THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEMS RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESMENT (FTNA) 2024

ELECTRONICS AND COMMUNICATION ENGINEERING

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081 ELECTRONICS AND COMMUNICATION ENGINEERING

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LIST OF SYMBOLS AND ABBREVIATIONS

AC	Alternating Current
A	Ampere
C	Capacitance
CRO	Cathode Ray Oscilloscope
I	Current
DC	Direct Current
FTNA	Form Two National Assessment
Hz	Hertz
k	Kilo
μ	Micro
mm	Millimetre
NECTA	National Examinations Council of Tanzania
Ω	Ohm
mV	millivolt
R	Resistance
SIRA	Students’ Items Response Analysis
t	Time
V	Volt
W	Watt

FOREWORD

This report presents the Students' Items Response Analysis (SIRA) on Form Two National Assessment in Electronics and Communication Engineering, conducted in 2024. The report aims to provide feedback to all educational stakeholders on the factors that contributed to the student's performance in this subject.

The Form Two National Assessment (FTNA) is a summative evaluation that intends to measure the knowledge, skills, and competencies acquired by the students in two years of the instructional period of the ordinary level of secondary education. The report, therefore, provides feedback that teachers, students, and other educational stakeholders can use to improve the teaching and learning process. The students who attained high scores demonstrated their ability to understand the requirements of the questions, their knowledge, skills and competence in the subject matter, and mastery of calculation skills. However, students who scored low marks faced difficulty in responding to the questions due to their insufficient knowledge of the tested concepts, lack of mathematical skills, and in efficient drawing skills.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will shed light on the challenges for which teachers and other education stakeholders should take proper measures to improve the teaching and learning process in Electronics and Communication Engineering. Consequently, prospective students will acquire knowledge, skills and competence indicated in the syllabus for better performance in future.

The Council appreciates the contribution of all those who prepared this report.

Dr. Said Ally Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents the performance analysis of students who sat for the Form Two National Assessment (FTNA) 2024 in Electronics and Communication Engineering. The paper consisted of ten (10) questions, which were categorized into three sections, namely A, B, and C.

Section A consisted of objective type of questions 1 and 2. Question 1 had ten multiple-choice items, (i) to (x), and question 2 consisted of five matching items, (i) to (v). These items were set from the topics of *Semiconductor Devices, Introduction to Electricity, Drawing Techniques, Introduction to Electronics and Communication, Semiconductors, Electronic Drawing, Introduction to Measurement and Instrumentation, Safety Management and Rules, Semiconductor Devices,* as well as *Introduction to Electricity*. The students were required to answer all items in this section. Each item carried 01 mark, making a total of 15 marks.

Section B consisted of seven (07) short answer questions, set from the topics of *Semiconductor Devices, Introduction to Measurement and Instrumentation, Electronics Device, Semiconductors and Drawing Techniques.* The students were required to answer all the questions in this section. Each question carried 10 marks, making a total of 70 marks.

Section C consisted of one (01) structured essay question from the topic of *Introduction to Measurement and Instrumentation* carrying fifteen 15 marks.

This analysis reveals that 271 (100%) students sat for the Electronics and Communication Engineering paper in 2024. Among them, 158 (58.30%) students passed, while 113 (41.70%) failed. In 2023, 307 students sat for the assessment, of which 239 (77.85%) students passed, while 68 (22.15%) failed. Thus, the performance has decreased by 16.60% in 2024. The students' performance in the years 2023 and 2024 is summarized in Table 1.

Table 1: Students' Performance for the Years 2023 and 2024

Year	**2024**	**2023**
Total number of Students	271	307
Passed (%)	58.30	77.85
Failed (%)	41.70	22.15

In this analysis, the students who scored 30 percent or above of the marks allocated to the respective questions are considered to pass the assessment. The performance is rated as good, average or weak if the percentage ranges from 65-100, 30-64 and 0-29, respectively, as shown in Table 2.

Table 2: Grade Ranges of the Student's Performance

Range in %	**0 - 29**	**30 - 64**	**65 - 100**
Remark on performance	Weak	Average	Good

2.0 ANALYSIS OF THE STUDENTS' RESPONSES TO EACH QUESTION

This part analyses the students' performance in sections A, B and C. It presents the students' strengths and weaknesses as they responded to each question. The analysis for each question is as follows:

2.1 SECTION A: OBJECTIVE QUESTIONS

This section is composed of questions one (1) and two (2), with a total of 15 marks. Question 1 consisted of 10 multiple-choice items carrying 10 marks, and question 2 consisted of 5 matching items, which carried a total of 05 marks.

2.1.1 Question 1: Multiple Choice Items

The question consisted of 10 multiple-choice items (i-x) derived from the following topics: *Semiconductor Devices, Introduction to Electricity, Drawing Techniques, Introduction to Electronics and Communication, Semiconductors, Electronics Drawing, Electronic Components, Introduction to Measurements and Instrumentation* and *Safety Management and Rules.* The students were required to select the correct answer from the given four alternatives by writing the letter of the most correct answer in the box provided.

A total of 271 (100%) students attempted this question. Among them, 20 (7.38%) scored from 0 to 2 marks, 217 (80.07%) scored from 3 to 6 marks, and 34 (12.55%) scored from 7 to 10 marks. Figure 1 illustrates the students' performance on this question.

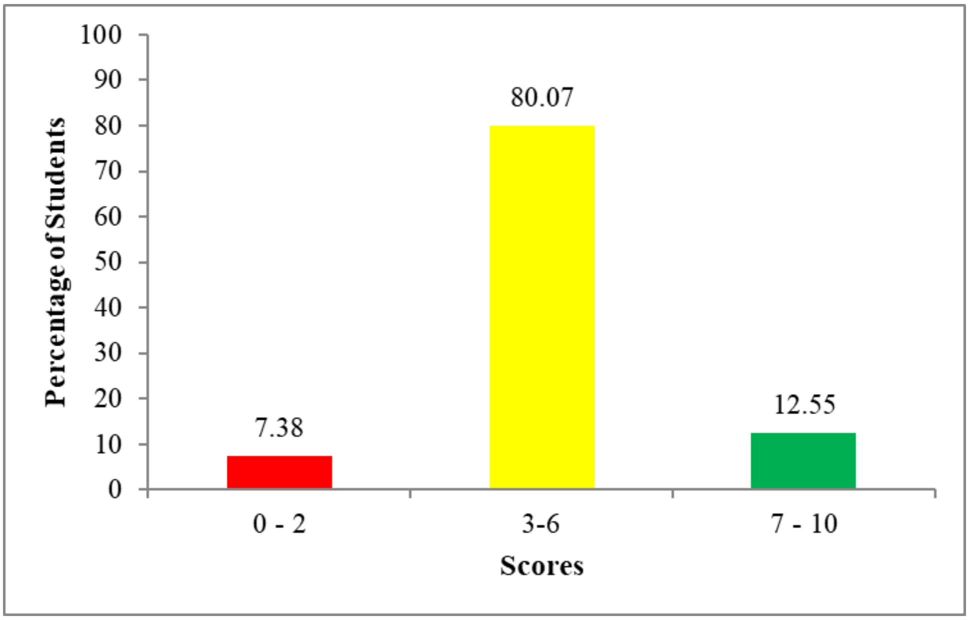


Figure 1: *The Students' Performance in Question 1*

The analysis of the students' responses to this question shows that most of them chose the correct answer in all items set from the tested topics. However, the overall performance was good because 217 (80.07%) scored from 3 to 6 marks. The following is an analysis of students' responses to each item of question.

Item (i) was constructed from the topic of *semiconductor devices*. The item tested the student's ability to select the correct behaviour of the NPN BJT transistor as its base current was increased. The question was as follows:

The emitter base of an NPN BJT transistor is normally forward biased and its collector base is reverse biased. How does collector current behave when the base current is increased?

A	*It decreases*	*B*	*It increases*
C	*It doubles*	*D*	*It remains constant*

A large number of students opted for alternative A, *It decreases* which was the correct response. These students had sufficient knowledge of the behaviour of the BJT transistor, in which the relationship between BJT currents is given by $I_E = I_C + I_B$ where I_E is emitter current, I_C is collector current and I_B is a base current. Those who opted for alternative B, *It* *increases* failed to understand how the change in the base current affects the collector current. They confused the relationship of I_C and I_B by using the current gain of common emitter configuration, i.e., $I_C = \beta I_B$. Those who opted for alternative C, *It doubles,* had insufficient knowledge about the characteristics of BJT-transistors, while those who opted for alternative D, *It remains constant,* failed to differentiate the behaviour of BJT current between collector and base current.

Item (ii) was set from the topic of *Introduction to Electricity*. It aimed to assess the student's knowledge on the relationship between current, voltage, and resistance in basic electrical circuits. The question was as follows:

Identify the parameter, which its value remains the same in a series circuit

A	*Voltage*	*B*	*Power*
C	*Resistance*	*D*	*Current*

Few students opted for alternative A, *Voltage,* which is wrong answer. These students had insufficient knowledge of electric circuits because they could not know the difference between the properties of series and parallel circuits, which is important to know because the change in voltage depends on the change in resistance. Students had inadequate knowledge of Kirchhoff's' voltage and current laws. Those who opted for alternative *D, current,* which was the correct answer, understood that current does not always change in a series circuit. Those who opted for alternative *C, Resistance,* had insufficient knowledge about the properties of a series circuit.

Item (iii) was constructed from the topic of *Drawing Techniques*. The question measured the student's ability to use the appropriate drawing tools and instruments. The question was as follows:

Which instrument represent a thin flat piece of plastic containing various cut-out shapes like circles, bolts, and ellipse?

A	*Protector*	*B*	*Template*
C	*Perforator*	*D*	*Divider*

Most of the students opted for alternative *B, Template,* which was the correct response, as these students had sufficient knowledge of the applications of drawing tools. Those who opted for alternative *A,* *Protector,* failed to understand that the protector is used to measure angle. Those who opted for alternative *C, Perforator,* had insufficient knowledge about the application of the tool, which is to make holes in paper or cards. Those who opted for alternative *D, Divider,* failed to realize that the application of the divider in drawing technique is to transfer dimensions and to divide angles.

Item (iv) was constructed from the topic of *Introduction to Electronics and Communication*. The question intended to measure the student's knowledge of the application of electronic devices in communication. The question was as follows:

Some of the electronics devices perform both communication and metrological functions. Identify the device which saves both purposes.

A Television	*B Computer*
C Satellite	*D Oscilloscope*

Most of the students opted for alternative B, *Computer,* which is incorrect response. These students did not know that in meteorology, computer is used in the manipulation and processing of data, not in the communication process. Those who opted for alternative *A, Television*, confused the application of satellite with that of Television. Those who opted for alternative *C, Satellite,* had sufficient knowledge of the function of satellite that it can forward relay or regenerate communication signals and monitor the weather and climate of the earth. Those who opted for alternative D, *Oscilloscope* did not know that this device is for measuring communication and electrical signals not for communication purposes.

Item (v) was constructed from the topic of *Semiconductors.* The question intended to measure the student's knowledge on the behaviour of semiconductors when subjected to the temperature. The question was as follows:

How does the conductivity of the intrinsic semiconductor behave when temperature rises?

A Remains constant	*B Increases*
C Decreases	*D Becomes zero*

Most students opted for alternative *B, Increases,* which was the correct response. These students had sufficient knowledge of the characteristics of semiconductor materials. Those who opted for alternative *A, Remains constant,* had insufficient knowledge of intrinsic semiconductors. Those who opted for alternative *C, Decreases,* confused the characteristics of metals and intrinsic semiconductors when subjected to high temperature. Those who opted for alternative *D, Become zero,* had insufficient knowledge of semiconductors.

Item (vi) was constructed from the topic of *Electronics Drawing*. The question measured the student's understanding of the flow of signals from the source to the destination. The question was as follows:

You are given a task to draw a block diagram of a communication system showing the flow of signals. In which sequence will a signal flow?

A	*From right to left*	*B*	*From left to right*
C	*From top to bottom*	*D*	*From bottom to top*

Those who wrongly opted for alternative A, *From right to left*, forgot that signals are always coming from left to right. Those who opted for alternative C, *From top to bottom,* and alternative *D, From bottom to top,* had insufficient knowledge on drawing block diagrams. They confused the sequence of signal flow in a flow chart diagram with that of block diagrams. Few students opted for alternative *B, From left to right,* which was the correct response, had sufficient knowledge of the block diagrams.

Item (vii) was constructed from the topic of *Introduction to Measurements and Instrumentation*. The purpose of the question was to assess the student's ability to use a cathode ray oscilloscope to measure voltage. The question was as follows:

Before starting measuring voltage using cathode ray oscilloscope (CRO), beam spot should be located at the correct position on the screen. Which one refers to the correct position?

A	*Center of the screen*	*B*	*Top right of the screen*
C	*Top center of the screen*	*D*	*Top left of the screen*

Most of the students opted for the correct alternative *A, Center of the screen,* because they had sufficient knowledge of the operation of the cathode ray oscilloscope. Those who opted for alternative *B, Top right of* *the screen,* had insufficient knowledge of a cathode ray oscilloscope. Those who opted for alternative *C, Top center of the screen,* confused with alternative *A, Center of the screen,* and those who selected alternative *D, Top left of the screen,* had insufficient knowledge of the operation of the cathode ray oscilloscope.

Item (viii) was constructed from the topic *Safety Management and Rules*. The question measured the student's ability to apply safety rules to provide first aid to an electric shock victim. The question was as follows:

Identify the first action to be taken when someone is suffering from electric shock.

