2521/105 2602/106
2601/106 2603/106
ELECTRICAL MEASUREMENTS AND
ANALOGUE ELECTRONICS I
Oct./Nov. 2018
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**.*
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 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.

SECTION A: ELECTRICAL MEASUREMENTS

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

1. (a) (i) State **three** errors that can occur in electrical measurement systems.

(ii) With the aid of a labelled diagram, describe the operation of a multicellular-type electrostatic voltmeter.

(9 marks)

(b) A multi range d.c milliammeter has an internal resistance of 50 Ω. A current of 2 mA gives full scale deflection on the meter. The meter has current ranges of 0 -10 mA, 0 - 50 mA, 0 - 100 mA and 0 - 500 mA. Determine the value of the shunt resistor for each range. (7 marks)

(c) (i) Sketch a labelled waveform of an amplitude modulated wave displayed on an oscilloscope.

(ii) From the display in c (i), state the expression for the modulation index.

(4 marks)

2. (a) (i) Distinguish between sudden failure and complete failure.

(ii) With the aid of a failure rate versus time curve, describe the performance of an equipment from the time it is put into use up to the end of its life.

(8 marks)

(b) Table 1 shows the failure rate, quantity and weighting factors for components used in an electronic equipment. For the equipment, determine the:

(i) failure rate;
(ii) mean time between failure;
(iii) reliability for an operating period of 1,000 hours.

(10 marks)

Table 1

Component	Failure rate (λ) percent per 1000 hours	Quantity (n)	Weighting Factor (w)
Transistors	0.01	50	1.5
Diodes	0.01	100	1.0
Composition resistors	0.005	80	1.0
Ceramic capacitors	0.025	30	1.0
Electrolytic capacitors	0.2	20	3.0
Film resistors	0.1	40	1.5
Inductors	0.05	15	1.5

(c) State **two** effects of humidity on an equipment. (2 marks)

3. (a) (i) State **two** faults that can be revealed by visual inspection.

(ii) Describe reflow soldering method.

(6 marks)

(b) The voltage gain of an audio frequency (AF) amplifier that has been repaired is to be tested. You have been provided with an AF signal generator, oscilloscope, switched attenuator, dummy load and the amplifier under test.

(i) Draw a labelled block diagram for the set-up.

(ii) Outline the procedure for the test.

(8 marks)

(c) (i) Draw a diagram illustrating how a multimeter is used to test a P-N diode.

(ii) Describe how the test in c (i) is carried out.

(6 marks)

4. (a) State the units for each of the following electrical quantities:

(i) magnetic field strength;

(ii) quantity of electricity;

(iii) magnetomotive force.

(3 marks)

(b) Derive, from first principles, the dimensional equation for the pole strength in the c.g.s. electromagnetic units. (8 marks)

(c) Describe "standard" as used in measurements. (4 marks)

(d) Derive the dimensional equation for mechanical energy. (5 marks)

5. (a) Explain the reason for performing the following during routine maintenance:

(i) lubrication;
(ii) cleaning;
(iii) re-alignment.

(6 marks)

(b) (i) State **two** assumptions to be made in the half-split method of locating a fault.

(ii) Describe the following phases of corrective maintenance tasks:

(I) fault detection;
(II) fault location.

(6 marks)

(c) A ballistic galvanometer has a coil of 120 turns with a mean area of 900 mm^2. The flux density in the airgap is 0.18 Wb/m^2. Taking the moment of inertia as 0.55×10^{-4} kg m^2 and stiffness as 47×10^{-6} Nm/rad, determine the:

(i) displacement constant;
(ii) current to give a deflection of 120°;
(iii) damping constant;
(iv) value of resistor to be added in series to give critical damping.

(8 marks)

SECTION B: ANALOGUE ELECTRONICS I

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

6. (a) (i) Define the following with respect to semiconductors:

(I) covalent bond;
(II) drift current.

(ii) With the aid of a labelled diagram, describe the formation of a p-type semiconductor.

(9 marks)

(b) Explain Rutherford's atomic structure.

(4 marks)

(c) (i) State **three** parameters used to describe semiconductor diode specifications.

(ii) Sketch a labelled voltage-current characteristic curve of the diode in c (i).

(7 marks)

7. (a) Figure 1 shows a circuit diagram of a depletion MOSFET amplifier. The MOSFET has a drain saturation current of 4 mA and a pinchoff voltage of $-5V$. Determine the:

(i) gate bias voltage, V_G;
(ii) gate-to-source voltage, V_{GS};
(iii) drain current, I_D;
(iv) drain voltage; V_D.

(8 marks)

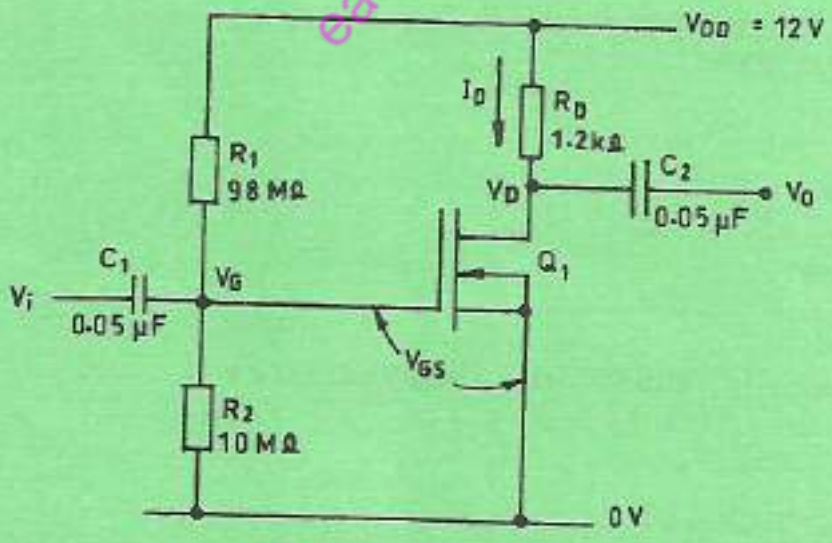

Fig. 1

(b) Derive the expression for the common-base current gain, α, in terms of the common-emitter current gain, β. (6 marks)

(c) (i) State the **three** operating regions of a transistor.

(ii) Draw the circuit diagram of the common-collector configuration of a transistor amplifier.

(6 marks)

8. (a) Explain the function of the following parts of a cathode-ray oscilloscope:

(i) time base generator;
(ii) trigger pulse generator;
(iii) Y-amplifier.

(6 marks)

(b) An electrostatic CRT has a final anode voltage of 2000 V and parallel deflecting plates 1.5 cm long. Taking electronic charge, $e = 1.6 \times 10^{-19} C$ and mass of electron, $m = 9.1 \times 10^{-31}$ kg, determine the following for an electron emitted from the cathode:

(i) maximum velocity;
(ii) transit time through the deflecting plates;
(iii) kinetic energy.

(6 marks)

(c) (i) State the properties of capacitors that make them suitable for use as power supply filters.

(ii) With the aid of a circuit diagram, describe the operation of a zener diode voltage regulator.

(8 marks)

THIS IS THE LAST PRINTED PAGE.