THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT FOR THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2019

080 ELECTRICAL ENGINEERING

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT FOR FORM TWO NATIONAL ASSESSMENT (FTNA) 2019

080 ELECTRICAL ENGINEERING

Published by
The National Examinations Council of Tanzania
P. O. Box 2624,
Dar es Salaam, Tanzania.

TABLE OF CONTENTS

FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to prepare *Students' Item Response Analysis* (SIRA) reports in order to provide feedback on students' performance. This report presents the analysis on the Form Two National Assessment (FTNA) 2019 in Electrical Engineering subject. The report aims to give feedback to students, teachers, examiners and other key education stakeholders on the general performance, specific areas of weakness and recommendations for improvement. Therefore, this landmark report is important for future FTNA processes.

The report is mostly based on responses obtained from students' scripts and statistical data processed by NECTA. The students' responses for each question have been analysed in this report and identified some factors which hinder the students' good performance. The factors observed include inability of the students to interpret the requirements of the questions, failure in using correct formulae in solving problems, and lack of enough knowledge and skills in various topics. Each factor has been clarified using extracts from students' scripts for more illustrations.

The National Examinations Council of Tanzania hopes that the feedback provided in this report will be useful to education stakeholders and that, the suggestions and recommendations offered will enable them to take appropriate measures in enhancing students' performance in future.

Finally, NECTA wishes to acknowledge the tireless efforts of the examination officers and all who participated in one way or another to provide important inputs that have been used in the preparation of this report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

LIST OF SYMBOLS AND ABBREVIATIONS

A.C	Alternating Current
BJT	Bipolar Junction Transistor
SIRA	Students' Items Response Analysis
FTNA	Form Two National Assessment
D.C	Direct Current
mA	Milliampere
MHz	Mega Hertz
NECTA	National Examinations Council of Tanzania
TV	Television
Ω	Ohm
μ	Micro
α	Alpha

1.0 INTRODUCTION

The Electrical Engineering paper consisted of two sections, namely A and B. Section A consisted of 9 questions established from various topics from the Electrical Engineering Science syllabus. The students were required to answer all questions from this section.

Question 1 was a multiple choice with ten (10) items set from various topics. Question 2 was composed from the *Electromagnetism* and question 3 was composed from *soldering*. Question 4 and 5 were set from *D.C Circuits* and *Batteries & Cells* respectively. Question 6 was composed from *Magnetism & Electromagnetism* while questions 7 and 8 were set from *Conductors & Cables* and *Transformers* respectively. Question 9 was composed from *DC Circuits* in the subtopic of capacitor and capacitance. The total marks allocated to this entire section were 50.

Section B consisted of two parts, namely part I and part II. The students were required to answer **all** questions depending on the area of their specialization. Part I was Electrical Installation which had one question (question 10) with five parts (a) to (e) drawn from various topics. The topics covered were: *Tools, Electrical Accessories & symbols, Protective Devices, Supply System* and *Conductors, Insulators & Cables*. Total marks allotted to this part were 50.

Part II had one question (Question 11) set from the syllabus of Electronics, Radio Repair and TV servicing. The question had five parts (a) to (e). Part (a) was set from the topics *Semiconductor Diodes, Bipolar Transistors, Electronic Circuits Components, Semiconductor Diodes* and *Power*. This part was allotted 50 marks.

A total number of 486 students sat for the Electrical Engineering paper. Among them 331 (68.11%) students passed while 155 (31.89%) failed. The analysis of the students' performance in each question is categorized into three grade ranges as follow: the performance is considered to be ***good*** if the percentage of students scored from 30% and above the total marks allocated in the intended question is at least 65%. The question is considered to be ***averagely*** performed if the percentage of the students scored from 30 % to 64% and ***poorly*** performed if the percentage of students scored below 30% of the total marks were more than 70%.

2.0 ANALYSIS OF STUDENTS' RESPONSE IN EACH QUESTION

2.1 SECTION A: ELECTRICAL ENGINEERING SCIENCE

2.1.1 Question 1: Multiple Choice Items

Question 1 comprised of ten (10) items, (i) – (x) constructed from various topics in the prescribed syllabus of Electrical Engineering Science. The students were required to choose the correct answer from the given alternatives by writing the correct letter in the box provided. The total marks for this question were 10 of which 1 mark was allotted to each item.

A total of 486 (100%) students attempted this question. Among them 26 (5.3%) students performed poorly because they scored from 00 to 02 marks. Also 299 (61.6%) students performed averagely as they scored from 03 to 06 marks. The remaining 161 (33.1%) students had good performance because they scored from 07 to 09 marks. Although there were no student who managed to score full (10) marks allotted to this question, the general performance of the students in this question was good because 460 (94.7%) students passed.

The items in which most of students failed to select the correct responses were (iv), (vii) and (x). In item (iv) the students were required to identify the quantity which is measured by the moving coil voltmeter. Most students selected alternative A, *Only A.C voltage* as a correct answer instead of alternative B, *Only D.C voltage*. They confused the *moving coil voltmeter* with another instrument known as *moving iron voltmeter* which is used to measure both D.C and A.C voltages.

In item (vi), students were asked to identify the term which refers to electrons in the last orbit of an atom. Students made an assumption by considering the nature of an atom in reference to its free electron which normally found in the outer shell. This concept led them to choose alternative A, *Free electrons* instead of C, *Valence electrons*.

In item (x), students were asked to identify the factor which the specific resistance (resistivity) of a wire depends on. Most of them opted for alternative B, *Cross sectional area* instead of D, *Material itself*. This was due to the fact that the cross sectional area is one of the factors which the

resistance of a material depends on, hence, the students confused between *resistance* of a material and *specific resistance* (resistivity) of a material as both terms applied in electrical cables and conductors.

The analysis indicates that a number of students performed averagely and above average in items (i), (ii), (iii), (v) (viii). In these items most of the students had sufficient and moderate knowledge on the topics of D.C circuits especially in the application of ohms law, units, measuring instruments and transformers. The overall students' performance in this question is summarized in Figure 1.

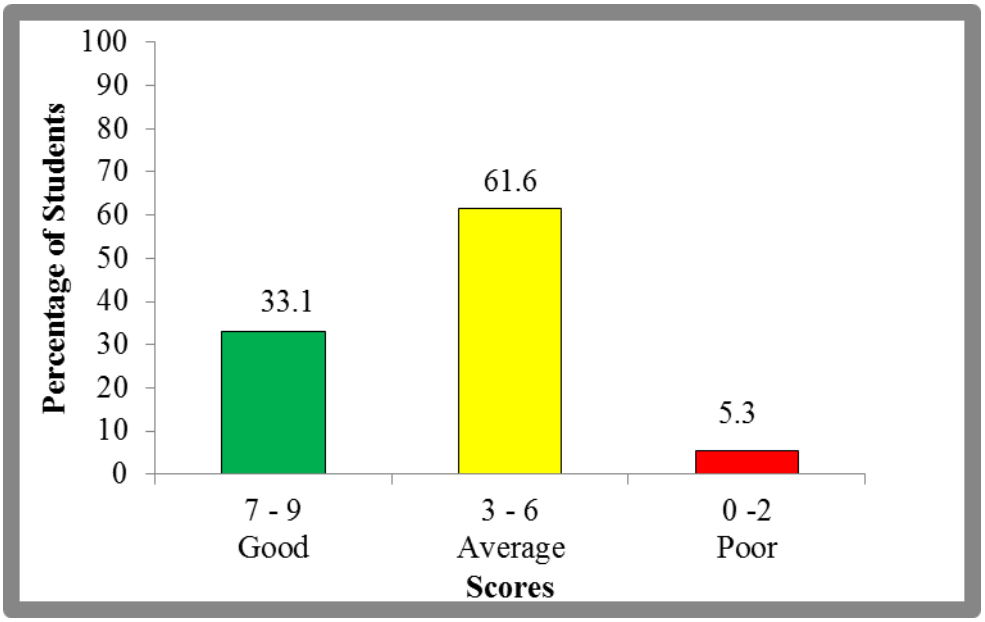


Figure 1: *The overall Performance of the Students in Question 1*

2.1.2 Question 2: Electromagnetism

The question consisted of two parts namely part (a) and (b). In part (a) the students were required to give the meaning of the term 'Mutual inductance' as used in Electrical Engineering Science. In part (b) they were required to calculate mutual inductance between two coils, A and B having self-inductances of 120 µH and 300 µH respectively and if a current of 1 A flows through coil A produces flux linkages of 100 µWb turns in coil B.

The question was attempted by 453 students. Out of these students 384 (84.8%) scored 0 to 1 mark, 56 (12.3%) scored from 1.5 to 3 marks and 13 (2.9%) from 3.5 to 5 marks. Figure 2 summarizes the overall performance of students in this question.

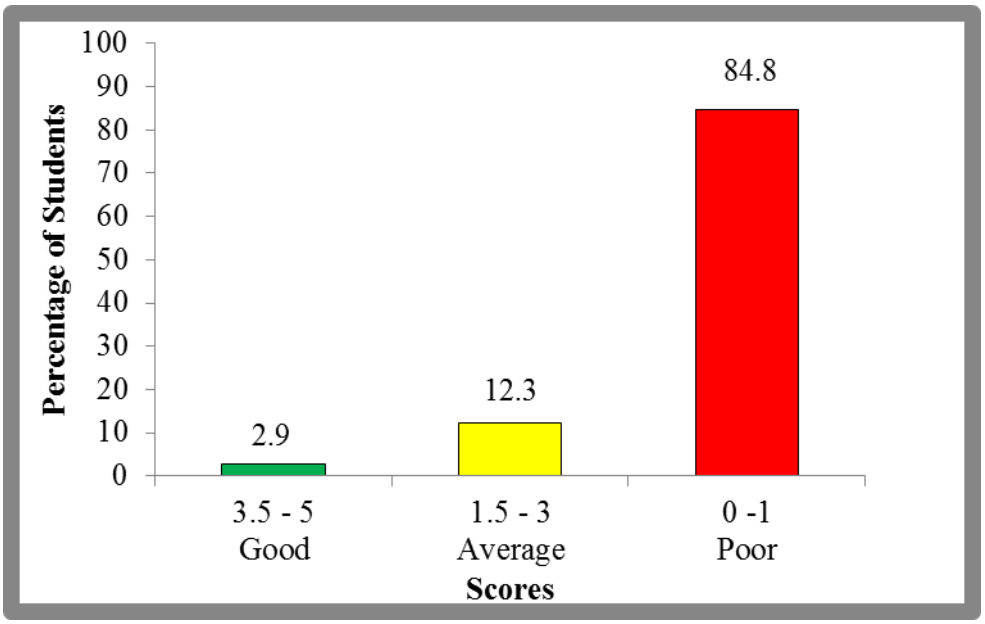


Figure 2: *The overall Students Performance in Question 2*

The general performance in this question was **poor** because 384 (84.8%) students scored below average. The students lacked skills on how to apply correct formula to calculate mutual inductance, flux linkage and the currents flowing in the coils. They also failed to define the term "mutual inductance" as it was seen in one of the students' script who wrote: "*Mutual inductance is the increase or decrease of capacity of anybody or temperature*". This performance shows that the majority of the students had little knowledge in the topic of electromagnetism particularly in sub-topic electromagnetic induction. Extract 2.1 shows a sample of poor response from one of the students.

2. (a) 'Mutual inductance' is the common terminology used in electrical engineering science. What does the term imply?

for example, Two coils, A and B have self-inductances, and the current flowing through coil are the same

(b) Two coils, A and B have self-inductances of 120 μH and 300 μH respectively. If a current of 1 A flowing through coil A produces flux linkages of 100 μWb turns in coil B. Calculate mutual inductance between the two coils.

Data given

Self inductances = 120μH, 300μH

Flux linkages = 100μWb

Mutual inductance = $\frac{4200\mu H}{100\mu Wb}$ = 4.2 H/Wb

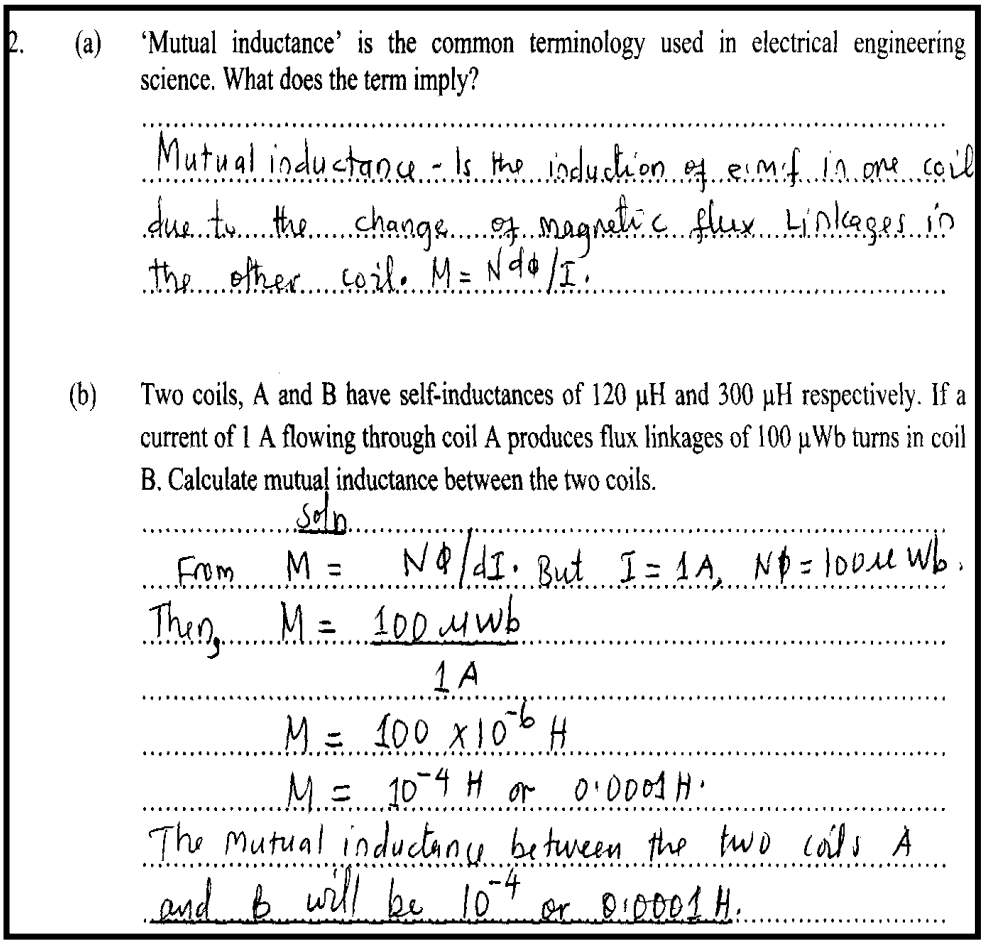
∴ The mutual inductance between the two coils are 4.2 H/Wb

Extract 2.1: *A sample of poor response from one of the students who failed to provide correct responses in question 2*

This student failed to define mutual inductance in part (a). The student's response reveals that he/she just extracted some words from question 2 (b). The student also applied irrelevant formula to calculate the value of mutual inductance between two coils in part (b). The student's response proved that he/she lacked knowledge in the area of electromagnetism.

However, there were 69 (15.2%) students who responded well to this question of which 56 (12.3%) performed averagely as they scored from 1.5 to 3 marks. These students provided correct responses in some parts of the question but failed in the other which makes them to have average performance. Students with average performance lacked sufficient knowledge in some aspects of Electromagnetism. Other students 13 (2.9%) had good performance as they scored above average. These students

managed to provide correct responses in both parts of the question. This indicates that, students under this group acquired adequate knowledge and skills on the topic of Electromagnetism. To illustrate this performance, Extract 2.2 is presented as a sample response from one of the students.



2. (a) 'Mutual inductance' is the common terminology used in electrical engineering science. What does the term imply?

Mutual inductance - Is the induction of e.m.f in one coil due to the change of magnetic flux linkages in the other coil. $M = N\Phi/I$.

(b) Two coils, A and B have self-inductances of 120 μH and 300 μH respectively. If a current of 1 A flowing through coil A produces flux linkages of 100 μWb turns in coil B. Calculate mutual inductance between the two coils.

Soln

From $M = N\Phi/dI$. But $I = 1A$, $N\Phi = 100\mu Wb$.

Then, $M = \frac{100\ \mu Wb}{1A}$

$M = 100 \times 10^{-6}\ H$

$M = 10^{-4}\ H$ or $0.0001\ H$.

The mutual inductance between the two coils A and B will be 10^{-4} or $0.0001\ H$.

Extract 2.2*: A sample of good response from one of the students*

The student managed to define the term mutual inductance and applied the appropriate formula to calculate mutual inductance between the coils. This student demonstrated competence on recalling terms and formulae used in electromagnetism.

2.1.3 Question 3: Soldering

The question consisted of four parts (a), (b), (c) and (d). Part (a) required the students to give the meaning of the term "soldering" as applied in electrical works. Part (b) required students to recommend two best materials to be used for making electronic solder. In part (c), the students were required to give the importance of soldering paste during soldering works, while in part (d), the students were required to give the necessity of having desoldering pump when performing repair and maintenance of electronic circuits.

The question was attempted by 352 students. Out of these 352 (76.0%) scored from 0 to 1 mark, 83(18%) scored from 1.5 to 3 marks and 28 (6%) scored from 3.5 to 5 marks. Figure 3 summarizes the overall performance of students in this question.