A Call for an ambulance
B Disconnect from the supply
C Run for helping the victim on their back
D Lay the victim on their back

Most of the students opted for alternative *B, Disconnect from the supply,* which was the correct response. These students had sufficient knowledge on appropriate steps of providing first aid to a victim of electric shock. They knew the effect of touching a victim of electric shock. Those who opted for alternative *A, Call for an ambulance;* alternative *C, Run for helping the victim on their back,* and alternative *D, Lay the victim on their back,* had insufficient knowledge of the steps to follow to save the victim from an electric shock.

Item (ix) was set from the topic of *Electronic components*, and it aimed to test the students' knowledge of transformer behaviour when subjected to a d.c source. The question was as follows:

What will happen when a transformer is supplied with dc source above 30 V

A Transformer will step down the voltage
B Transformer will operate with high efficiency
C Transformer will be damaged
D Transformer will operate with low efficiency

A few students opted for alternative C, *Transformer will be damaged*, which was the correct answer. These students had sufficient knowledge on the topic of the transformers. They knew that d.c supply produces a constant magnetic field leading to the core. Saturation causes excessive current flow through the primary winding and overheating; hence it damages the transformer. Most of the students opted for alternative *B, Transformer will operate with high efficiency.* These students did not know that the d.c supply has no frequency (approximately zero). Those who chose *alternative D, Transformer will operate with low efficiency,* and A, *Transformer will step down the voltage,* did not have an adequate knowledge bout transformers in relation to d.c current.

Item (x) was set from the topic of *Semiconductor Devices.* It measured the students' ability to design a rectifier circuit. The question was as follows:

A technician checked a radio receiver and discovered that the rectifier circuit was completely defective. Which combination of components will the technician use to make a new rectifier circuit?

A *Transformer, diodes and resistor*
B *Diodes, transformer and capacitor*
C *Inductor, capacitor and resistor*
D *Resistor, transformer and capacitor*

The correct answer was alternative B, *Diodes, transformer and capacitor.* Those who chose the correct option had sufficient knowledge of constructing the rectifier circuit. Those who opted for alternative A, *Transformer, diodes and resistor*, had some knowledge on rectifier circuits, but this alternative misses the filter circuit, which is the most important in filtering ripples caused by a.c signals. Most students opted for the wrong alternative C, *Inductor, capacitor and resistor* or D, *Resistor, transformer and capacitor*. These alternatives did not include diode, which is the main component in the rectifier circuit.

2.1.2 Question 2: Matching Items

The question comprised of five (5) items, numbered (i) – (v), constructed from the topic of *Introduction on Electricity*. Each item carried 1 mark, making a total of 5 marks. The question tested the ability of students to identify the units of the given electrical quantities. The question was as follows:

Match the electric quantities in List A with their corresponding measuring units in List B by writing the letter of the correct answer in the table provided.

List A	***List B***
(i) An electric current.	*A Ohm*
(ii) An electric energy.	*B Joule*
(iii) P.D between two points in an electric circuit.	*C Watt*
(iv) An electric charge.	*D Volt*
(v) Electric resistance in one volt per ampere.	*E Ampere*
	F Coulomb
	G Farad
	H Hertz

A total of 271 (100%) students attempted this question. Among them, 9 (3.32%) scored from 0 to 1 mark; 41 (15.13%) scored from 2 to 3 marks; and 221 (81.55%) scored from 4 to 5 marks. A total of 262 (96.68%) students scored average marks and above. Thus, the general performance of the students in this question was good since 262 (96.68%) students scored average marks and above. The overall students' performance in this question is summarized in Figure 2.

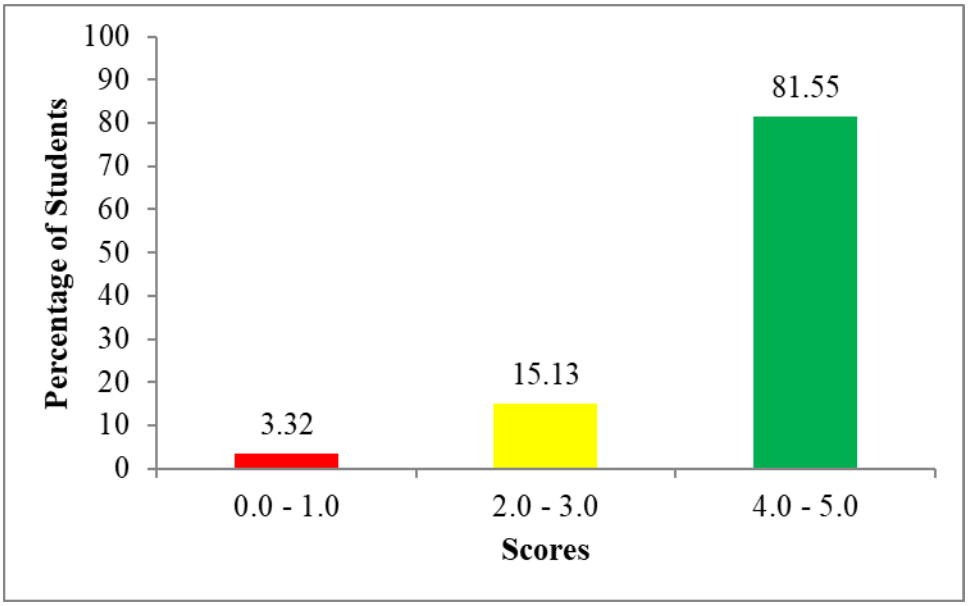


Figure 2: *The Students' Performance in Question 2*

The analysis of the student's responses to this question shows that a large number of the students, that is, 262 (96.68%), matched correctly the measuring units with their corresponding electric quantities. These students had sufficient knowledge of electric quantities and their units. However, 9 (3.32%) students failed to match correctly the items. The analysis of students' responses to each item of question 2 is as follows:

Item (i), *An Electric current.* The correct response was *E, Ampere*. The students who matched the item correctly demonstrated their ability to identify units of electric current. Some students matched it with *F, Coulomb,* confused electric charge and electric current. Those who matched with other alternatives had insufficient knowledge of electric units.

Item (ii), *An Electric energy.* The correct response was *B, Joule.* The students who correctly matched this item demonstrated knowledge and understanding of the unit of electric energy. Other students mismatched this item. For example, one student wrongly matched the item with response *C, Watt.* This student might have a partial understanding of electric energy and power.

Item (iii), potential difference (*p.d) between two points in an electric circuit.* The correct answer was *D, Volt.* Students who selected this option had a deep understanding of the unit of potential difference between two points in the electric circuit. Other students matched this item with *G, Farad.* These students might partially understand the unit of potential difference and capacitance.

Item (iv), *An electric charge.* The correct response was *F, Coulomb.* Most of the students matched this item correctly, had sufficient knowledge about the electric charge unit. Those who selected other alternatives had inadequate understanding of the electric charge unit.

Item (v), *Electric resistance in one volt per ampere.* The correct answer was *A*, *Ohm*. The students who matched this item correctly had a good understanding of electric resistance, including the relationship between voltage and current. On the other hand, students who incorrectly matched the item with the remaining options lacked knowledge of electric resistance. Extracts **2.1** and **2.2** show samples of student's correct and incorrect responses to question 2, respectively.

List A	(i)	(ii)	(iii)	(iv)	(v)
List B	E	B	D	F	A

Extract 2.1: A sample of the correct responses to Question 2

In Extract 2.1, the student correctly matched the five electric quantities with their units. The students showed competence in the topic.

List A	(i)	(ii)	(iii)	(iv)	(v)
List B	D	B	A C	A	E

Extract 2.2: A sample of the incorrect responses to Question 2

Extract 2.2 indicates that the student did not provide relevant responses to all the items except (ii). The student incorrectly matched the four of the items in List A to those in List B and, as a result, scored one 1 mark.

2.2 SECTION B: SHORT ANSWER QUESTIONS

Section B consisted of seven (7) compulsory questions (questions 3 to 9). Ten (10) marks were awarded for each question, to make a total of seventy (70) marks. Students' responses to each question in section B are given as follows:

2.2.1 Question 3: Semiconductor and Semiconductor Devices

Question 3 consisted of two parts, (a) and (b). The question measured the students' understanding of the behaviour of biased and unbiased PN junctions and illustrated different ways of connecting NPN transistors in amplifier circuits. The question was as follows:

(a) Transistor operation is based on charge levels made of P-type and N-type semiconductor materials. Draw unbiased P-N junction indicating the following:

(i) Depletion layer.

(ii) Majority charge carriers in each region.

(iii) The direction of junction voltage.

(b) Using diagrams, illustrate three different ways of configuring NPN transistor in amplifier circuit.

Based on the data analysis, out of the 271 (100%) students who attempted this question, 157 (57.93%), scored from 0 to 2.5 marks, while 59 (21.77%) of the students scored from 3 to 6 marks, and 55 (20.30%) of the students scored from 6.5 to 10 marks. The overall students' performance in this question is summarized in Figure 3.

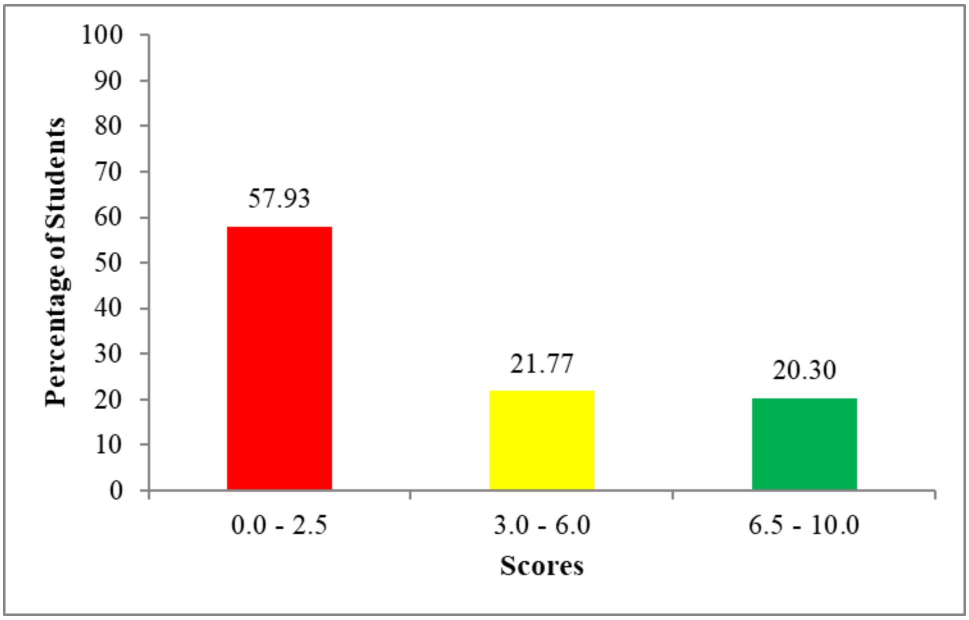


Figure 3: The *Students' Performance in Question 3*

The general performance of this question was poor since 157 (57.93%) failed and 114 (42.07%) students obtained an average score. This indicates that the majority of students had insufficient knowledge of semiconductor and semiconductor device topics.

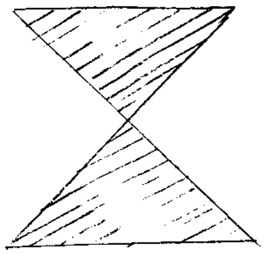
The analysis shows that in part (a), students failed to draw the PN junction and show the depletion layer, the majority charge carriers in each region, and the direction of junction voltage. For example, one student drew the emergency lighting point circuit's symbol instead of an unbiased PN junction. Also, the students failed to use diagrams to illustrate three different ways of configuring NPN transistors in amplifier circuits. Instead, they drew the symbols of NPN, PNP and Tunnel diode, which was incorrect. It seems that they misunderstood the question, and hence failed to distinguish between symbols and the amplifier circuit. Some students failed to draw the PN junction and to show the depletion layer of the unbiased PN junction; instead, they drew an unknown figure, which does not show the depletion layer, the majority of charge carriers in each region, and the direction of the junction voltage, which does not relate to the question demand. This shows that the students had insufficient knowledge of semiconductor devices. Extract 3.1 Illustrate the student who failed to answer question 3 correctly.

3. (a) Transistor operation is based on charge levels made of P-type and N-type semiconductor materials. Draw unbiased P-N junction indicating the following:

(i) Depletion layer.

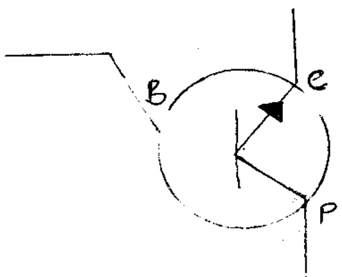
(ii) Majority charge carriers in each region.

(iii) The direction of junction voltage.

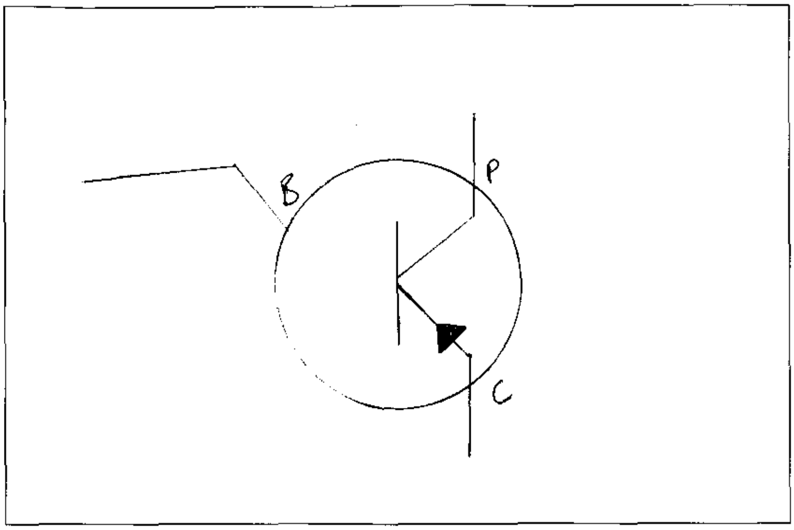


(b) Using diagrams, illustrate three different ways of configuring NPN transistor in amplifier circuits.

