THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEMS RESPONSE ANALYSIS REPORT FOR THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2018

080 ELETRICAL ENGINEERING

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

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FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to issue *Students' Item Response Analysis* (SIRA) reports in order to provide feedback on students' performance on form two national assessments 2018 in Electrical Engineering subject. The report is intended to sensitize students, teachers, examiners and other key education stakeholders on the general performance, specific areas of weakness and suggestions for improvement. Therefore, this report is an important guide for future Form Two National Assessment (FTNA) processes.

The report is mainly based on responses obtained from students' scripts and statistical data processed by NECTA. The examiners have analyzed students' responses for each question and identified some factors for scoring low marks which include students' inability to interpret the requirements of the questions, failure in using correct formulae in solving problems and lack of knowledge and skills in various topics. Each factor has been clarified using extracts from students' scripts as illustrations.

The National Examinations Council of Tanzania is confident that the feedback which is provided in this report will be useful to education stakeholders and that, the suggestions 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, examiners 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
D.C	Direct Current
e.m.f	Electromotive Force
FTNA	Form Two National Assessment
mA	Milliampere
m.m.f	Magnetomotive force
NECTA	National Examinations Council of Tanzania
SIRA	Students' Items Response Analysis
TV	Television
Ω	Ohm

1.0 INTRODUCTION

The Electrical Engineering paper comprised of two sections, namely A and B. Section A consisted of 9 questions established from various topics on Electrical Engineering Science. The students were required to answer all the questions from this section. Question 1 was a multiple choice with ten items set from different topics within the syllabus. Question 2 was composed from *Nature of Electricity,* while question 3 was taken from *Batteries and Cells.* Questions 4 and 5 were based on *Electric Heating* and *D.C. Circuits,* respectively. Question 7 was composed from *Conductors, Insulators and Cables,* while question 8 was set from *A.C Voltage.* The topic of *Magnetism and Electromagnetism* was covered in question 9. Total marks allocated to this section were 50.

Section B consisted of two parts, namely part I and part II. Students were required to answer **All** questions from either part depending on their area of specialization. Part I was from Electrical Installations which had one question (Question 10) with five parts (a) – (e) drawn from different topics. Part 10 (a) was from the topic of *Safety*, 10 (b) from C*onduit, Trunking* and *Ducts* topic, 10 (c) from *Conductors, Insulators and Cables,* 10 (d) from *Wiring System* and 10 (e) was from the topic of *Inspection and Testing*. Total marks allotted to this part were 50.

Part II also had one question (Question 11) set from Electronics, Radio Repair and TV Servicing. The question consisted of five parts. Part 11 (a) was from the topic of *Transducers*, 11 (b) from *Tools and Test Equipment*, 11 (c) from *Semiconductors*, 11 (d) from *Electric Components* and part 11 (e) was from *Bipolar Transistors*. This part was allotted 50 marks.

A total of 369 students sat for Electrical Engineering paper. 174 (47.15%) of students passed, while 195 (52.85%) failed. The analysis of the students' performance in each question is categorized into three grade ranges as follows: The performance is considered to be ***good*** if the percentage of students who scored from 30 percent and above of the total marks allocated in a question is at least 65 percent. The question is considered to be ***averagely*** performed if the percentage of the students who scored from 30 percent and above of the total marks is between 30 to 64 percent, and ***poorly*** performed if the percentage of those who scored below 30 percent of the total marks were more than 70 percent.

2.0 ANALYSIS OF STUDENTS' PERFORMANCE IN EACH QUESTION

2.1 ELECTRICAL ENGINEERING SCIENCE

2.1.1 Question 1: Multiple Choice Items

Question 1 comprised of ten (10) items, (i) – (x) drawn from various topics in the prescribed syllabus. Students were required to choose the correct answer from the given alternatives by writing its letter in the box provided. Total marks allocated for this question were 10.

A total of 369 students attempted this question. Among them, 26 (7.0%) performed poorly because they scored from 0 to 2 marks. There were 274 (74.2%) students who performed averagely as they scored from 3 to 6 marks. The rest, 69 (18.8 %) had good performance by scoring 7 to 10 marks. The general performance of students in this question was, therefore, good.

The items in which most of the students failed to select the correct responses were (iii), (v) and (viii). In item (iii), the question required the students to choose the unit of luminous flux among the provided alternatives. Most students chose alternative A: *candela* as the correct answer instead of B: *Lumen*. They confused the term luminous flux with luminous intensity as both terms are used in the topic of illumination. Students used these terms interchangeably in terms of their units. In this context luminous flux bears the unit of lumen, while luminous intensity bears the unit of candela.

In item (v), students were asked to give the relationship between voltage and current when an alternating voltage is applied across a pure resistance. The correct answer in this item was D: *Voltage is in phase with current* but majority chose alternative C: *Voltage is leading current by 90%*. Students failed to distinguish the relationship between voltage and current when an alternating voltage is applied across a pure resistance and pure inductance. They could not recognize that in pure resistance voltage is in phase with current, while in pure inductance voltage is leading current by 90º.

Another item which was poorly performed was item (viii) which required the students to identify the electrical circuit in which an ohmmeter operated on. Most of the students opted for alternative A: *Live current* instead of alternative B: *Dead current*. The analysis of the students' responses suggests that students were knowledgeable on various measuring instruments, but could not distinguish one instrument from the other. For example, those who failed could not differentiate ohmmeter from other instruments such as voltmeter and ammeter that are used to operate on live circuit.

The analysis indicates that a number of students had average performance in items (i), (ii), (iv), (vi), (vii), (ix) and (x). The performance indicated that most of students had sufficient knowledge on the topic of Measuring Instruments.
The overall students' performance in this question is summarized in Figure 1.

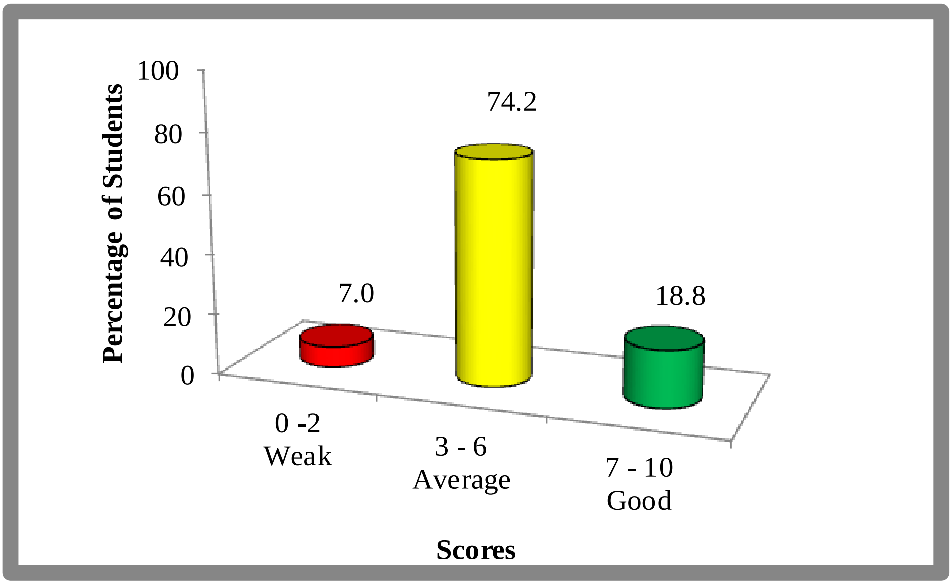


Figure 1: *Overall Students' Scores in Percentage for Question 1*

2.1.2 Question 2: Supply System, Batteries and Cells

The question consisted of two parts, (a) and (b). The students were required to mention two types of electrical sources in part (a) while in part (b) they were required to define terms, (i) Local action (ii) Polarization as applied in cells and batteries.

The question was attempted by 369 students, out of these, 323 (87.5%) scored from 0 to 1 mark, 22 (6%) scored from 1.5 to 3 marks and the remaining 24 (6.5%) scored from 3.5 to 5 marks. The overall performance of the students in this question is summarized in Figure 2.

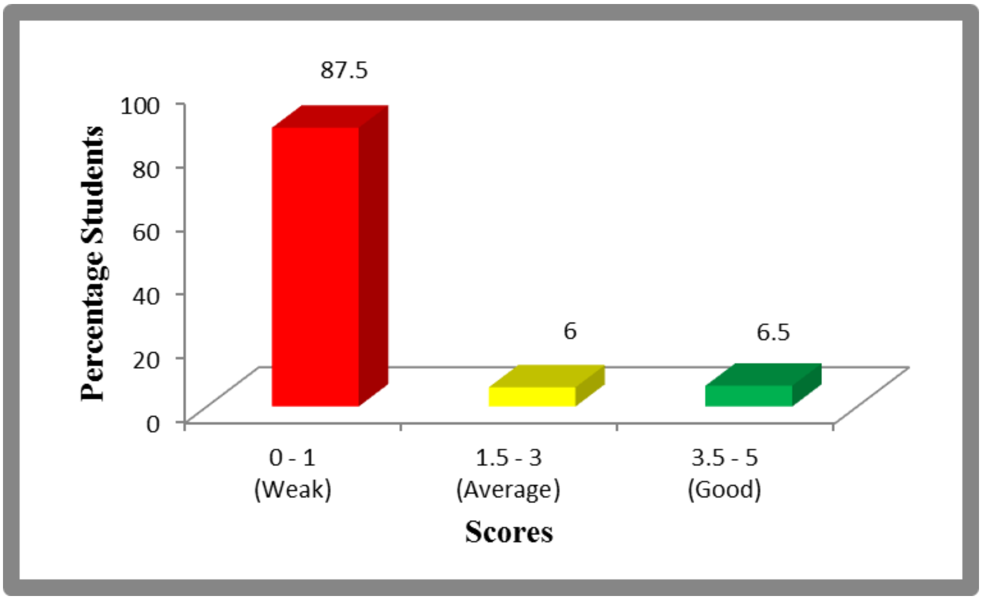


Figure 2: *Overall Performance of the Students in Question 2*

The general performance of the students in this question was poor because 323 (87.5%) scored below average. This shows that the majority had inadequate knowledge on the topic of Supply System, particularly in Batteries and Cells. Most of the students failed to mention the types of electrical sources as well as defining the terms, local action and polarization. Extract 2.1 shows a sample of poor response from one of the students who seemed to have little knowledge and skills in this area.

2. (a) Mention two types of electrical sources.

(i) Generator

(ii) Accummulator

(b) Define the following terms as applied in cells and batteries:

(i) Local action

Is the action that lecalnche' cell has befor improved.

(ii) Polarization

Is the process of improving leclachel' cell.

Extract 2.1: A sample of poor response from a student who mentioned the types of electrical generating devices instead of types of electrical sources in part (a). Also, in part (b) the student failed to define the terms local action and polarization.

Although most of students performed poorly in this question, there were 46 (12.5%) students who scored from 1.5 to 5 marks. Out of these, 5 (1.4%) performed very well as they scored 5 marks. This suggests that, these students had adequate knowledge in Supply System; hence they were able to provide the correct responses in all parts of the question. 41 (11.1%) had average performance as they scored from 1.5 to 4 marks. These students managed to provide correct response for some parts of the question but failed in others. Extract 2.2 shows a sample of good response from one of the students.