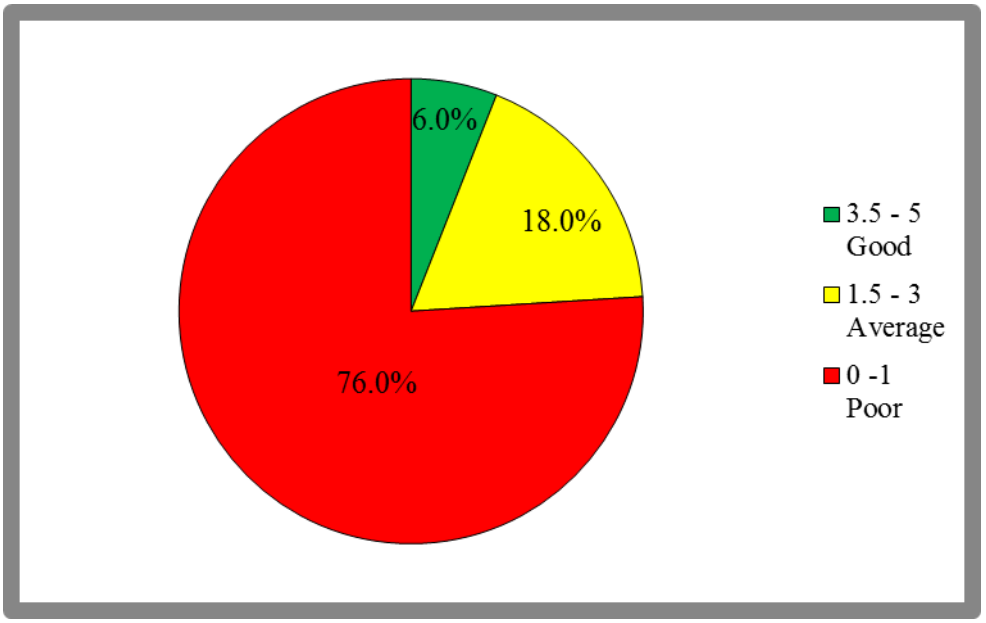
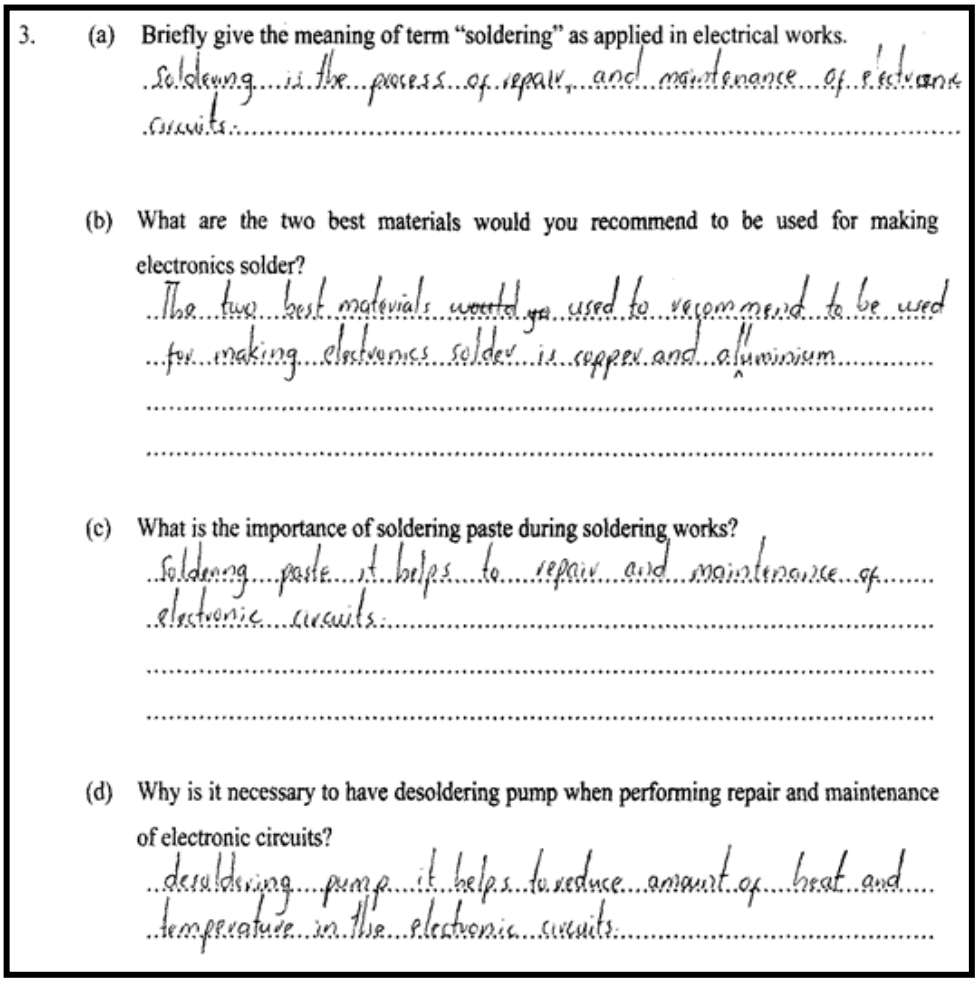


Figure 3: *The overall students' performance in question 3*

The analysis shows that the question was poorly performed because 352 (76.0%) students scored below average. Majority failed to provide the correct responses in all parts of the question while very few of them were able to provide the meaning of the term soldering in part (a) but failed to recommend the best material to be used for making electronic soldering in part (b), give the importance of soldering paste during soldering works in (c) and the necessity of having desoldering pump when perform repair and

maintenance in electronic circuits as required in (d). This performance identified that students lacked knowledge in the area of soldering. Extract 3.1 illustrates this performance.



3. (a) Briefly give the meaning of term "soldering" as applied in electrical works.

Soldering is the process of repair and maintenance of electronic circuits.

(b) What are the two best materials would you recommend to be used for making electronics solder?

The two best materials would ~~ga~~ used to recommend to be used for making electronics solder is copper and aluminium

(c) What is the importance of soldering paste during soldering works?

Soldering paste it helps to repair and maintenance of electronic circuits.

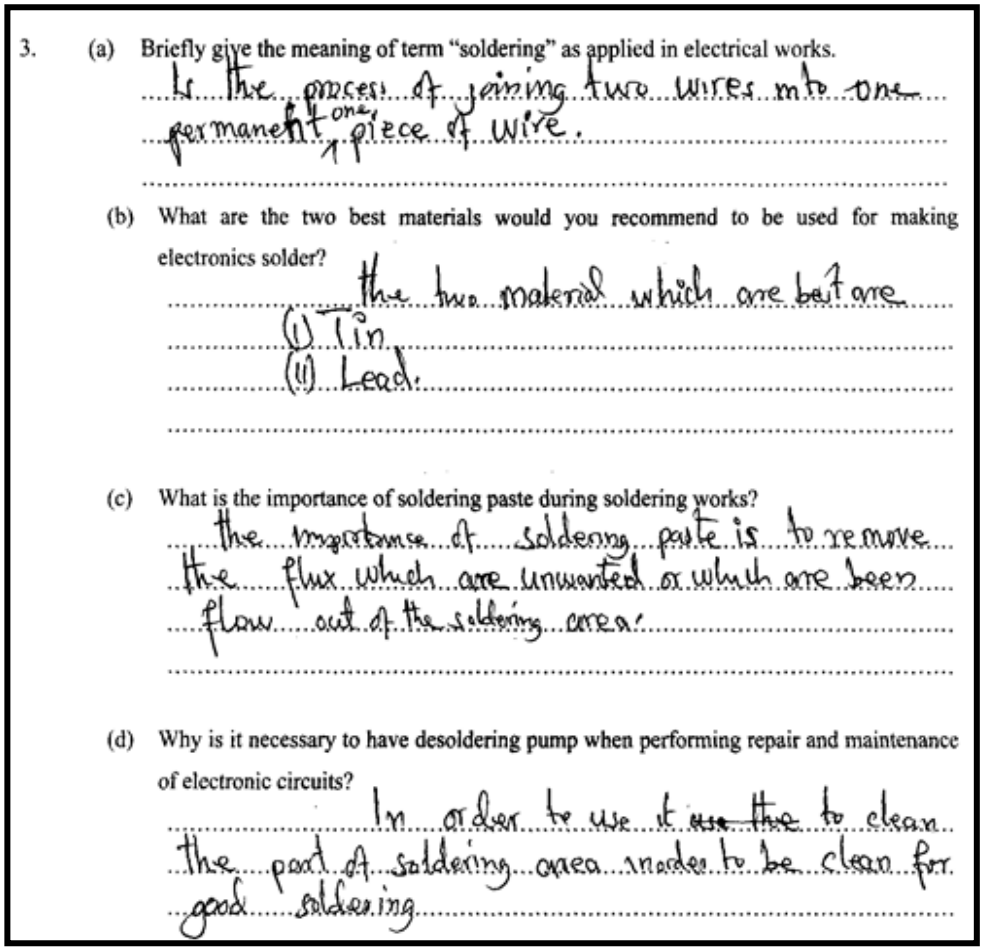
(d) Why is it necessary to have desoldering pump when performing repair and maintenance of electronic circuits?

desoldering pump it helps to reduce amount of heat and temperature in the electronic circuits.

Extract 3.1: *A sample of poor response from one of the students*

Extract 3.1 shows that the student failed to give the meaning of the term "soldering". What the student did is just trying to link "soldering" with repair and maintenance because in some cases soldering may be performed for the sake of repair or maintenance of electronic circuits. However, the student was unable to express exactly what is soldering. The student also failed to identify best materials for making electronics solder and importance of soldering paste during soldering works and failed to give reason for having desoldering pump. This student demonstrated poor mastery of the terms and concepts related to soldering.

Although most of the students performed poorly in this question, some of them performed well. There were 28 (5.8%) students who scored from 3.5 to 5 marks. Those who scored full (05) marks were able to provide the meaning of the term soldering, recommend the best materials used for electronic soldering, give the importance of soldering paste during soldering works and mention the necessity of having desordering pump when performing repair and maintenance of electronic circuits. The rest were able to provide correct responses in more than two parts. This justifies that the students acquired adequate knowledge and practical skills regarding soldering. Extract 3.2 shows a sample of correct response from the student who provided reasonable responses.


3. (a) Briefly give the meaning of term "soldering" as applied in electrical works.

It the process of joining two wires into one permanent one piece of wire.

(b) What are the two best materials would you recommend to be used for making electronics solder?

the two material which are best are
(i) Tin
(ii) Lead.

(c) What is the importance of soldering paste during soldering works?

the importance of soldering paste is to remove the flux which are unwanted or which are been flow out of the soldering area.

(d) Why is it necessary to have desoldering pump when performing repair and maintenance of electronic circuits?

In order to use it ~~use~~ the to clean the part of soldering area inorder to be clean for good soldering

Extract 3.2: *A sample of good response provided by one of the students*

In Extract 3.2, the student managed to give the meaning of the term soldering, identify the common materials recommended to be used for

making electric solder, give the importance of soldering paste and provide the necessity of desoldering pump. This student demonstrated high competency in the area of soldering.

2.1.4 Question 4: D.C Circuits

The question had three parts which required the students to state Ohm's law in part (a), to find the resistance of a circuit which comprises a battery of 12.8 volts and supplies a current of 3.2 A in (b) and (c) briefly explain how the increase of temperature affects the resistance of a conductor.

A total of 482 students attempted this question. Performance analysis of this question indicates that 56 (11.6%) students scored from 0 to 1 mark, 92 (19.1%) scored from 1.5 to 3 marks and 334 (69.3%) scored from 3.5 to 5 marks. The overall performance in this question is summarized in Figure 4.

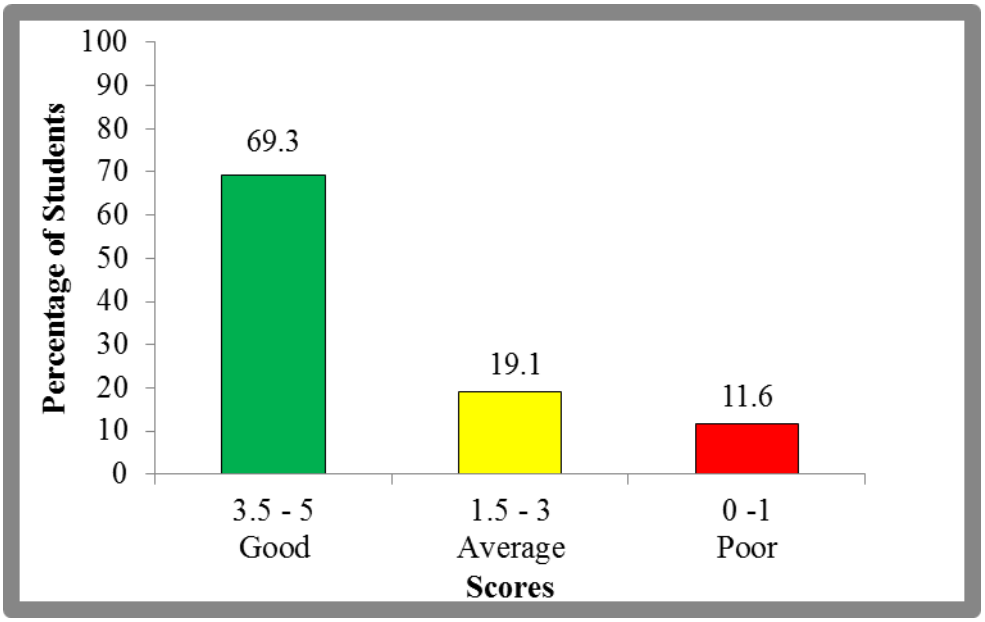


Figure 4: *The overall students' performance in question 4*

The general performance of the students in this question was good because 88.4 percent of them scored average and above. This performance defines that, students were relatively knowledgeable on D.C circuits especially in the area of Ohm's law and its applications. Extract 4.1 shows a sample of good response in question 4.

4. (a) State Ohm's law.

Ohm's law state that "The current paring through a closed circuit is directly proportional to the voltage and inverly proportional to the resistance and the given temperature remains constant"

(b) A battery has an e.m.f of 12.8 volts and supplies a current of 3.2 A. What is the resistance of a circuit?

Solu.

Data given

E.m.f = 12.8 V

I = 3.2 A $R = \frac{V}{I}$

R = ?

$R = \frac{12.8\,V}{3.2\,A}$

$R = 4\,\Omega$

$\therefore R = 4\,\Omega$

(c) How does the increase of temperature affect the resistance of a conductor? Briefly explain.

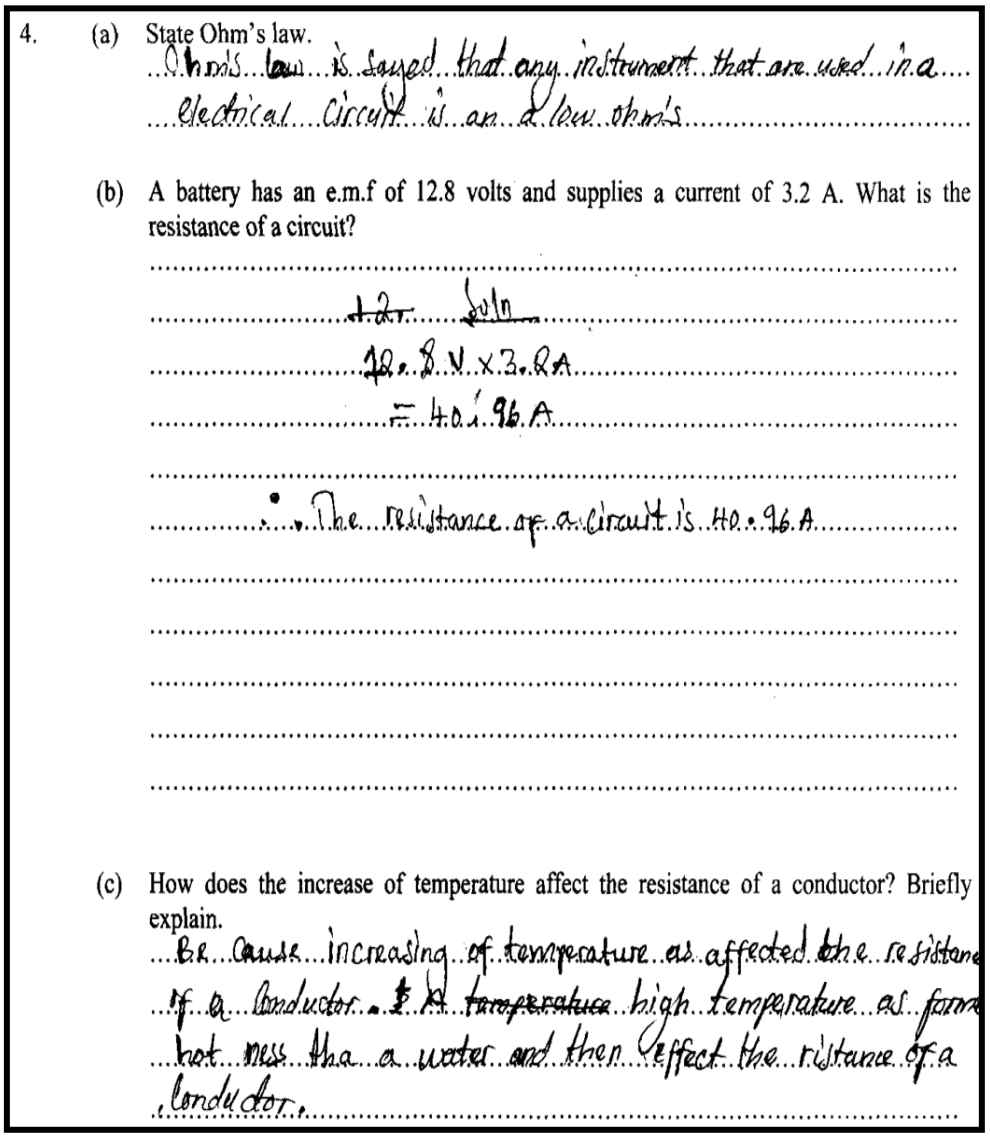
The increase of temperature affect the resistance in this way., when a temperature of a conductor increases also the resistance increases and when the temperature of a conductor decreases the resistance will too, and this most depends on nature of material.

Extract 4.1: *A sample of good response from one of the students*

The student managed to state Ohm's law, applied Ohms' law properly to calculate the resistance of the circuit and explained how the increase of temperature affects the resistance. This implies that the student had adequate knowledge on this area

However, some students failed to provide correct responses either in all or some of the parts of the question. This was due to lack of adequate

knowledge regarding D.C Circuits particularly applications of Ohms law. A sample of poor response from one of the students is shown in Extract 4.2.