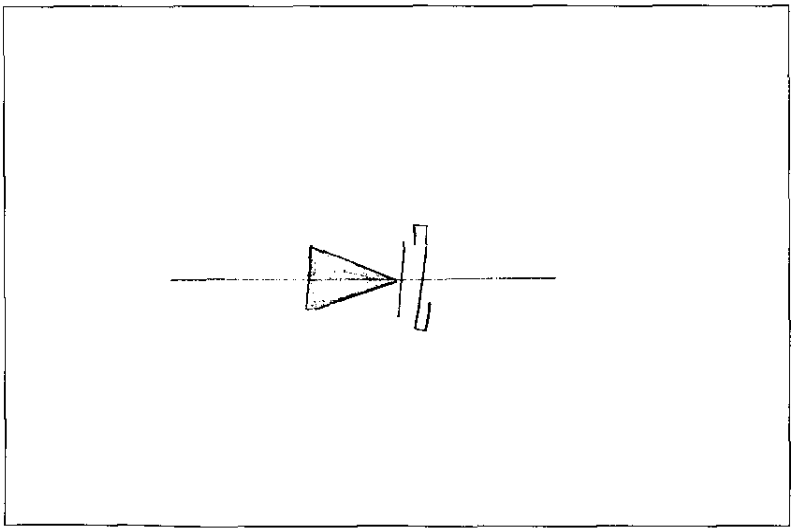
(i) Configuring NPN transistors through P-N junction connection.



(ii) Configuring NPN transistors through N-P junction connection.



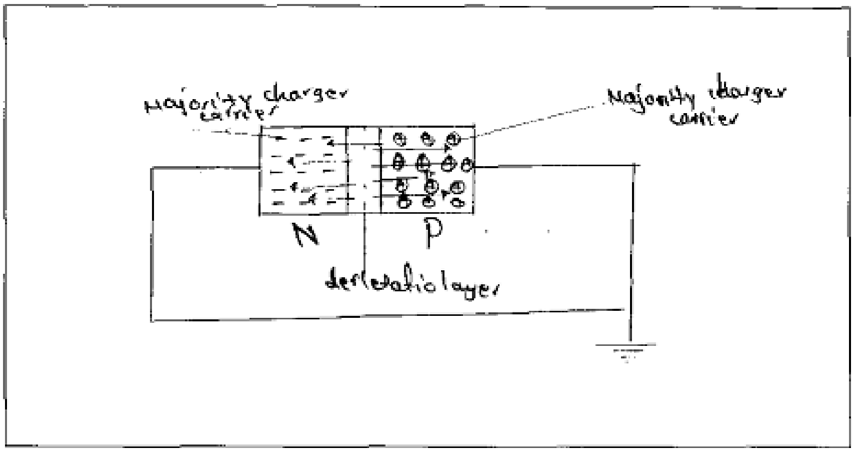
(iii) Configuiing NPN tiansistors through the use of Zener diodes



Extract 3.1: A sample of the incorrect responses to Question 3

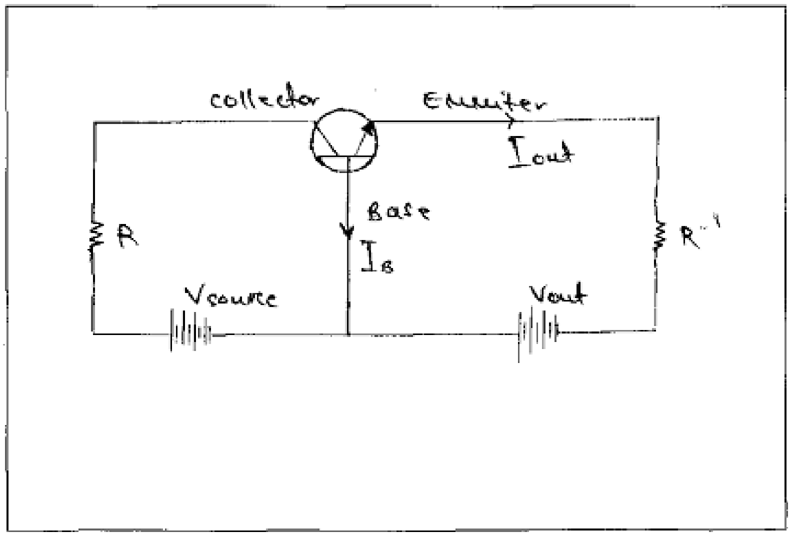
Extract 3.1 shows the responses of a student who failed to illustrate three different ways of configuring an NPN transistor in an amplifier; instead, he/she tried to draw symbols of NPN, PNP and Tunnel diode, contrary to the question demand.

However, 114 (42.07%) students scored average and above in this question. The students drew the P-N junction and showed the depletion layer, the majority of charge carriers in each region and the direction of junction voltage. Also, they were able to use diagrams to illustrate three different ways of configuring an NPN transistor in the amplifier circuit. Furthermore, the students drew the common base configuration, common emitter configuration, and common collect configuration of the NPN transistor amplifier circuit. This shows that the students had sufficient knowledge of the tested topic. Extract 3.2 shows a sample of responses provided by a student who gave the correct response.

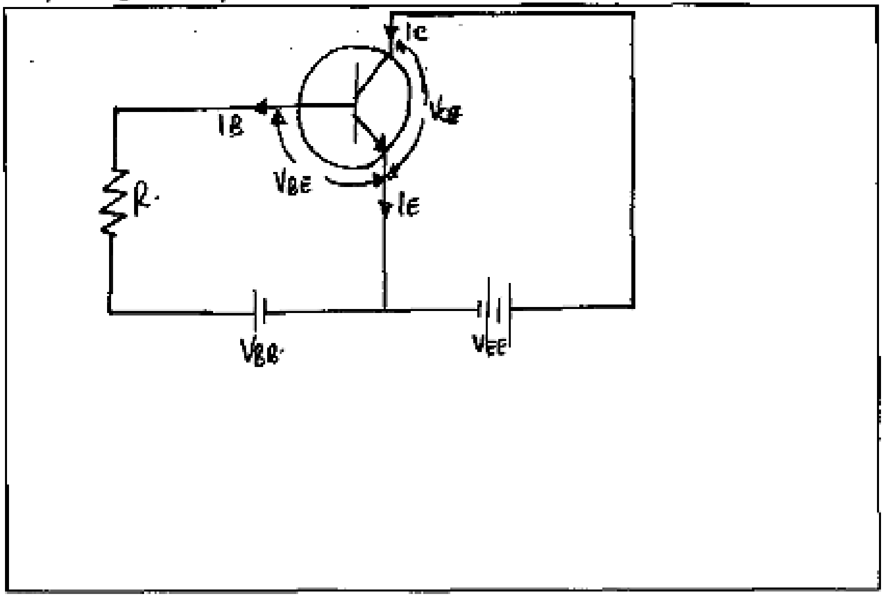


(b) Using diagrams, illustrate three different ways of configuring NPN transistor in amplifier circuits.

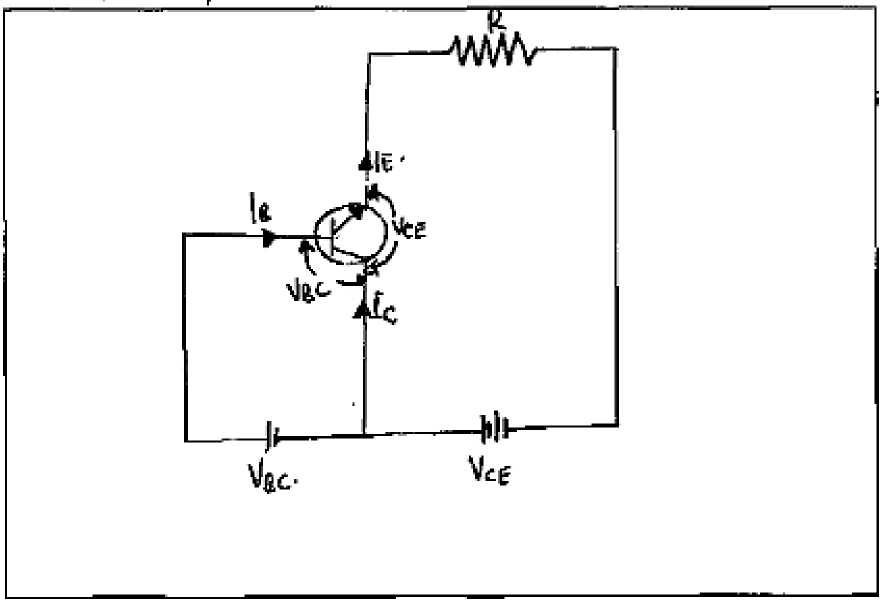
(i) common base configuration were the base terminal is being connected in both output and input



(ii) Common Emmitter (CE) Configuration is the type of configuration in which the Emitter current, I_E is grounding or become output and input signals of the circuits.



(iii) Common collector, (CC) configuration is the type of configuration in which the collector current is grounded or become output and input of the signals of the circuit



Extract 3.2: A sample of the correct responses to Question 3

Extract 3.2 shows an example of the responses from a student who scored the highest marks. Student correctly drew the PN junction and depicted the depletion layer's majority charge carriers in each region, but he/she indicated the direction of junction voltage. Furthermore, the student was able to use diagrams to illustrate three different ways of configuring an NPN transistor in the amplifier circuits. That is the common base, emitter, and collector configuration of the NPN transistor amplifier circuit. Despite the fact that the student changed the polarity of the supply voltage in CE configuration, but he/she had sufficient knowledge of the tested topic.

2.2.2 Question 4: Introduction to Measurement and Instrumentation

Question 4 tested the students' ability to identify the function of the measuring instruments while troubleshooting electronic systems and to calculate various parameters of the measurements. The question was:

(a) *Why are the following measuring instruments needed when troubleshooting a faulty radio receiver?*
- *(i)* *Multimeter*
- *(ii)* *Oscilloscope*

(b) *The CRO display of a pulse waveform indicates that the time/cm switch is on 50 ms/cm and the volts/cm switch is on 0.2 V/cm. Determine:*
- *(i)* *Periodic time*
- *(ii)* *Frequency*
- *(iii)* *Magnitude of the pulse voltage*

According to the data, 271 (100%) students attempted this question. Out of them, 158 (58.30%) scored from 0 to 2.5 marks, 103 (38.01%) scored between 3 and 6 marks, and 10 (3.69%) scored from 6.5 to 10 marks. Overall, the students' performance was average since 113 (41.70%) students scored average marks and above as shown in Figure 4.

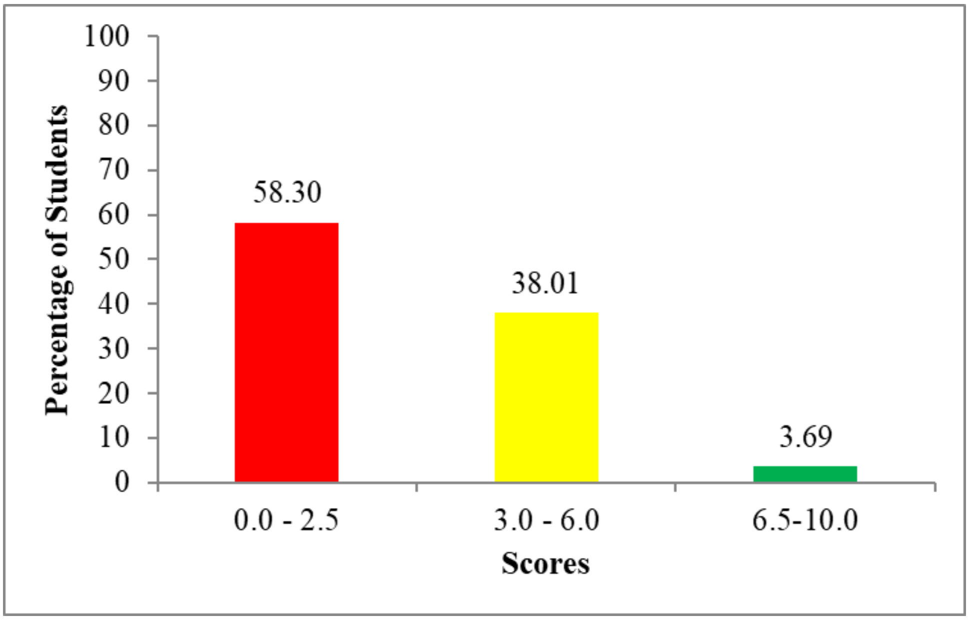


Figure 4: *The Students' Performance in Question 4*

The analysis shows that, the general performance of this question was poor, with 158 (58.30%) students failed. These students were unable to correctly answer why the multimeter and oscilloscope are needed when troubleshooting a faulty radio receiver. Some students responded that the multimeter measures the faults of the components in the electronics equipment effectively while in fact the multimeter is used to identify the faulty components by measuring current, resistance, voltage and continuity. For example, one student responded that '*an oscilloscope is the instrument measure fault in the radio, TV, and other electronic instruments',* instead of explaining that an oscilloscope is needed for measuring signal parameters (such as current, voltage and frequency). In addition, students failed to determine the pulse voltage's periodic time, frequency and magnitude. For example, one student's response to b (i) such that Period, $T = \frac{Waveform}{Time}$ instead of, $T = \frac{1}{frequency}$ and for (ii) $F = \frac{Time}{Waveform}$ instead of $F = \frac{1}{Time}$ This shows that the student had insufficient knowledge of the tested topic. Extract 4.1 shows a sample of incorrect responses from one of the students.