2. (a) Mention two types of electrical sources.

(i) Heat

(ii) Friction

(b) Define the following terms as applied in cells and batteries:

(i) Local action

Is the type of effect or problem of battery or cell where by electrolyte attract impurities in zinc Forming cell corroding the electrode

(ii) Polarization

Is the type of effect or problem of battery or cell where by bubbles of hydrogen gas Forming around a cabon plate when cells in use and resist flow of current.

Extract 2.2: A sample of good response from one of the students who mentioned two types of electrical sources and defined the terms local action and polarization as applied in Batteries and Cells correctly.

2.1.3 Question 3: Magnetism and Electromagnetism

The questions consisted of two parts and required the students in (a) to provide the meaning of the term self inductance as used in electrical technology, and in (b), to calculate mutual inductance between the two coils. If two coils, A and B had self inductances of 120µH and 300µH respectively, and. a current of 1 A flowing through coil A produces flux linkages of 100µWb turns in coil B.

The question was attempted by 369 students. Out of these students, 352 (95.4%) scored from 0 to 1 mark, but 16 (4.3%) scored from 1.5 to 3 marks. Only 1 (0.3%) student scored 4 marks. Figure 3, summarizes the overall performance of students in this question.

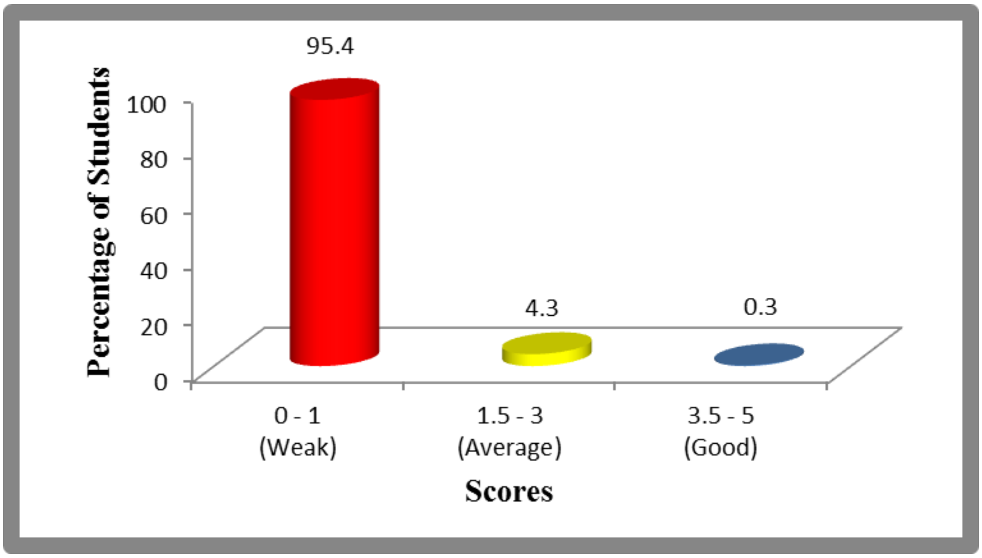


Figure 3: *Overall Students Performance in Question 3*

The analysis indicates further that this question was poorly performed because 352 (95.4%) of the students scored 0 to 1 mark. It has been established that none of the students managed to score full (5) marks allotted in this question. Majority failed to provide the correct meaning of "self inductance" and to recall appropriate formula of calculating the mutual inductance in coil A and B. This implies that a number of students had no sufficient knowledge in Electromagnetism topic. Extracts 3.1.1, 3.1.2 and 3.1.3 are samples of poor responses extracted from three different students.

3. (a) What is the meaning of the term "self inductance" as used in electrical technology?

Is a process of increasing or decreasing of capacity of any body or temperature.

(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 = 120 μH and 300 μH

Current (I) 1A

flux linkages of 100 μWb.

$\frac{120\,\mu H}{} = \frac{300\,\mu H}{100\,\mu Wb}$

$\frac{12000\,\mu H\mu Wb}{} = \frac{300\,\mu H}{}$

$12000\,\mu H\mu Wb = 12000\,\mu H Wb = 0.025\,WbA$

Extract 3.1.1: A sample of poor response from a student who provided definition of insulator instead of self-inductance in part (a) and failed to recall a formula to calculate the mutual inductance in part (b).

3. (a) What is the meaning of the term "self inductance" as used in electrical technology?

Self inducance is the ability of a device have automatically device that offer higher resistance to a flow of current.

(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 inductance - 120μH

- 300μH

Current - 1A

flux Linkage of 100μWb

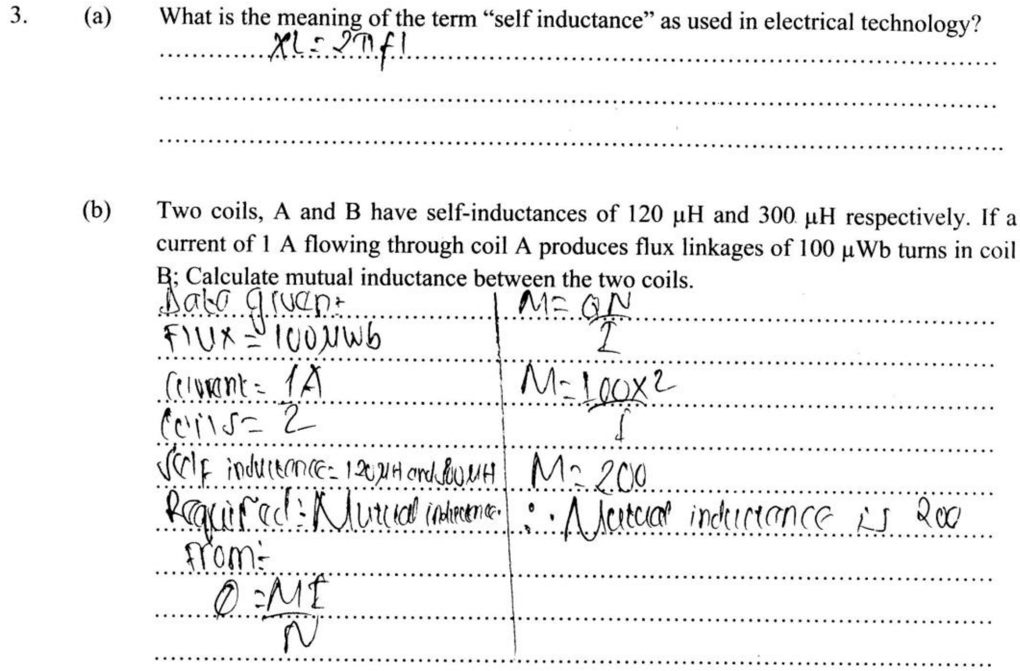
From

Mutual inductance = 300μH - 120μH

M.I 180μH

Mutual inductance = 180μH

Extract 3.1.2: A sample of incorrect response from a student who provided irrelevant definition of self inductance in (a), and failed to calculate correctly the mutual inductance in (b).


3. (a) What is the meaning of the term "self inductance" as used in electrical technology?

$X_L = 2\pi f l$

(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:	$M = \frac{\emptyset N}{I}$
Flux = 100μWb	
current = 1A	$M = \frac{100 \times 2}{1}$
coils = 2	
self inductance = 120μH and 300μH	M = 200
Required: Mutual inductance	∴ Mutual inductance is 200
from:	
$\emptyset = \frac{MI}{N}$	

Extract 3.1.3: A sample of incorrect response from a student who provided the correct formula for inductive reactance instead of defining self inductance in (a), and failed to calculate correctly the mutual inductance in (b).

Students' performance analysis for question 3 shows that 17 (4.6%) students scored from 2 to 4 marks. These students managed to provide correct responses at least in some parts of the question which enabled them to have average performance. Most of them were able to provide some explanations concerning self inductance, although they could not provide the complete meaning as expected. However, for student who performed averagely none had an ability to calculate the mutual inductance, as required in 3 (b). Students with average performance lacked sufficient knowledge in some aspects of Electromagnetism. Extract 3.2 shows a sample of good response from one of the students who partly responded to this question correctly.

3. (a) What is the meaning of the term "self inductance" as used in electrical technology?

Self inductance is the property of a circuit whereby change in current in a circuit cause the e.m.f to be induced on itself.

(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.

Solution.

Data given.

$L_1 = 120\mu H$

$L_2 = 300\mu H$

$I = 1A$

$\Phi = 100\mu Wb$ turns

From

Mutual inductance = ΔI x Flux

= 1A x 10μWbturns

∴ Mutual inductance 10μ Henry

Extract 3.2: A sample of good response from one of a candidate who provided correct meaning of self-inductance in part (a), but failed to recall proper formula in calculating mutual inductance in part (b).

2.1.4 Question 4: Electrical Heating

The question had two parts which required students in (a) to define the term "temperature" as used in electrical engineering science, and in (b) (i) to convert 85^0F into degrees Celsius, and in (b) (ii) to convert 90^0C into Fahrenheit.

369 (100%) students attempted this question. Performance analysis indicates that 149 (40%) scored from 0 to 1 mark, 43 (12%) scored from 1.5 to 3 marks, and 177 (48%) scored 3.5 to 5 marks. The overall performance in this question is as summarized in Figure 4.

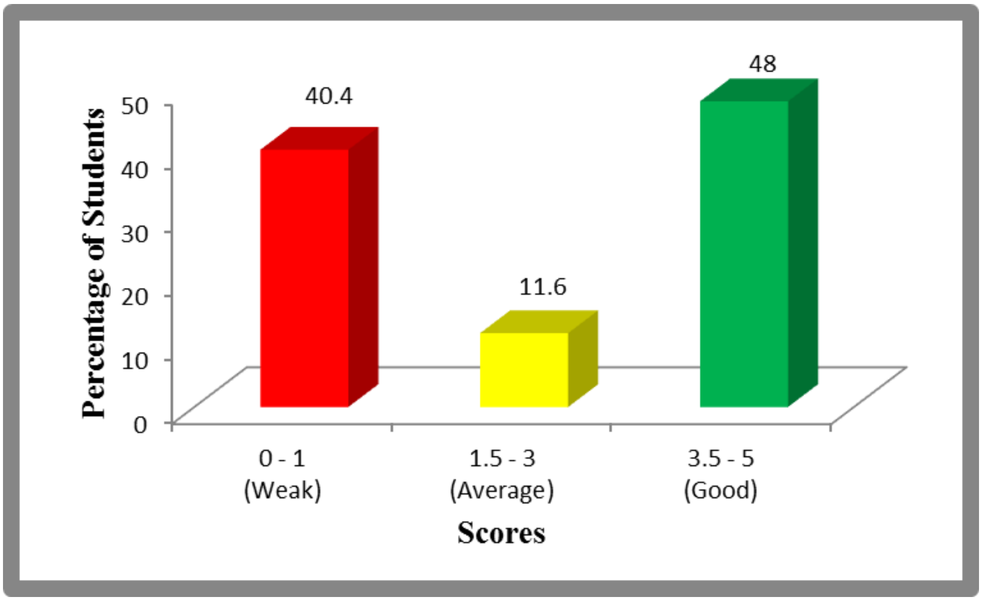


Figure 4: *Overall Students' Performance in Question 4*

The general performance of the students in this question was average because 220 (59.6%) scored average marks and above. This performance suggests that, students were relatively knowledgeable on Electrical Heating topic. Most of them managed to provide correct definition of the term temperature and used proper formulae for heat conversion units. However, few students could not provide correct responses to some parts. Extract 4.1 indicates a sample of good response given by one of the students.