4. (a) State Ohm's law.

Ohm's law is saied that any instrument that are used in a electrical circuit is an a law ohm's

(b) A battery has an e.m.f of 12.8 volts and supplies a current of 3.2 A. What is the resistance of a circuit?

12v Solu

12.8 V x 3.2A

= 40.96 A

∴ The resistance of a circuit is 40.96 A

(c) How does the increase of temperature affect the resistance of a conductor? Briefly explain.

Because increasing of temperature as affected the resistance of a conductor. ~~If temperature~~ high temperature as form hot mess tha a water and then effect the ristance of a conductor.

Extract 4.2: *A sample of poor response given by one of the students*

The student had a misconception between Ohms' law, and ohmmeter which is an instrument used to measure resistance in Ohms. The student also failed to apply Ohms' law to calculate the resistance and confused between the effects of temperature on a material and the general definition of temperature. This implies that the student had a little knowledge in this topic.

2.1.5 Question 5: Batteries and Cells

The question had two parts (a) and (b). Part (a) required the students to identify two ways used by electrical technicians in order to reduce polarization in a simple cell. Part (b) asked the students to calculate the resistance which will be required to give the constant voltage when a 24 V car battery is charged by using a source of 30 V and a constant current of 1.2 A. Total number of students who attempted this question were 476. The general performance of students in this question is average as it is summarized in Figure 5.

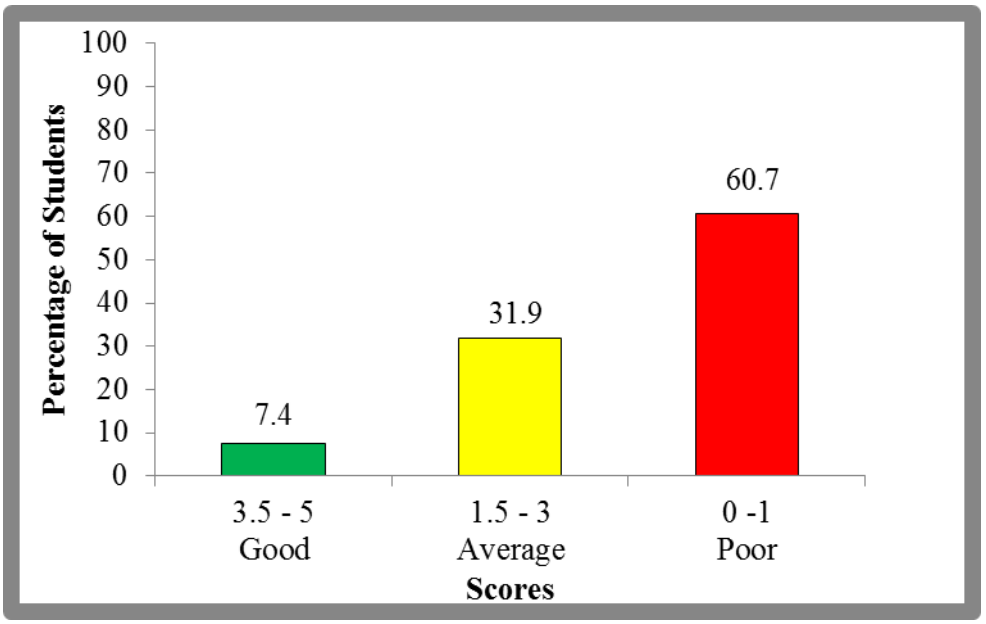
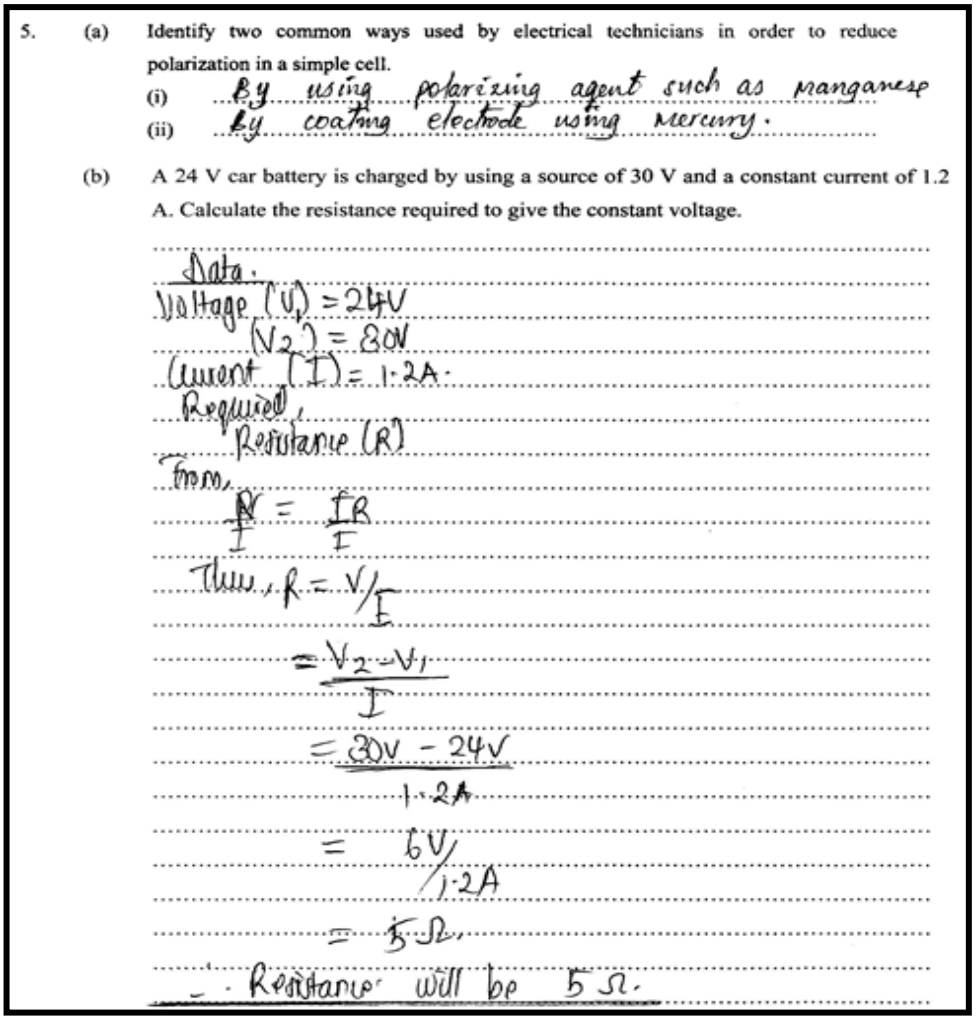


Figure 5: *The overall students' performance in question 5*

Those who scored from 0 to 1 mark were 286 (60.7%) and they are considered to perform poorly. There were 156 (31.9%) students who performed averagely as they scored from 1.5 to 3 marks while 35 (7.4%) performed well because they scored from 3.5 to 5 marks. The students' average performance in this question signify the partial ability of most of the students in recalling and identifying two common ways to reduce polarization in simple cell and the formula to be used in order to calculate the resistance required to give constant voltage. Extract 5.1 shows a sample of good response from one of the students.


5. (a) Identify two common ways used by electrical technicians in order to reduce polarization in a simple cell.

(i) By using polarizing agent such as manganese

(ii) By coating electrode using mercury.

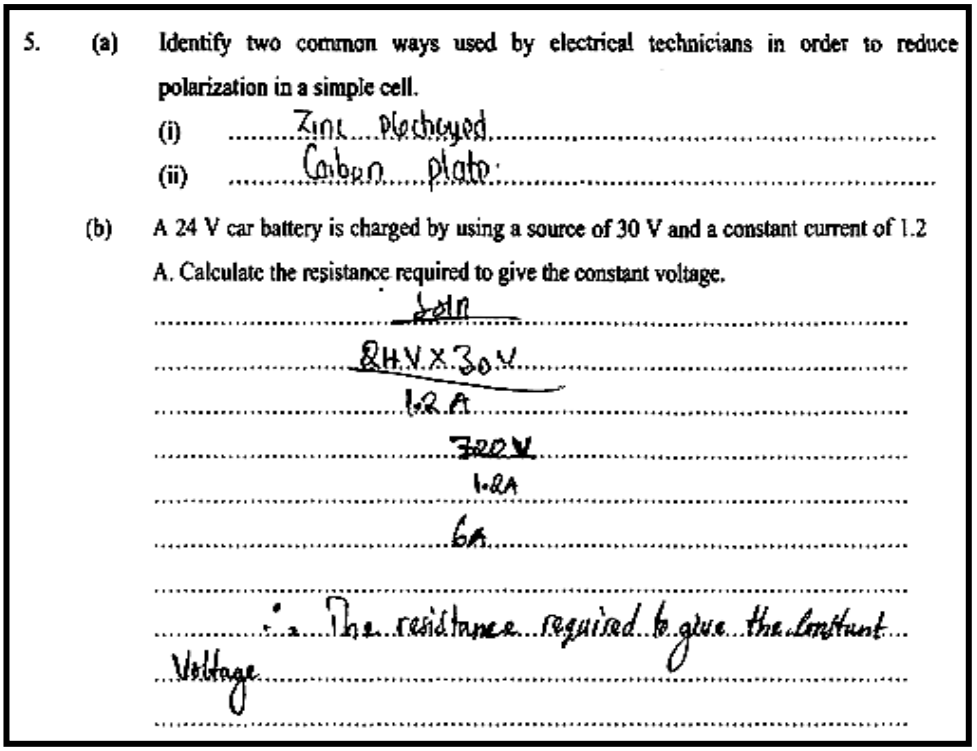
(b) A 24 V car battery is charged by using a source of 30 V and a constant current of 1.2 A. Calculate the resistance required to give the constant voltage.

Data.
Voltage (V_1) = 24V
(V_2) = 30V
Current (I) = 1.2A.
Required,
Resistance (R)
From,
$\frac{V}{I} = \frac{IR}{I}$
Thus, $R = V/I$
$= \frac{V_2 - V_1}{I}$
$= \frac{30V - 24V}{1.2A}$
$= 6V / 1.2A$
$= 5\Omega$.
∴ Resistance will be 5Ω.

Extract 5.1: *A sample of good responses from one of the students*

The student was able to identify two ways of reducing polarization in a simple cell and calculating the resistance required to give a constant voltage. This implies that the students had sufficient knowledge in batteries and cells.

However, the analysis showed that there were 289 (60.7%) students who scored below average. This indicates that most of the students lacked knowledge particularly in computing the resistance. A sample of poor response extracted from one of the students' script is shown in Extract 5.


5. (a) Identify two common ways used by electrical technicians in order to reduce polarization in a simple cell.

(i) Zinc plechoyed

(ii) Carbon plate

(b) A 24 V car battery is charged by using a source of 30 V and a constant current of 1.2 A. Calculate the resistance required to give the constant voltage.

Soln

R=V×30V

1.2A

=20V

1.2A

=6Ω

∴ The resistance required to give the constant voltage

Extract 5.2: *A sample of poor response from one of the students*

The student failed to identify the common ways of reducing polarization instead he/she mentioned the electrodes of dry cell. Also the student applied irrelevant formula to calculate the required resistance.

2.1.6 Question 6: Magnetism and Electromagnetism

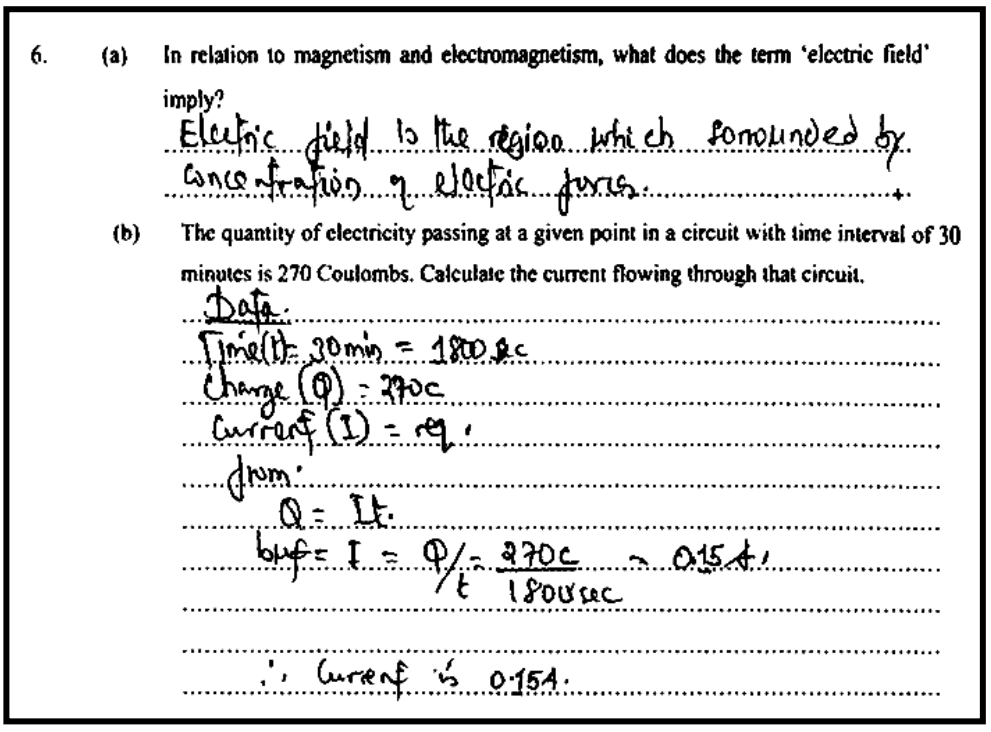
The question had two parts (a) and (b). The students were required to give the meaning of the term 'electric field' in (a) and in (b) the students were required to calculate the current flowing through the circuit with time quantity of electricity at a given point in a circuit with interval of 30 minutes is 270 Coulombs.

This question was attempted by 474 students. The performance analysis indicates that 175 (36.9%) students scored from 0 to 1 mark, 159 (33.6%) scored from 1.5 to 3 marks and 140 (29.5%) scored from 3.5 to 5 marks. Table 1 summarizes the overall performance of the question.

Table 1: Overall Performance of Students in Question 6

Scores (Marks)	Students		Remarks
	Number	**Percentage (%)**	
3.5 to 5	**140**	29.5	Good
1.5 to 3	**159**	33.6	Average
0 to 1	**175**	36.9	Weak
Total	**474**	**100**	

The general performance of the students in this question was average because 299 (63.1%) scored from 1.5 to 5 marks. Among these, 107 (22.0%) scored full (5) marks. The students were able to provide correct responses in both parts (a) and (b). This result indicates that students had adequate knowledge regarding magnetism and electromagnetism. Extract 6.1 shows a sample of good response from one of the students.


6. (a) In relation to magnetism and electromagnetism, what does the term 'electric field' imply?

Electric field is the region which surrounded by concentration of electric forces.

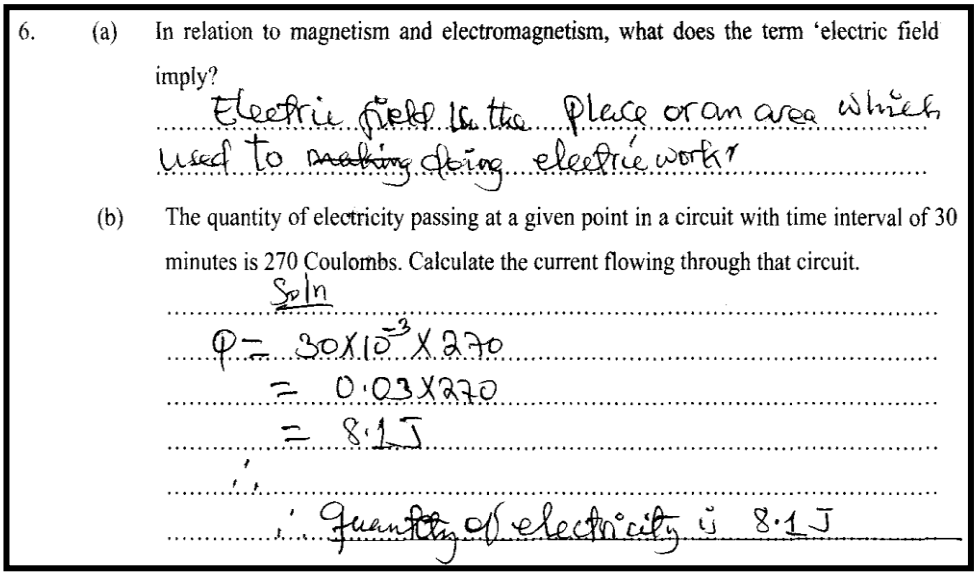
(b) The quantity of electricity passing at a given point in a circuit with time interval of 30 minutes is 270 Coulombs. Calculate the current flowing through that circuit.

Data:
Time(t) = 30 min = 1800 sec
Charge (Q) = 270c
Current (I) = req.
from:
Q = It.
but = I = Q/t = 270c / 1800sec = 0.15A
∴ Current is 0.15A.

Extract 6.1: *A correct response from one of the students*

The student described properly the term "electric field" and applied the correct formula to calculate the current flowing through the circuit. This implies that the student acquired sufficient knowledge and skills about Magnetism and Electromagnetism.

However, the analysis shows that there were 175 (36.9%) students who performed poorly. This indicates that these students had an inadequate knowledge on the topic of magnetism and electromagnetism particularly in the sub topic of electromagnetic induction. They failed to explain what does the term "electric field" imply and could not recall the formula to calculate the current flowing in the circuit. Extract 6.2 shows a sample of poor response provided by one of the students.


6. (a) In relation to magnetism and electromagnetism, what does the term 'electric field imply?

Electric field is the place or an area which used to ~~making~~ doing electric work

(b) The quantity of electricity passing at a given point in a circuit with time interval of 30 minutes is 270 Coulombs. Calculate the current flowing through that circuit.

