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ELECTRICAL MEASUREMENT
AND ANALOGUE ELECTRONICS

June/July 2016

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

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

MODULE I

ELECTRICAL MEASUREMENT AND ANALOGUE ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Drawing instruments;

Non-programmable electronic calculator;

Mathematical tables.

This paper consists **EIGHT** questions into **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 shown.

Candidates should answer the questions in English.

f.s

Oscillates

1100.50
25
550

This paper consists of 5 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 in this section.



1. (a) Define the following system of units as applied in measurements: (2 marks)
- (i) absolute unit;
 - (ii) derived unit.

- (b) Derive the dimensions of the following quantities using the electrostatic system of units: (8 marks)
- (i) charge (Q);
 - (ii) current (I).

$Q = I \times \text{time}$
 $I = \frac{V}{R}$

- (c) State **four** advantages of the MKS system of units in electrical measurements. (4 marks)

- (d) Using the LMTI system of units, derive the dimensional equations for: (6 marks)
- (i) EMF; $= \frac{\text{work}}{\text{charge}}$
 - (ii) magnetic flux density. $= \frac{\text{flux density}}{\text{area}} = \frac{\text{EMF}}{\text{length}}$

2. (a) Explain the following types of measurement errors: (8 marks)
- (i) environmental errors; - due to external conditions external to the instrument eg
 - (ii) instrumental errors; - occur due to the fault of the instrument
 - (iii) gross errors; - error due to human mistake
 - (iv) residue errors. - errors due to the lack of cleaning
 Random - accidental - small one

- (b) State **three** detectors and their operational frequencies as commonly used for a.c. bridges. (6 marks)

- (c) Explain how the following factors affect precision measurement of medium resistance with wheatstone bridge: (6 marks)
- (i) temperature effects;
 - (ii) contact resistance;
 - (iii) thermo-electric effects.



3. (a) State **three** causes of faults on a printed circuit board. (3 marks)
- (b) List **five** tools used in the repair and maintenance of electronic equipment. (5 marks)

- (c) Explain **three** points a service engineer should consider when fault finding on electronic equipment. (6 marks)

- (d) Outline **three** operational objectives and **three** cost objectives of good maintenance. (6 marks)



(a) Describe the term 'reliability' as applied in electrical measurements.
 It is the ability of a machine to perform operationally to failure over a given time under specified conditions.

(b) Explain the importance of the following in relation to reliability:

- (i) mean time between failures; - Time when the machine will stop the work.
- (ii) mean time to failure; - To solve the purpose when in need of failure.
- (iii) availability. - the availability of a machine to solve the specified purpose. (6 marks)

(c) Table 1 shows the performance of ten pressure monitors, observed while operating for a period of 1200 hours. Every failed unit is replaced immediately. Determine the:

- (i) MTBF;
- (ii) failure rate (10 marks)

Table 1

Unit Number	Time of Failure (hours)	Failure
1	650	1
2	420	1
3	130 and 725	2
4	585	1
5	630 and 950	2
6	390	1
7	No failure	0
8	880	1
9	No failure	0
10	220 and 675	2

- (a) State three reasons for the inaccuracies encountered in magnetic measurements. (3 marks)
- (b) Outline six methods of fault location in electronic systems. (6 marks)
- (c) Explain the following wattmeter errors:
 - (i) eddy current errors;
 - (ii) stray magnetic field errors. (6 marks)
- (d) Draw a labelled construction diagram of Hibberts magnetic standard used in magnetic measurements. (5 marks)



SECTION B: ANALOGUE ELECTRONICS

Answer any TWO questions from this section.

1.2
12.5 MF

6. (a) Explain how the following extrinsic semi-conductors are formed.