4. (a) Why are the following measuring instruments needed when troubleshooting a faulty radio receiver?

(i) Multimeter

Because multimeter are measure the fault of the componets of the electronics equipment effectively.

(ii) Oscilloscope

Oscilloscope - Is the instrument measure faulty in the radio, television and other electronic's instrument and many people use it to measure faulty.

(b) The CRO display of a pulse waveform indicates that, the *time/cm* switch is on 50 ms/cm and the *volts/cm* switch is on 0.2 V/cm. Determine:

(i) Periodic time

Periodic time = $\frac{\text{Wave Form}}{\text{Time}}$

$\frac{50 \times 10}{0.2 \times 10}$ $\frac{500}{2}$ 250

The periodic time is 250time/cm

(ii) Frequency

Frequency = $\frac{\text{Time}}{\text{Wave Fom}}$

$= \frac{250}{50}$ 5

∴ The Frequency is 5

(iii) Magnitude of the pulse voltage

Magnitude of the pulse voltage

Time × Frequency

250 × 5

= 1250

The ~~freq~~ Magnitude of the pulse Voltage is 1250.

Extract 4.1: A sample of incorrect responses to Question 4

In Extract 4.1**,** the student failed to explain why troubleshooting a radio receiver requires the use of a multimeter and oscilloscope. In addition, the student failed to determine the pulse voltage's periodic time, frequency, and magnitude by applying the wrong formula.

However, there are students who performed better on this question. They correctly explained the need for a multimeter and oscilloscope when troubleshooting a faulty radio receiver. For example, one student responded that a multimeter is required for measuring current, resistance, voltage, and continuity, and an oscilloscope is for measuring signal parameters such as current, voltage, and frequency. Also, the students used the appropriate formula to calculate periodic time, frequency, and the magnitude of the pulse voltage. This shows that the students had sufficient knowledge of the topic, as they scored high marks on this question. Extract 4.2 shows a sample of correct responses from one of the students.

4. (a) Why are the following measuring instruments needed when troubleshooting a faulty radio receiver?

(i) Multimeter

Used to measure different electrical parameters, eg. Current, Voltage, Resistance, Temperature etc.

(ii) Oscilloscope

Used to measure and display the ~~the~~ ~~Frequen~~ wave form ~~in Vol~~ which keeps in changing of voltage and time.

(b) The CRO display of a pulse waveform indicates that, the *time/cm* switch is on 50 ms/cm and the *volts/cm* switch is on 0.2 V/cm. Determine:

(i) Periodic time

Period = 50 ms / cm x 2cm.

= 50x10^-3 s ~~/cm~~ x 2cm

= ~~0.0050 x~~ 0.05 s/cm x 2cm

∴ Periodic time = 0.1 s.

(ii) Frequency

~~Fro~~ F= 1/T From

From

F= 1/T.

F= 1/0.1 = 10/1 = 10

∴ Frequency is 10 Hz

(iii) Magnitude of the pulse voltage

From.

Magnitude = V x V/cm.

= 4 ~~cm~~ x 0.2V/cm

= 0.8 ~~V~~

= 0.8V.

∴ Magnitude of pulse voltage is 0.8V.

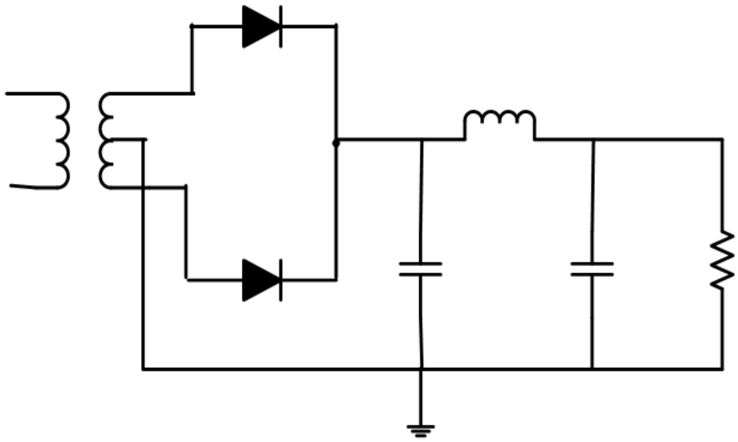
Extract 4.2: A sample of correct responses to Question 4

In Extract 4.2, the student correctly explained why a multimeter and oscilloscope are needed when troubleshooting a radio receiver's fault. The student also used the correct formula to calculate the pulse voltage's periodic time, frequency, and magnitude. This shows that the student had sufficient knowledge of the assessed topic.

2.2.3 Question 5: Semiconductor Devices

The Question consisted of two parts, (a) and (b). Part (a) required the students to draw a block diagram illustrating the sequence of a signal flow, while part (b) required them to construct a circuit diagram using the provided electronic components and draw the output waveform from the circuit. The purpose of this question was to assess the students' proficiency in drawing rectifier blocks and circuit diagrams. The question was:

(a) *The figure below is a schematic diagram of an electronic system that converts a.c to d.c signal. Represent the figure with a block diagram showing the sequence of the signal flow.*



(b) *An a.c source is applied to a circuit which consists of one PN junction diode, a transformer and a load resistor to produce a d.c signal output. Use the given components to construct a circuit diagram and show the produced output waveform.*

A total of 271 (100%) students attempted the question. Out of those who attempted it, 138 (50.92%) scored from 0 to 2.5 marks, 96 (35.42%) scored from 3 to 6 marks, and 37 (13.66%) scored from 6.5 to 10 marks. Thus, the general performance of the students in this question was average since 133 (49.08%) students scored average marks and above. The overall students' performance in this question is summarized in Figure 5.

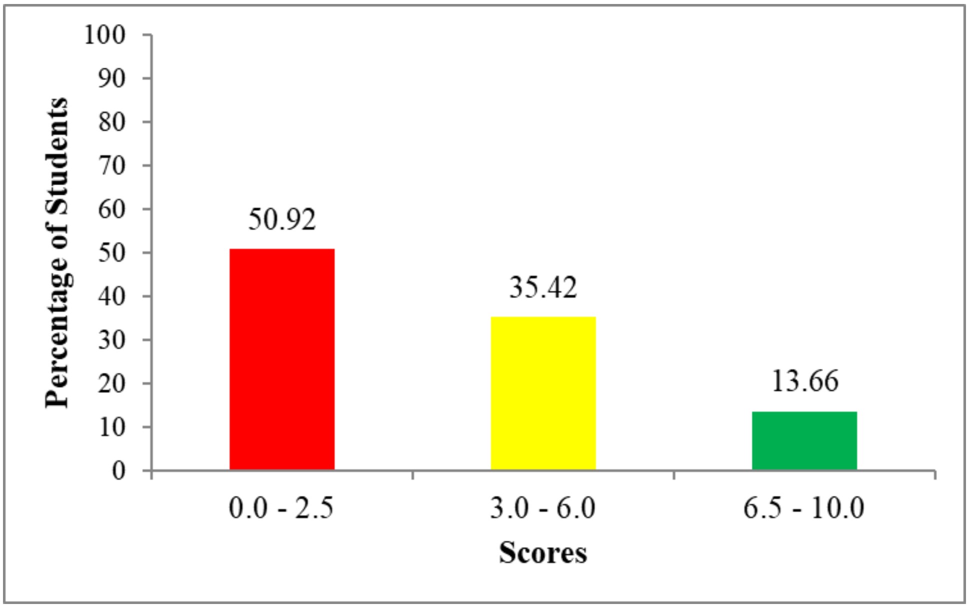


Figure 5: *The Students' Performance in Question 5*

The students correctly represented some parts of the figure of an electronic system that converts a.c to d.c signals into a block diagram by showing the sequence of the signal flow. For example, one student managed to represent only the transformer but failed to represent the other parts; thus, he/she drew the diode, capacitor, inductor, resistor, and transformer instead of the transformer, rectifier, filter, and load. Some students used one PN junction diode, a transformer, and a load resistor to construct a circuit diagram showing the produced output waveform. This indicates that the students had partial knowledge of a smoothed d.c power supply circuit as they partially responded correctly to the question. Extract 5.1 shows the correct responses to the question from one of the students.

5. (a) Figure 1 is a schematic diagram of an electronic system that converts A.C to D.C signal. Represent the figure with a block diagram showing the sequence of the signal flow.

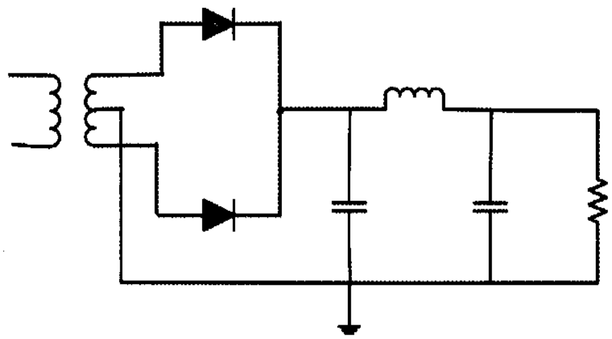
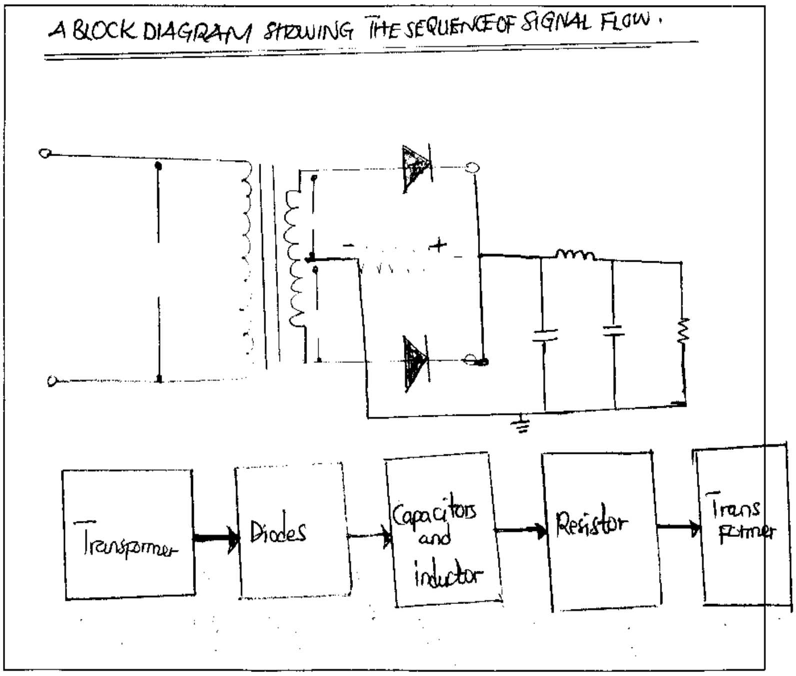
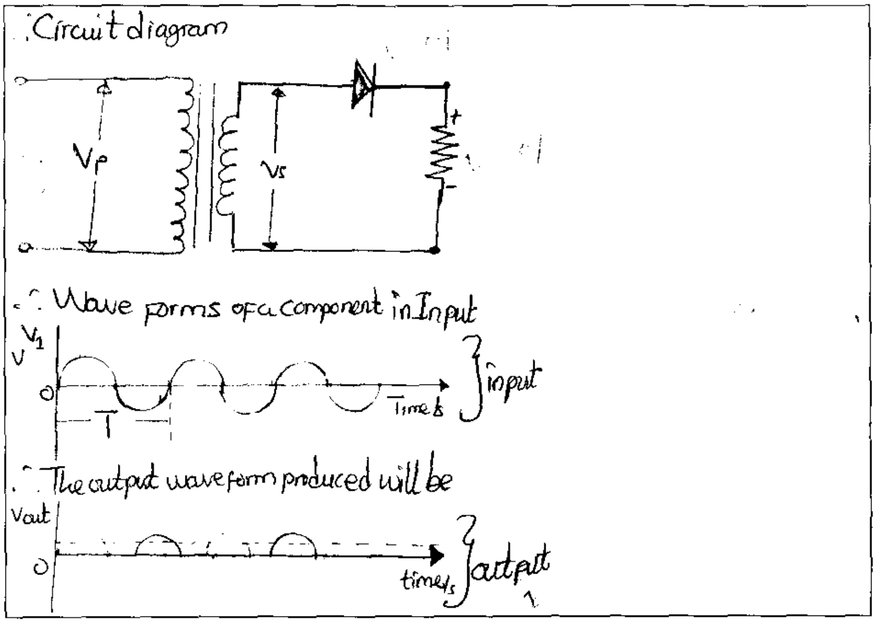


Figure 1



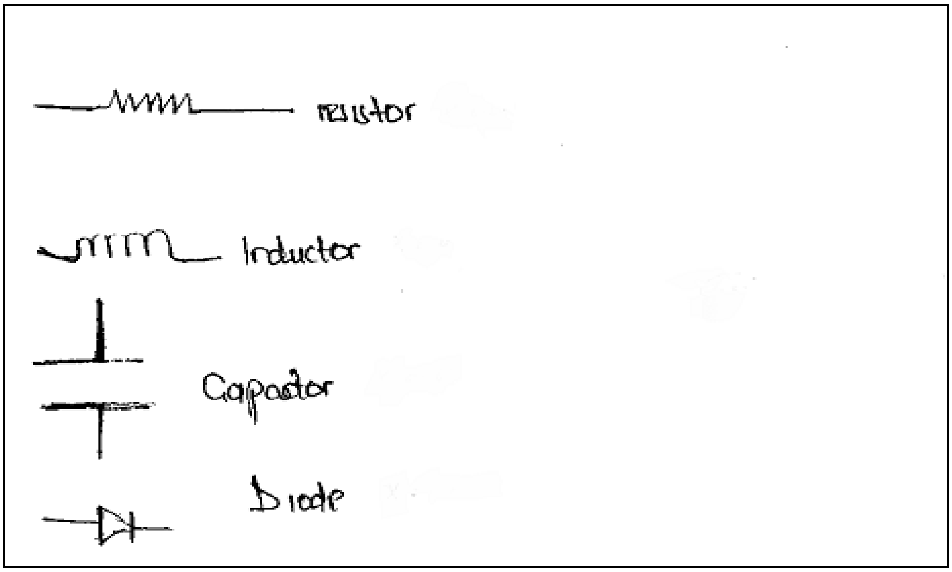
(b) An a.c source is applied to a circuit which consists of one PN junction diode, a transformer and a load resistor to produce a d.c signal output. Use the given components to construct a circuit diagram and show the produced output waveform.