Soln

$Q = 30 \times 10^{-3} \times 270$

$= 0.03 \times 270$

$= 8.1 J$

∴ Quantity of electricity is 8.1 J

Extract 6.2: *A sample of the student's incorrect response in question 6*

Based on the extract, the student failed to describe the term "electric field" in relation to magnetism and electromagnetism as required in (a). Nevertheless, the student translated the terms 'field' as a place, area or ground where things are done practically. This misconception lead the student to 'interpret electric' field as a place used to perform electric works. In part (b) the student also failed to calculate the current flowing through the circuit because he/she multiplied the given data to get the answer, which is wrong. This student lacked knowledge and skills in Magnetism and Electromagnetism.

2.1.7 Question 7: Conductors and Cables

The question comprised two parts (a) and (b). Part (a) required the students to give the reason as to why copper material is said to be an excellent electric conductor. In part (b) the students were to calculate the length of copper conductor having 4.0 mm^2 with resistance of 0.68 Ω and its resistivity is 17 x 10^{-6} Ωmm.

This question was attempted by 474 students. The score were as follows: 147 (30.6%) students scored from 0 to 1 mark, 147 (31.0%) scored from 1.5 to 3 marks and 182 (38.4%) scored from 3.5 to 5 marks. Figure 6 summarizes the overall performance of the students in this question.

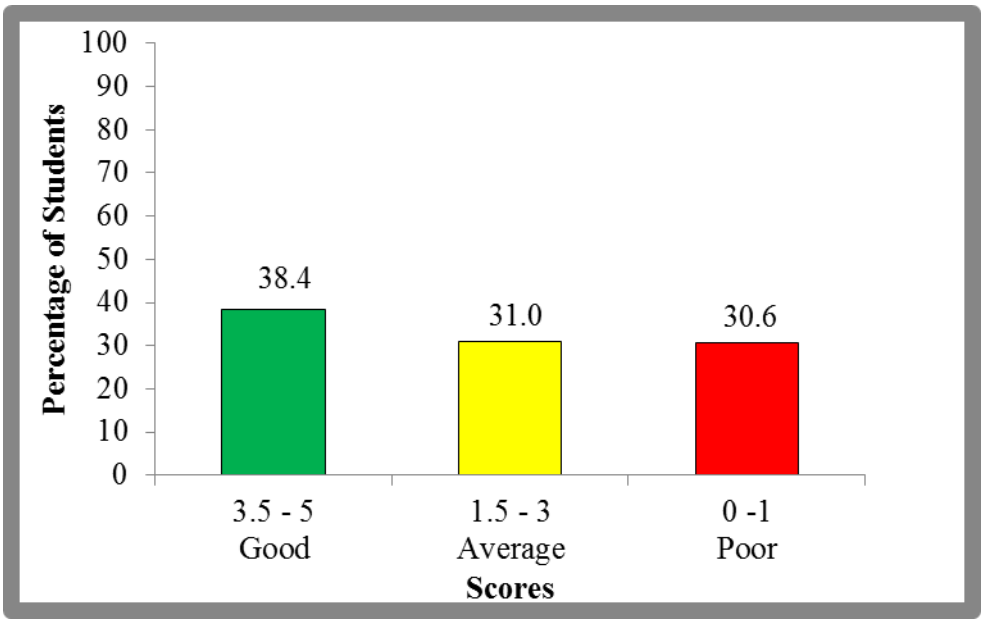
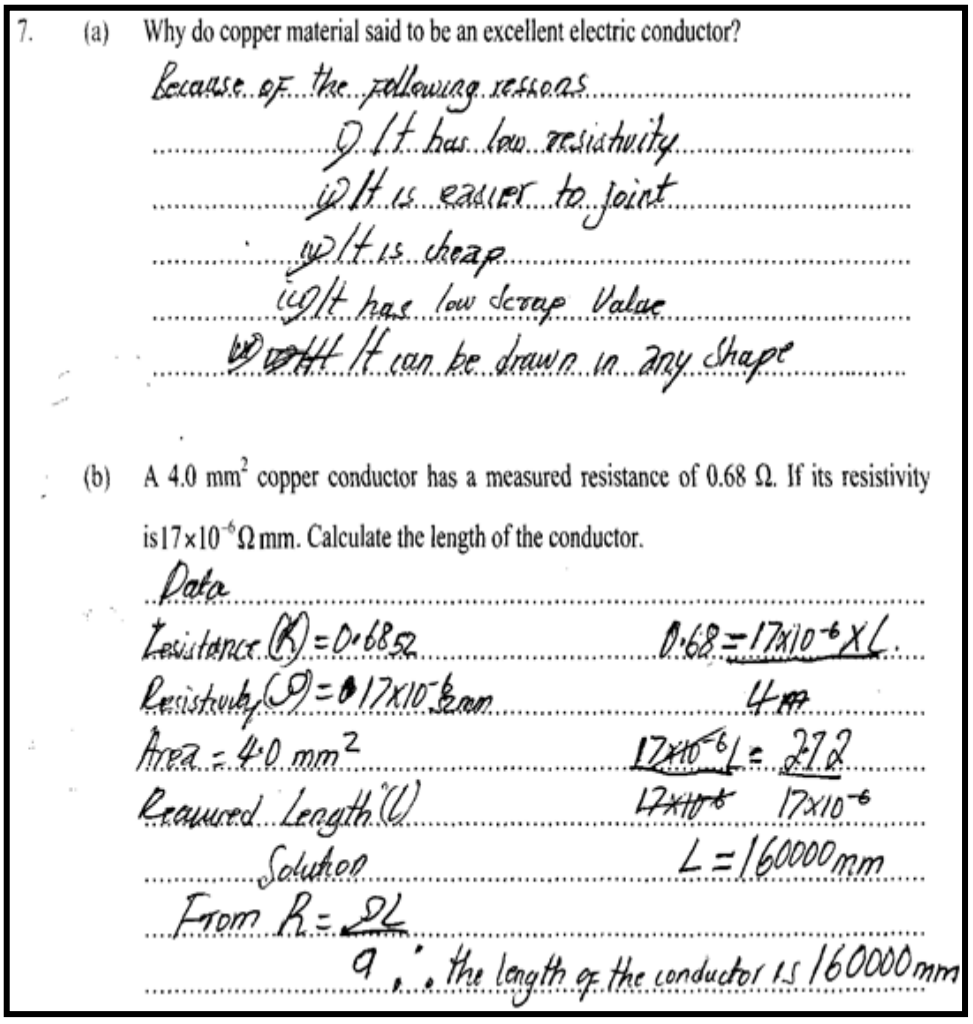


Figure 6: *The overall students' performance in Question 7*

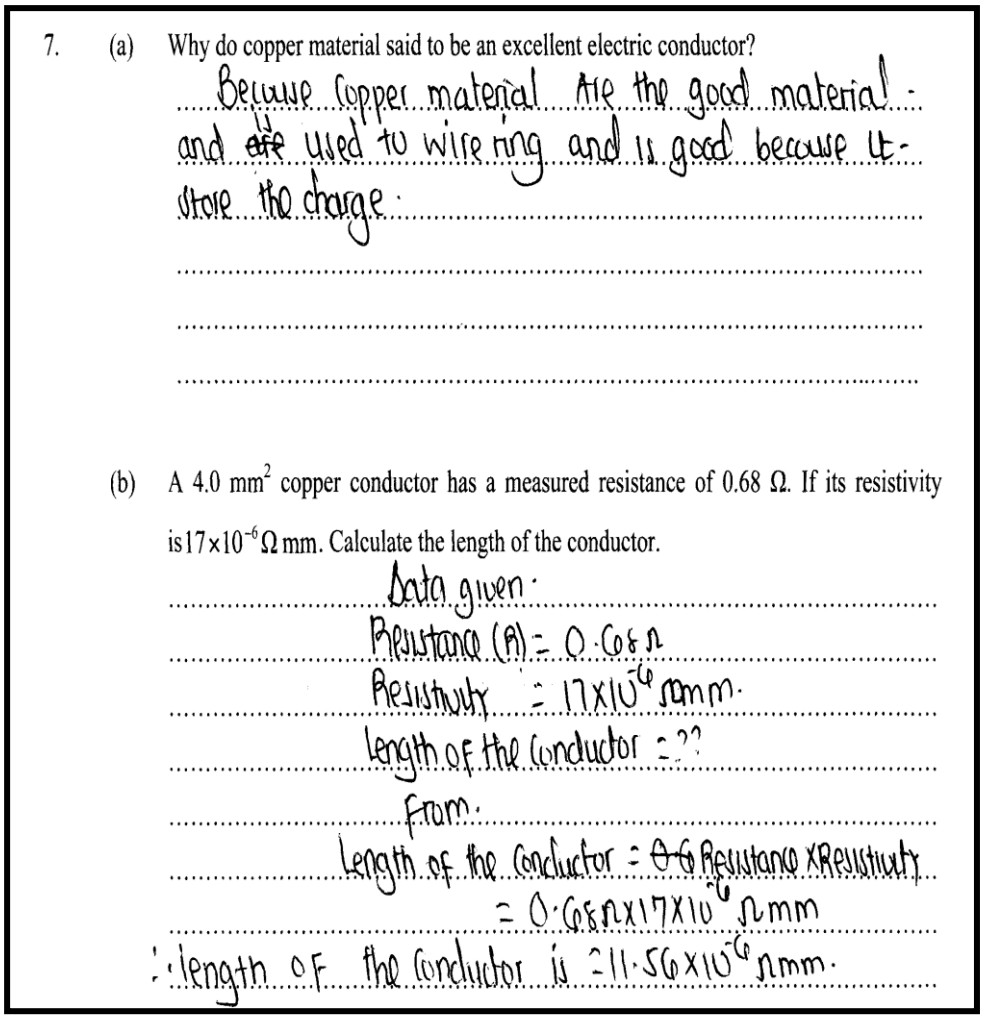
The general performance in this question was good because 329 (69.4%) students had average and good performance. Those who scored full (5) marks were able to give the reason which makes copper material to be an excellent electric conductor and calculated the length of the conductor using the appropriate formula. This indicates that students under this group had acquired sufficient knowledge in various aspects of Conductors and Cables. Extract 7.1 shows a sample of good response in this question.



Extract 7.1: *A sample of good response from one of the students*

This student managed to explain why copper material said to be an excellent electric conductor and applied the formula to calculate the length of a conductor. This implies that the student acquired sufficient knowledge in this topic.

Furthermore, the analysis shows that some of the students were unable to recall the properties of coper material. However, they failed to use the appropriate formula which relates to resistivity, cross sectional area, length and resistance of a material. Extract 7.2 shows a sample of poor response from one of the students who produced incorrect responses.



7. (a) Why do copper material said to be an excellent electric conductor?

Because Copper material Are the good material - and ~~are~~ used to wire ring and is good because it - store the charge.

(b) A 4.0 mm^2 copper conductor has a measured resistance of 0.68 Ω. If its resistivity is 17×10^{-6} Ω mm. Calculate the length of the conductor.

Data given.
Resistance (R) = 0.68 Ω
Resistivity = 17×10^{-6} Ωmm.
length of the conductor = ??
From.
Length of the conductor = ~~0.68~~ Resistance x Resistivity
= $0.68\Omega \times 17 \times 10^{-6}$ Ωmm
∴ length of the conductor is = 11.56×10^{-6} Ωmm.

Extract 7.2: *A sample of an incorrect response from one of the students*

Poor response provided by the student was due to lack of knowledge. He/she showed incompetence regarding properties of various conductor materials as well as the use of appropriate formula to calculate the length of conductor.

2.1.8 Question 8: Transformers

This question had two parts, (a) and (b). In part (a) the students were required to give two reasons for electric circuits to be incorporated with transformers. Part (b) required the students to calculate number of turns in secondary to produce 20 Volts when a transformer has 120 turns in the primary side and is connected to 80 Volts A.C.

The question was attempted by 473 students. Out of these 97 (20.5%) students scored from 0 to 1 mark, 238 (50.3%) scored from 1.5 to 3. marks and 138 (29.2%) scored from 3.5 to 5 marks. Figure 7 summarizes the overall performance of the students in this question.

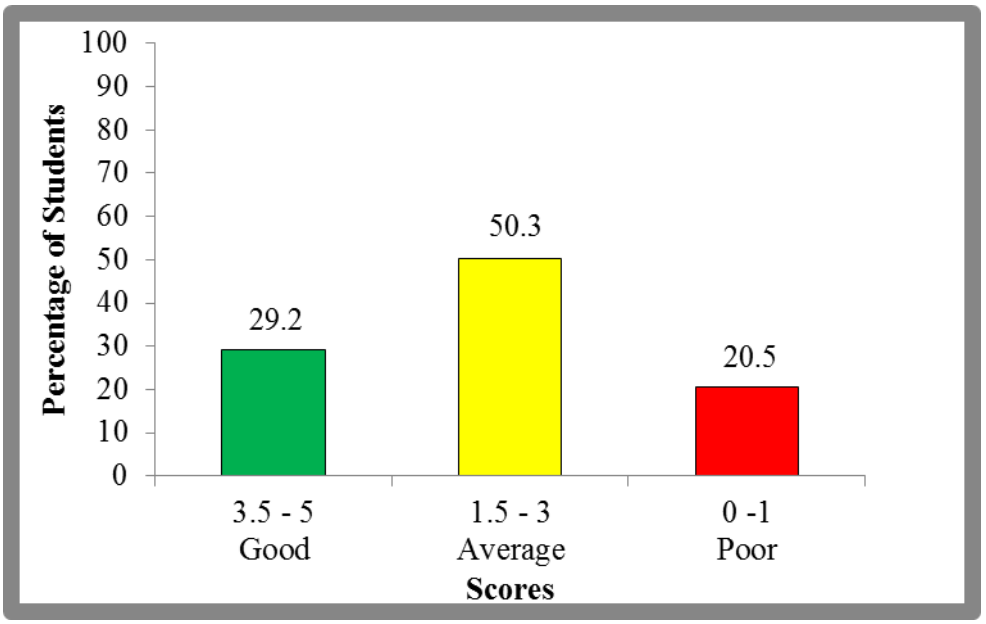
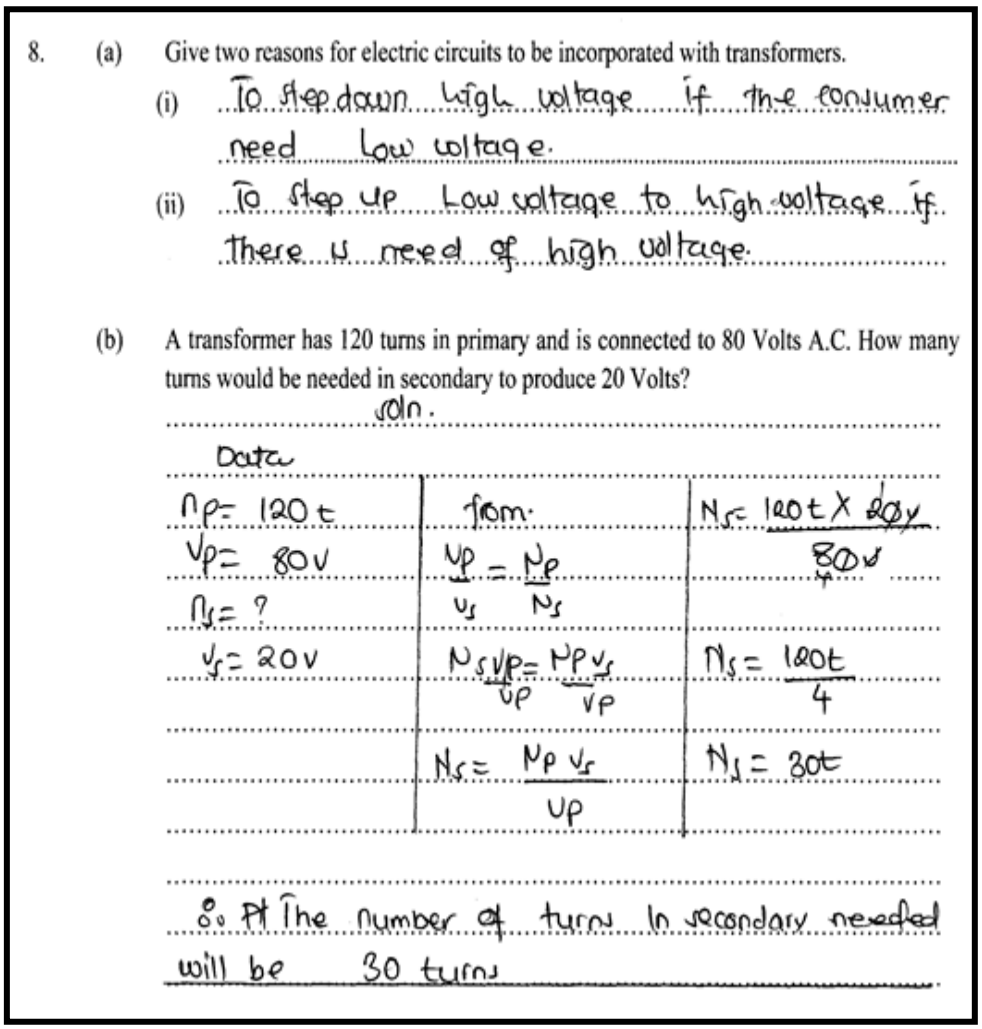


Figure 7: *The overall students' performance in question 8*

The general performance of the students in this question was good because 79.5 percent of them had good and average performance. Most of the students were able to provide correct responses in either both parts of the question or provided response in one part of the question. This postulates that, the student had sufficient knowledge and skills concerning transformers. A sample of good response from one of the students is represented by Extract 8.1.