4. (a) Define the term "temperature" as used in electrical engineering science.

Temperature is the degree of hotness or coldness of a body.

(b) (i) Convert 85°F into degrees Celsius.

Solution	
From $°C = \frac{5}{9} \times (F - 32)$	$°C = 29.4$
$°C = \frac{5}{9} \times (85 - 32)$	$\therefore 85°F = 29.4°C$
$°C = \frac{5}{9} \times 53$	$\therefore 85°F = 29.4°C$

(ii) Convert 90°C into Fahrenheit.

Solution	
From $°F = \frac{9}{5} \times °C + 32$	$°F = (9 \times 18) + 32$
	$°F = 162 + 32$
	$°F = 194$
$°F = \frac{9}{5} \times 90 + 32$	$\therefore 90°C = 194°F$

Extract 4.1: A good response from the student who defined the term temperature correctly and use proper formulae to convert Fahrenheit to degrees Celsius and vice versa.

Performance analysis indicates further that 149 (40.4%) of students performed poorly in this question. This implies that these students had no knowledge in the concerned topic. Most of them failed to define the term temperature and to apply correct formulae for conversion of Fahrenheit to degrees Celsius and vice versa. Extract 4.2 shows a sample of poor response given by one of the students.

4. (a) Define the term "temperature" as used in electrical engineering science.

temperature : Is used in electrical engineering science by means of knowing high population of the mathine.

(b) (i) Convert 85°F into degrees Celsius.

C = 9/9 (32 - F)

C = 9/9 (85° - 32) = 9 x 17 - 32

C = 9/9 (85 - 32) = 9 x 15 = 135°C

= 135°C

(ii) Convert 90°C into Fahrenheit.

F = 9/5 x (32 + C)

F = 5/9 (32 + 90)

= 5 x 42 = 210°F

210°F

Extract 4.2: An incorrect response from a student who provided wrong definition and failed to use appropriate formulae for temperature conversion, thus failed to meet the requirements for question 4.

2.1.5 Question 5: Batteries and Cells

The question had two parts and required the students to calculate in (a) total internal resistance and (b) current through the external resistance of 4 Ω. Given ten cells each of e.m.f of 1.5 V and internal resistance of 0.2 Ω connected in series.

All students attempted this question. The students who scored from 0 to 1 mark were 217 (58.8%), those who scored from 1.5 to 3 marks were 115 (31.2%), whereas 37 (10%) scored from 3.5 to 5 marks. The general performance of students in this question is summarized in Figure 5.

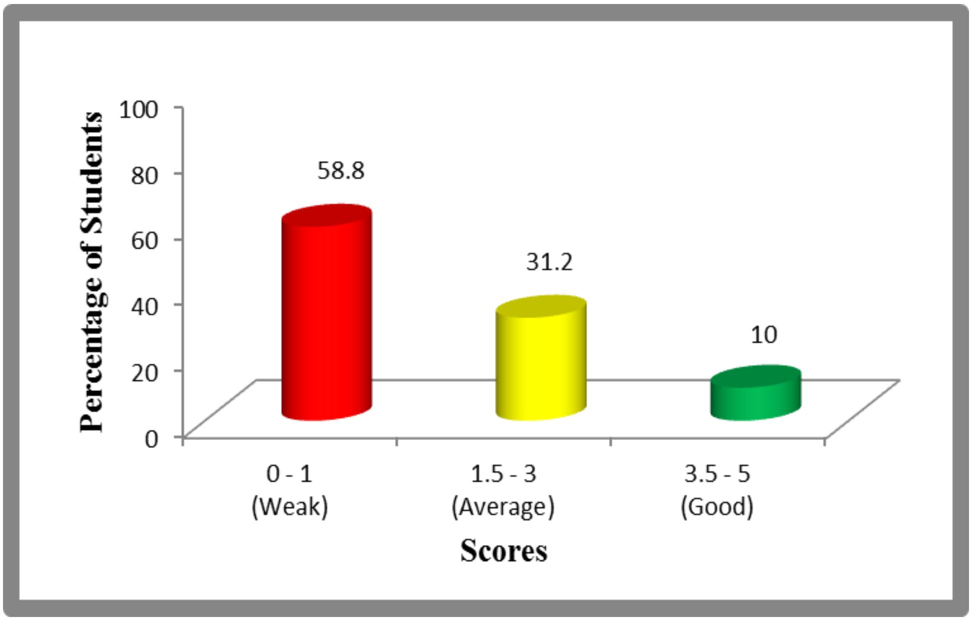


Figure 5: *Overall Students Performance in Question 5*

The overall performance of the students in this question is average because 152 (41.2%) managed to score from 1.5 to 5 marks. 120 (32.5%) students who scored 1.5 to 4 marks provided correct responses for some parts of the question but failed in others. The analysis shows that 32 (8.7%) of the students scored full (5) marks in this question. These students demonstrated ability in recalling and applying proper formulae for computing the required parameters. Extract 5.1 shows a sample of good response from one of the students.

5. Ten cells each of e.m.f of 1.5 V and internal resistance of 0.2 Ω are connected in series. Calculate:

(a) Total internal resistance.

Solution

total internal resistance = number of cells X internal resistance

∴ Total internal resistance = 0.2Ω X 10 = 2Ω.

(b) Current through the external resistance of 4 Ω.

Solution

From; $\frac{\text{Total voltage}}{\text{total resistance}}$ = Current $\left(\frac{nE}{R+nr} = I\right)$

where n = number of cells

$I = \frac{10 \times 1.5}{4\Omega + 2\Omega} = \frac{15}{6}A$

∴ Current = 2.5A

Extract 5.1: A sample of a good response from a student who correctly calculated the total internal resistance in part (a) and current through external resistance in part (b).

The analysis indicates that although a good number of students had good performance, 217 (58.8%) performed poorly. This suggests that most of the students had no sufficient knowledge on the topic, particularly in areas of electrical circuit connection and Ohm’s law. Most of them failed to calculate the total internal resistance for the given ten cells and the current through the external resistance. A sample of poor response from one of the students is shown in extract 5.2.

5. Ten cells each of e.m.f of 1.5 V and internal resistance of 0.2 Ω are connected in series. Calculate:

(a) Total internal resistance.

$= 1{\cdot}5V = 0{\cdot}2\Omega = 0{\cdot}01$

$= \frac{15V}{10} - \frac{2}{10} = \frac{30}{100} = 0{\cdot}3\,\Omega$

(b) Current through the external resistance of 4 Ω.

$= 4\Omega = 0{\cdot}3\Omega$

$= \frac{4\Omega}{1} = \frac{3\Omega}{10}$

$= \frac{4\Omega}{1} \times \frac{10}{3} = \frac{40}{3} = \frac{12}{10}$

$= 1{\cdot}2\,\Omega$

Extract 5.2: A sample of poor response from one of the students who failed to calculate the total internal resistance in (a) and current through external resistance in (b).

2.1.6 Question 6: Conductors and Cables

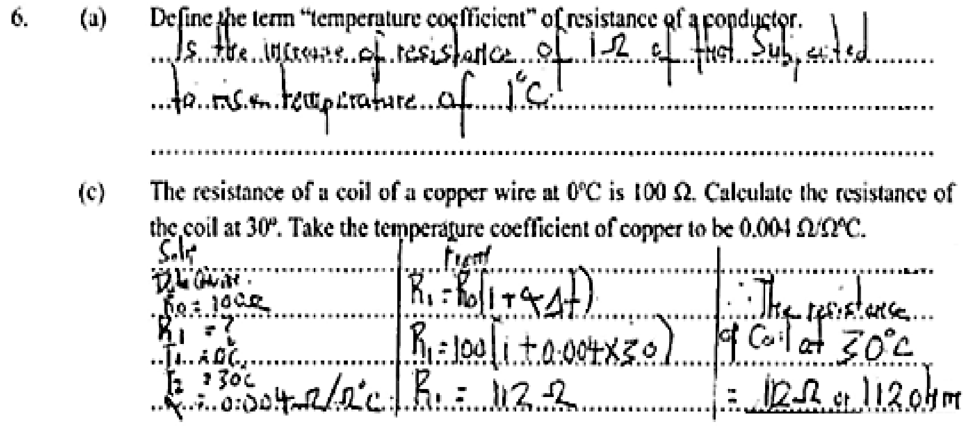
The question had two parts (a) and (b), and the students were required in (a) to define the "temperature coefficient" of resistance of a conductor and (b) to calculate the resistance of the coil at 30^0C if the resistance of a coil of a copper wire at 0^0C is 100 Ω and the temperature coefficient of copper is 0.004 Ω/Ω^0C.

This question was attempted by 369 (100%) students. Performance analysis indicates that 212 (57.5%) scored from 0 to 1 mark, 86 (23.3%) scored from 1.5 to 3 marks, and 69 (19.2%) 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	Students		Remarks
	Number	**Percentage (%)**	
0 to 1	**212**	57.5	Weak
1.5 to 3	**86**	23.3	Average
3.5 to 5	**71**	19.2	Good
Total	**369**	**100**	

The general performance of the students in this question was average because 157 (42.5%) scored from 2 to 5 marks. Among those, 95 (25.7%) scored between 2 to 4.5 marks. These students managed to provide correct responses in some parts of the question but failed in others. Only 62 (16.8%) of the students were able to respond correctly in this question. These students provided correct definition of the term "temperature coefficient" and applied relevant formula in calculating the resistance of a coil. These students had sufficient knowledge in Conductors and Cables especially in the effect of temperature on conductors. Extract 6.1 shows a sample of good response given by one of the students.


6. (a) Define the term "temperature coefficient" of resistance of a conductor.

Is the increase of resistance of 1 Ω of the sub. ected to rise temperature of 1°C.

(c) The resistance of a coil of a copper wire at 0°C is 100 Ω. Calculate the resistance of the coil at 30°. Take the temperature coefficient of copper to be 0.004 Ω/Ω°C.

Soln

Data Given:

R₀ = 100Ω

R₁ = ?

T₁ = 0°C

T₂ = 30°C

∝ = 0.004 Ω/Ω°C

From

R₁ = R₀(1 + ∝Δt)

R₁ = 100(1 + 0.004 × 30)

R₁ = 112 Ω

∴ The resistance of coil at 30°C = 112 Ω or 112 ohm

Extract 6.1: A correct response from a student who defined the term "temperature coefficient" of resistance of the conductor in part (a) and calculate correctly the resistance of the coil in part (b).

However, the analysis showed that there were 212 (57.5%) students who scored below average. Majority scored 0 in this question. This indicates that some of the students lacked knowledge of Conductors and Cables, particularly on the effect of temperature in conductors. They failed to define the term “temperature coefficient” of resistance of the conductor and could not calculate the resistance of the coil. An example of an incorrect response given by one of the students is shown in extract 6.2.