- (i) N-type; - formed by adding pentavalent atoms
- (ii) P-type; - formed by adding trivalent atoms. (4 marks)

(b) (i) State **three** applications of semi-conductor diodes - as a switch, photo diode, LED, light emitting Diode
 (ii) With aid of voltage-current characteristics, describe the avalanche breakdown in a P-N junction diode. (10 marks)

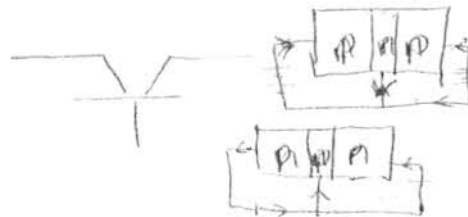


(c) A silicon diode has a forward voltage drop of 1.5V and a forward d.c. current of 150 mA. It has a reverse current of 1.2 μA and a reverse voltage of 12 V. Determine for the diode the:

- (i) forward resistance; $R_f = \frac{V_f}{I_f} = \frac{1.5}{150 \text{ mA}}$
- (ii) reverse resistance; $R_r = \frac{V_r}{I_r} = \frac{12 \text{ V}}{1.2 \mu\text{A}}$ (6 marks)

7. (a) Draw equivalent two source biasing circuits using the transistor symbol for the following:

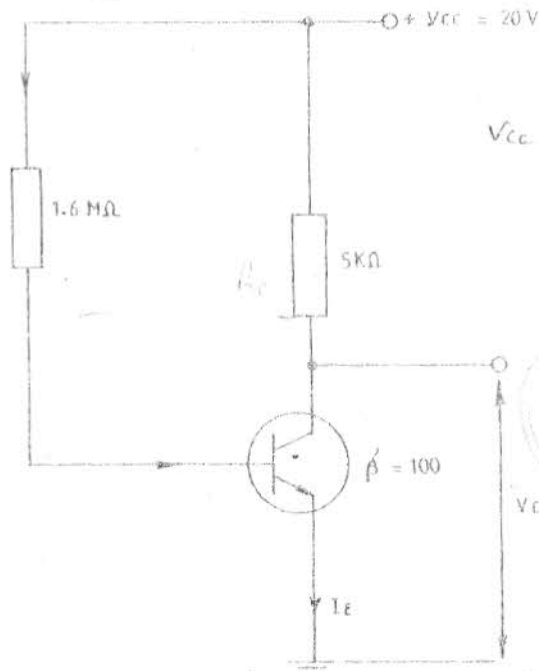
- (i) PNP transistor;
- (ii) NPN transistor.



(b) Figure 1 shows an amplifier circuit.

- (i) Determine the d.c. operating point.
- (ii) Sketch the d.c. loadline.

NB: neglect V_{BE}



$V_{CC} \quad I_{C(sat)} \approx \frac{V_{CC}}{R_B + R_C}$



Fig. 1

- (c) State **two** advantages and **two** disadvantages of field effect transistors over bipolar junction transistors. (4 marks)
8. (a) State **three** advantages of bridge rectifier over bi-phase rectifier. (3 marks)
- (b) (i) With aid of circuit diagram and voltage waveforms, describe the operation of a single phase half wave rectifier feeding a purely resistive load. (11 marks)
- (ii) Derive the expression for the output d.c. current for the rectifier in b(i).
- (c) Figure 2 shows a zener diode stabilizer. Determine the output voltage with no load current. (6 marks)

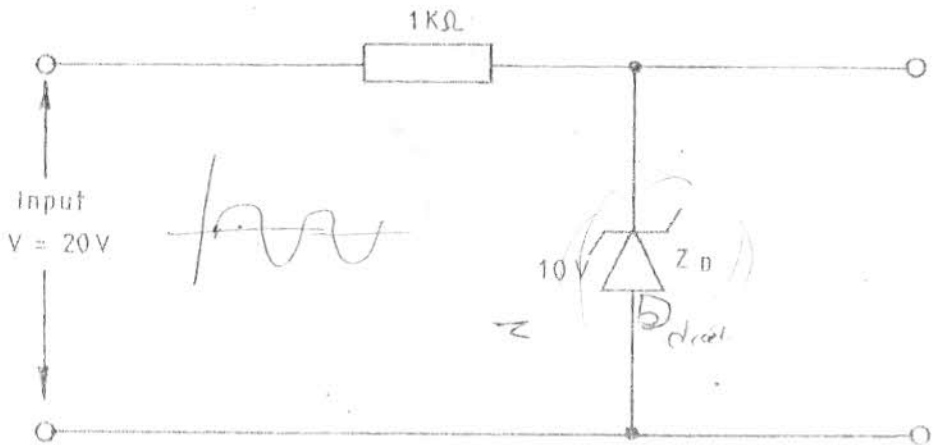


Fig. 2



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