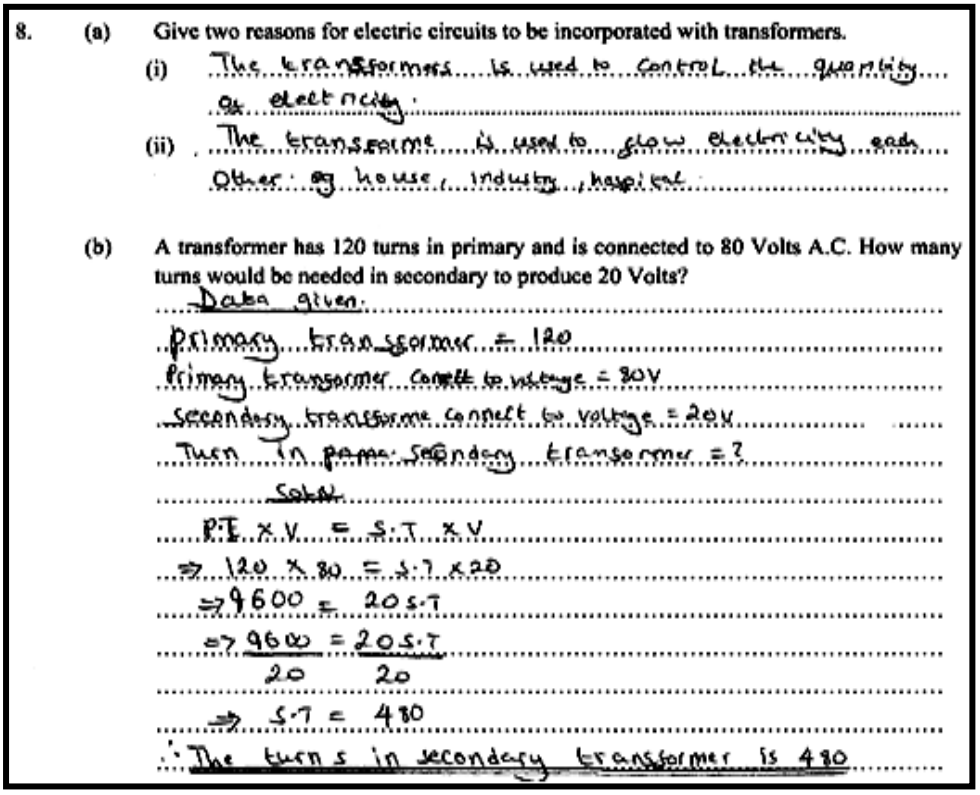


Extract 8.1: *A sample of good response from one of the students*

This student gave clear reasons for electric circuits to be incorporated with transformers and correctly calculated the number of turns in the secondary side of the transformer.

Despite the good performance, 97 (20.5%) students performed this question unsatisfactorily as they scored below average. These students lacked knowledge concerning transformers. Most of them were unable to give reasons for electric circuits to be incorporated with transformers. For example, one student gave wrong reasons by writing "to *ensure supply current*" and "*to reduce voltage to the voltage needed in the circuit"*. Students also failed to recall formula to calculate number of turns in the

secondary side of the transformer. Extract 8.2 shows a sample of incorrect responses from one of the students.


8. (a) Give two reasons for electric circuits to be incorporated with transformers.

(i) The transformers is used to control the quantity of electricity.

(ii) The transformer is used to flow electricity each other: eg house, industry, hospital

(b) A transformer has 120 turns in primary and is connected to 80 Volts A.C. How many turns would be needed in secondary to produce 20 Volts?

Data given.

primary transformer = 120

primary transformer connect to voltage = 80V

secondary transformer connect to voltage = 20V

Turn in prime: secondary transformer = ?

Solve

P:T x V = S:T x V

⇒ 120 x 80 = S:T x 20

⇒ 9600 = 20S:T

⇒ 9600 / 20 = 20S:T / 20

⇒ S:T = 480

∴ The turns in secondary transformer is 480

Extract 8.1: *A sample of poor response from one of the students*

The extract shows that the student gave the area where transformers are used instead of providing the reasons for electric circuits to be incorporated with transformers. The student also failed to apply the correct formula to find the number of turns in the secondary side of the transformer from the given number of turns in the primary. This performance justifies the student acquired little knowledge on application of transformers.

2.1.9 Question 9: DC Circuits

This question had two parts namely (a) and (b). Part (a) required the students to classify four types of fixed capacitors according to their dielectrics. In part (b), the students were asked to study the figure provided and then calculate the overall capacitance of the circuit.

A total number of 476 students attempted this question. Out of these, 98 (20.6%) students scored from 0 to 1 mark. Those who scored from 1.5 to 3 marks were 128 (26.9%) and they are considered having average performance. There were 250 (52.5%) students who performed well as they scored from 3.5 to 5 marks. The overall students' performance is summarized in Figure 8.

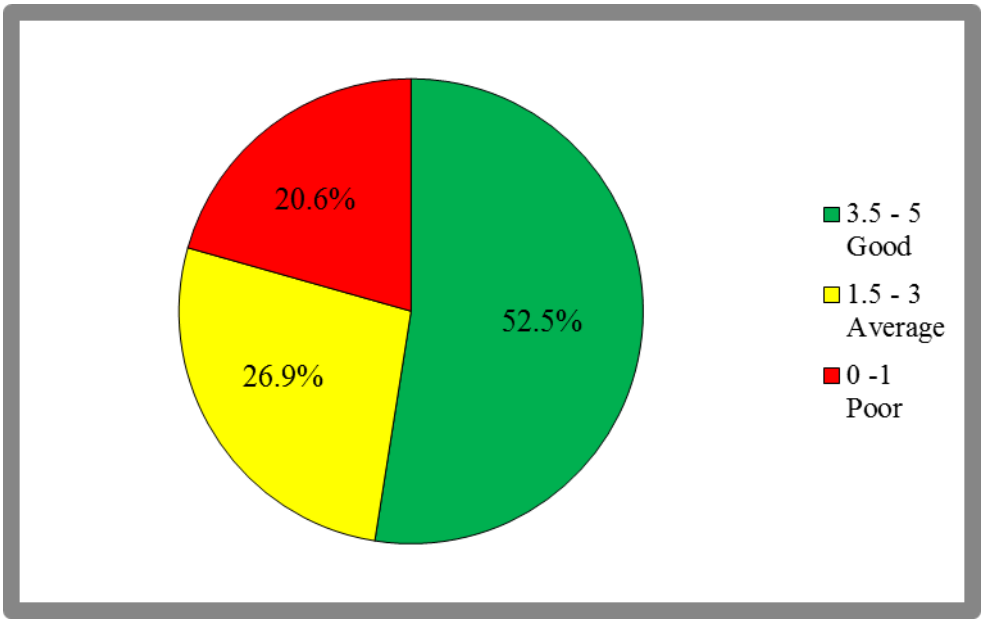


Figure 8: *The overall students' performance in question 9*

The general performance of the students in this question was good because 378 (79.4%) students had average performance and above. These candidates showed to have adequate knowledge on D.C Circuits. They managed to classify the four types of fixed capacitors according to their dielectrics and calculate the overall capacitance of the circuit according to the given Figure. Extract 9.1 illustrate a sample of good response.

9. (a) Classify four types of fixed capacitors according to their dielectrics.

(i) Air capacitor

(ii) Ceramic capacitor

(iii) Mica capacitor

(iv) Paper capacitors

(b) Study Figure 1 and calculate the overall capacitance of the circuit.

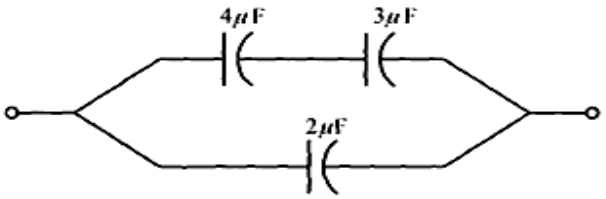


Figure 1

Data

$C_1 = 4\,\mu F$

$C_2 = 3\,\mu F$

$C_3 = 2\,\mu F$

$C_T = \frac{C_1 C_2}{C_1 + C_2}$

$C_T = \frac{4\,\mu F \times 3\,\mu F}{4\,\mu F + 3\,\mu F}$

$C_T = \frac{12\,\mu}{7\,\mu F}$

$C_T = 12/7$ or $1\frac{5}{7}\,\mu F$ 1.7

$C_T = C_1 + C_2$

$= 1.7 + 2$

$C_T = 3.7$

∴ Overall capacitance of a circuit : $3.7\,\mu F$

Extract 9.2: *A sample of good response from one of the students*

The student managed to classify four types of fixed capacitors according to their dielectrics and calculated the overall capacitance. This student had appropriate knowledge and skills on D.C circuits especially in the area of capacitor and capacitance.

The further analysis shows that 98 (20.6%) students performed poorly. These students lacked enough knowledge on D.C Circuits. They showed inability in attempting this question as most of them failed to classify four types of fixed capacitors according to their dielectrics. Likewise they failed

to calculate the overall capacitance of the circuit according to the given Figure. Extract 9.2 illustrates a sample of poor response.

9. (a) Classify four types of fixed capacitors according to their dielectrics.

(i) series capacitors

(ii) parallel capacitors

(iii) combination capacitors:

(iv) series - parallel capacitors.

(b) Study Figure 1 and calculate the overall capacitance of the circuit.

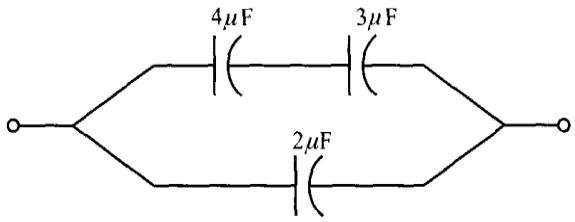


Figure 1

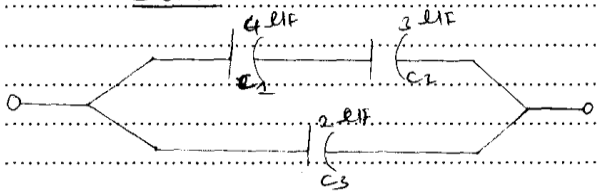
Data given:

Capacitance one, $C_1 = 4\,\mu F$

Capacitance ~~three~~ two, $C_2 = 3\,\mu F$

Capacitance three, $C_3 = 2\,\mu F$

SOLN



$C_T = C_1 + C_2 + C_3$

$= 4 + 3 + 2$

$= 9\,\mu F$

∴ The overall capacitance of the circuit is $9\,\mu F$

Extract 9.2 *A sample of poor response from one of the students*

This student confused between ways of connecting capacitors and classification (types) of capacitors. He/she failed to interpret the given circuit diagram to deduce the correct formula for calculating the overall capacitance of capacitors when connected in different ways. The student's response signifies that he/she lacked skills and knowledge on the area of D.C Circuits, especially on capacitors and capacitances.

2.2 SECTION B: SPECIALIZATION

2.2.1 PART (I): ELECTICAL INSTALLATION

2.2.1.1 Question 10: Tools, Electrical Accessories & Symbols, Protective Devices, Supply System, Conductors, Insulators & Cables and Inspection & Testing

This question consisted of five parts (a), (b), (c), (d) and (e). The question was composed from various topics of Electrical Installation Syllabus. The total marks allotted to the question were 50.

A total of 340 students attempted this question. Out of these 115(33.8%) scored from 0 to 14.5 marks, 218 (64.1%) scored from 15 to 32 marks and 7 (2.1%) students scored from 32.5 to 37 marks. The general performance of the question was good because 225 (66.2%) students performed averagely and above average. Figure 9 summarizes the overall students' performance in this question.

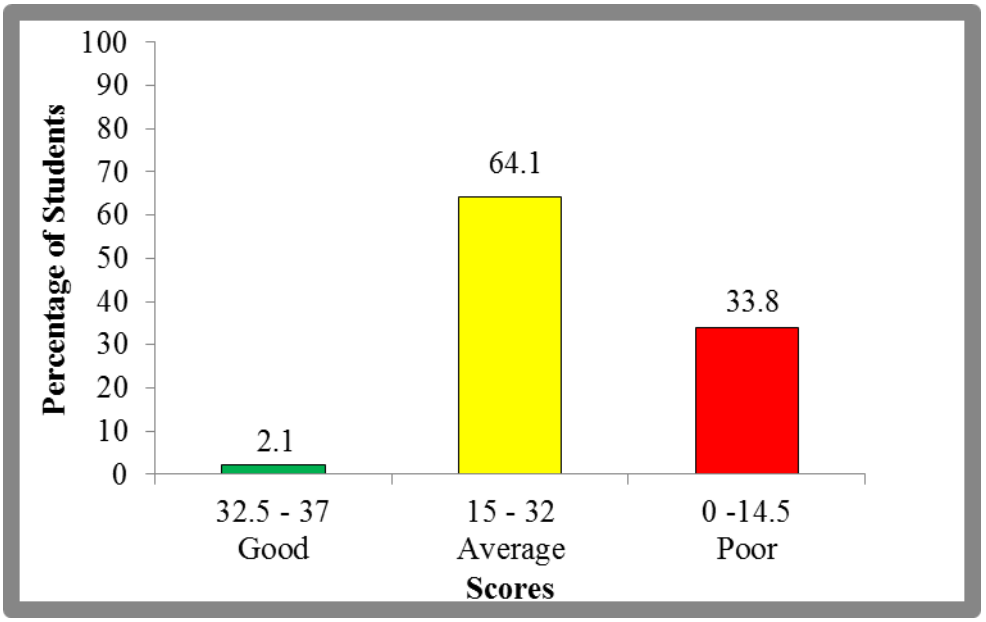
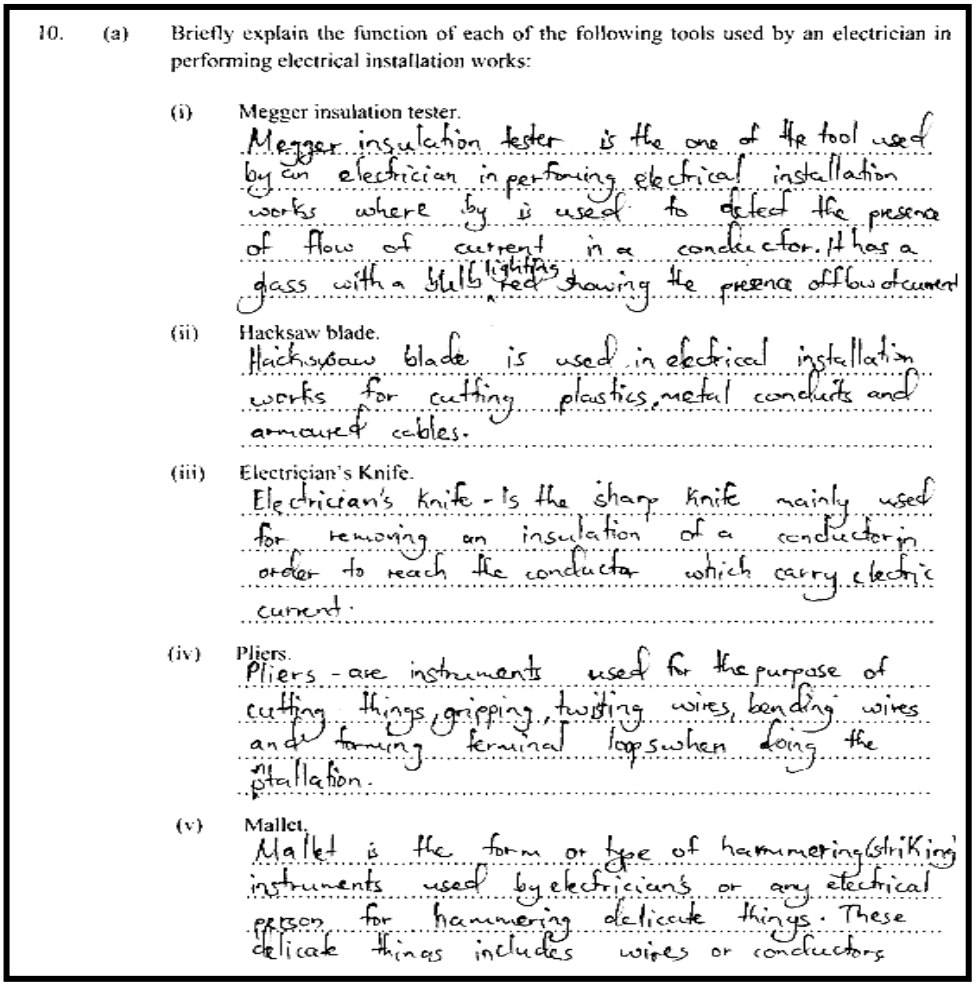


Figure 9: *The overall Performance of Students in Question 10*

Part (a) had five items (i) to (v) set from the topic of tools. The question required the students to explain the function of the following tools:

(i) Megger installation tester
(ii) Hacksaw blade
(iii) Electrician's knife
(iv) Pliers
(v) Mallet

The performance in this part was good because most of them managed to provide correct response in all items. However there were few of them who performed averagely as they provided correct responses in some items but failed in others. This average performance indicates that students had partial knowledge on the topic of tools. Extract 10.1 shows a sample of good response from one of the students'.



10. (a) Briefly explain the function of each of the following tools used by an electrician in performing electrical installation works:

(i) Megger insulation tester.
Megger insulation tester is the one of the tool used by an electrician in performing electrical installation works where by is used to detect the presence of flow of current in a conductor. It has a glass with a bulb lighting red showing the presence of flow of current

(ii) Hacksaw blade.
Hacksaw blade is used in electrical installation works for cutting plastics, metal conduits and armoured cables.

(iii) Electrician's Knife.
Electrician's knife - Is the sharp knife mainly used for removing an insulation of a conductor in order to reach the conductor which carry electric current.

(iv) Pliers.
Pliers - are instruments used for the purpose of cutting things, gripping, twisting wires, bending wires and forming terminal loops when doing the installation.

(v) Mallet.
Mallet is the form or type of hammering (striking) instruments used by electricians or any electrical person for hammering delicate things. These delicate things includes wires or conductors

Extract 10.1: *A sample of good response from one of the students*

Extract 10.1shows clearly that, the student managed to explain the function of the tools provided in items (i) to (v). The good performance in this part indicates that the student was familiar with the tools as they are common in electrical installation works.

Performance analysis showes that students with poor response failed to provide correct response in all items of part (a), although there were some students who managed to provide correct responses in either one or two of the given items. These students lacked knowledge and skills on the topic of tools especial the types of tools and their application. Extract 10.2 shows a sample of poor response from one of the students.

