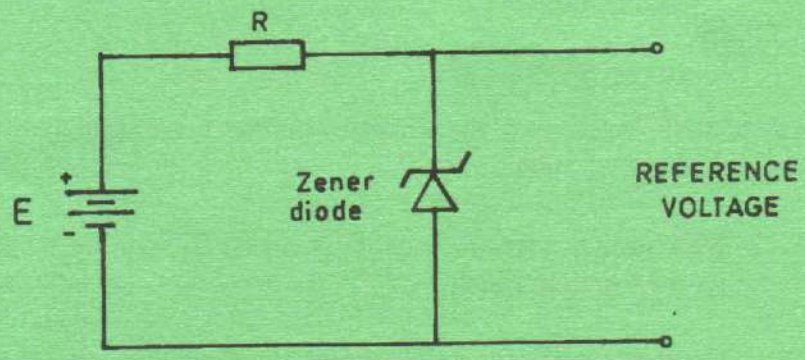

Fig. 2

(b) The dimensional equation of resistance in the LMTI system of dimensions is $[R]=[ML^2I^{-2}T^{-3}]$. Use this equation to obtain the dimensional equations for the following in the LMTI system of dimensions:

(i) resistivity;
(ii) conductivity;
(iii) e.m.f.

(9 marks)

(c) Derive the dimensional equation for capacitance in c.g.s. electrostatic units. Take the dimensional equation for charge, $[Q]=[\varepsilon^{\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1}]$. (6 marks)

3. (a) (i) Distinguish between reliability and failure with respect to an engineering system.

(ii) State **two** effects of each of the following on the reliability of an equipment:

(I) high temperatures;

(II) mechanical vibrations and shock.

(6 marks)

(b) Two units x and y have mean time between failures of 33000 hours and 26000 hours respectively. For an operating period of 1000 hours, determine the reliability and probability of failure for the units if they are connected in:

(i) parallel;
(ii) series.

(9 marks)

(c) Sketch, on the same axes, the curves of reliability and unreliability for an engineering item and state their relationship. (5 marks)

4. (a) (i) State **four** factors that would determine the maintenance policy to be adopted for a particular system.

(ii) Draw block diagrams illustrating divergent and convergent systems.

(8 marks)

(b) An equipment has a mean time between failures of 800 hours and mean time to repair of 12 hours. For the equipment, determine the:

(i) maintainability for a time of 7 hours;
(ii) availability;
(iii) unavailability.

(6 marks)

(c) Explain the function of the following tools when used for maintenance:

(i) desoldering pump;
(ii) long nose pliers;
(iii) logic probe.

(6 marks)

5. (a) Table 1 shows various components. Complete the table by filling in **one** fault and **one** possible cause. (6 marks)

Table 1

Component	**Fault**	**Possible Cause**
Film resistor		
Mica capacitor		
Bipolar junction transistor		

(b) (i) List **three** merits of oscilloscopes when used in maintenance.

(ii) Describe how to test a coil using an ohmmeter.

(6 marks)

(c) Figure 3 shows a circuit diagram for the ammeter-voltmeter method of resistance measurement. The voltmeter has a resistance of 5000 Ω and the full scale current of the ammeter is 1 A. The accuracy of the ammeter is ±0.5% at full scale. In the measurement, the readings were 0.55 A and 37.6 V. Determine the:

(i) measured value of the resistor;
(ii) true value of the resistor;
(iii) error in ammeter reading;
(iv) percentage error in ammeter reading at 0.55 A.

(8 marks)

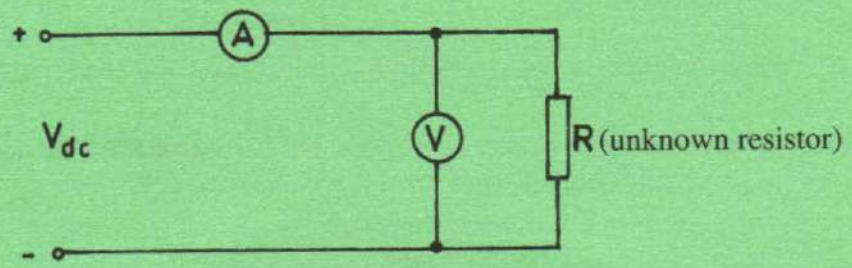

Fig. 3

SECTION B: ANALOGUE ELECTRONICS I

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

6. (a) State:

(i) **two** ways of ionizing an atom;

(ii) **two** advantages of silicon over germanium diodes.