Extract 5.1: A sample of correct responses to Question 5

Extract 5.1 is the response from a student who scored the highest marks. In part (a), the student correctly drew and named only one part (transformer) at the input of the block diagram from the given circuit. The student failed to realize that the other parts are rectifiers, filters, and load resistors, and not diodes, capacitors, inductors, and resistors, as he/she wrote in the block diagram. In part (b), the student correctly drew the circuit diagram to show the output waveform when an a.c source with a PN junction diode, a transformer, and a load resistor is connected to the circuit.

On contrary, 138 (50.92%) students who scored from 0 to 2.5 had a weak performance as they failed to draw the correct block diagram of an electronic system that converts a.c to d.c signals. An example of an incorrect response is of a student who failed to draw the block diagram; instead, he/she drew the component symbols of a diode, earth, transformer, inductor, capacitor, and resistor in part (a) of the question. Extract 5.2 shows a sample of incorrect responses from one of the students.



Extract 5.2: A sample of incorrect responses to Question 5

In Extract 5.2, part (a), the student failed to draw a well-labelled block diagram of an electronic system schematic that converts a.c to d.c signals. In part (b), the students failed to construct the circuit diagram to produce an output waveform when an a.c source is applied to a circuit consisting of one PN junction diode, a transformer, and a load resistor.

2.2.4 Question 6: Electronic Devices

The question consisted of parts (a) and (b). The question tested the student's ability to classify resistors according to their voltage-current characteristics, use of colour code to determine maximum and minimum resistance range, and identify the instrument used to measure the resistance of a resistor. The question was:

(a) *Resistor is a basic and important component in electronics circuits.*

- *(i) Classify resistors according to their voltage-current (V-I) characteristics.*
- *(ii) Determine the maximum and minimum resistance range of a resistor with yellow, violet, orange and gold colour codes.*
- *(iii) Suggest an instrument which can be used to measure the resistance of a resistor.*

(b) *A resistor in part (a) (ii) is needed to be tested. You are given a supply voltage, a voltmeter, an ammeter and a bulb. Draw the circuit to show the connection of the ammeter and voltmeter to measure the circuit current and potential difference across the resistor under test when connected in series with the bulb.*

A total of 271 (100%) students attempted the question. Out of them, 102 (37.64%) scored from 0 to 2.5 marks, 150 (55.35%) scored from 3 to 6 marks, and 19 (7.01%) scored from 6.5 to 10 marks. The overall students' performance is summarized in Figure 6.

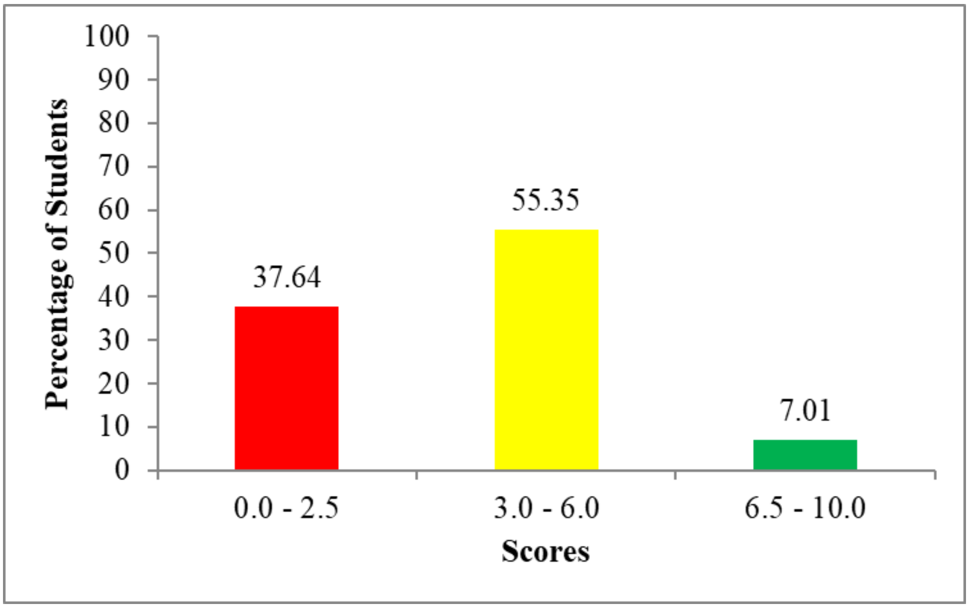


Figure 6: *The Students' Performance in Question 6*

The overall performance of this question was average since 169 (62.36%) students scored average marks and above. Although most students failed to classify resistors according to their voltage-current characteristics, most of the student's responses were fixed and variable resistors. In contrast, the correct responses were the linear and nonlinear resistors. Most of the students were able to determine the maximum and minimum resistance range of a resistor with yellow, violet, orange and gold colour codes. They suggested a tool that can be used to measure the resistance of a resistor and drew the circuit to show how the ammeter and voltmeter can be connected when measuring the current and potential difference across the resistor being tested when it was connected in series with the bulb. This signifies that the students had insufficient knowledge concerning the classes of resistors but had sufficient understanding of the other tested part of the topic. Extract 6.1 illustrates a sample of correct responses from one of the students.

(a) Resistor is a basic and important component in Electronics circuits.

(i) Classify resistors according to their voltage-current (V-I) characteristics.

i/ Fixed resistor.

ii/ Variable resistor.

iii/ ~~Resistor~~ Special purpose resistor.

(ii) Determine the maximum and minimum resistance range of a resistor with yellow, violet, orange and gold colour code.

Soln

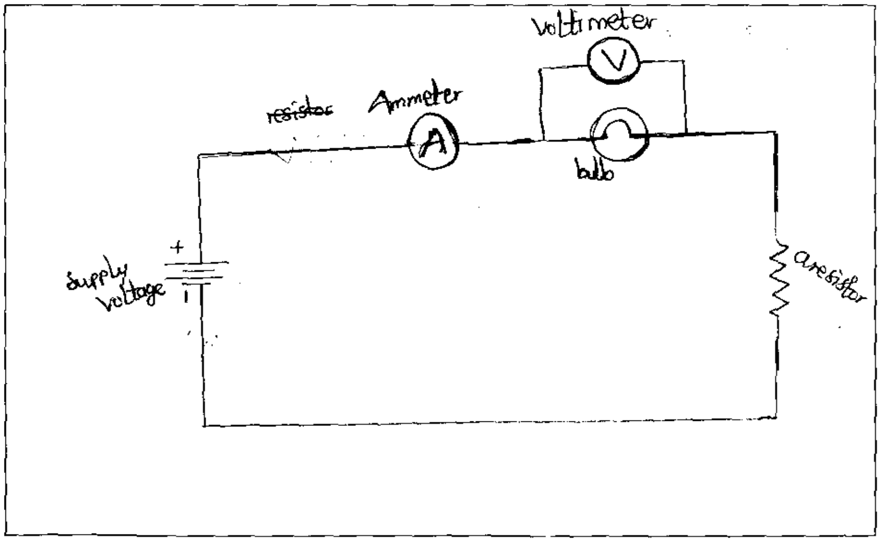
Yellow, Violet, Orange and gold colour code.

$= 47 \times 10^3 \pm 5\%$

$= 47 \times 1000 \pm 5\%$

$= 47000\Omega \pm 5\%$

(b) A resistor in part (a) (ii) is needed to be tested. You are given a supply voltage, a voltmeter, an ammeter and a bulb. Draw the circuit to show the connection of the ammeter and voltmeter to measure the circuit current and potential difference across the resistor under test when connected in series with the bulb.



Extract 6.1: A sample of correct responses to Question 6

In Extract 6.1, most of students classified the resistor according to their V-I characteristics in (a) (i). Abled to determine the maximum and minimum resistor in (a) (ii) and in part (a) (iii) managed to suggest the instrument used to measure the resistance of a resistor. In part (b), the student correctly drew the circuit to show the ammeter's and voltmeter's connection when measuring current and potential difference across the resistor being tested when connected in series with the bulb.

However, 102 (37.64%) students performed poorly on this question; in part (a) (i), they failed to classify resistors according to their voltage-current characteristics. For example, one student's response was that "a resistor is used to start metal". In part (a) (ii), most students failed to recall the resistance colour code table. For example, one student wrote yellow = 5, violet = 8, orange = 4 and gold ±5%, which was wrong. The correct arrangement was Yellow = 4, Violet = 7, Orange = 3 and Gold ± 5%, therefore the required value was

$R = 47 \times 10^3 \pm 5\%\ \Omega \quad = 47\ k\Omega \pm 5\%$

Maximum value.

$5\%R = \frac{47k\Omega \times 5}{100} = 2350\ \Omega$

$R_{max} = 47000\ \Omega + 2350\ \Omega$

$R_{max} = 49350\ \Omega$

$R_{max} \simeq 49\ k\Omega$

Minimum value

$R_{min} = 47000\ \Omega - 2350\ \Omega$

$R_{min} = 44650\ \Omega$

$R_{min} = 45\ k\Omega$

In part (a) (iii), some students failed to suggest an instrument for measuring the resistance of a resistor. One student mentioned that the instrument is an Ammeter instead of an Ohmmeter. This Student did not realize that an Ammeter measures current, not resistance.

In part (b), the students failed to draw the circuit, showing how the ammeter and voltmeter can be connected when measuring the current and potential difference across the resistor being tested when connected in series with the bulb. For example, one of the students drew the circuit diagram showing the switch, voltmeter and Ohmmeter connected in series. These students were confused by the term ‘series’ in the question, resulting to this mistake. An appropriate connection is an ammeter in series with a resistor and the bulb, and placing the voltmeter across the resistor. These responses imply that the students had inadequate knowledge and skills in measurements and instrumentation. Extract 6.2 shows a sample of incorrect responses from one of the students.

6. (a) Resistor is a basic and important component in Electronics circuits.

(i) Classify resistors according to their voltage-current (V-I) characteristics.

Resistor id is used to stal meter

(ii) Determine the maximum and minimum resistance range of a resistor with yellow, violet, orange and gold colour code.

Soln

yellow violet orange ~~and~~ gold colar code

5 8 4 5%

Soln

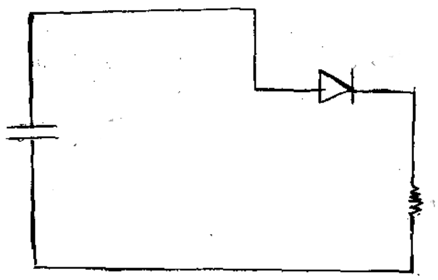
Orange = 52×10^{-6}

gold = 64×10^{-5}

(iii) Suggest an instrument which can be used to measure resistance of a resistor.

Instrument : Is the process of measuring tools and indicating measuring marhiral.

(b) A resistor in part (a) (ii) is needed to be tested. You are given a supply voltage, a voltmeter, an ammeter and a bulb. Draw the circuit to show the connection of the ammeter and voltmeter to measure the circuit current and potential difference across the resistor under test when connected in series with the bulb.



Extract 6.2: A sample of incorrect responses to Question 6

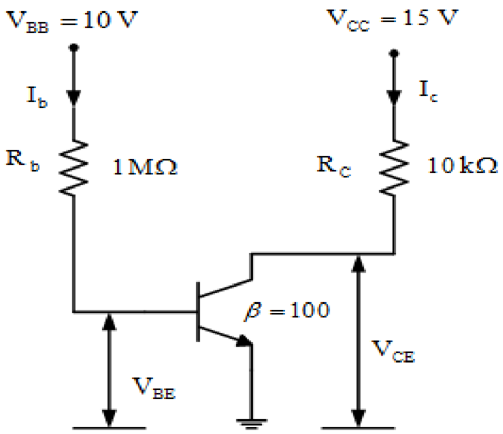
In Extract 6.2, the student explained the function of a resistor in a circuit rather than classifying resistors according to their V-I characteristics as required in part (a) (i). Additionally, in part (a) (ii), the student failed to determine the maximum and minimum resistance ranges using the colour codes. Moreover, in part (a) (iii), the student defined the term "instrumentation" instead of suggesting the instrument used to measure a resistor's resistance. In part (b), the student drew a series closed circuit containing a capacitor, a p-n junction diode, and a resistor, instead of the circuit that shows the connection of the ammeter and voltmeter.

2.2.5 Question 7: Semiconductor Devices

The question consisted of parts (a) and (b). This question tested the students' competence in calculating the input resistance, base current, collector current, emitter current and collector-emitter voltage of the NPN transistor. The question was:

(a) *In a performance test of a transistor amplifier, a change of 200 mV in base-emitter voltage caused a change of 100 µA in the base current. Calculate its input resistance.*

(b) *The NPN transistor circuit in figure below is required to replace the faulty one in a certain electronic system.*



To ensure better performance of the circuit in above before replacement, calculate the following parameters (Neglect V_{BE}):

(i) I_B

(ii) I_C

(iii) I_E

(iv) V_{CE}

A total of 271 (100%) students attempted the question. Out of those who attempted it, 176 (64.95%) scored from 0 to 2.5 marks, 89 (32.84%) scored from 3 to 6 marks, and 6 (2.21%) scored from 6.5 to 10 marks. Students' performance in this question is summarized in Figure 7.