10. (a) Briefly explain the function of each of the following tools used by an electrician in performing electrical installation works:

(i) Megger insulation tester.

refers to metallic insulation for the test of and megger

(ii) Hacksaw blade.

is the any law activity reson that hacksaw blade.

(iii) Electrician's Knife.

is the charged by using a sourface and a cutter electrician's knife.

(iv) Pliers.

is the constant voltage is applied between the a metallic wire of a uniform of cross section.

(v) Mallet.

is property of the electric circuit which opposes the flow at current is ~~co~~ ~~cattle~~ called

Extract 10.2: *A sample of poor responses in question 10(a)*

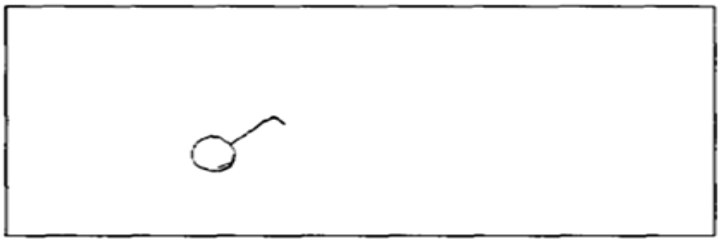
This student provided responses which are irrelevant to the question. The student picked some words from the question to create inappropriate sentences which he/she presented as the functions of the asked tools. All the answers in items (i) to (v) were absolutely wrong. The big challenge to this student is lack of knowledge and skills regarding tools and their applications.

Part (b) of this question was composed from the topic of *Electrical Accessories and Symbols*. It had five items in which the students were required to draw electrical symbol for each of the following components. (i) Single pole switch (ii) Double pole switch (iii) Wire not crossing (iv) Shielded wire and (v) Signal lamp.

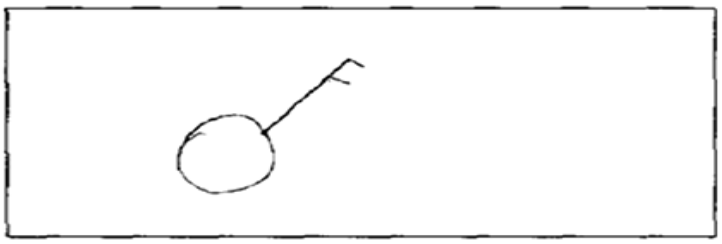
The general performance of students in this part was average because, majorities were able to produce correct electric symbols for some items but failed in others. Some students presented the symbols interchangeably. For example, instead of drawing *wire not crossing*, they draw *wire crossing.* Others drew *two way switch* instead *of double pole switch.* Extract 10.3 shows a sample of response which is partially correct from one of the students.

(b) Draw an electric symbol for each of the following components;

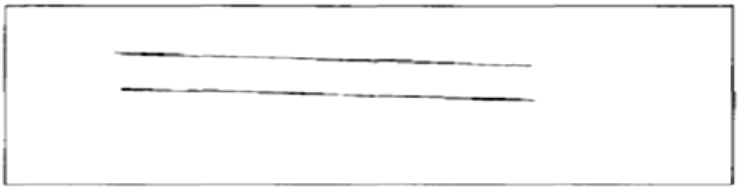
(i) Single pole switch



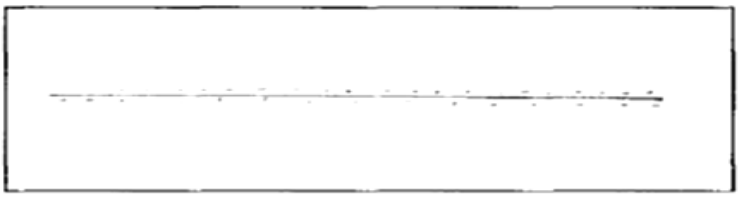
(ii) Double pole switch



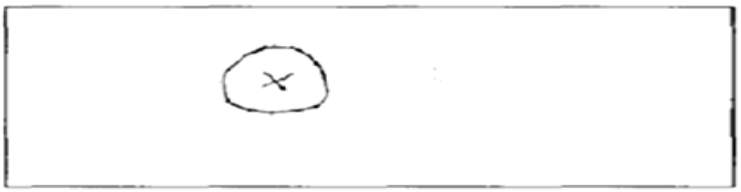
(iii) Wire not crossing



(iv) Shielded wire



(v) Signal lamp



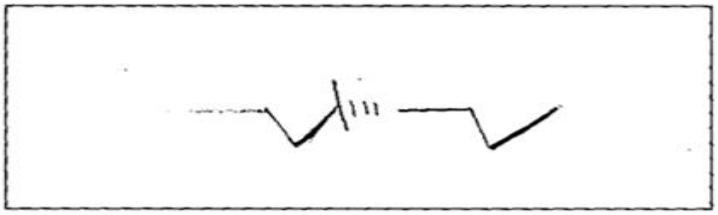
Extract 10.3: *A sample of average response in part (10) b*

The student presented three symbols (i), (ii) and (iv) correctly. In item (iii) the student drew two parallel lines to represent wire not crossing which is not correct. Also in part (v) the student tried a bit to draw a symbol for signal lamp but the central part of it was incorrect. This implies that the student acquired knowledge in the area of electrical symbols but lacked the ability to remember.

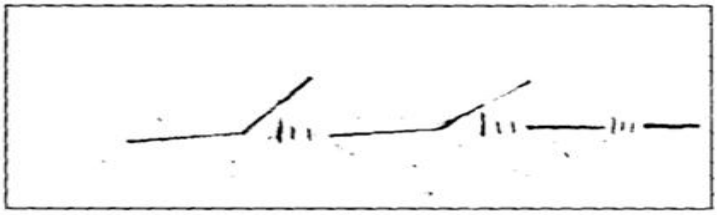
On the other hand, there were few students who failed to produce correct symbol in all items. These students had inadequate knowledge and skills on the topic of electrical accessories and symbols. Extract 10.4 shows a sample of poor response from one of the students.

(b) Draw an electric symbol for each of the following components;

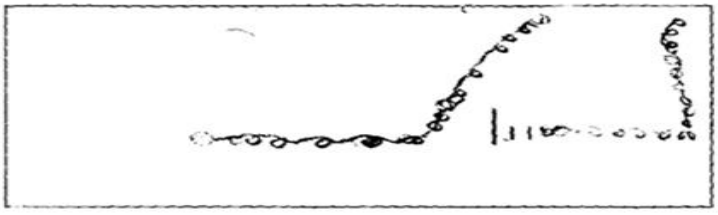
(i) Single pole switch



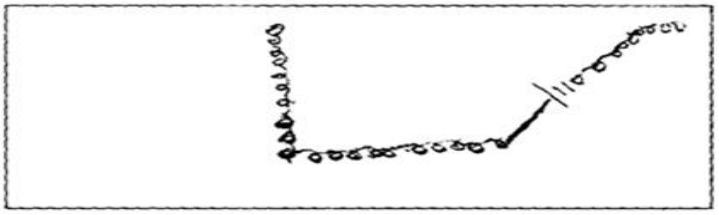
(ii) Double pole switch



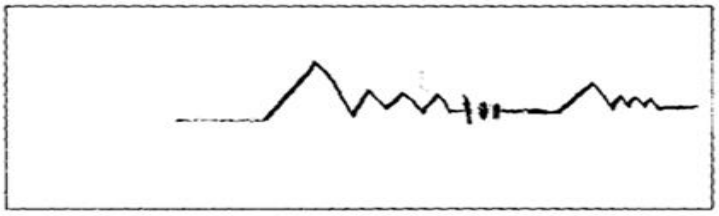
(iii) Wire not crossing



(iv) Shielded wire



(v) Signal lamp



Extract 10.4: *A sample of poor response from one of the students*

Responses in extract 10.4 showes that the student failed to produce correct symbols in all items. It is obvious that he/she completely lacked knowledge in electrical symbols and accessories. Hence, drew irrelevant pictures.

Part (c) of this question was derived from the topic of protective devices. It comprised of four items, (i) to (iv). In item (i) the students were required to categorize three types of fuses commonly used in electrical works. Item (ii) required the students to give major operational difference between fuse and circuit breaker. In item (iii) the students were required to suggest a type of lamp which can be used for both d.c and a.c circuits and item (iv) required the students to give reason as to why choke and capacitor are considered to be an important part and parcel of a fluorescent lamp.

Students' response analysis reveals that, most of the students did well in item (i) because they succeeded to categorize and distinguish three types of fuses commonly used in electrical works. The remaining items were moderately attempted because most of students were able to provide correct responses in any of the three items. Extract 10.5 shows a sample of correct responses provided by one of the students.

(c) (i) Before replacing a damaged fuse, it is necessary to distinguish various types and characteristics of fuses. Categorize three types of fuses commonly used in electrical works.

- Rewirable fuse
- Cartridge fuse
- high breaking capacity fuse

(ii) Give one major operational difference between fuse and circuit breaker.

Fuse	Circuit breaker
- Is protective device used to cut current by melting a wire when normal or abnormal condition occurs.	- Is protective device used to make and break under normal and abnormal condition.

(iii) Suggest a type of lamp which can be used for both d.c and a.c circuits.

fluorescent lamp

(iv) Why the following components are considered to be an important part and parcel of a fluorescent lamp?

Choke

Because used to limit and reduce voltage either low or high

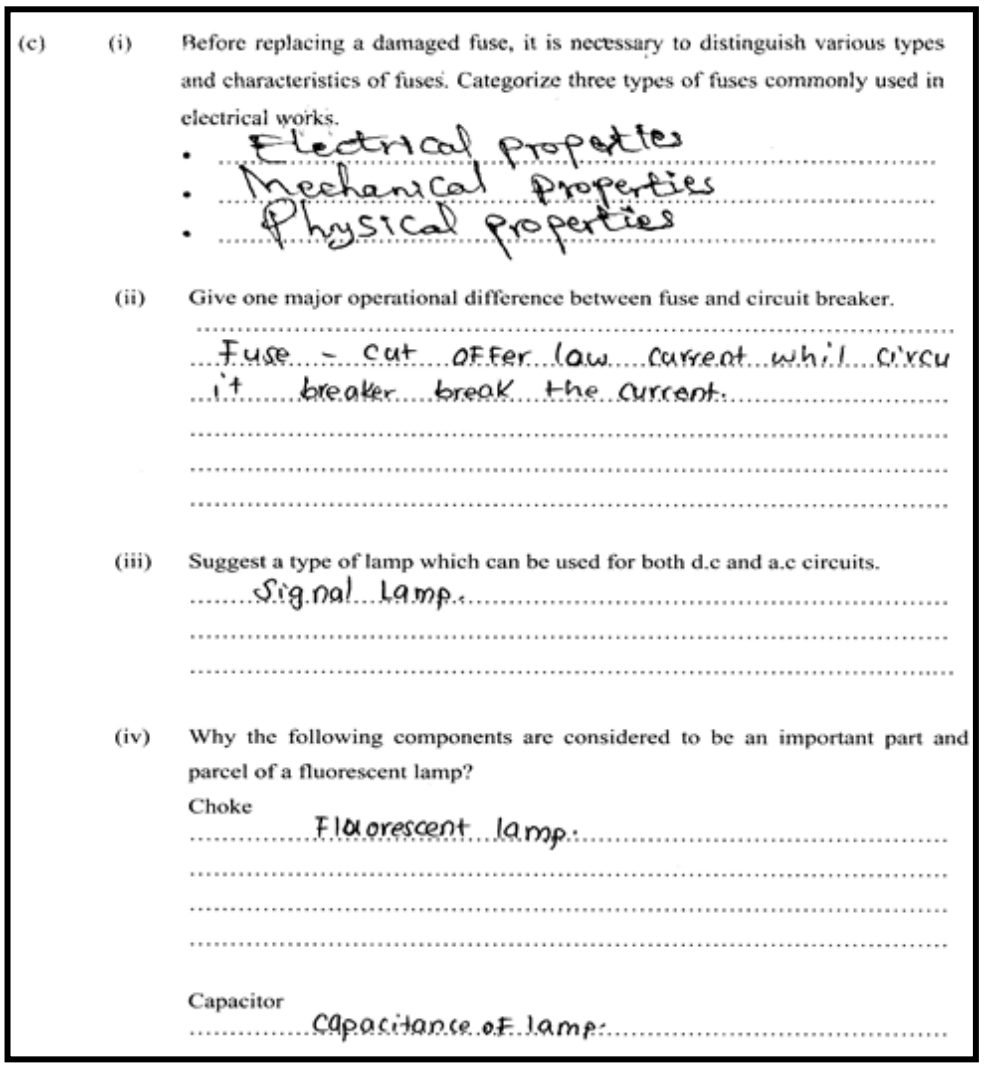
Capacitor

Used to store charge.

Extract 10.5: ***A*** *sample of the student's good response in part (10) c*

A good performance of the student in this part indicates that he/she had appropriate knowledge in the area of protective devices. Thus, he/she provided correct response in all items.

Further Analysis indicates that, some of the students provided responses to some items interchangeably while others failed completely to give correct responses. This led to unsatisfactory performance which proves that these students were not equipped with skills and knowledge concerning the topic of protective devices. Extract 10.6 shows a sample of poor response from one of the students' script.



(c) (i) Before replacing a damaged fuse, it is necessary to distinguish various types and characteristics of fuses. Categorize three types of fuses commonly used in electrical works.

- Electrical properties
- Mechanical properties
- Physical properties

(ii) Give one major operational difference between fuse and circuit breaker.

Fuse - cut offer low current whi'l circu it breaker break the current.

(iii) Suggest a type of lamp which can be used for both d.c and a.c circuits.

Signal lamp.

(iv) Why the following components are considered to be an important part and parcel of a fluorescent lamp?

Choke

Flaorescent lamp.

Capacitor

Capacitance of lamp.

Extract 10.6: *A sample of student's poor response in part 10 (c)*

The student provided the properties of engineering materials instead of types of fuses in (i). The student also seems to lack practical knowledge in the area of protective devices because he/she presented irrelevant responses in items (ii), (iii) and (iv).

Part (d) of this question was composed from the topic of Supply System. It comprised two items (i) and (ii). Item (i) required the student to suggest three common ways of generating electrical power for various areas and item (ii) required the students to calculate the potentials of points A, B and C from the given figure. Given that neutral wire carries 30 A outwards to B and the resistance of the neutral is twice that of an outer which is equal to 0.4 Ω.

Majority of the students managed to mention different methods of generating electrical power as required in (i). Some of them failed to find the potentials in item (ii). The analysis shows that many students confused the term ‘potential difference’ with ‘voltage drop’ thus, used the terms interchangeably. Therefore, the students’ performance in this part was average. However few students managed to give correct response in both items of this part. Extract 10.7 is a sample of good response from one of the students’ script.

(d) (i) Suggest three common ways of generating electrical power for various areas which needs electricity.

- Hydro electric power station.
- Nuclear power station.
- Steam power station
- Diesel power station.

(ii) Figure 2 shows that the neutral carries 30 A outwards to B and the resistance of the neutral is twice that of an outer which is equal to 0.4 Ω. Calculate the potential of A above earth, potential at B and at C.

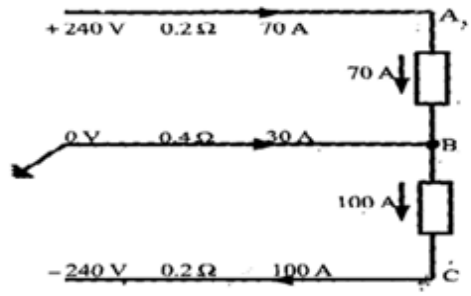


Figure 2

Soln

$E = IR$ (A) $I = \frac{V}{R}$

$0.2 \times 70 = \frac{V}{0.2} \times 0.2$

$V = 14\text{ V}$

(B) $I = \frac{V}{R}$

$30 = \frac{V}{0.4}$ $V = 12\text{ V}$

(C) $I = \frac{V}{R}$, $V = 100 \times 0.2$

$V = 20\text{ V}$

∴ potential at A = 14V

B = 12V

C = 20V

Extract 10.7: *A sample of good response from one of the students*.

This student proved to have sufficient knowledge on supply systems. That's why he/she managed to suggest common ways of generating electrical power as well as calculating potentials at points A, B and C.

The analysis indicates further that there were also some students who failed to produce the correct response in both items due to lack of enough knowledge on the topic of supply system. Extract 10.8 shows a sample of reposes from a student who provided incorrect responses in all items.

(d) (i) Suggest three common ways of generating electrical power for various areas which needs electricity.

- ~~Hydro~~ ~~Wind~~ 3) Friction.
- ~~Water~~ 2) Magnetism.
  ~~Sunlight~~ or flow energy. 3) Chemical action
- ~~Steam~~ or diesel. 4) Light.

(ii) Figure 2 shows that the neutral carries 30 A outwards to B and the resistance of the neutral is twice that of an outer which is equal to 0.4 Ω. Calculate the potential of A above earth, potential at B and at C.

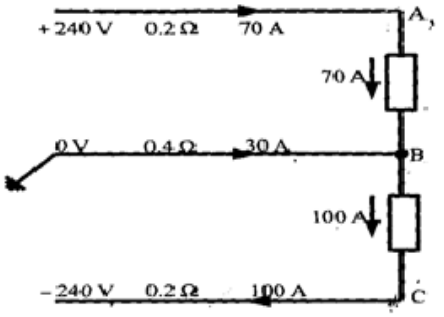


Figure 2

$I = \frac{V}{R}$

$\frac{240 \times 70}{0.2} = 8.4$

$V = 140$

$I = \frac{V}{R}$

$\frac{240}{0.4} = 30 \quad V = 120\ V$

$100 = I = \frac{V}{R}, \quad V = 12 \times 0.2$

$V = 24$

Extract 10.8: *A sample of student's poor response in part 10(d)*

The student mentioned the effects of electrical current instead of ways of generating electrical power as required. He/she also failed to recall formula for calculating potential at points A, B and C from the given figure. This reveals an incompetence of the student in doing calculations related to electrical circuits.

Part (e) of this question was composed from the topics conductors, insulators and cables, electrical accessories and symbols and inspection and testing. The part had three items; (i), (ii) and (iii).