6 (a) Define the term "temperature coefficient" of resistance of a conductor.

temperature is degree Of hotness and coldness in resistance of a conductor

(c) The resistance of a coil of a copper wire at 0°C is 100 Ω. Calculate the resistance of the coil at 30°. Take the temperature coefficient of copper to be 0.004 Ω/Ω°C.

100Ω x 30° x 0·004Ω/Ω°C

3000Ω x 0·004Ω/Ω°C

12000 = 1200Ω°C

Extract 6.2: A sample of incorrect response from a student who provided the definition of the term “temperature” instead of “temperature coefficient” in (a) and failed to apply correct formula for calculating the resistance of the coil in (b).

2.1.7 Question 7: D.C Circuits

The question required the students to calculate the supply current from two resistors of 6 Ω and 8Ω respectively, which were connected across a 100 V supply.

The question was attempted by 369 (100%) students. Among those, 320 (86.7%) scored from 0 to 1 mark, 19 (5.2%) scored from 1.5 to 3 marks, and 30 (8.1%) scored from 3.5 to 5 marks. The overall performance of the students for this question is summarized in Figure 6.

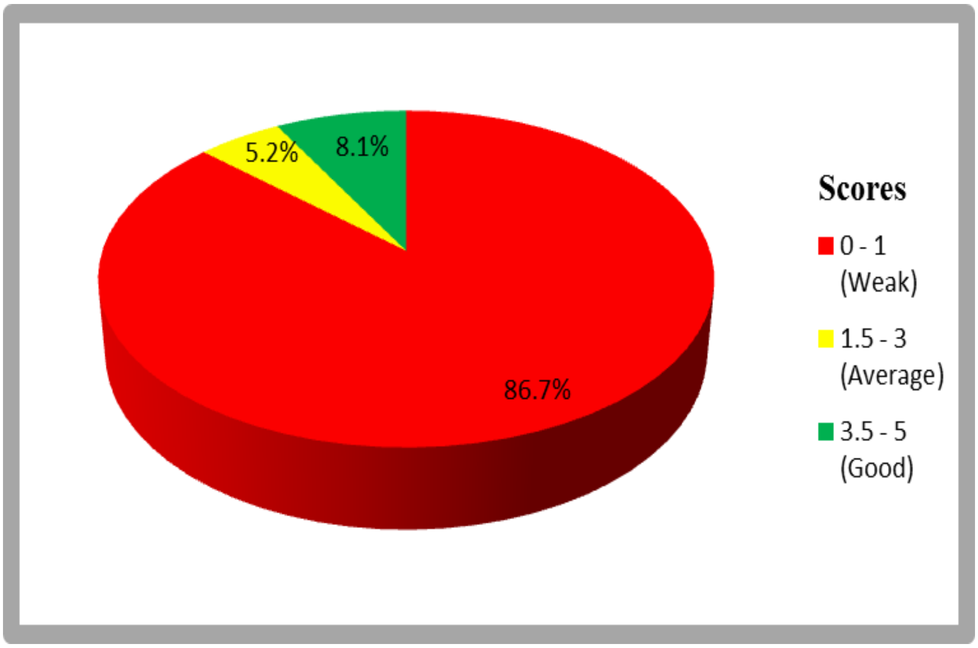
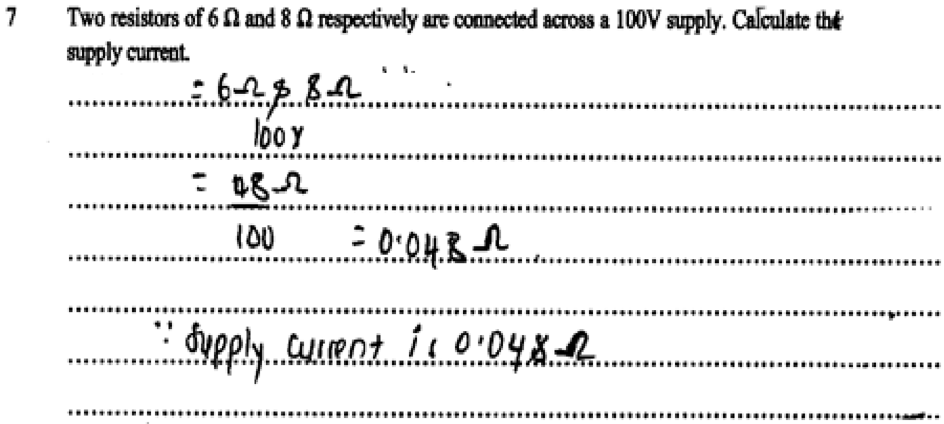


Figure 6: *The Overall Performance of the Students for Question 7*

The general performance of the students in this question was poor because 320 (86.7%) of students scored from 0 and 1 mark. The analysis shows that the students who scored zero were incompetent in the DC Circuits topic, especially in the area of circuit connections. Many students failed to distinguish between series and parallel connections. They failed to understand that the two resistors were connected in parallel. The analysis indicates that students who managed to score 1 mark were able to recall Ohm's law, but failed to find the equivalent resistance, thus failure to get the supply current. Extract 7.1 shows a sample of poor response from one of the students.



7 Two resistors of 6 Ω and 8 Ω respectively are connected across a 100V supply. Calculate the supply current.

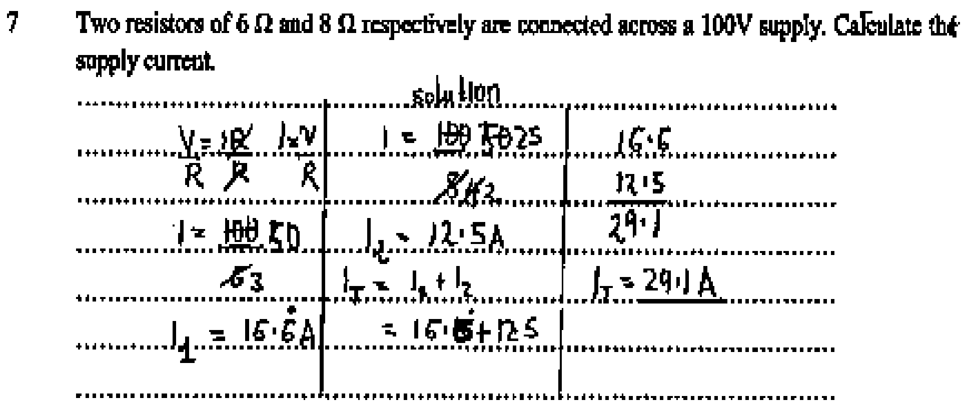
= 6Ω × 8Ω / 100V

= 48Ω / 100 = 0.048Ω

∴ supply current is 0.048Ω

Extract 7.1: A sample of an incorrect response from a student who failed to calculate the supply current from two resistors connected across the supply.

Performance analysis indicates further that, 49 (13.3%) students scored the average and above. Those who scored between 1.5 to 4 marks were able to recall some concepts of DC Circuits, hence managed to calculate the supply current but failed to find the equivalent resistance of the circuit. The analysis establishes that, 28 students scored full (5) marks allotted in this question. This indicates that these students were able to recall the formula for computing the value of the supply current. A sample of a correct response from one of the students is shown in extract 7.2



7 Two resistors of 6 Ω and 8 Ω respectively are connected across a 100V supply. Calculate the supply current.

solution

V = IR, I = V/R	I = 100/8	16.6
I = 100/6	I₂ = 12.5A	12.5
I₁ = 16.6A	$I_T = I_1 + I_2$	29.1
	= 16.6 + 12.5	I_T = 29.1 A

Extract 7.2: A sample of the student who provided good response by applying Ohm's law to find the supply current.

2.1.8 Question 8: A.C Voltage

Question 8 had two parts, (a) and (b). Students were required to calculate the period time in (a), and average value of current in (b), given an alternating current with a maximum value of 6 A and frequency of 50 Hz.

The question was attempted by 369 students, out of these 328 (88.9%) scored from 0 to 1 mark, and the rest 41 (11.1%) scored from 1.5 to 2.5 marks. Figure 7 summarizes the overall performance of students in this question.

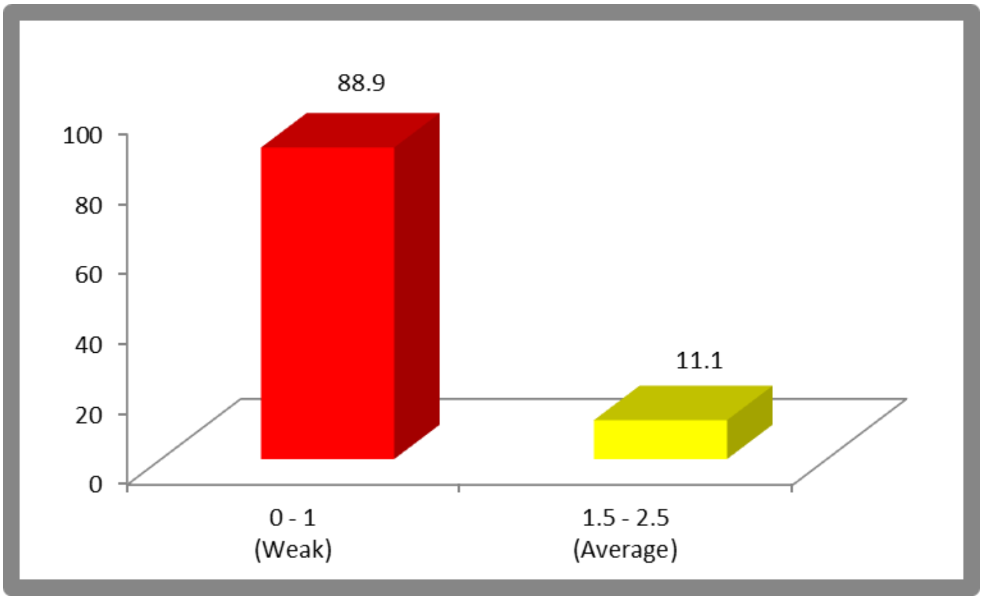


Figure 7: *The Overall Students' Performance in Question 8*

The general performance of the students in this question was poor because 328 (88.9%) scored below average. Out of these, 325 (88.1%) students scored zero. These students failed to recognize the relationship between the frequency and period time in (a) as well as average value and the maximum value of the alternating current in (b); hence, applied inappropriate formulae in calculating period time and average value. This suggests that students had poor understanding on AC Circuits. Extracts 8.1.1 and 8.1.2 show samples of incorrect responses from two different students.

8. An alternating current has a maximum value of 6 A and frequency of 50 Hz. Calculate:

(a) Its period time.

$= 50Hz \times 6A$

$= 300$

∴ Its period time is 300

(b) Its average value.

$= \frac{50Hz}{6A}$

$= 8.33$

∴ Its average value is 8.33

Extract 8.1.1: A sample of poor response from a student who failed to apply formulae for calculating the period time and average value of current.

8. An alternating current has a maximum value of 6 A and frequency of 50 Hz. Calculate:

(a) Its period time.