(4 marks)

(b) With the aid of a labelled diagram, describe the formation of depletion layer at the p-n junction. (7 marks)

(c) Figure 4 shows a diagram of an n-type material of resistance 2 kΩ connected across a 15 V d.c. supply.

(i) State the direction of electrons and holes inside the material;

(ii) Taking electronic charge, $e = 1.6 \times 10^{-19}\ C$, determine the:

(I) current through the material;

(II) number of electrons passing through a given point per second;

(III) electrical energy expended if the current is maintained for 30 mS.

(9 marks)

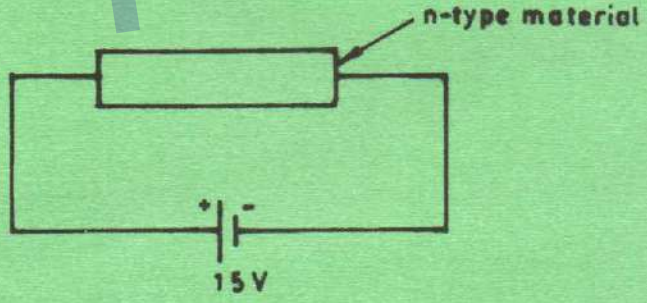

Fig. 4

7. (a) (i) State **two** materials used in making the cathode of thermionic valves.

(ii) Explain the function of each of the following parts of a cathode-ray tube:

(I) aquadag layer;
(II) screen.

(6 marks)

(b) The x-sensitivity of a CRO is set at 50 mS/cm and one cycle of the waveform displayed occupies 2.5 cm in the horizontal plane. The time base voltage rises at a rate of 10 V/cm. Determine the:

(i) amplitude of time base voltage for one cycle of the signal;

(ii) periodic time of the signal;

(iii) frequency of the signal.

(6 marks)

(c) (i) A half-wave rectifier feeds a pure resistive load. Derive the expression for the d.c. load current in terms of the peak voltage and the load resistor, R.

(ii) The peak voltage and load resistance in c (i) are 24 V and 6 Ω respectively. Determine the d.c. load voltage.

(8 marks)

8. (a) (i) Define mutual conductance with respect to field-effect transistors.

(ii) With the aid of a labelled diagram and characteristic curves describe the operation of a p-channel enhancement MOSFET.

(9 marks)

(b) Figure 5 shows a circuit diagram of an amplifier using the collector-base feedback bias. Taking $\beta = 50$ and Vbe = 0.7 V, determine the:

(i) base current, I_b;
(ii) collector current, I_c;
(iii) collector-emitter voltage, Vc_e.

(7 marks)

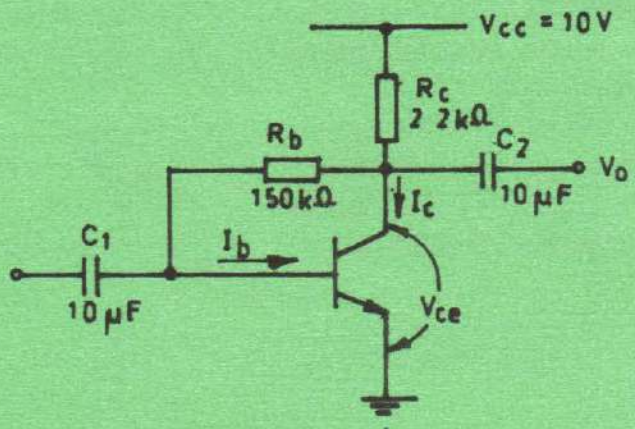

Fig. 5

(c) (i) Sketch the transfer characteristic curve for a common-emitter transistor.

(ii) Show how the curve in c (i) is used to obtain the current gain, β, of the transistor.

(4 marks)

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