2521/105 2602/106
2601/106 2603/106
ELECTRICAL MEASUREMENTS AND
ANALOGUE ELECTRONICS I
Oct./Nov. 2023
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;
Mathematical table/Non-programmable electronic calculator;
Drawing instruments.
*The paper consists of **EIGHT** questions in **TWO** sections; A and B.*
*Answer **THREE** questions from section **A** and **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 the questions in English.
Take: Electron charge, $e = 1.602 \times 10^{-19}\ C$;
Electron mass, $m = 9.109 \times 10^{-31}\ kg$.

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: ELECTRICAL MEASUREMENTS

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

1. (a) (i) State the physical quantities whose units are classified as primary fundamental units.

(ii) Describe secondary standards with respect to measurements. (7 marks)

(b) Derive, from first principles, the dimensional equation for electromotive force (e.m.f) in c.g.s. electromagnetic units. (10 marks)

(c) State the derived units for each of the following quantities:

(i) magnetic flux density;
(ii) angular acceleration;
(iii) density. (3 marks)

2. (a) (i) State **three** factors that can introduce errors in power measurements when using wattmeters;

(ii) With aid of a phasor diagram, show that the two-wattmeter method of power measurement gives the total power in a 3-phase balanced load. (12 marks)

(b) (i) With aid of a labelled diagram, explain the measurement of magnetic flux density using the hall effect;

(ii) Sketch and label the B-H curve of a magnetic material. (8 marks)

3. (a) State **four** merits of a circuit diagram as a fault finding aid. (4 marks)

(b) Figure 1 shows a diagram of a d.c motor speed control system. A fault occurs that results in the loss of the feedback voltage.

(i) State **three** possible causes of the fault;

(ii) Explain the effect of the fault on the speed of the motor. (6 marks)

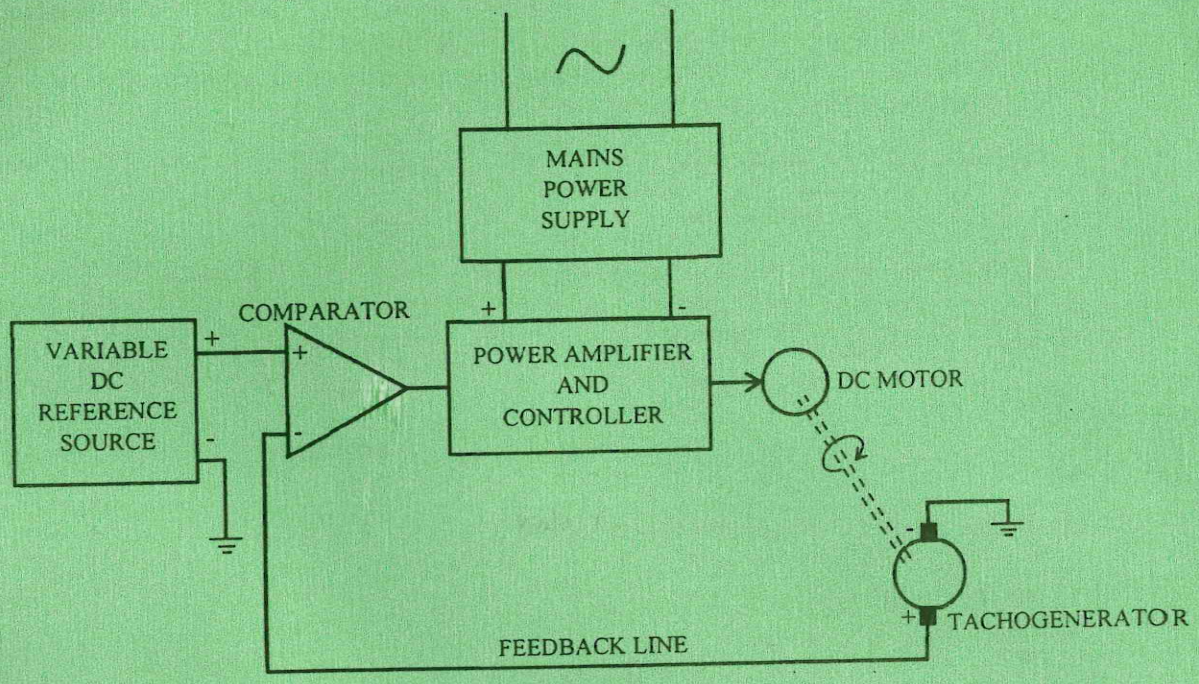

Fig. 1

(c) Outline the procedure of soldering a component on to a printed circuit board. (6 marks)

(d) Explain the function of each of the following test equipment used in logic circuits:

(ii) logic state monitor;

(iii) logic probe. (4 marks)

4. (a) (i) Distinguish between quality and reliability of an engineering system.