From :- $I = \frac{\text{Frequence}}{\text{Time}}$

$\text{time} = \frac{\text{Frequence}}{\text{Current}} = \frac{50Hz}{6A}$ ∴ Time is 8.3 seconds

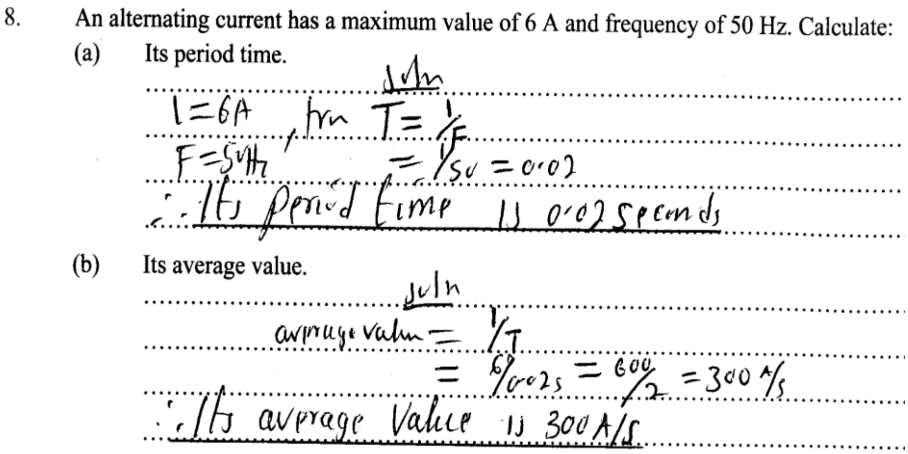
(b) Its average value.

From ! average value $= \frac{\text{Frequency} \times \text{current}}{\text{time}}$

$= \frac{50Hz \times 6A}{8.3}$ ∴ Average value = 36.1

Extract 8.1.2: A sample of poor response from a student who failed to apply formulae for calculating the period time and average value of current.

Even though the general performance of this question was poor, it was observed that there were 41 (11.1%) students scored from 1.5 to 2.5 marks. None of these students managed to score more than 3 marks. The analysis indicates that these students applied correct formula for calculating period time in (a) which enabled them to score averagely, while in (b) the majority of students failed to score any mark. This suggests that most of students had insufficient knowledge in the AC Circuits. A sample of this average response provided by one of the students is indicated in extract 8.2.


8. An alternating current has a maximum value of 6 A and frequency of 50 Hz. Calculate:

(a) Its period time.

soln

I=6A , frm T = 1/F

F=50Hz = 1/50 = 0.02

∴ Its period time is 0.02 seconds

(b) Its average value.

soln

average value = 1/T

= 6/0.02s = 600/2 = 300 A/s

∴ Its average value is 300 A/s

Extract 8.2: A sample of average response from a student who in (a) calculated the period time correctly, but failed to find average current in (b).

2.1.9 Question 9: Magnetism and Electromagnetism

Question 9 had two parts, (a) and (b). Students were required in (a) to state Lenz's law of electromagnetism, and in (b), to find the e.m.f induced in the coil when a coil of 500 turns is limited by flux of 0.4 mWb and the flux is reversed in 0.01 sec.

The question was attempted by a total of 369 students. Out of them, 363 (98.4%) scored between 0 to 1 mark. There were 4 (1.1%) students scored 2 marks and the rest 2 (0.5%) scored 4 marks. The overall students' performance is summarized in Figure 8.

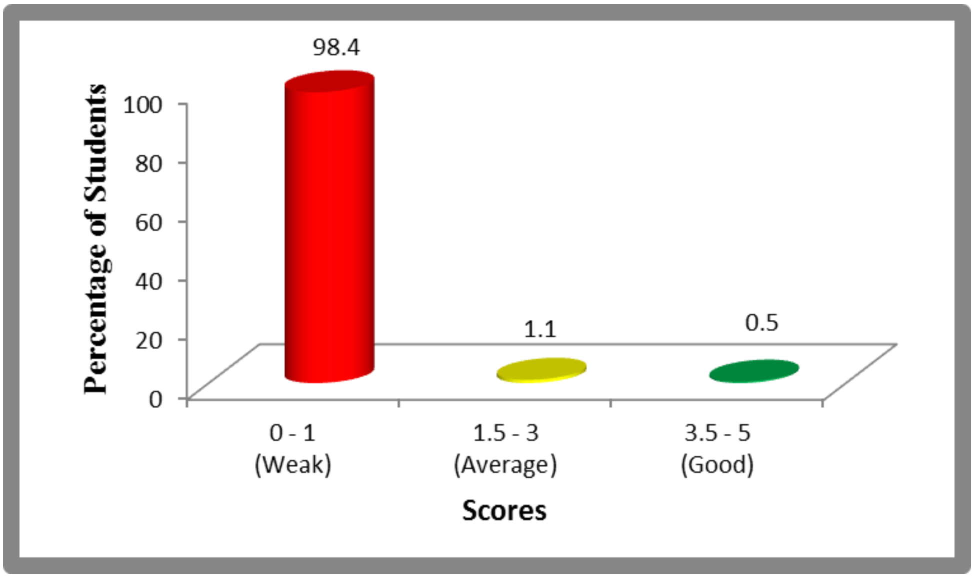


Figure 8: *The Overall Students' Performance of Question 9*

The analysis shows that compared to other questions provided in this paper, this was the most poorly performed question. The general students' performance in this question was poor because 363 (98.4%) scored from 0 to 1 mark. Among these, 348 students scored zero. This signifies that students lacked the basic knowledge on electromagnetism especially in Lenz's law and its application for calculating the e.m.f induced in the coil. Extracts 9.1.1 and 9.1.2 show samples of students who performed poorly in this question.

9. (a) State Lenz's law of electromagnetism.

states that:

" Like poles of magnets repel, unlike poles of magnets attract each other"

(b) A coil of 500 turns is limited by a flux of 0.4 m Wb. If the flux is reversed in 0.01 second; Find the e.m.f induced in the coil.

solution.

From

e.m.F = Φ/t

where; Φ = Magnetic flux.

t = Time.

E.m.f = 0.4mWb (0.4 x 10⁻³ Wb) / 0.01 sec.

E.m.f = 0.0004 wb x100 / 0.01s x100 = 0.04wb / 1sec

E.m.f = 0.04v

∴ The (e.m.f) induced is 0.04V

Extract 9.1.1: A sample of an incorrect response from a student who instead of stating the Lenz's law of electromagnetism, he/she stated the Law of magnetism in (a), while in (b) failed to apply proper formula for calculating the induced e.m.f

9. (a) State Lenz's law of electromagnetism.

State that " induced electromotive force is established in a circuit whenever there are change of flux linking in a coil or conductor"

(b) A coil of 500 turns is limited by a flux of 0.4 m Wb. If the flux is reversed in 0.01 second; Find the e.m.f induced in the coil.

Soln.

Data given

No Turn = 500

Magnetic Flux = 0.4mwb = 0.0004wb

T = 0.01 sec

F = N I

500x0.01 = 5v

∴ 5A

Extract 9.1.2: A sample of an incorrect response from a student who stated Faraday's law of electromagnetic induction, instead of Lenz's law of electromagnetism in (a), while in (b), applied formula for calculating m.m.f instead of induced e.m.f.

Performance analysis indicates further that there were 6 (1.6%) students who scored above 1 mark. Out of these, 4 (1.1%) scored 2 marks and the rest 2 (0.5%) scored 4 marks. None of the students managed to score full (5) marks. The students who scored averagely failed to state Lenz's law of electromagnetism, though they managed to apply the correct formula for calculating the induced e.m.f. These students had insufficient knowledge in the magnetism and electromagnetism topic. Extract 9.2 shows a sample of an average response from one of the students.

9. (a) State Lenz's law of electromagnetism.

state that the induced emf will flow in the direction so as to oppose the direction the magnetic flux linkers in the conductor

(b) A coil of 500 turns is limited by a flux of 0.4 m Wb. If the flux is reversed in 0.01 second; Find the e.m.f induced in the coil.

Data given

turn = 500N

ϕ = 0.4mWb

time = 0.01s

Soln

from $emf = N\frac{\Delta\phi}{\Delta t}$

$emf = 500N\frac{(0.4 - -0.4)\,Wb}{0.01s}$

$emf = 500N \times \frac{0.8\ mWb}{0.01}$

$emf = 40V$

Extract 9.2: A sample of average response from a student who failed to state Lenz's law of electromagnetism in part (a), but applied appropriate formula for calculating e.m.f in part (b).

2.2 ELECTRICAL INSTALLATION

2.2.1 Question 10: Safety, Earthing, Conduit, Trunking & Ducts; Conductors, Insulators & Cables, Consumer Circuit and Inspection & Testing

The question consisted of parts (a), (b), (c), (d) and (e). Questions in these parts were composed from various topics of Electrical installation. Total marks allotted to the question were 50.

A total of 210 students attempted the question. 117 (55.7%) scored from 0 to 14 marks, 84 (40%) scored from 15 to 31 marks, while 9 (4.3%) students scored from 33 to 39.5 marks. The general performance of this question was average because 93 (44.3%) students passed. Figure 9 summarizes the overall students' performance in this question.

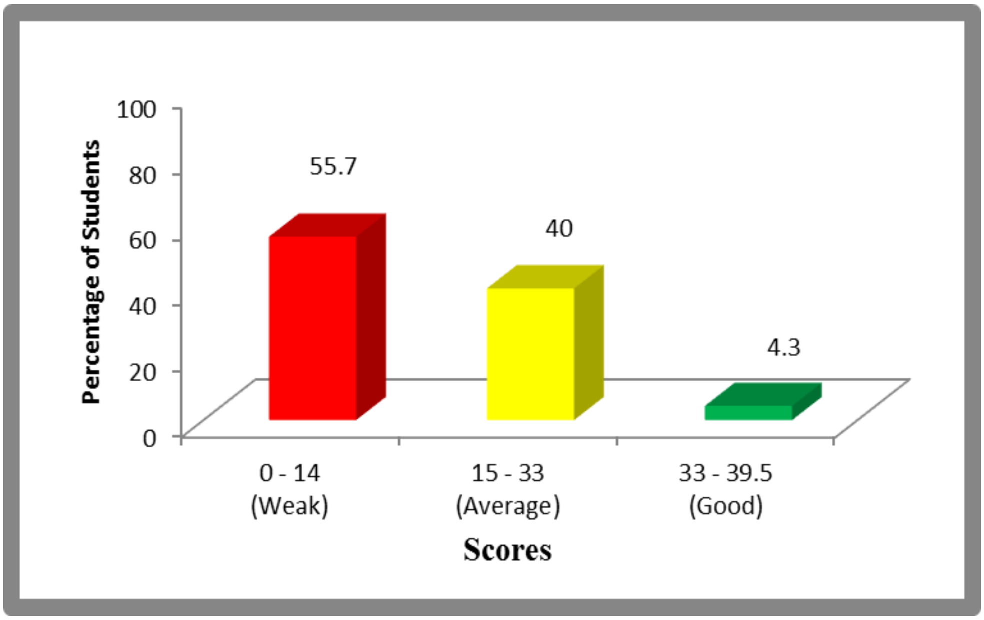


Figure 9: *The Overall Performance of Students in Question 10*

Students demonstrated good mastering of the topic in parts (a), (b), and (c). Students had average performance in part (d). However, part (e) was poorly performed.

Part (a) had two items set from two topics namely, Safety and Earthing. In item (i), students were required to name five protective garments used by electricians and technicians, and in item (ii), students were required to give five reasons that makes all metal parts of an electrical installation to be earthed.