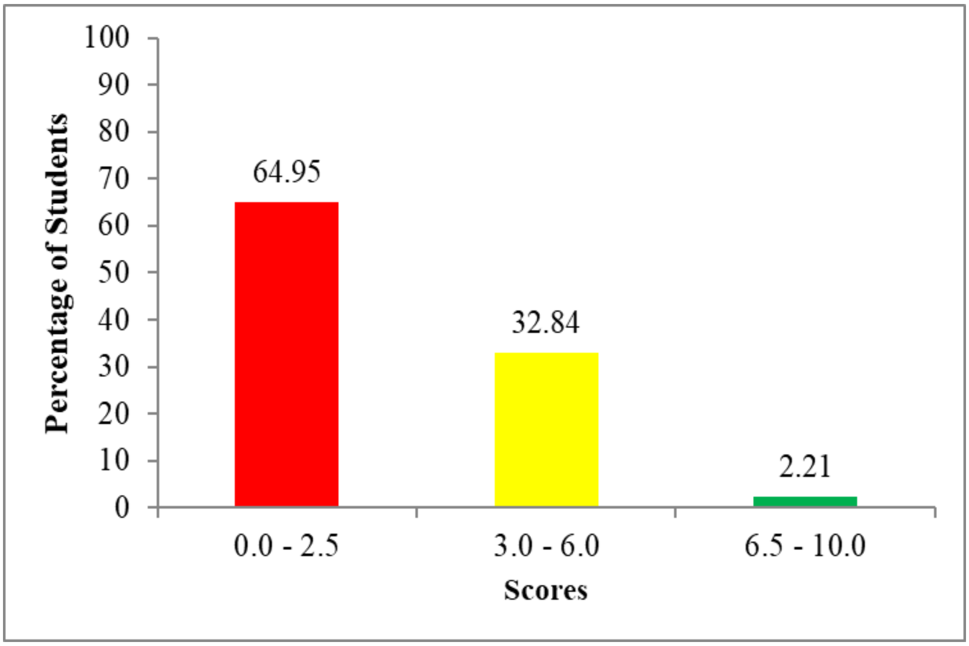


Figure 7: *The Students' Performance in Question 7*

The overall performance of this question was poor since 176 (64.95%) of the students scored below average. The students failed to calculate the input resistance of a transistor amplifier in part (a). Most of the students applied the incorrect formula, and some wrote the correct formula but had insufficient knowledge of prefixes used in the metric system to represent specific fractions of a unit, i.e., millivolt (mV) and micro (µA); hence, they failed to convert the unit, as a result, they got the answer as 2 Ω instead of 2 kΩ. In part (b), the students could not calculate base, collector and emitter currents or collector-emitter voltage (VCE). Most of them failed to write the formulas instead they just collected the data. Others used the incorrect formula in their calculation. For example, one student wrote the wrong formula $V_{BB} = I_B R_B - V_{BE}$ and could not form the equation for the given circuit. The correct formulas were, $V_{BB} = I_B R_B + V_{BE}$, $I_E = I_B + I_C$, $\beta = \frac{I_C}{I_B}$ and $V_{CC} = I_C R_C + V_{CE}$, respectively. Where V_{BB} is a total base voltage, $I_B R_B$ is base current multiplied by base resistance and V_{BE} is base emitter voltage drop. Vcc is total collector current, $I_C R_C$ is a collector current multiplied by collector resistance and V_{CE} is a collector to emitter voltage drop.

This shows that the student had insufficient knowledge of semiconductor devices. Extract 7.1 shows an example of incorrect response to question 7.

7. (a) In a performance test of a transistor amplifier, a change of 200 mV in base-emitter voltage caused a change of 100 μA in the base current. Calculate its input resistance.

~~Data~~ given:

Voltage = 200mV

Current = 100μ

Soln

$\frac{200}{100}$

The input resistance = 2Ω

(b) The NPN transistor circuit in Figure 2 is required to replace the faulty one in a certain electronic system.

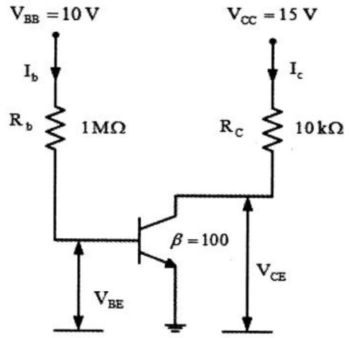


Figure 2

To ensure better performance of the circuit in Figure 2 before replacement, calculate the following parameters (Neglect V_{BE}):

(i) I_B

Soln

$V_{BE} = 10V$

$I_B = ?$

$1M\Omega \times 10V$

$= 10V$

(ii) I_C

Soln.

$\frac{15V}{10k\Omega}$

$\frac{15^3}{10^3}$

$1.5V$

(iii) I_E

Soln.

$1M\Omega \times 10k\Omega$

$= 10k\Omega$

(iv) V_{CE}

Soln

$\frac{15^3}{10^2}$

$1.5V$

Extract 7.1: A sample of incorrect responses to question 7

In Extract 7.1, a student demonstrated insufficient knowledge and skills in semiconductor devices. In part (a), a student could not calculate the input resistance. In part (b), the student incorrectly calculated the values of I_B, I_C, I_E and V_{CE} because of applying the incorrect formula.

However, 95 students (35.06%) scored average and above. In part (a), these students applied the correct formula to calculate the input resistance. In part (b) students also applied correct formula to calculate emitter current I_E, collector current I_C, base current I_B and VCE; this shows that the students had sufficient knowledge of the topic tested. Extract 7.2 shows a sample of a good response from one student.

(a) In a performance test of a transistor amplifier, a change of 200 mV in base-emitter voltage caused a change of 100 μA in the base current. Calculate its input resistance.

Solution

from $r' = \frac{\Delta V_{BE}}{\Delta I_E}$.

$r' = \frac{200mV}{100\mu A} = \frac{200 \times 10^{-3} V}{100 \times 10^{-6} A}$.

$r' = 2 \times 10^3 \Omega = 2k\Omega$.

∴ Input resistance is $2k\Omega$.

(b) The NPN transistor circuit in Figure 2 is required to replace the faulty one in a certain electronic system.

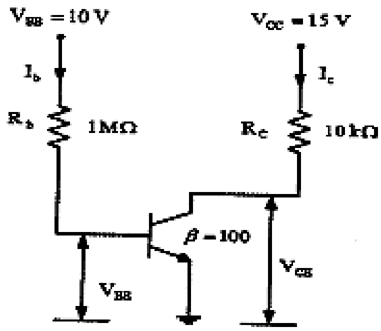


Figure 2

To ensure better performance of the circuit in Figure 2 before replacement, calculate the following parameters (Neglect V_{BE}):

(i) I_B

from $V_B = V_{BB}$

$I_B R_B = V_{BB}$.

$I_B \times 1 \times 10^6 \Omega = 10V$

$\frac{I_B \times 10^6 \times 1\Omega}{10^6 \times 1\Omega} = \frac{10V}{10^6 \times 1\Omega}$.

$I_B = 10 \times 10^{-6} A$.

$I_B = 10\mu A$.

∴ $I_B = 10\mu A$.

(ii) I_C

from $\beta = \frac{I_c}{I_B}$.

$100 = \frac{I_c}{10\mu A}$

$I_c = 100 \times 10 \times 10^{-6} A$.

$I_c = 1mA$.

(iii) I_E

from $I_E = I_c + I_B$.

$I_E = 0.01mA + 1mA$.

$I_E = 1.01mA$.

$\therefore I_E = 1.01mA$.

(iv) V_{CE}

from.

$V_{CC} = V_C + V_{CE} \Rightarrow V_C = V_{CC} - V_{CE}$.

$V_{CE} = V_{CC} - V_C$.

$V_{CE} = 15 - I_C R_C$.

$V_{CE} = 15V - 1mA \times 10k\Omega$

$V_{CE} = 15V - 10V$

$\therefore V_{CE} = \cancel{15V}.\ 5V$ $\qquad \therefore V_{CE} = 5V$.

Extract 7.2: A sample of the correct responses to Question 7

In Extract 7.2, a student could calculate the input resistance in part (a). In part (b), the student correctly calculated the values of I_B, I_C, I_E and V_{CE}.

2.2.6 Question 8: Semiconductor

This consisted of two parts: (a) and (b). The question intended to test the student's knowledge of the effect of temperature on semiconductor materials, mainly silicon and germanium. The question was as follows:

(a) *Although a pure germanium has more free electrons and higher conductivity than silicon, it was observed that silicon is more widely used in semiconductor devices than germanium. Give a reason for this observation.*

(b) *Use well labelled diagrams to differentiate the energy levels of the following materials:*

(i) Insulator

(ii) Semiconductor

(iii) Conductor

A total of 271 (100%) students attempted this question. According to the data analysis, 97 (35.79%) students scored from 0 to 2.5 marks, 80 (29.52%) scored from 3 to 6 marks, and 94 (34.69%) scored from 6.5 to 10 marks. The overall performance was average since 174 (64.21%) students scored from 3 to 10 marks. The summary of the student's performance in this question is shown in Figure 8.

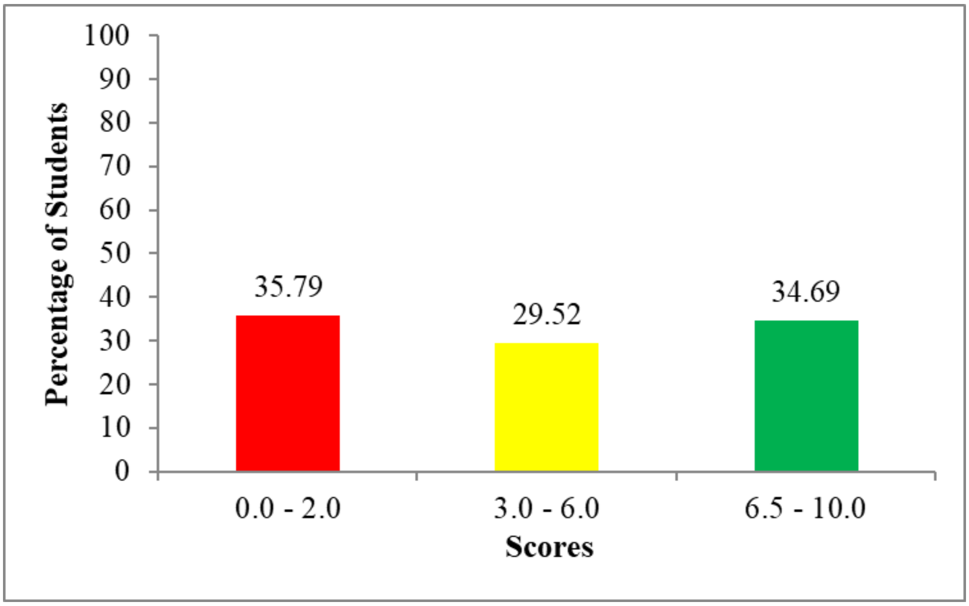


Figure 8: *The Students' Performance in Question 8*

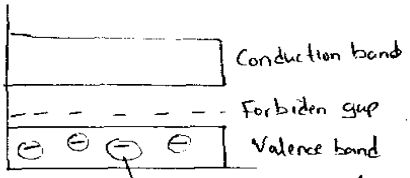
The analysis shows that the performance in this question was average since 174 (64.21%) of the students scored average and above. The students explained why silicon is more widely used in semiconductor devices than germanium. They also drew a well-labelled diagram to differentiate the energy levels of insulator, semiconductor, and conductor materials. This means that most students had good knowledge and skills in semiconductor devices. Extract 8.1 shows a sample of correct responses from one of the students.

8. (a) Although a pure germanium has more free electrons and higher conductivity than silicon, it is observed that silicon is more widely used in semiconductor devices than germanium. Give a reason for this observation.

Silicon is more stable on temperature change while Germanium is unstable ~~to~~ on temperature variations

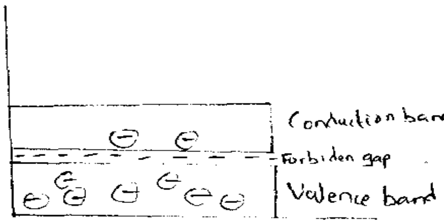
(b) Use well labelled diagrams to differentiate the energy levels of the following materials:

(i) Insulator



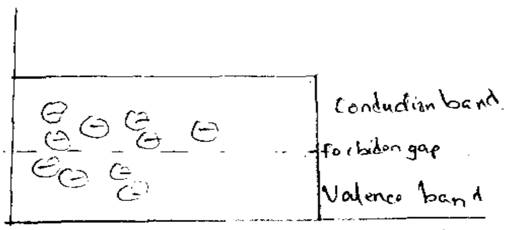
Electrons don't move to the conduction band

(ii) Semiconductor



moderately, electrons move to the conduction band

(iii) Conductor



Freely, electrons move to the conduction band

Extract 8.1: A sample of correct responses to Question 8

In Extract 8.1, a student correctly gave the required reason why silicon is more widely used in semiconductor devices than pure germanium in part (a). In part (b), the student also correctly drew well-labelled diagrams to differentiate the energy levels of insulator, semiconductor and conductor materials.

