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:
- *Mathematical table/Non-programmable scientific calculator;*
- *Drawing instruments;*
- *Graph paper.*

*The 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 the questions in English.

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: ELECTRICAL MEASUREMENTS

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

1. (a) (i) With the aid of a circuit diagram, explain the operation of a moving coil rectifier instrument.

(ii) State **two** limitations of the instrument in a(i).

(7 marks)

(b) Figure 1 shows a circuit diagram of the ammeter-voltmeter method of measuring the resistance of R. The resistance of the ammeter is 0.02Ω and that of the voltmeter is 2.5 kΩ. Determine the:

(i) measured value of R;
(ii) time value of R;
(iii) percent error in the measurement.

(9 marks)

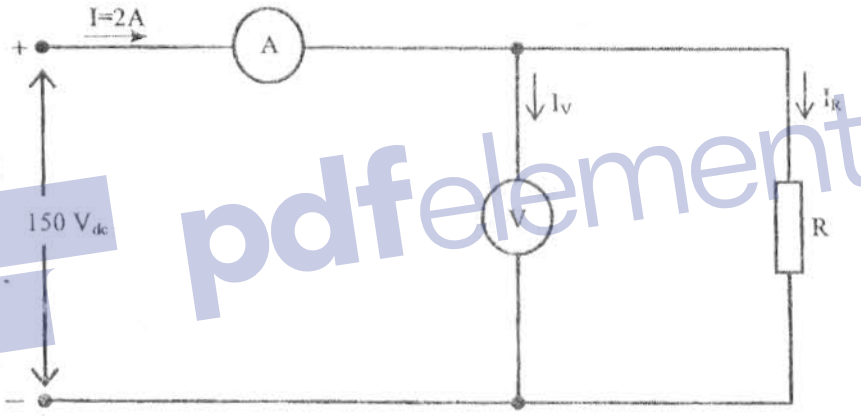

Fig. 1

(c) Draw a circuit diagram of universal shunt with seven different ranges of current.

(4 marks)

2. (a) (i) Distinguish between mean time between failure (MTBF) and mean time to fail (MTTF) as used in reliability.

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

I. low temperatures;
II. high levels of humidity.

(8 marks)

(b) Equipment A and B have reliabilities of 0.85 and 0.76 respectively. Determine the probability of failure when the equipment are connected in:

(i) series;
(ii) parallel.

(8 marks)

(c) During a test on a batch of 500 diodes, a total of 4 failed over a period of 1000 hours. Determine the:

(i) failure rate;
(ii) mean time to fail.

(4 marks)

3. (a) (i) Distinguish between preventive and corrective maintenance.

(ii) Explain how the repair of a faulty equipment should be approached in the absence of a maintenance manual or a fault location guide.

(6 marks)

(b) Explain the function of each of the following knobs on an oscilloscope:

(i) level;
(ii) ac/dc;
(iii) intensity.

(6 marks)

(c) (i) State two precautions to observe when troubleshooting Integrated Circuits (ICs).

(ii) Figure 2 shows a diagram for the pin-out of the 741 operational amplifier. State the function of each pin.

(8 marks)

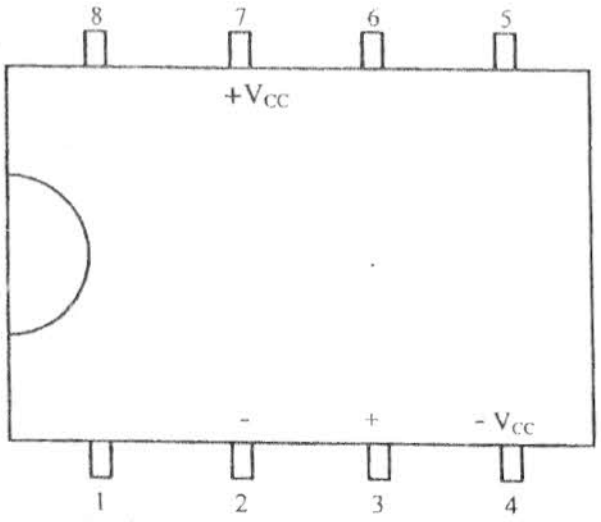

Fig. 2

4. (a) Figure 3 shows a circuit diagram of a Wien's bridge. Obtain the expression for the angular frequency of the input signal at balance condition in terms of the circuit components. (6 marks)

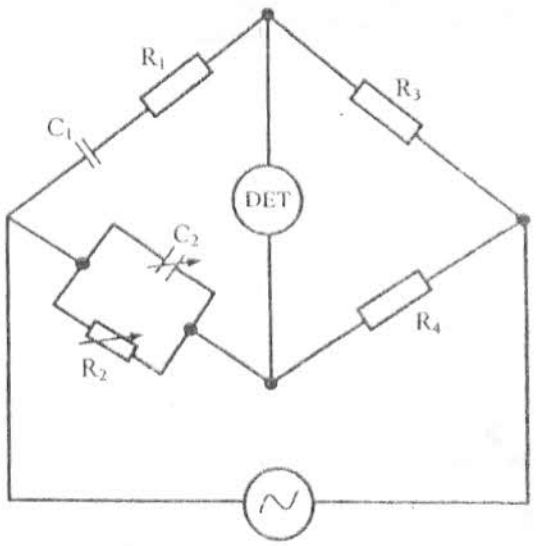

Fig. 3

(b) (i) Draw the equivalent circuit diagram of a non-ideal capacitor.

(ii) With the aid of a labelled diagram, describe the resonance method of measuring the inductance and effective resistance of a coil. (8 marks)

(c) A magnetic potentiometer has a coil of 400 turns. When a current of 0.8A is reversed, there is a throw of 165 scale divisions on the galvanometer. Determine the:

(i) magnetomotive force of the coil;
(ii) galvanometer constant;
(iii) magnetomotive force to give a throw of 280 scale divisions. (6 marks)

5. (a) (i) State **three** errors that affect the accuracy of electrical measurements.