The students' performance in this part was good because most of them managed to provide correct responses in all items. This performance indicates that students had enough knowledge on Safety and Earthing. Extract 10.1 is a sample of good response from one of the students.

10. (a) (i) Name five protective garments used by electricians and technicians.

- Safety gugles.
- Safty boots.
- safty belt.
- safty helment.
- Protective gloves.

(ii) Why all metal parts of an electrical installation must be earthed? Give five reasons.

- Inorder to avoid fire, when there is earth learage current may flow randomly that may cause fire.
- To avoid electric shock, when there is no earthing in metal, may cause free passage of current in the metal that may lead shock.
- To avoid electrical Appliances to be destroyed by electrical current, because excess flow of current may cause destruction in appliances
- ~~To reduce~~ To absorb current which get out in its path which is electrical conductor to go down through earth rod.
- To protect electricity system, when there is no earth may cause shock between metal and other conductor which may destroy all system.

Extract 10.1: A sample of good response from one of the students who managed to name five protective garments as well as giving reason for earthing all metal parts of an electrical installation.

Performance analysis showed that students with average performance managed to provide correct responses in either of the items. There was a student who was able to give the correct answer in item (ii) but failed in (i) by mentioning; "*Isolator, Cable, P.V.C, Vulcanized rubber* and *Plastic"* which was wrong. The student mentioned the materials found in conductors and cables instead of listing the protective garments.

Few students failed to provide any correct response in all items of part (a). These students lacked knowledge and skills on the area of Safety and Earthing. Extract 10.2 shows a sample of poor responses picked from the script of one of the students who performed poorly.

10. (a) (i) **Name five protective garments used by electricians and technicians.**

- Overall - used drawn not be dirty
- visor - Used to magnify the spring outs
- Shoes - Used to support if you can electrical short
-
-

(ii) **Why all metal parts of an electrical installation must be earthed? Give five reasons.**

- Because its the reduced charges in a cell or in a battery.
- Because should must be not make the electrical short in experiments
- Because it used to store charge in a capacitor and capacitance.
- Because it used to magnify the metal conduits in a ~~..~~ current.
-

Extract 10.2: A sample of poor responses picked from a student who couldn't name five protective garments in (i) as well as give the reason for all metal parts of electrical installation to be earthed in (ii).

Part (b) of this question was derived from the topic of Conduit, Trunking & Ducts. It had two items which required the students to list four basic methods of fixing conduits in item (i), and write six advantages of metal conduits in item (ii). Majorities were able to list basic methods of fixing conduits and give the advantages of using metal conduits. The good performance in this part indicates that students attained appropriate knowledge in the area of conduits. Extract 10.3 shows a sample of good response extracted from one of the student's script.

(b) (i) List four basic method of fixing conduits.

- By using spacer saddles.
- By using clips.
- By using distance saddles.
- By using Multiple Sadles.

(ii) Write six advantages of metal conduits.

- Protect electrical conductor from mechanical damage.
- It reduce risk of fire.
- provide earth to return to earth path.
- It cope with onerous condition.
- They have long life since they cannot be creack.
- They can be easy extended.

Extract 10.3: A sample of good response from a student who provided correct response in item (i) and write correctly four advantages of metal conduits in item (ii).

There were also few students who scored average marks in this part. These managed to give the advantages of metal conduits but many of them failed to list the methods used for fixing conduits as required in (b) (i) and (b) (ii), respectively. This suggests that students had insufficient knowledge and skills on conduits.

Analysis indicates further that, there were some students who responded poorly in this part. They provided wrong responses in each item as it was seen in one of the student's script who listed: "*By using cable wire, By using meatal conduit and by using had conduit* in part (b) (i) as the basic methods of fixing conduits, and in (b) (ii), the student wrote: "*It is very cheap, It is flus, It is very easily to get it, It is portable material* and *They transfer small amount of electricity"* as the advantages of metal conduit. These responses were actually incorrect. This performance proved that students lacked knowledge in the area of Conduits. Extract 10.4 shows a sample of poor response from one of the students.

(b) (i) List four basic method of fixing conduits.

- One fixing conduits
- Two fixing conduits
- Live fixing conduits
- Neutral fixind conduits

(ii) Write six advantages of metal conduits.

- Is used to magnify the metal conduit.
- Is used to magnify the battery to reduce charge.
- Is used to store the charge in capacitor and capacitance.
- Is used to reduce charge.
-

Extract 10.4: An incorrect response from a student who failed to mention the methods of fixing conduit in item (i), and list advantages of metal conduits in item (ii).

Part (c) of the question was based from the topic of Conductors, Insulators and Cables. It comprised of three items; (i), (ii) and (iii). In item (i) the students were asked to name two physical properties and one chemical property of the perfect insulator. Item (ii) required the students to give two reasons that make copper material to be largely used in the manufacture of cables in preference to other metals, whereas, item (iii) required the students to outline three essential characteristics which an insulator should possess.

This was another part which was performed well by most of the students. They succeeded to give correct responses in all items. This demonstrated that students had suitable knowledge in Conductors, Insulators and Cables. Extract 10.5 illustrates a sample of correct response provided by one of the students.

(c) (i) Name two physical properties and one chemical property of the perfect insulator.

- They Should not absorbent.
- They Should withstand high temperature.
- Chemical, They Should withstand Corrosive and Chemical effect.

(ii) Give two reasons that make copper material to be largely used in the manufacture of cables in preference to other metals.

- Copper has large Conductance of electric Current Since has purity of 99.9%
- Availability, Copper are available easy than other material.

(iii) Outline three essential characteristics which an insulator should possess.

- Physically, Insulator Should withstand high temperature
- Chemically, Insulator Should withstand Corrosive.
- Electrically, Insulator Should have high resistance.

Extract 10.5: A sample of good response from a student who scored full marks in all items of this part.

Analysis also revealed that those who scored average in this part provided correct response in items (ii) and (iii) but failed in item (i). The major weakness of the students in this part was to differentiate between the properties and characteristics of insulators, hence interchanged the two. Also, there were those who provided properties instead of the types of insulators. These students demonstrated poor mastery of the concepts of this area particularly those used in insulators.

However, few students who responded poorly in this part had no sufficient knowledge on Conductors, Insulators and Cables. They failed to provide properties and characteristics of insulators in items (i) and (iii) respectively, and in item (ii), they could not pinpoint the criteria for selection of conductors and cables, as illustrated in Extract 10.6.

(c) (i) Name two physical properties and one chemical property of the perfect insulator.

- physical is wire
- physical is Iron
- Chemical is paper,

(ii) Give two reasons that make copper material to be largely used in the manufacture of cables in preference to other metals.

- Coppe is the wire that is metals used to crossing two conection of wir
- Crossing Cables prefence other metals in the Cables

(iii) Outline three essential characteristics which an insulator should possess.

- because the shold possess in the wirer
- because the Insulator is possess
- because the which an Insulator Should possess

Extract 10.6: A sample of poor response from student who failed to provide correct answers in all parts.

Part (d) of the question was composed from the topics of Consumer Circuit, Conductors, Insulators & Cables and Inspection & Testing. The general performance of students in this part was average. Majority attempted some item of this part correctly, but failed in others. Analysis shows that a big number of students performed well in items (i), (ii) and (iv). However, item (iii) was poorly performed. This indicates that these students were familiar on the concepts of electrical wiring system, but lacked knowledge and skills on standard and bunched conductors. Extract 10.7 is provided to illustrate the scenario.

(d) (i) Define the term 'wiring system' as used in electrical installation works.

Is the System of laying and fixing of Conductors In house or power Circuit.

(ii) Mention three types of cable used in wiring systems.

a/ Polyvinyl chloride (PVC) Cable

b/ Vulcanized indian rubber (VIR) cable

c/ Copper sheathed armoured cable (CSA) Cable.

(iii) Give two differences between a standard conductor and a bunched conductor.

- Standard Conductor Is used over all The world
- Conductance, large Conductance, low Conductance, Respectively.

(iv) Mention two main parts of an electrical cable.

- Conductor
- Insulator

Extract 10.7: A sample of good response from a student who responded correctly in items (i), (ii) and (iv), but failed in item (iii).

The analysis confirms further that a significant number of students performed poorly in this part. They failed to present correct responses in all items. Majority provided answers which were irrelevant to wiring system particularly in relationship to conductors and cables. This result implies that students had little knowledge on the area of Consumer circuits, Conductors and Cables. Extract 10.8 demonstrates a sample of poor response from one of the students.

(d) (i) Define the term 'wiring system' as used in electrical installation works.

Is the process of to take wire to use the road of wiring system and to go back to the Socket or Cable

(ii) Mention three types of cable used in wiring systems.

i/ Socket

ii/ Mainswitch

iii/ Insulator

(iii) Give two differences between a standard conductor and a bunched conductor.

- Standard Conductor is Low to the flow Current
- bunched Conductor Is the high to the Current of the flow

(iv) Mention two main parts of an electrical cable.

- Circuit breaker
- Mainswitch

Extract 10.8: A sample of incorrect response from a student who failed to define the term "wiring system" in item (i), mention three types of cables in (ii), give two differences between a standard and bunched conductor, and mention two main parts of an electrical cable in (iv).

Part (e) of this question was composed from the topic of Inspection and Testing. This was the most poorly performed part because a number of students failed to give the correct responses in all items. Very few students managed to score marks in some parts but failed in other parts. This revealed that, students had insufficient knowledge on the topic of Testing and Inspection. Samples of poor responses are shown in extracts 10.9.1 and 10.9.2.

(e) (i) Give two reasons of testing an electrical installation.

- electrical installation is the study has teaching you to be a good Electricial
- It help you to dy your job without to found to the Tanesco
-

(ii) Mention six factors which influence earth resistance.

- It help our house dont heat and the electrical
- It reduce the light in our house
- It make people to feel good Life
- It help our Country people to dont wory in the electrical
- It promote the electrical and to live free anytime
- It help to reduce the money example mteca is go Zambia

Extract 10.9.1: A sample of poor response from a student who provided irrelevant answers.

(e) (i) Give two reasons of testing an electrical installation.

- avoid touching live wire can cause death
- protection from electricity
- test for looking if is dead or live especially for doing amendment/new constructions.

(ii) Mention six factors which influence earth resistance.

- Lightining
- earthquackes
- Sunderstorm.
- Risod temperature
- type of resistance.
- increasing of capacitancy.

Extract 10.9.2: A sample of poor response from a student who provided safety precaution when working in live circuits instead of reasons for testing an electrical installation in (i), while in (ii) the student provided terms which are irrelevant to the topic under test.

On the contrary, few students performed well in this part. These students were capable of giving the reasons of testing an electrical installation in item (i), and mention factors which influence earth resistance in item (ii). The good performance obtained by these few students was due to the fact that they demonstrated high competency in the area of Inspection and Testing. Extract 10.10 shows a sample of good response from one of the students.

(e) (i) Give two reasons of testing an electrical installation.

- To check an efficiency of the carried installation so as to inspect the wiring system.
- The installation should be inspected in order to avoid fire risk, electric shock and other faults
-

(ii) Mention six factors which influence earth resistance.