However, the analysis indicates that 97 (35.79%) students performed poorly. These students could not give reasons why silicon is more widely used than germanium. For example, in part (a), one student's response was that "*because silicon has more semi-conductivity than germanium*" which is wrong. Also, in part (b) same students failed to draw the diagram to distinguish the energy levels of the insulator, semiconductor and conductor; instead, the students drew the unknown circuit diagram and labelled the insulator, semiconductor, conductor, energy source, and energy flow instead of drawing the energy levels.

This illustrates that the students lacked knowledge of the tested topic. Extract 8.2 presents incorrect responses from one of the students.

(a) Although a pure germanium has more free electrons and higher conductivity than silicon, it is observed that silicon is more widely used in semiconductor devices than germanium. Give a reason for this observation.

Because Silicon has more semiconductivity than the Germanium.

Extract 8.2: A sample of incorrect responses to Question 8

In Extract 8.2, the student failed to explain why silicon is more widely used in semiconductor devices than germanium and ultimately failed to draw and differentiate the energy levels of insulator, semiconductor and conductor materials.

2.2.7 Question 9: Drawing Techniques

This question tested the student's skills in drawing an ellipse from the given two circles using the concentric circle method. The question was as follows:

You have been given 2 circles with 90 mm diameter and 45 mm diameter. Using concentric circle method, draw an ellipse by using a compass, a ruler and a protractor only.

According to the data analysis, 271 (100%) students attempted the question. Out of them, 169 (62.36%) students scored from 0 to 2.5 marks, 81 (29.89%) scored from 3 to 6 marks, and 21 (7.75%) scored from 6.5 to 10 marks. The overall students' performance in this question is summarized in Figure 9.

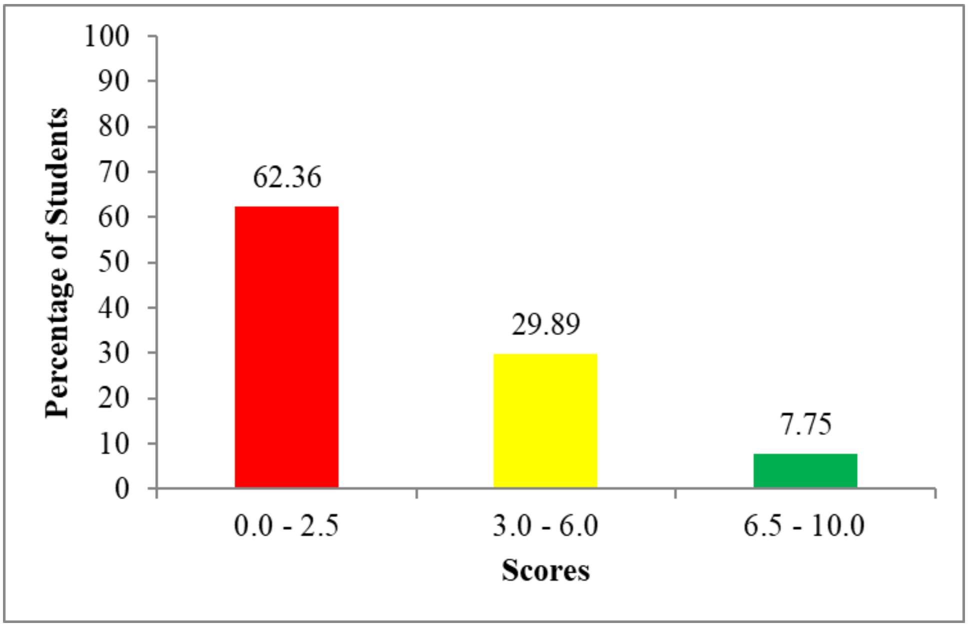
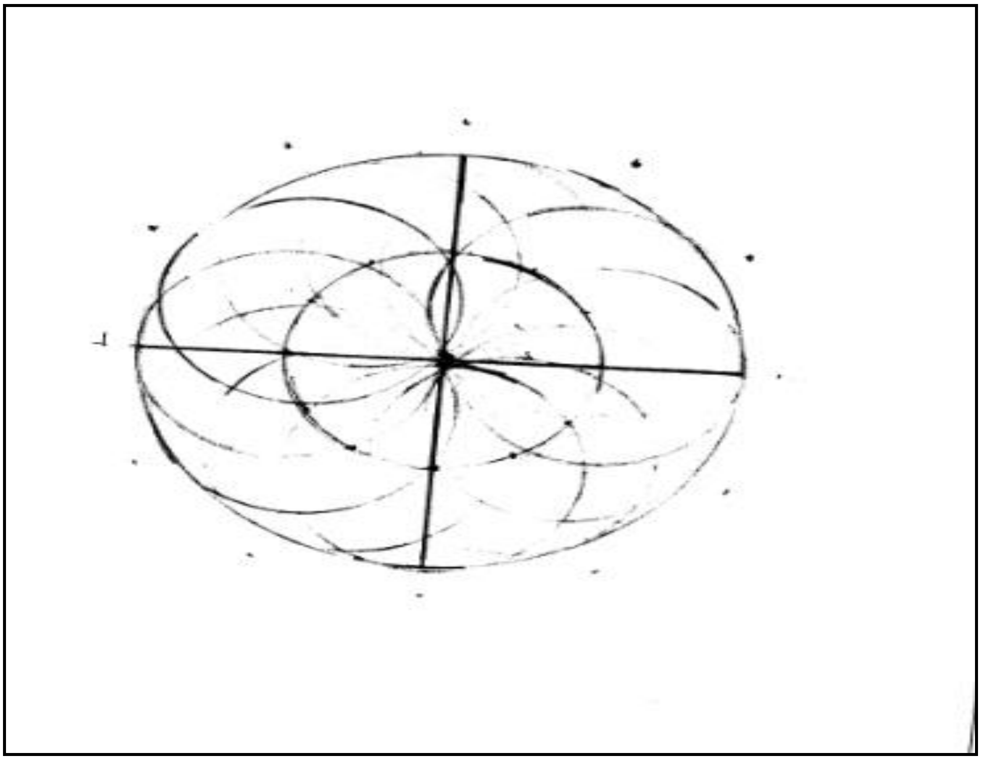


Figure 9: *The Students' Performance in Question 9*

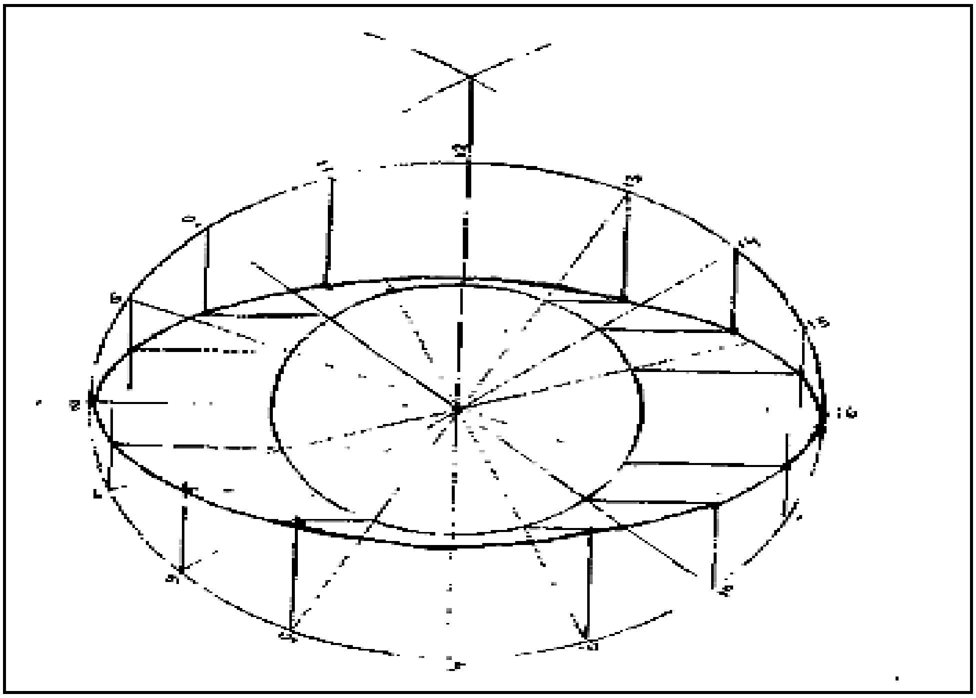
The analysis shows that overall, students' performance on this question was poor, since 169 (62.36%) of the students who attempted the question scored below average. The students failed to use the concentric circle method to draw an ellipse given 2 circles with a 90 mm diameter and a 45 mm diameter by using only a compass, a ruler and a protractor. Most of the students failed to understand the question requirements. For example, one of the students drew two circles but not the ellipse, and others failed to show the angles and the lines as per the question, instead they drew the line crossing the circles like the diameter. This implies that the students had insufficient knowledge of the topic of drawing techniques. Extract 9.1 shows the sample of poor responses from a student who incorrectly drew an ellipse from the given two circles using the concentric circle method.



Extract 9.1: A sample of incorrect responses to Question 9

In Extract 9.1, the student failed to draw an ellipse from the two circles using the concentric circle method. Instead, a student drew many small circles inscribed by the large circle, which was wrong.

However, the analysis shows that 102 (37.64%) students scored an average mark and above. The students demonstrated their ability to draw an ellipse using the concentric circle method. This indicates that they had adequate skills in the topic of technique drawing. Extract 9.2 illustrates a sample of correct responses to this question.



Extract 9.2: A sample of correct responses to Question 9

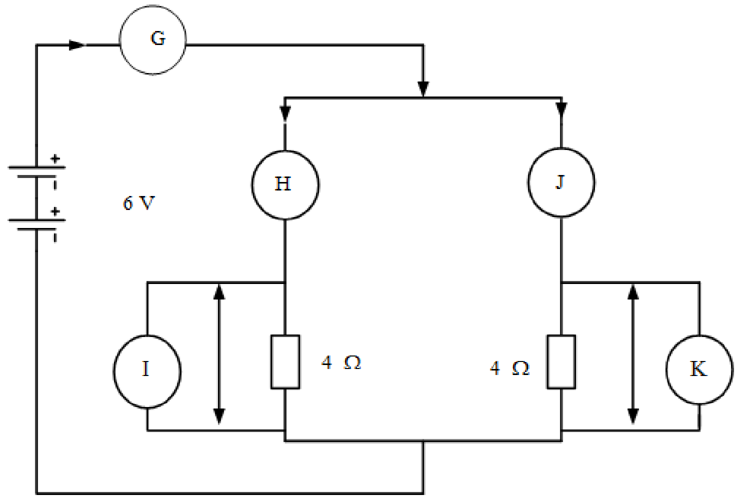
In Extract 9.2, the student drew the ellipse correctly using two circles. This student had sufficient knowledge of the tested topic.

2.3 SECTION C: STRUCTURED QUESTION

2.3.1 Question 10: Introduction to Measurement and Instrumentation

This question tested the students' knowledge and skills in measuring electrical parameters in series and parallel circuits and mathematical skills to compute the required value using Ohm's law. The question was as follows:

(a) *The figure below represents a measuring instrument used in the electronics workshop. Study it and answer the questions that follow.*



(i) *Identify the names of the instruments labelled by letters G, H, J, I and K with its function according to the positions to which they are connected. Calculate the total resistance of the circuit.*

(ii) *Calculate the value measured by the instruments labelled by letter G, H and J.*

(iii) *Find the value measured by the instruments labelled by letter I and* K.

(b) *Do you agree that, data in analogue measuring instruments are more likely to be read wrongly than digital instruments? Give two reasons to support your answer.*

A total of 271 (100%) students attempted the question. The analysis shows that 126 (46.49%) students scored from 0 to 4.5 marks, 91 (33.58%) scored from 5 to 9.5 marks, and 54 (19.93%) scored from 10 to 15 marks. The overall performance was average since 145 (53.51%) students scored average marks and above. The student's performance in this question is summarized in Figure 10.

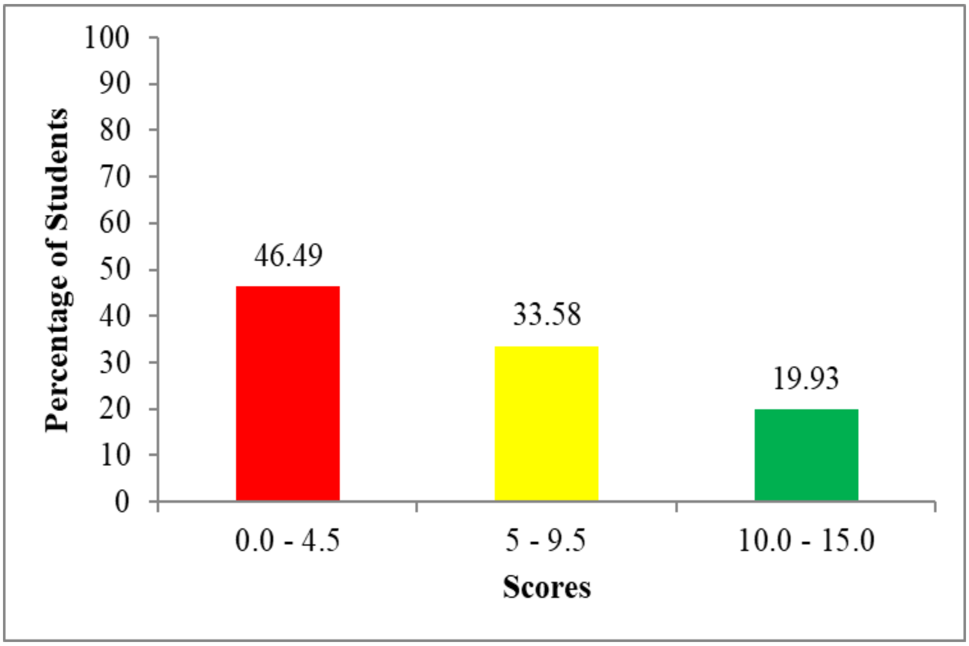


Figure 10: *The Students' Performance in Question 10*

The analysis shows that 145 (53.51%) students scored from 5 to 15 marks on this question. Thus, the general performance was average. Most students were able to identify the names and the functions of the instruments labelled by letter G, H, J, K and I according to the positions to which they are connected. The students applied the correct formulas to calculate the value measured by the instruments labelled by letters G, H, and J and find the value measured by the instruments labelled by letters I and K. They were also able to give two reasons why data in analogue measuring instruments are more likely to be read wrongly than in digital instruments. Extract 10.1 represents a sample of correct responses from one of the students.