(ii) Explain each of the following with respect to reliability:

I. mean time between failure (MTBF).

II. mean time to fail (MTTF). (6 marks)

(b) State:

(i) **two** causes of failure in an engineering system;
(ii) **two** methods used to minimize failures due to high temperatures. (4 marks)

(c) Figure 2 shows a block diagram arrangement of various components in an equipment. The MTBFs for the components are: A = 30,000 hours, B = 60,000 hours, C= 100,000 hours and D = 75,000 hours. Determine the reliability of the equipment for an operating period of 1,000 hours. (10 marks)

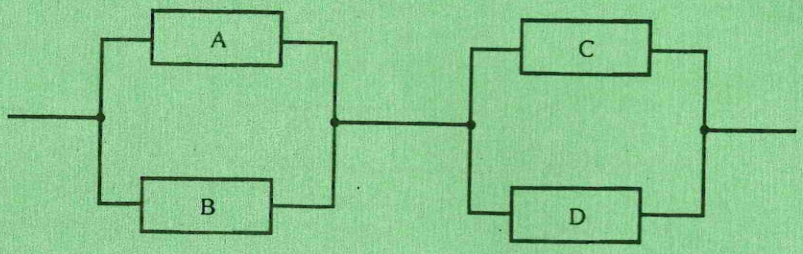

Fig. 2

5. (a) Describe each of the following phases of corrective maintenance:

(i) fault detection;
(ii) fault location. (4 marks)

(b) Figure 3 shows a schematic block diagram of a regulated d.c power supply. Draw a flow chart for troubleshooting the power supply. (8 marks)

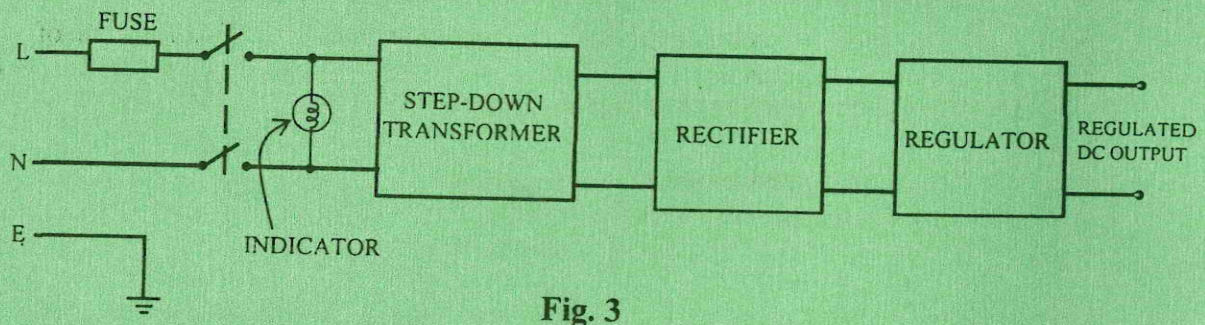

Fig. 3

(c) The repair rate of a large generator, which has a mean time between failure of 58,000 hours, is 6.25% per hour. Determine the following for the generator:

(i) mean time to repair;
(ii) maintainability for an operating period of 24 hours.
(iii) availability;
(iv) unavailability due to breakdown. (8 marks)

SECTION B: ANALOGUE ELECTRONICS I

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

6. (a) With respect to atomic theory, state:

(i) **two** Bohr's postulates;
(ii) **one** Plank's quantum theory. (3 marks)

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

(c) The base-emitter voltage of a transistor connected in common-emitter configuration varies from 0.8V to 2.5V . This causes a corresponding variation of base current from 20 μA to 50 μA and collector current from 1.6mA to 4.6mA. Assuming linear operation, determine the:

(i) input resistance, r_i;
(ii) d.c current gain, β;
(iii) equivalent common-base d.c current gain, α. (6 marks)

(d) Explain each of the following energy bands:

(i) conduction band;
(ii) valence band. (4 marks)

7. (a) (i) State **three** areas of application of bipolar junction transistors .

(ii) Draw a circuit diagram showing the common collector configuration of a n-p-n transistor. (6 marks)

(b) A transistor used in a common-emmitter amplifier has the data given in table 1. The amplifier is supplied from a $16V_{dc}$ source and has a collector load resistor of $1.5\,K\Omega$. The quiescent base current $150\,\mu A$.

(i) Plot the output characteristic curves;
(ii) Draw the d.c loadline;
(iii) Determine the Q-point;
(iv) Obtain the quiescent values of the collector current and, the collector-to-emmitter voltage.

(11 marks)

Table 1

V_{ce}(V)	I_c (mA)		
	I_b=0 μA	I_b=150 μA	I_b=300 μA
2	1.5	4.5	8.0
14	2.0	5.3	9.5

(c) State the factors that affect the bias stability of transistor amplifiers. (3 marks)

(a) Define each of the following with respect to d.c power supplies:

(i) peak inverse voltage;
(ii) ripple factor.

(2 marks)

(b) Show that the d.c voltage from a single-phase full-wave rectifier is given by the expression.

$$V_{dc} = \frac{2V_p}{\pi}$$

Where V_p = peak value of the rectified voltage.

(6 marks)

(c) Draw a circuit diagram of a half-wave voltage doubler and describe its operation.

(6 marks)

(d) An electrostatic cathode ray tube (CRT) has a deflection voltage of 200V and a parallel deflecting plate 2cm long. The amount of deflection of the electron beam is 6cm and the velocity of the electron beam is 26.52×10^6 m/s. Determine the:

(i) deflection sensitivity;
(ii) deflection factor;
(iii) transit time of the beam through the deflecting plates. (6 marks)

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