- Soil condition
- ~~soit~~ Moisture content of soil.
- Temperature of the soil.
- Quality of coal dust and charcoal in the pit of earth electrode
- Distance and spacing in which earth electrodes is embeded.
- The types of material made electrode.

Extract 10.10: A sample of good response from a student who was able to give the reasons of testing an electrical installation in item (i), and mention factors which influence earth resistance in item (ii).

2.3 ELECTRONICS, RADIO REPAIR AND TV SERVICING

2.3.1 Question 11: Transducers, Tools and Equipment, Electronic Circuit Components, Semiconductors, A.C Voltage and Bipolar Transistors

The question was attempted by 159 students who specialized in Electronics, Radio and TV Servicing. The question was divided into parts (a) to (e) and the total marks allotted for the question were 50.

Analysis shows that out of 159 students who attempted the question, 40.9 percent scored lower marks from 0 to 14.5, 51.6 percent performed averagely as they scored from 15 to 32 marks and the remaining 7.5 percent who performed well scored from 33 to 38 marks. There was no student who scored above 38 marks. Figure 11 summarizes performance of the students.

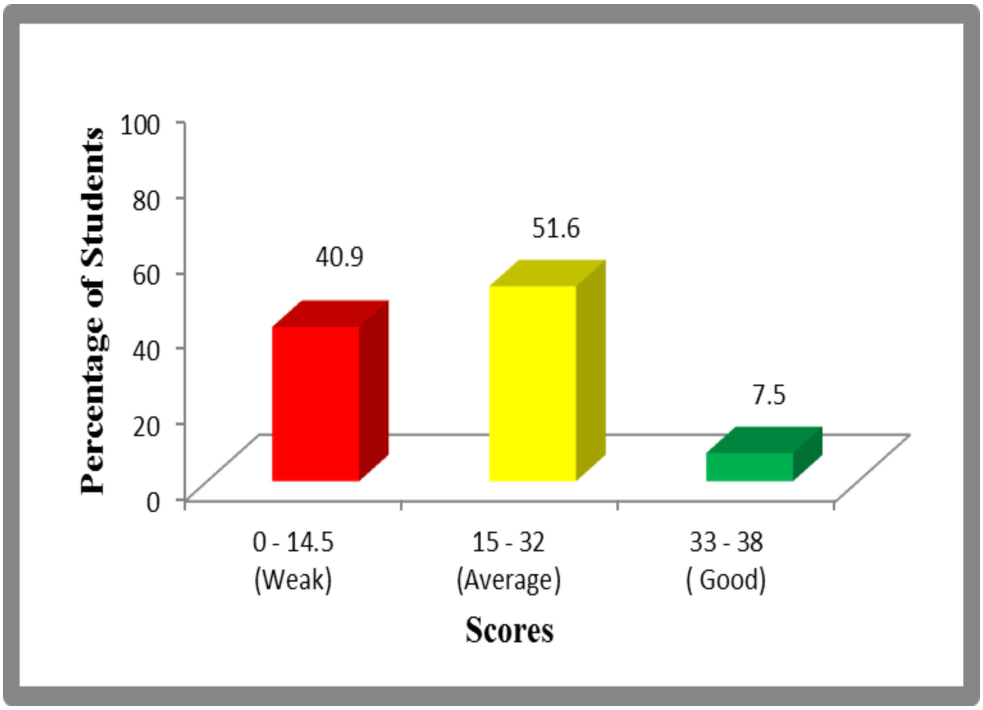


Figure 10: *The Performance of the Students in Question 11*

In this question, a number of students performed well in parts (b), (c) and (e), whereas parts (a) and (d) were averagely performed. In part (b), the question was divided into four items in which item (b) (i) required the students to state the major function of side cutter, screw driver and electronic knife.

In item (b) (ii), the students were required to give the use of an Ohmmeter in electronics. Students were also required to study the circuit given in Figure 1 and answer the questions that followed in item (b) (iii). Moreover, in item (b) (iv), students were asked to find the power delivered to a load resistor of 20 Ω if the electronic circuit has a total voltage of 20 V and internal resistance being 50 Ω.

Majority of students performed well in this part as they were able to provide correct responses in each item. The analysis indicates that students had sufficient knowledge and skills in the area of tools and equipment. Extract 11.1 presents a sample of good response picked from one of the students’ script.

(b) (i) State one major function of each of the following electronics tools:

Side cutter
It cuts sides of wire.

Screw driver
~~is a driving~~
It drives screw of circuit

Electronic knife
is to cut wires.

(ii) What is the use of an Ohmmeter in electronics?
is to measure the presence of resistance ~~and electric current~~ of a conductor

(iii) Study careful the electronic measurement circuit given in Figure 1 and answer the question that follows.

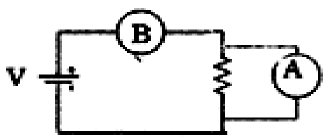


Figure 1

What instrument should be connected at point A and B for measuring the required quantities?
- In A there so should be Voltmeter to measure voltage.
- In B should be Ammeter to measure electric current

(iv) If the electronic circuit has a total voltage of 20 V and internal resistance of 50 Ω. Find the power delivered to a load resistor of 150 Ω.

soln

Power = IV = $\frac{V^2}{R}$,	Power = $\frac{(20)^2}{200}$
but V = 20,	
and r = 50 so R_T = 200 Ω	$\frac{400}{200}$ = 2.
R = 150	Power is 2watt

Extract 11.1: A sample of good response from one of the students who was capable of providing correct responses in all items of part (b).

Nevertheless, there were few students who performed poorly in this part as they failed to supply correct responses in each item. There was a student who stated wrong application of side cutter by writing "It *is used for cutting the side electronic devices to be in a certain regular shape"*. These students seemed to lack practical knowledge and skills in the uses of various electronics tools and equipment. Extract 11.2 presents a sample of poor response from one of the students.

(b) (i) State one major function of each of the following electronics tools:

Side cutter

is the side cutter of between current are side cutter of are capacitor.

Screw driver

is the electronics of are screw of the means of are which of that measuring Current of Capacitor are Screw driver.

Electronic knife

Electronic is subject which of Knife deal of are electrical engineering science.

(ii) What is the use of an Ohmmeter in electronics?

Ohmmeter is the Ohm of the electronics of Capacitor is the which deal Capacitance.

(iii) Study careful the electronic measurement circuit given in Figure 1 and answer the question that follows.

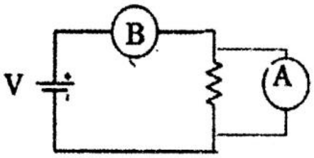


Figure 1

What instrument should be connected at point A and B for measuring the required quantities?

R1 + R2 = is the should be connected at point A and B is connection measuring require quantities electrical wire.

(iv) If the electronic circuit has a total voltage of 20 V and internal resistance of 50 Ω. Find the power delivered to a load resistor of 150 Ω.

Data given	Current = Resistance + Resistor
Voltage = 20v	150/200 Voltage
Resistance = 50Ω	Resistance = 200
Resistor = 150Ω	Voltage = 20 = it is the Current of 10

Extract 11.2: A sample of poor response from one of the students who failed to provide correct responses in all items of part (b).

In part (c) the question was required the students to:

(i) Name two commonly used semiconductor materials

(ii) Identify two devices which are made up from semiconductor materials.

(iii) Give the meaning of the term "doping" in semiconductors.

(iv) Outline two types of semiconductors obtained in "doping".

(v) List two main uses of a zener diode.

Most of the students attempted the question appropriately. They were able to provide correct responses in all items of the part. Generally, students demonstrated sufficient knowledge in the area of semiconductors materials except few students who failed to list two main uses of a zener diode as required in item (c) (v). Extract 11.3 shows a sample of good response.

(c) (i) Name two commonly used pure semiconductor materials.

- Silicon
- Germanium

(ii) Identify two devices which are made up from semiconductor materials.

- Diode
- Transistor

(iii) What is the meaning of "doping" in semiconductor?

Doping : Is the process of adding impurities to a semiconductor to modify its conductivity.

(iv) Outline two types of semiconductors obtained in "doping".

- P- type semiconductor
- n- type semiconductor

(v) List two main uses of a zener diode.

- Used to stablize voltage to get reference voltage
- Used in stablizers circuits.

Extract 11.3 A sample of good response from one of the students who indicated high capability in presenting correct response in all items of part (c).

Performance analysis indicates further that few students performed poorly in part (c) because they presented wrong responses in each item. For example, the response that was provided by one of the students in item (c) (iv) was "At *absolute zero* and *Above absolute zero"* which was wrong. This suggests that students had no sufficient knowledge in the topic of semiconductors. Extract 11.4 is presented as a sample to illustrate how poorly some students performed in this part.

(c) (i) Name two commonly used pure semiconductor materials.

- Primary Semiconductor.
- Secondary Semiconductor.

(ii) Identify two devices which are made up from semiconductor materials.

- ...
- ...

(iii) What is the meaning of "doping" in semiconductor?

doping is the which electrical of Semi conductor. of are meaning of Semiconductor.

(iv) Outline two types of semiconductors obtained in "doping".

- ~~Secondary Semi Condutor~~ Extrinsic semiconductor.
- ~~Primary Semi Conductor.~~ Doping Semiconductor

(v) List two main uses of a zener diode.

- Zener diode.
- Zener (

Extract 11.4: A sample of poor response from a student who performed poorly in all items of part (c).

Part (e) was also performed well by many students. This part comprised three items. Item (i) required the students to give two types of bipolar junction transistor, in (ii), students were to find the value of I_C if I_E = 5.34 mA and I_B = 475 μA. In item (iii), students were required to mention two types of extrinsic semiconductor, whereas in item (iv) required the students to give reason as to why an ordinary junction transistor is called bipolar transistor.

Performance analysis indicates that students performed well in this part as they were able to provide correct responses in all items. This suggests that students had enough knowledge and skills on bipolar junction transistors and semiconductors. Extract 11.5 presents a sample of good responses from one of the students.

(e) (i) What are the two types of bipolar junction transistor?

- p:n:p
- n:p:n

(ii) What will be the value of I_C if $I_E = 5.34$ mA and $I_B = 475$ µA.

From,

$I_E = I_C + I_B$

$I_C = I_E - I_B$

$I_C = (5.34 \times 10^{-3})A - (475 \times 10^{-6})A$

$I_C = 0.00534 A - 0.000475 A$

$I_C = 0.004865 A$

$I_C = 4.865 mA$

$\therefore I_C = 4.865 mA$

(iii) Mention two types of extrinsic semiconductor.

- N-type
- P-type

(iii) Why an ordinary junction transistor is called bipolar transistor?

It is called bipolar transistor because it is made up of two p-n junction material and has got polarity.

Extract 11.5: A sample of good responses from one of the students who was capable of delivering correct responses in all four items of part (e).

However, there were few students who performed poorly in this part as they failed to provide correct responses in all items. There was a student who responded to item (iii) wrongly by writing "*insulator* and *conductor*" as two types of extrinsic semiconductor instead of *N-type* and *P-type*. Students with this performance demonstrated insufficient knowledge and skills on the area of bipolar junction transistor and semiconductors. Extract 11.6 illustrates this performance.

(e) (i) What are the two types of bipolar junction transistor?

- Revers bias
- doping

(ii) What will be the value of I_C if $I_E = 5.34$ mA and $I_B = 475$ μA.