(ii) The current flowing through a resistor of 0.105Ω was measured as 30.4A. It was later discovered that the ammeter reading was low by 1.3 percent and the marked resistance was high by 0.4 percent. Determine the percent error in calculating the power dissipated in the resistor. (11 marks)

(b) (i) Define the term "unit" with respect to measurements.

(ii) Derive the dimensional expression for each of the following mechanical quantities:

I. force;
II. power. (9 marks)

SECTION B: ANALOGUE ELECTRONICS I

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

6. (a) (i) State **two** reasons for biasing a transistor.

(ii) Figure 4 shows a circuit diagram of an amplifier. Taking $V_{ce} = 6.96V$, $I_b = 48\mu A$, $\beta = 50$ and $V_{be} = 0.7V$, determine the value of the:

I. collector current, I_c;
II. base bias resistor, R_b;
III. collector load resistor, R_c.

(8 marks)

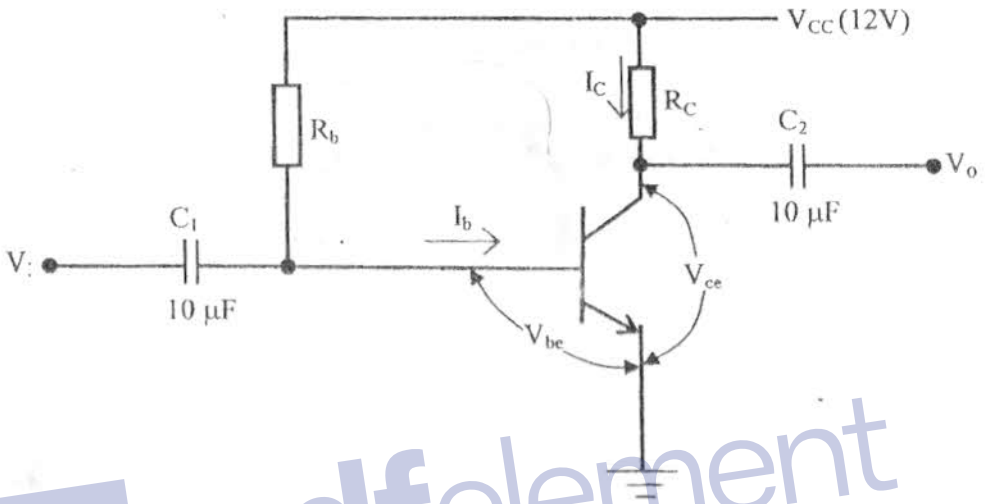

Fig. 4

(b) (i) Define each of the following with respect to field effect transistors:

I. drain-source saturation current,
II. source-gate breakdown voltage.

(ii) With the aid of a labelled diagram, describe the operation of an n-channel enhancement metal oxide semiconductor field effect transistor.

(8 marks)

(c) An n-channel junction field effect transistor has a pinch-off voltage, $Vp = -4V$ and drain-source saturation current $I_{DSS} = 12mA$. Determine the following if the gate-source voltage, $V_{GS} = 0V$:

I. transconductance;
II. drain current.

(4 marks)

7. (a) (i) State **two** advantages of electromagnetic over electrostatic cathode-ray tube (CRT).

(ii) An electrostatic CRT has a final anode voltage of 2.5 kV and the length of the horizontal plates is 50 cm. The maximum transit time of the electron beam is $\frac{1}{4}$ of a cycle. Taking electronic charge, $e = 1.6 \times 10^{-19}$C and mass of electron, $m = 9.1 \times 10^{-31}$kg, determine the:

I. velocity of the electron beam;
II. cutoff frequency.

(6 marks)

(b) (i) Define each of the following with respect to semiconductors:

I. intrinsic semiconductor;
II. covalent bond.

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

(8 marks)

(c) Figure 5 shows a circuit diagram of a diode and a resistor connected in series across a 12V dc supply. If the current in the circuit is 20 mA, determine the:

(i) forward resistance of the diode;
(ii) power dissipated in the diode.

(6 marks)

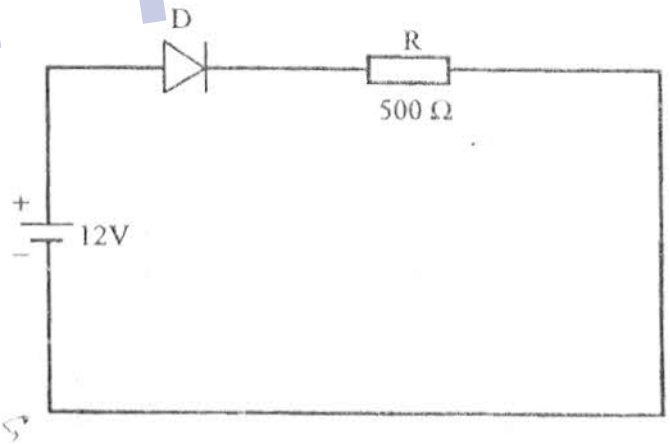

Fig. 5

8. (a) (i) With the aid of a circuit diagram and input and output voltage waveforms, describe the operation of a single-phase full-wave bridge rectifier.

(ii) State **two** disadvantages of half-wave as compared to full-wave rectifiers.

(12 marks)

(b) A single-phase centre-tapped full-wave rectifier feeds a resistive load of 2.2 kΩ. the peak value of the rectified voltage is 100 V. Determine the:

(i) dc load voltage;
(ii) dc load current;
(iii) dc load power;
(iv) diode peak inverse voltage.

(8 marks)

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