Item (i) was from the topic conductor, insulator and cables. It required the students to give a brief explanation on the importance of conductor, insulator and mechanical protection as used in electrical cable.

Item (ii) required the students to give the importance of junction box and socket outlets when they are performing electrical installation. The item was composed from the topic electrical accessories and symbols.

Item (iii) required the students to outline three types of faults that should be taken into account when performing electrical installation. This item was about inspection and testing. Most of the students managed to provide the correct responses in at least two items. This indicates that the knowledge possessed by the students in the prescribed areas is limited. Extract 10.9 shows a sample of good response from one of the students.

(c) (i) Briefly explain the importance of each of the following part of an electrical cable.

Conductor

Parts of this are all cables which allow the flow of current such as copper, aluminium and this is the part which conducts electricity.

Insulator

These is the part of the cable which does not allow the flow of current in a conductor such as plastic and therefore it become as a resistance to the over currents and prevents from damage such as electrical shock.

Mechanical protection

This is the part of the cable used for protecting the cable from mechanical damage and this part is usually hard to prevent the cables inside not be damaged

(ii) Why is it important for a technician to be conversant in the use of the following electrical accessories when performing electrical installation?

Junction box

Because the junction box provides protection and safety barriers for electrical connection, thus preventing accidents such as electric shock.

Socket outlets:

The socket outlets consist of a fixed position connected to the fixed wiring so it provides the direct connection of the appliance to the live supply.

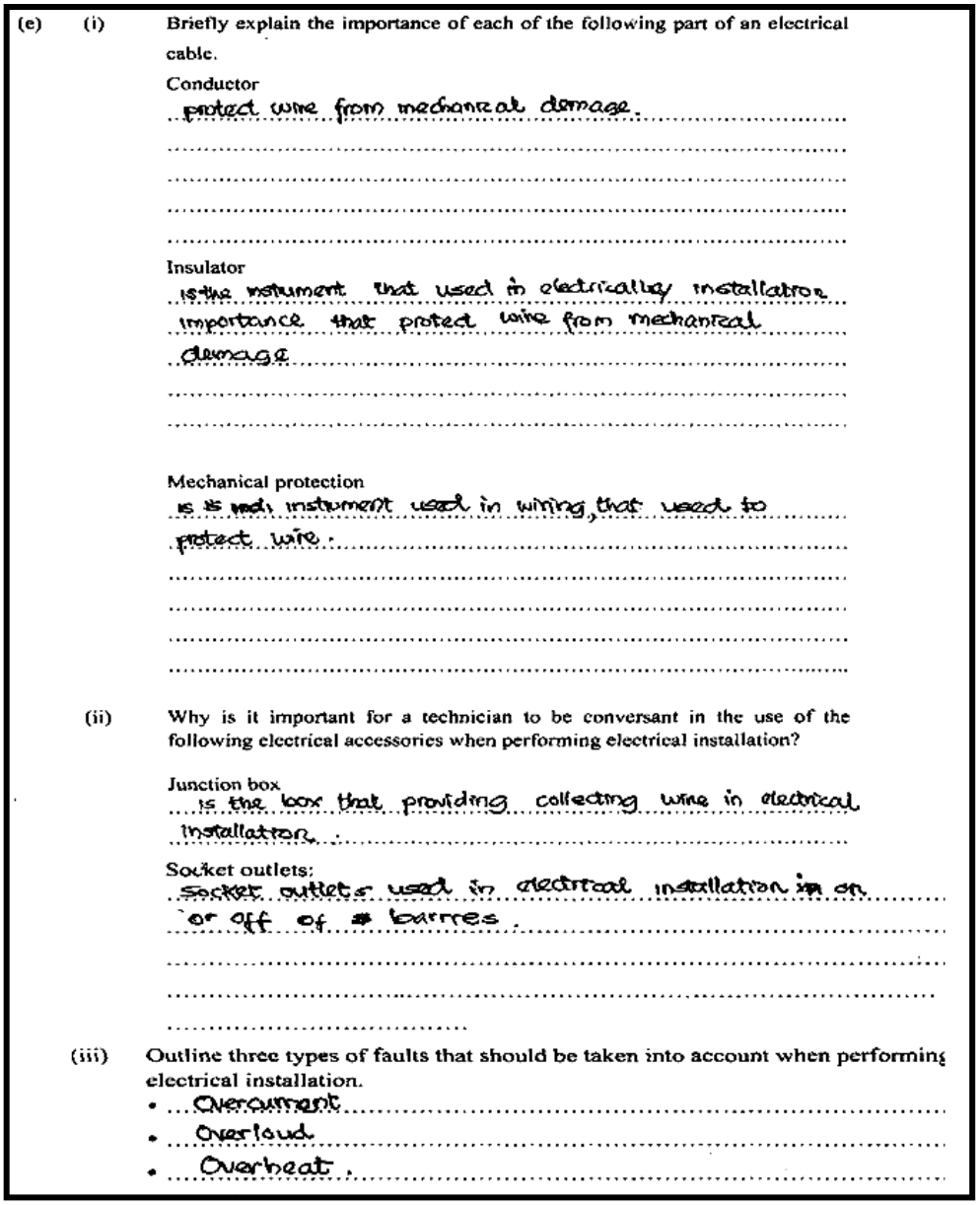
(iii) Outline three types of faults that should be taken into account when performing electrical installation.

- earth fault
- open circuit fault
- short circuit fault

Extract 10.9: *A sample of good response from one of the students' script*

The student managed to provide correct responses in items (i), (ii) and (iii) as required. This student revealed to have knowledge and skills on the specified areas.

On the other hand some students performed poorly because they lacked enough knowledge and skills on the areas of Cables and Conductors. This poor performance is illustrated in Extract 10.10.



(e) (i) Briefly explain the importance of each of the following part of an electrical cable.

Conductor

protect wire from mechanical damage.

Insulator

is the instument that used in electrically installation importance that protect wire from mechanical damage

Mechanical protection

is is mech instument used in wiring that used to protect wire.

(ii) Why is it important for a technician to be conversant in the use of the following electrical accessories when performing electrical installation?

Junction box

is the box that providing collecting wire in electrical installation.

Socket outlets:

Socket outlets used in electrical installation in on or off of # barres.

(iii) Outline three types of faults that should be taken into account when performing electrical installation.

- Overcurrent
- Overloud
- Overheat.

Extract 10.10: *A sample of poor response from one of the students*

This student failed to give the importance of conductor, insulator and mechanical protection of a cable and the uses of electrical accessories such as *junction box*. In item (iii) the student presented some sources of electrical fault instead of types of faults. This was due to insufficient knowledge and skills that the student had in the prescribed area.

2.2.2 PART (II): ELECTRONICS, RADIO REPAIR AND TV SERVICING

2.2.2.1 Question 11: Semiconductors, Semiconductor Diodes, Bipolar transistor, Electronic circuit components, Transistor amplifier and Power supply

The question consisted of parts (a), (b), (c), (d) and (e). The items in this part were composed from various topics of Radio and TV servicing syllabus. Total marks allotted to this question were 50.

Analysis shows that out of 145 students who attempted the question, 79 (54.5%) scored from 0 to 14.5 marks, 61 (42.1%) performed averagely as they scored from 15 to 31 marks and the remaining 5 (3.4%) students performed well as they scored from 32.5 to 39.5 marks. Table 2 summarizes performance of the students. None of the students scored full (50) marks allotted to this question. Table 2 summarizes the overall students' performance in this question.

Table 2: The Overall Performance of Students in Question 11

Scores (Marks)	**Students**		**Remarks**
	Number	**Percentage (%)**	
32.5 to 39.5	5	3.4	Good
15 to 31	61	42.1	Average
0 to 14.5	79	54.5	Weak
Total	**474**	**100**	

The analysis indicated further that, a number of students performed well in parts (a), (b), (c) and (d). In part (e) most of them performed averagely. Part (a) was divided into four items. Item (i) required the students to give a brief description on semiconductor materials. In item (ii) the students were required to give reasons as to why doping is an important process in semiconductor theories. Item (iii) required the students to identify two intrinsic semiconductor materials which are commonly used for the construction of electronic devices. Item (iv) required the students to draw a characteristic curve of a semiconductor diode.

The analysis shows that, there were some students who performed averagely as they were able to provide correct responses partially in each item. However, there were some of students who managed to provide correct responses in each item. Extract 11.1 is a sample of good response from one of the students who presented correct response in all items of part 11(a).

11. (a) (i) Briefly describe semiconductor materials.

– Semiconductor materials are materials which their properties lies ~~btn~~ between those of conductor and insulator.

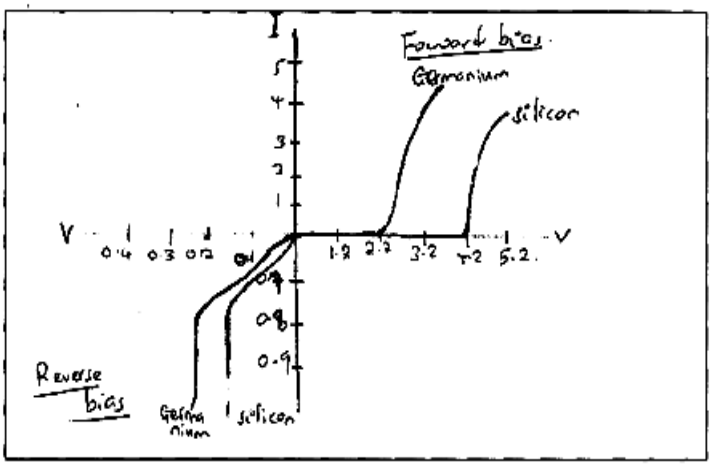
(ii) Why doping is an important process in semiconductor theories?

– so as to increase the conductivity of the semiconductor materials

(iii) Most of electronic devices are made up of semiconductor materials. Identify two intrinsic semiconductor materials which are commonly used for construction of such devises?

- Germanium
- silicon

(iv) Draw a characteristic curve of a semiconductor diode.



Extract 11.1: *A sample of good response from one of the students*

The students described briefly the semiconductor materials, importance of doping and drew a characteristic curve of semiconductor diode correctly. Generally, the student demonstrated sufficient knowledge in the area of semiconductors materials.

However, there were some students who performed poorly in this part. Most of them failed to provide the correct responses in each item. For example, one student provided wrong description of the term 'semiconductors material' by writing "*It contains both intrinsic and extrinsic properties"* This suggests that students had no sufficient knowledge in semiconductors. Extract 11.2 shows a sample of poor response from one of the students.

11. (a) (i) Briefly describe semiconductor materials.

(i) Silicon

(ii) Arsenium

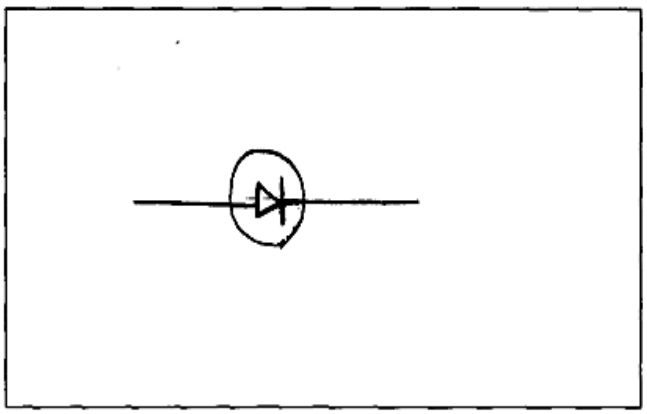
(ii) Why doping is an important process in semiconductor theories?

Because doping is the process of adding impurities so it is an important process in semiconductor due to adding process

(iii) Most of electronic devices are made up of semiconductor materials. Identify two intrinsic semiconductor materials which are commonly used for construction of such devises?

- N- type material
- P- type material

(iv) Draw a characteristic curve of a semiconductor diode.



Extract 11.2: *A sample of student's poor response in question 11(a)*

The student mentioned the two commonly used semiconductor materials instead of giving description of semiconductor materials as required in item (i). In item (ii) the student provided response using some terms related to the process of doping but he/she did not explain the importance of doping process. In item (iii), the student identified the types of semiconductors instead of intrinsic semiconductors. The student also drew a symbol of semiconductor diode instead of the characteristic curve of a semiconductor diode. This implies that the student had little practical knowledge and skills on the area of semiconductors and semiconductor diodes.

Part (b) had three items set from two different topics, namely Bipolar Transistors and Transistor Amplifiers. Item (i) required the students to give two necessary conditions for a bipolar junction transistor (BJT) to be in saturation. Item (ii) required the students to identify four methods of transistor biasing and item (iii) required the students to calculate the value of α when the base current in a transistor is 0.01 mA and emitter current is 1 mA.

The students' performance in this part was moderate because no student managed to provide correct responses in all items. The analysis shows that the main challenge was in item (i) and (ii) as most of them failed to provide correct responses. For example in item (i), one student wrote "*It should have emitter" and "It should have collector*" as two necessary conditions for BJT to saturate, which is wrong. In item (ii) most of the students confused the methods of transistor biasing with the modes of connecting or configuring transistors. For example one student wrote "*common base, common emitter and common collector*". These responses were actually incorrect. This proves that students had little practical knowledge and skills in the area of Bipolar Junction Transistor (BJT). Extract 11.3 shows a sample of poor response from one of the students.

(b) (i) Give two necessary conditions for a bipolar junction transistor (BJT) to be in saturation.

- Diffuse planer
- Grown Crystal

(ii) Identify four methods of transistor biasing.

- Epitencial
- Grown Crystal
- Diffuse planer
- Alloy junction

(iii) The base current in a transistor is 0.01mA and emitter current is 1mA. Calculate the value of α.

Data given

Current in transister (B) $= 0.01 \times 10^{-3}$A

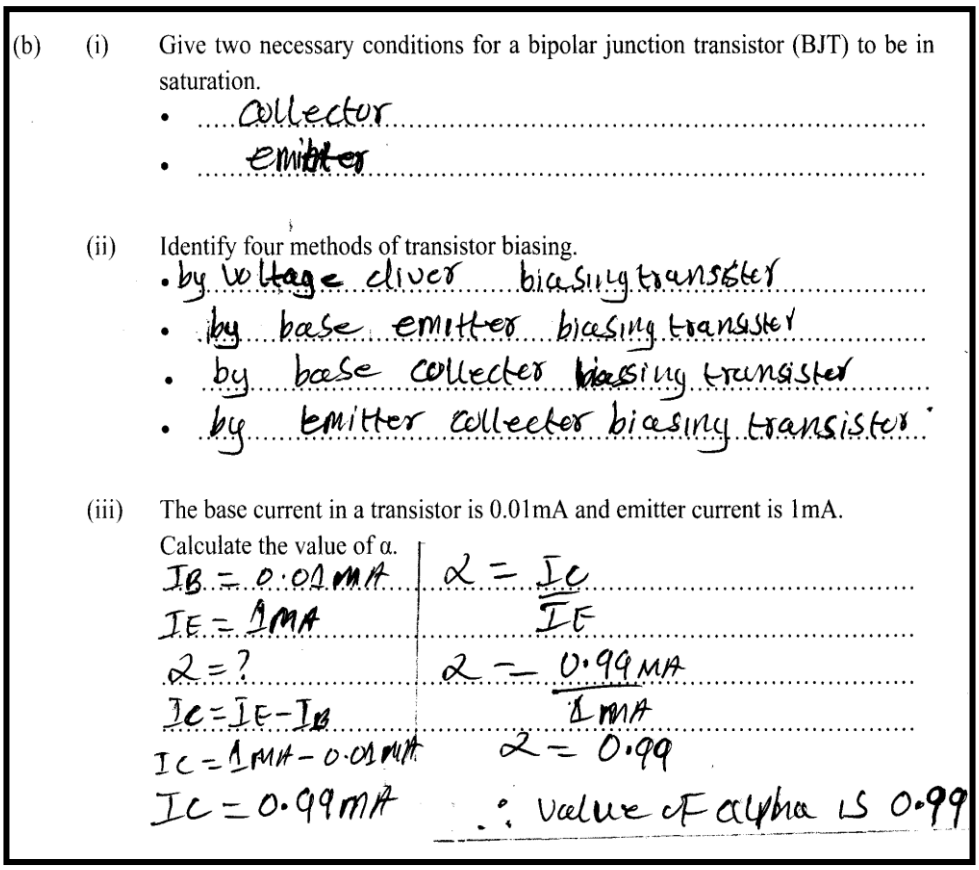
Emitter current (E) $= 1 \times 10^{-3}$A

Required

Extract 11.3: *A sample of poor responses from one of the students*

The student produced incorrect necessary conditions for (BJT) to be in saturation, methods of transistor biasing and formula to calculate the value of α. All responses of the student in this part were irrelevant to BJTs.

Nevertheless, there were some few students who responded partly correct in this part. They were capable of giving correct answer in one of the items or sub items. Students with this performance demonstrated partial knowledge and skills on the area of bipolar junction transistor. Extract 11.4 illustrates this performance.



Extract 11.4: *A sample of responses from among the students*

The student managed to calculate the value of α and identified at least two methods of transistor biasing but failed to give two conditions necessary for BJT to be in saturation. This implies that the student had partial knowledge in this area.

The analysis indicates further that majority of the students performed poorly in part (c) of question 11 because they presented wrong responses in all items. For example, in item (i) the students were required to state Kirchhoff's voltage law. The response provided by one of the students in this item was as follows: *Kirchhoff's voltage law states that, 'the voltage across parallel connected resistor circuits is the same as the voltage across each resistor in series circuit'*. This statement is wrong. The student confused with other concepts applied in DC circuits particularly those related to voltage in series and parallel circuits.

The same happened to item (ii) in which most of the students filled the table with wrong colours. Extract 11.5 shows a sample of poor response from one of the students.

(c) (i) **State Kirchhoff's voltage law.**

The applied voltage is inversely proportional to the resistance at constant temperature.