(a) Figure 3 represents a measuring instrument used in the electronics workshop. Study it and answer the questions that follow.

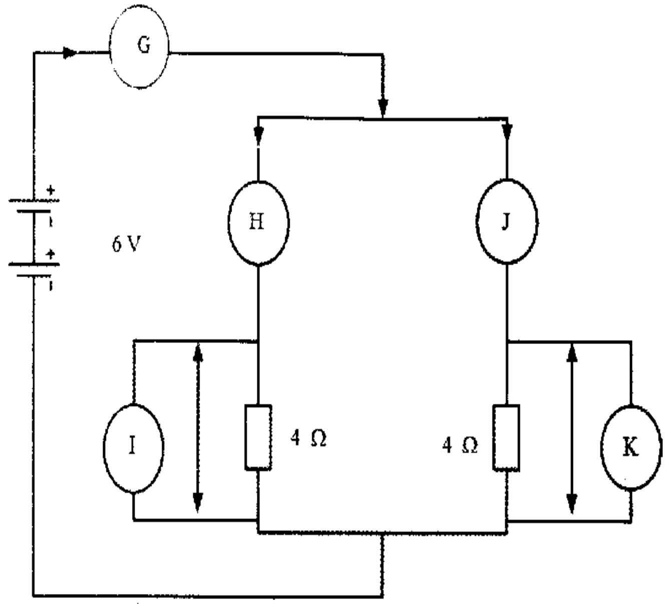


Figure 3

(i) Identify the names of the instruments labeled by letters G, H, J, I and K with its function according to the positions to which they are connected.

- G. Ammeter - Used to measure the electric current in a whole circuit
- H. Ammeter - Used to measure current flowing in a resistor with 4Ω ~~wid~~ which is also connected with voltimeter I.
- J. Ammeter - Used to measure current flowing in a resistor with 4Ω which is also connected with voltimeter K
- I. Voltimeter - Used to measure potential difference across a resistor with 4Ω hence connected parallel with it.
- K. Voltimeter - Used to measure voltage or potential difference across a resistor with 4Ω where it is is connected in parallel with it.

(ii) Calculate the total resistance of the circuit.

~~Total resi~~

SOLUTION

Total Resistance = $\frac{\text{Product of resistance}}{\text{Sum of resistance}}$

$R_T = \frac{(4\times4)\Omega}{4\Omega+4\Omega}$

$R_T = \frac{16\Omega}{8\Omega} = 2\Omega$

∴ Total resistance of a circuit is 2Ω.

(iii) Calculate the value measured by the instruments labeled by letter G, H and J.

SOLUTION.

From ohm's law $I = V/R$

in Ammeter G current

$I_G = \frac{6V}{2\Omega} = 3A$.

Ammeter H

$I_H = \frac{6V}{4\Omega} = \frac{3}{2} = 1.5A$

Ammeter J

$I_J = 6V/4\Omega = 3/2 = 1.5A$

∴ The value measured in G = 3A, H = 1.5A and J = 1.5A

(iv) Find the value measured by the instruments labeled by letter I and K.

SOLUTION

From $V = IR$

(i) $V_I = 4\Omega \times 1.5A = 6V$

(ii) $V_K = 4\Omega \times 1.5A = 6V$

∴ The value measured by instrument $I = 6V$ and $K = 6V$

(b) Do you agree that, data in analogue measuring instruments are more likely to be read wrongly than digital instruments? Give two reasons to support your answer.

(i) Yes because In analogue Instruments a zero error may occur and cause the reading to start below or after the zero mark that may cause wrong reading In an Instrument measurement.

(ii) Yes, Because an analogue measuring Instrument a parallex error may happen and cause a person reading the wrong number pointed that may lead to wrongly answer from the measurement and cause unproovable answers In the experiment.

Extract 10.1: A sample of correct responses to Question 10

In Extract 10.1, the student correctly identified the names and the functions of the instruments labelled by letters G, H, J, I, and K as represented in the circuit diagram of the measuring instrument in a(i). In part (a) (ii), in part (a) (iii), and in part (a) (iv), the students managed to apply the correct formulas to calculate the electrical parameters of the circuit. The students showed competence by computing the value measured by the instruments labelled by the letters G, H, J, K. and I. In part 10 (b), the student provided clear explanation of why data in analogue measuring instruments are more likely to be read wrongly than in digital instruments. The student may have recalled that analogue instruments are prone to errors such as calibration errors, parallax errors, and the need for the reader to estimate the pointer's position between scale markings.

Despite the average performance, 126 (46.49%) students incorrectly answered this question. The students failed to identify the names of the instruments labelled with letters G, H, J, K and I and their functions according to the positions to which they are connected. Likewise, the students failed to apply the correct formulas to calculate the value measured by the instruments labelled by letters G, H, and J. They also failed to find the value measured by the instruments labelled by letters I and K. Also they were unable to give reasons why data in analogue measuring instruments are more likely to be read wrongly than in digital instruments. For example, one of the students in part (a) (i) wrote that, the instruments represented by the letters were G, *Better*, H, *Reuter*, J, *Voltage* I, *Wire* and K, *Current*. For case 1, G, the students compared the device 'ammeter' with the word 'Better'; it appears the student wanted to write the 'battery'. For case 2, H, the student wrote 'Reuter', by comparing the device 'ammeter' with a 'router.' In case 3, J, the student wrote 'Voltage' comparing the device 'ammeter' with the word 'voltage.' In case 4, I, the student wrote 'wire,' comparing the device 'voltmeter' with a 'wire.' Finally, in case 5, K, the student wrote 'Current,' comparing the word 'current' with the device 'voltmeter.'

In addition, the students failed to apply the correct formula to calculate the total resistance of the circuit. For example, one of the students used the formula $\frac{IR}{Y}$ to find total resistance instead of $R_T = \frac{R_1 R2}{R_1 + R_2}$ where R is a resister. This student did not remember the Ohms' law. He/she also used $\frac{IR}{Y}$ to find the current measured at G, H, and J instead of $Ic = \frac{V}{R_T}$. The student also used the formula $I_T = \frac{R}{V}$ to find the value of the measuring instrument labelled by letters I and K instead of the correct Ohms' law equation. The students also failed to explain why data from analogue measuring instruments are more likely to be misread compared to digital instruments. For example, one of the student responded, "The instrument is a semiconductor material with a digital insulator indicating a misunderstanding of digital electronics with the semiconductor materials. This response illustrates that the student had insufficient knowledge of the tested topic.

10. (a) Figure 3 represents a measuring instrument used in the electronics workshop. Study it and answer the questions that follow.

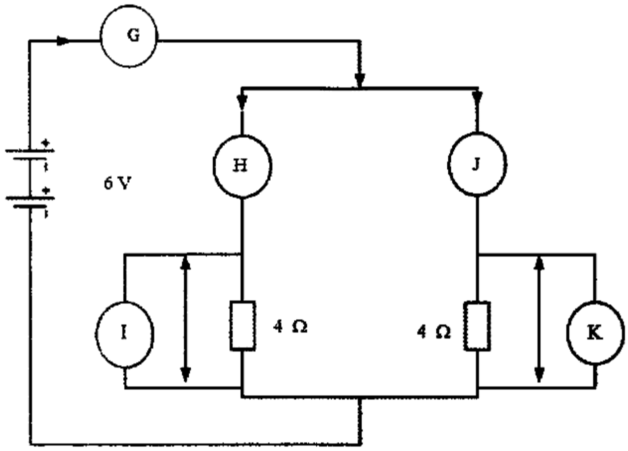


Figure 3

(i) Identify the names of the instruments labeled by letters G, H, J, I and K with its function according to the positions to which they are connected.

- G......Resistor......
- H......transistor circuit......
- J......current......
- I......~~voltage~~ Ampire......
- K......Voltage......

(ii) Calculate the total resistance of the circuit.

In figure and Electronic System

(iii) Calculate the value measured by the instruments labeled by letter G, H and J.

Electronic System

(iv) Find the value measured by the instruments labeled by letter I and K.

Resistance

Extract 10.2: A sample of incorrect responses to Question 10

In Extract 10.2, the student incorrectly identified the names and the functions of the instruments labelled by letters G, H, J, I and K as represented in the circuit diagram of the measuring instrument in part (a) (i). In other parts, the students showed incompetence by providing inappropriate responses.

3.0 THE STUDENTS' PERFORMANCE IN EACH QUESTION

The analysis of the students' performance on each question assessed in the Electronics and Communication Engineering subject for the year 2024 is summarized in Table 3.

Table 3: A Summary of the Students' Performance in Each Question

Question Number	Performance in Percentage		
	Weak	**Average**	**Good**
1	7.38	80.07	12.55
2	3.32	15.13	81.55
3	57.93	21.77	20.30
4	58.30	38.01	3.069
5	50.92	35.42	13.65
6	37.64	55.35	7.01
7	64.94	32.84	2.21
8	35.79	29.52	34.69
9	62.36	29.89	7.75
10	46.49	33.58	19.93

The analysis indicates that the student's performance was good in question 2, where 262 (96.68%) students scored average and above. The good performance on this question signifies that the students had sufficient knowledge, skills and competence in the tested concept.

Furthermore, the analysis of the students' performance in other questions indicates that the students also had good performance in question 1 (92.62%). Students performed average in question 8 (64.21%), question 6 (62.36%), and question 10 (53.51%). Students performed averagely in question 5 (49.08%), question 3 (42.07%), question 4 (41.70%), question (3&7) 38.57question 9 (37.64) question 7 (35.06%).

4.0 THE STUDENT'S PERFORMANCE ON EACH TOPIC

The analysis of the student's performance in the topics that were assessed in the Electronics and Communication Engineering subject for the year 2024 indicates that the students performed well on *Introduction on Electricity* (96.688%) tested in questions 2. Also, the students performed well in the topic of Semiconductor devices, Introduction on electricity, Drawing techniques, Introduction to electronics and communication, Semiconductors, Electronic drawing, Introduction to measurement and instrumentation, Safety management and rules (92.62%), tested in question 1 and Semiconductor (64.21%) tested in question 8.

The good performance on these topics signifies that the students had sufficient knowledge, skills and competence in the concepts assessed. In addition, it signifies that they were keen on the assessment instructions and understanding the demands of the questions. These students had good mastery of the subject matter.

The topics on which the students had average performance were *Introduction to measurement and instrumentation* (52.52%) tested in questions 4, 6 & 10, *Electronic devices (49.08%)* tested in question 5, *Semiconductor devices (38.57%)* tested in question 3 & 7 and *Drawing techniques (37.64%)* tested in question 9.

The average performance in these topics was attributed to some students failing to identify the requirements of the questions and incorrect application of calculation formulas. Moreover, some of them either gave correct points without satisfactory explanations or appropriate drawings, and some provided fewer points than those demanded by a particular question. None of the topics assessed had a weak performance. This indicates that the overall performance of students in the Electronics and communication Engineering assessment was good. A summary of students' performance in each topic is presented in the Appendix.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The general performance of students in Electronics and Communication Engineering on the Form Two National Assessment (FTNA) in 2024 was average. Out of 271 students who sat for the paper, 158 (58.30%) passed, while 113 (41.70%) failed. The average performance of the students resulted from their ability to understand the requirements of the questions, their knowledge, skills and competence in the subject matter, as well as their mastery of calculation skills.

The analysis of the students' performance reveals that some of the students faced some challenges when attempting the questions. Inadequate knowledge was identified as a major factor contributing to weak performance among most students. Some students provided incorrect responses, while others left some items without writing any answers. Further analysis shows that a lack of mathematical skills was another significant challenge to the majority of the students, particularly in questions requiring the application of formulas and multi-step calculations to arrive at the final answer. Additionally, insufficient drawing skills contributed to their poor performance.

5.2 Recommendations

Based on the shortcomings observed in the analysis of the student's item response, the following recommendations are provided:

(a) The teaching and learning process for electronics and communication engineering should place greater emphasis on practical methods using real-life examples and activities such as drawings. This approach will help learners to develop their skills and competence in the subject matter.

(b) Students are encouraged to study diligently to gain a thorough knowledge of the concepts as stipulated in the syllabus. They should also engage in a variety of computation to enhance their ability to tackle questions requiring the application of formulas and calculations.

Appendix

A Summary of Students' Performance in each Topic in Electronics and Communication Engineering Subject for the Year 2024

S/N	Topic	Question Number	Percentage of Students who Scored 30 per cent and above	Remarks
1	Introduction on electricity	2	96.68	Good
2	Semiconductor devices, Introduction on electricity, Drawing techniques, Introduction to electronics and communication, Semiconductors, Electronic drawing, Introduction to measurement and instrumentation, Safety management and rules.	1	92.62	Good
3	Semiconductor	8	64.21	Good
4	Introduction to measurement and instrumentation	4&6&10	52.52	Average
5	Electronics devices	5	49.08	Average
6	Semiconductor devices	3&7	38.57	Average
7	Drawing techniques	9	37.64	Average