~~8.34000 x 47~~

I_C = ~~IB Ie~~ 5.34

Ic = 8.34

(iii) Mention two types of extrinsic semiconductor.

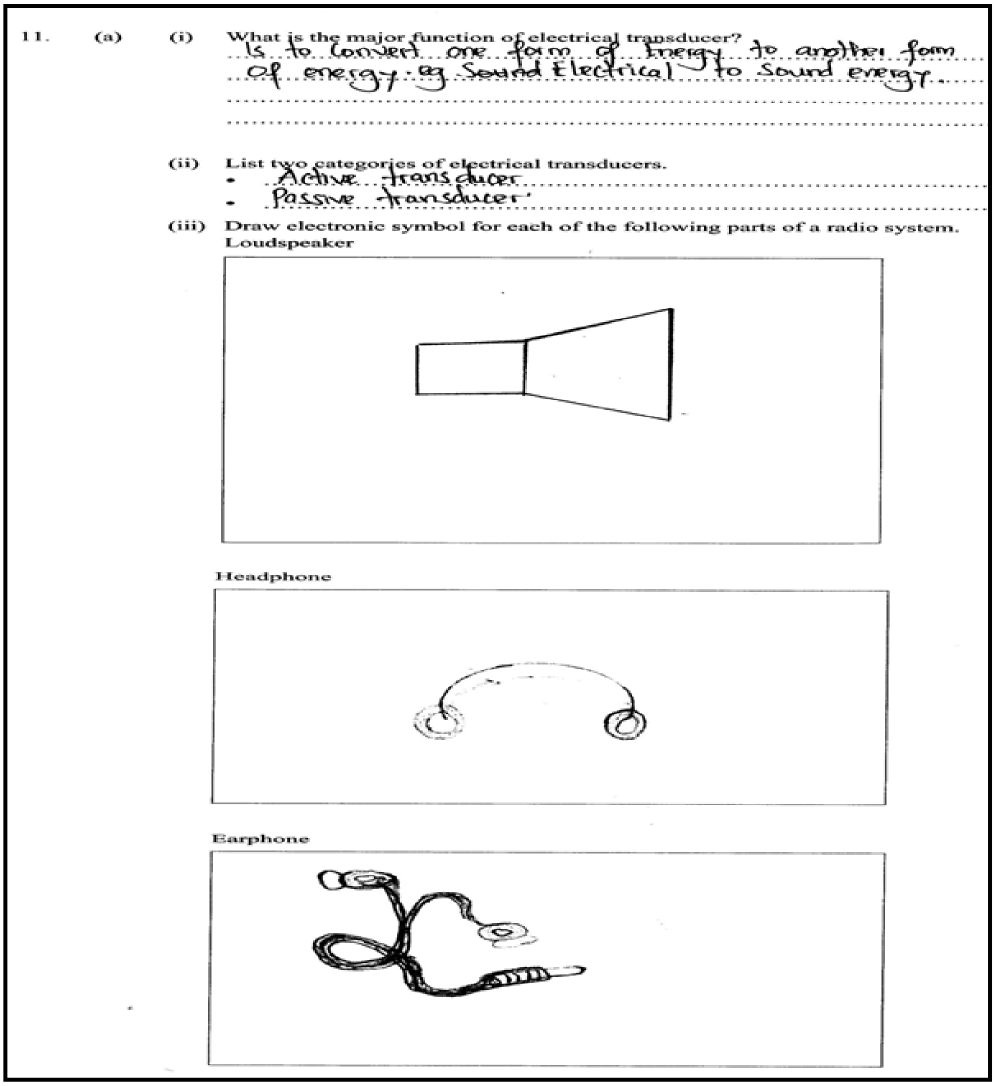
- ~~[illegible] Semi Conductor~~ P – type Semiconductor
- N – type semiconductor

(iii) Why an ordinary junction transistor is called bipolar transistor?

Extract 11.6 is a sample of poor responses provided by one of the students who failed to give two types of bipolar junction transistor, calculate the value of I_C, mention two types of extrinsic semiconductor and give reason as to why an ordinary junction transistor is called bipolar transistor.

In part (a), the question was set from the topic of Transducers. Item (a) (i) required the students to give the major function of electrical transducer. In item (a) (ii), students were asked to list two categories of electrical transducers, and in part (a) (iii), students were to draw symbols for loudspeaker, headphone and earphone. The marks allotted to this item were 10.

The analysis indicates that students' performance in this part was average. Most of them were able to provide correct responses in parts (a) (i) and (a) (ii) ,but failed in part (a) (iii) because majority of them could not draw the symbols. There was a student who drew a picture of microphone, instead of an earphone as required in (iii). The highest score in this part was 5 out of 10 marks allotted. Extract 11.7 presents a sample of partial responses provided by one of the student whose performance was average.


11. (a) (i) What is the major function of electrical transducer?

Is to Convert one form of Energy to another form of energy eg Sound Electrical to Sound energy.

(ii) List two categories of electrical transducers.

- Active transducer
- Passive transducer

(iii) Draw electronic symbol for each of the following parts of a radio system.

Loudspeaker

Headphone

Earphone

Extract 11.7: A sample of response from a student who managed to provide correct responses in part (a) (i), (a) (ii) and one component in (a) (iii) but failed in the two components in (a) (iii).

Analysis revealed further that part (d) was averagely performed by most of the students. The question was set from the topic of A.C Circuits and the students were required to calculate the electrical power dissipated in a 100 Ω resistor in part (d) (i). In part (d) (ii), students were supposed to determine the period, frequency and the r.ms voltage of an alternating voltage waveform having a peak value of 10 V and 50 Hz frequency, as shown in the given Figure.

In this part, many students were able to provide correct responses only in item (i), but failed in item (ii) which involved calculations. Some of those who failed in item (ii) used wrong formulae in calculating the period, frequency and the r.m.s voltage by just summing up the value that has been given in the question. This performance implies that students had insufficient knowledge on the topic of A.C Circuits, particularly in areas that involve calculations. Extract 11.8 illustrates the performance of the students.

(d) (i) What is the electrical power dissipated in a 100 Ω resistor carrying a current of 50 mA?

Data given: V = IR
R = 100 Ω = 100 × 50×10⁻³ Ω
I = 50mA = 50×10⁻³A V = 5volts
Required: Power = IV
Electrical = 50 × 10⁻³ × 5
power = 250 × 10⁻³
= 0.25
From Power = IV ∴ Electrical power = 0.25 watts
Find V from
Ohm's law ∴ Electrical power = 0.25 watts

(ii) An alternating voltage waveform has a peak value of 10 V and 50 Hz frequency as shown in Figure 2. Determine the period of the waveform, the frequency of the waveform and the r.m.s voltage.

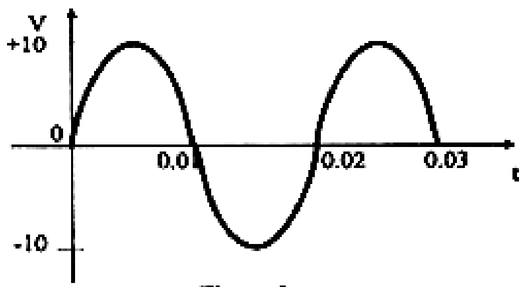


Figure 2

From Frequency
Period = V/f F = V × t ∗ Period of the waveform
F = 10V × = 0.01s
t = 10V/50Hz F = 10V × 0.01 ∗ Frequency of the wave
t = 0.2s F = V/t form = 1000Hz
Period = 0.2s Values Period × Frequency
V = F × t F = 10V/0.01s = 0.01s × 1000Hz
V = 0.01s × 1000Hz F = 1000Hz ∴ Voltage = 10Volt

Extract 11.8: A sample of an average response from a student who managed to calculate electrical power in item (i), but failed to determine the period, frequency and the r.ms voltage of the given waveform.

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 2018 indicated that most of the students performed averagely in many topics covered in the paper. However, in few topics, the students' performance was either good or poor.

The analysis of the students' performance in each question showed that questions 2,3,7,8 and 9 which were set from *Supply System & Battery and Cells*, *Magnetism & Electromagnetism*, *DC Circuits* and *AC Voltages* were poorly performed, whereas questions 4, 5, and 6, which were set from the topics of *Electric Heating*, *Batteries and Cells* and *Conductors*, *Insulators and Cables,* respectively were averagely performed. Question 10 was set from the topics of *Safety, Earthing, Conduits, Trunking & Ducts, Conductors, Insulators & Cables, Consumer Circuits and Inspection & Testing, while* question 11 was based on *Transducers, Tools & Equipment, Electronic Components, Semiconductors, A.C Voltages* and *Bipolar Transistors topics.* Generally, the analysis established that question one (1) which was composed from different 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, particularly those covered in Section A. This section contained questions from the area of Electrical Engineering Science. Students demonstrated poor capability in performing some calculations. However, section B which comprised of Parts I (Electrical Installation), and II (Electronics, Radio and TV Servicing) were performed well by most of the students because were the areas of their specialization.

Table 2 presents a summary of the students' performance in each topic. Green, yellow and red colours represent good, average and weak performance, respectively.

Table 2: A Summary of Students' Performance per Topic in Electrical Engineering Paper

S/N	Topic	Question number	Percentage of students who scored 30 percent or more	Remarks
1	Multiple-Choice Items	1	93	Good
2	Electric Heating	4	59.6	Average
3	Tools & Equipment, Transducers, Electronic Components, Semiconductors, A.C Voltages and Bipolar Transistors	11	59.1	Average
4	Safety, Earthing, Conduits, Trunking, Conductors & Cables, consumer Circuits and inspection & Testing	10	44.3	Average
5	Conductors and Cables	6	42.5	Average
6	Batteries and Cells	5	41.2	Average
7	D.C Circuits	7	13.3	Weak
8	Supply Systems and Batteries & Cells	2	12.5	Weak
9	A.C Voltages	8	11.1	Weak
10	Magnetism & Electromagnetism	3	4.6	Weak
11	Magnetism & Electromagnetism	9	1.6	Weak

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the students in Electrical Engineering paper for Form Two National Assessment (FTNA) in the year 2018 was Average. Out of 369 students who sat for the paper, 174 students (47.15%) passed, while 195 (52.85%) failed.

The analysis indicated further that the general performance and quality of students' responses to the questions examined was satisfactory. However, there were some few weakness noted. The major weaknesses noted include; students' insufficient knowledge and skills on some topics from which the questions were set. Many students were weak on the areas of electrical symbols & accessories, earthing, transistor amplifier as well as A.C voltages. Another weakness observed was inability of some students to tackle questions that involved mathematical computations, and failure to understand the requirement of the questions.

It is expected that the weaknesses noted and feedback provided in this report will be used as a guide to teachers and other education stakeholders during teaching and learning processes in order to improve performance in Electrical Engineering subject, 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 exercises and tests to students especially for those topics and areas that involve mathematical computation. This will strengthen students' learning ability in this area.

(ii) Teachers should guide the students in their preparation to make sure that all topics are thoroughly revised before assessment.

(iii) Students should be encouraged to do appropriate preparations for the National assessment well for the National assessment.

(iv) Students should also be oriented on commonly used instructional words used in composing questions in order to enable them follow instructions and answer questions appropriately.