(ii) **Fill the following table with the colour codes (band) for the given values of resistance and its tolerances.**

Value of resistance	Tolerance	Colour Code (bands)			
		I	II	III	IV
2.2 Ω	± 10%	2	2	16	+4
5.6 MΩ	± 5%	5	6	5	+2
5.1 KΩ	± 5%	5	1	5	-2
470 Ω	± 10%	4	7	10	-1

Extract 11.5: *A sample of poor responses from one of the students*

The student failed to state Kirchhoff's' law and filled the table with numbers instead of colours. This performance signifies that the student acquired insufficient knowledge in the area of resistor color coding.

However, some of the students performed the question partially, although few of them managed to attempt the question correctly. Extract 11.6 shows a sample of good response picked from one of the students' script.

(c) (i) State Kirchhoff's voltage law.

"In any closed circuit or a mesh the algebraic sum of Emf and potential difference is zero"

(ii) Fill the following table with the colour codes (band) for the given values of resistance and its tolerances.

Value of resistance	Tolerance	Colour Code (bands)			
		I	II	III	IV
2.2 Ω	± 10%	Red	Red	Gold	Silver
5.6 MΩ	± 5%	Green	Blue	Green	Gold
5.1 KΩ	± 5%	Green	Brown	Red	Gold
470 Ω	± 10%	Yellow	Violet (purple)	Brown	Silver

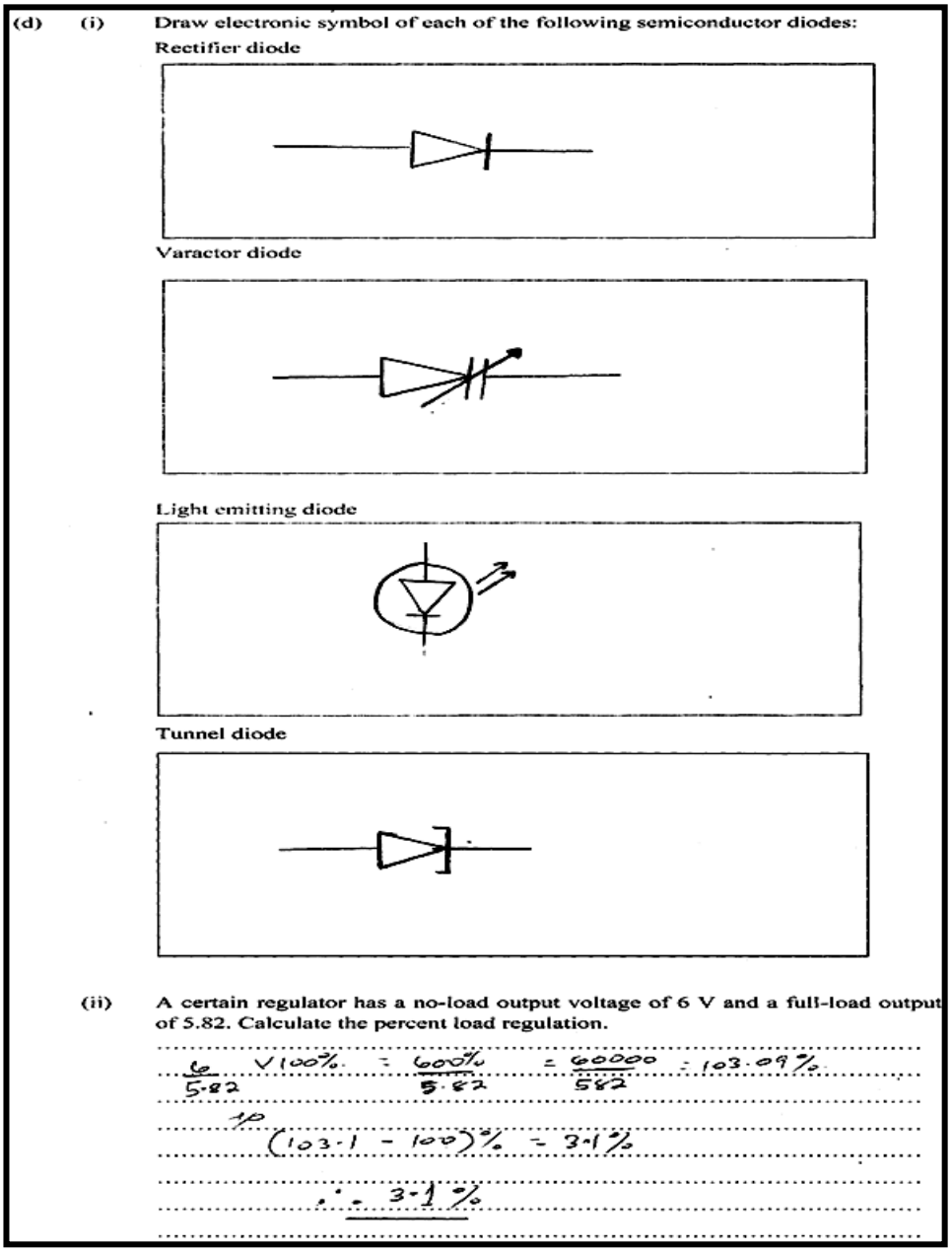
Extract 11.6: *A sample of good responses from one of the students*

This student demonstrated good knowledge and competence on electronic circuit components because he/she was able to state Kirchhoff's voltage law and filled the table with correct colour codes.

Part (d) had two items composed from two topics. Item (i) was composed from the topic semiconductor diode. The students were required to draw electronic symbols for rectifier diode, varactor diode, light emitting diode and tunnel diode. Item (ii) was composed from power supply. The students were asked to calculate the percentage load regulation when a certain regulator has a no-load output voltage of 6 V and a full 1oad output of 5.82 V.

The general performance of students in this part was average. There were some students who presented incorrect symbols in all items. Others presented them interchangeably. For example, one of the students drew a symbol of *photo diode* instead of *light emitting diode* and *rectifier diode* instead of *tunnel diode* and vice versa. This happened due to confusion

between the symbols as all of them are found in the same topic of semiconductor diodes. But still performance analysis indicates that some students performed well this part as they were able to provide correct symbols. Their good performance in this part justifies that these students were relatively knowledgeable on semiconductor diodes. Extract 11.7 presents a sample of good responses provided by one of the students.



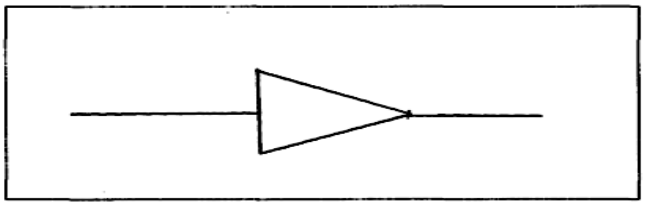
Extract 11.7: *A sample of good response from one of the students*

The student managed to draw the electronic symbols and to calculate correctly the voltage regulation.

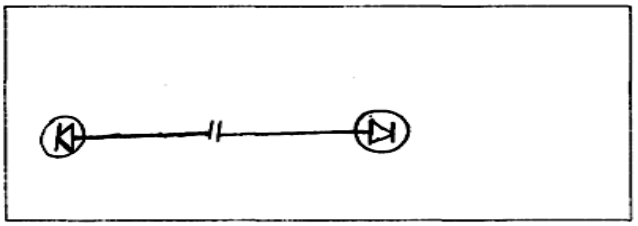
However, some of the students performed poorly as they failed to provide correct responses in all items. Extract 11.8 shows a sample of poor responses provided by one of the students.

(d) (i) Draw electronic symbol of each of the following semiconductor diodes:

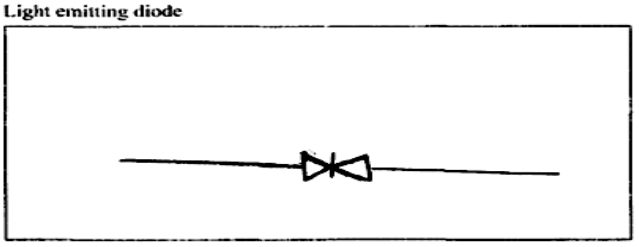
Rectifier diode



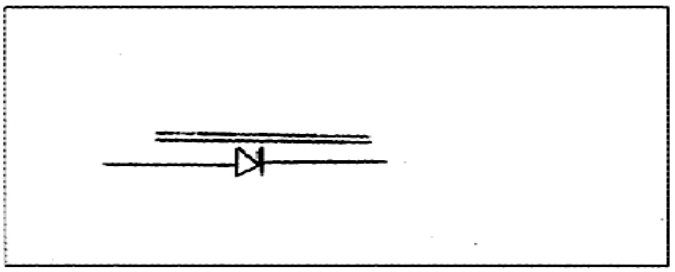
Varactor diode



Light emitting diode



Tunnel diode



(ii) A certain regulator has a no-load output voltage of 6 V and a full-load output of 5.82. Calculate the percent load regulation.

Sol:

Gv Full out put voltage

no load output voltage

$\frac{6V}{5.82} \quad \frac{6v - 5.82}{E} \quad \frac{= 6v \times 100}{100} \quad \frac{= 600}{582} \quad \frac{582}{582}$

$= 1.03\%$

Extract 11.8: *A sample of poor response from one of the students*

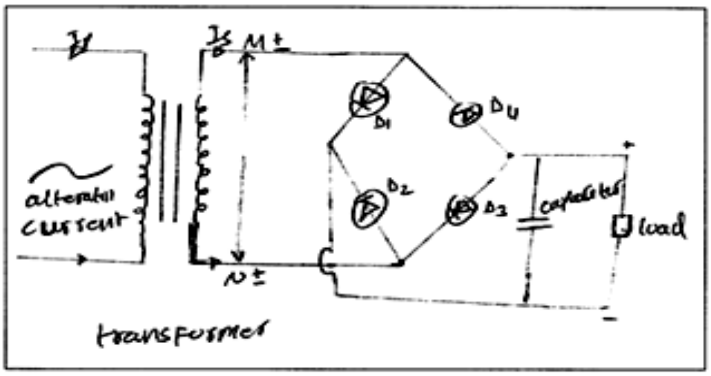
The students produced symbols which are undefined in all items and failed to apply the appropriate formula of calculating the percentage load regulation.

Part (e) had three items composed from the topic power supply. Item (i) required the students to give the meaning of the term ‘rectification’ in relation to electric circuits. Item (ii) required the students to draw a well labeled circuit diagram of a full wave bridge rectifier and item (iii) required the students to calculate the maximum secondary voltage for an A.C supply of 230 V when applied to half – wave rectifier circuit through a transformer having a ratio of 10:1. The analysis indicates that students’ performance in this part was average because many students responded correctly for at least two items and failed in other items. Extract 11.9 shows a sample of an average response taken from the script of one of the students.

(e) (i) Briefly give the meaning of the term 'rectification' in relation to electric circuits

Rectification - It the process of electronic component to convert ac to dc circuit. inorder to allow the flow of current

(ii) Draw a well labeled circuit diagram of a full wave bridge rectifier.



(iii) An a.c supply of 230 V is applied to a half-wave rectifier circuit through a transformer having a ratio of 10:1. Calculate the maximum secondary voltage.

Solution

$V_p = 230V$

$K = 10:1$

$V_S = ?$

$K = \frac{V_p}{V_S}$

$\frac{10}{1} \times \frac{230}{V_S}$

$\frac{230 \times 1}{10} = \frac{V_S \times 10}{10}$

$V_S = 23$ volt

The Secondary voltage = 23 volt

Extract 11.9: *A sample of average response from one of the students*

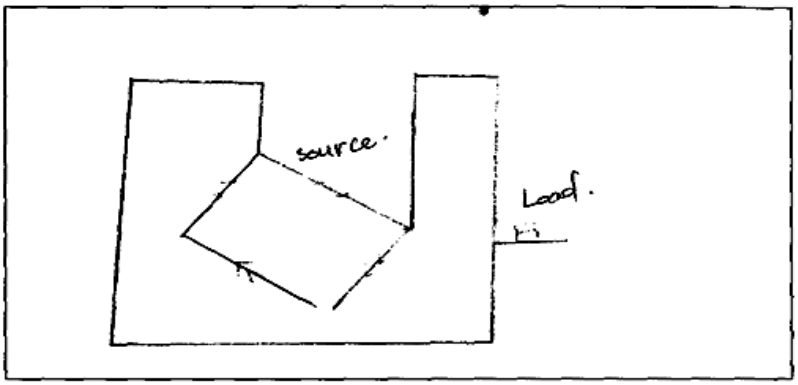
The student managed to give the meaning of rectification in (i), drew a circuit diagram of a full wave bridge rectifier in (ii) but failed to calculate the value of the maximum secondary voltage in (iii). The student's average performance is due to lack of enough knowledge particularly in performing calculations relating to power supply.

However, there were few students who performed poorly in this part as they failed to produce correct responses in all items. Some students confused a circuit diagram of a full wave bridge rectifier with that of single wave rectifier. These students lacked knowledge and practical skills on the power supplies. Extract 11.10 shows a sample of poor response from one of the students.

(e) (i) Briefly give the meaning of the term 'rectification' in relation to electric circuits

Is the change of Input Signals to output Signals in a circuit

(ii) Draw a well labeled circuit diagram of a full wave bridge rectifier.



(iii) An a.c supply of 230 V is applied to a half-wave rectifier circuit through a transformer having a ratio of 10:1. Calculate the maximum secondary voltage.

Data.
Voltage (V) = 30V
Ratio = 10:1
Secondary Voltage (V_s) = ?
$I_s = 10$
$I_p = 1$
From
$\frac{I_p}{I_s} = \frac{V_p}{V_s}$.
$\frac{1}{10} = \frac{30}{V_s}$
$V_s = 30 \times 10$
$= 300V$.
∴ The maximum Secondary Voltage (V_s) = 300V.

Extract 11.10: *A sample of poor response from one of the students*

In item (i), instead of giving the meaning of the term "rectification" the student wrote something related to the gain of an amplifier but still presented it wrongly. The student also drew a diagram which is irrelevant to the full wave bridge rectifier in (ii) and failed to recall appropriate formula to calculate maximum secondary voltage.

3.0 SUMMARY ON THE STUDENTS' PERFORMANCE IN EACH TOPIC

The analysis of the topics which were assessed in Electrical Engineering paper for the year 2019 indicates that most of the students performed well in many topics covered in the paper. However, in few topics, the students' performance was either average or poor.

The analysis of the students' performance in each question shows that questions 2 and 3 which were set from, *Electromagnetism* and *Soldering* respectively were poorly performed, whereas questions 5 and 6 which were set from the topics *Batteries & Cells* and *Magnetism and Electromagnetism* were averagely performed. Another question which was averagely performed is question 11 from the topics *Semiconductors, Semiconductor Diodes, Bipolar transistor, Electronic circuit components, Transistor amplifier and Power supply.*

Questions that were well performed include; 4, 7, 8 and 9 from the topics *D.C Circuits, Conductors, Insulators & Cables and transformers* respectively, while question 10 was based on *Tools, Electrical accessories & Symbols, Protective Devices, Supply system, Conductors, Insulators & Cables and Inspection & Testing.* Generally, the analysis reveals that question 1 which was composed from various topics within the syllabus was the best in terms of performance.

The analysis suggests further that students had no sufficient knowledge and practical skills on some topics covered in this paper such as *Soldering* and *Electromagnetism*. Students also demonstrated poor capability in performing questions with calculations. Table 3 presents a summary of the students' performance in each topic whereby *green, yellow* and *red* colours represent *good, average* and *weak* performance, respectively.

Table 3: A Summary of Students' Performance per Topic in Electrical Engineering Paper in 2019

S/N	Topic	Question number	Percentage of students who scored 30 percent or more	Remarks
1	Multiple-Choice Items from different Topics	1	94.7	Good
2	D.C Circuits	4	88.4	Good
3	Transformers	8	79.5	Good
4	D.C Circuits	9	79.4	Good
5	Conductors and Cables	7	69.4	Good
6	Tools, Electrical accessories & Symbols, Protective Devices, Supply system, Conductors, Insulators & Cables and Inspection & Testing	10	66.2	Good
7	Magnetism & Electromagnetism	6	63.1	Average
8	Semiconductors, Semiconductor Diodes, Bipolar transistor, Electronic circuit components, Transistor amplifier and Power supply.	11	45.5	Average
9	Batteries and Cells	5	39.3	Average
10	Soldering	3	24	Weak
11	Electromagnetism	2	15.2	Weak

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the students in Electrical Engineering for National Form Two National Assessment (FTNA) in the year 2019 was good. Out of 486 students who sat for the paper 331 (68.1%) passed, while 155 (31.9%) failed. In the year 2018 there were 369 students who sat for the FTNA, of which 174 (47.15%) students passed while 195 (52.85%) failed. This record signifies that, the number of students who sat for the assessment in November 2019 has increased by 117 (31.70%) compared to the number of students who sat for the November 2018 assessment. The analysis also shows that, the performance of the students in the year 2019 is increased by 20.96 percent in comparison with the year 2018. Table 4 presents the comparison of grade scores of the students in the year 2018 and 2019.

Table 4: Students Grade Scores in the year 2018 and 2019

YEAR	CANDIDATES GRADE SCORES					
	SAT	A	B	C	D	F
2018	369	0	7	65	102	195
2019	486	3	31	192	105	155

However, there were some few shortcomings observed. These include the students' inadequacy knowledge, lack of practical skills and incompetence in some of the topics, particularly *Electromagnetism* and *Soldering* which were poorly performed.

Another weakness observed was inability of some students to deal with questions that involved mathematical computations, and failure to understand the requirements of the questions.

It is expected that the weaknesses noted in this report will be used as a guidelines to teachers, students and other educational stakeholders for the purpose of enhancing teaching and learning processes to improve students' performance in Electrical Engineering in future.

4.2 Recommendations

From the shortcomings observed in the analysis of students' item response, the following are recommended:

(i) Teachers should provide enough exercise and tests to students especially for areas which involve mathematical computations. This will strengthen students' ability to study hard and get used to formulae and calculations.

(ii) Teachers should use laboratory and workshops when teaching electromagnetism and soldering so that students may perform experiments and practical for easy understanding.

(iii) Students also should take serious initiative on how to acquire knowledge and skills that will be useful in tackling questions from various topics such as performing practical works as well as paper work exercises.

(iv) Students should be well oriented on common terms used in composing questions in order to enable them to understand the requirements of the questions.