THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEMS RESPONSE ANALYSIS REPORT ON THE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2022

MECHANICAL DRAUGHTING

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097 MECHANICAL DRAUGHTING

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FOREWORD

This report presents Candidates' Item Response Analysis (CIRA) on Form Four National Examination in Mechanical Draughting subject which was conducted in November 2022. The report aims to provide feedback to all educational stakeholders on the factors that contributed to the candidates' performance in Mechanical Draughting subject.

The Certificate of Secondary Education Examination (CSEE) intends to monitor students' learning and to provide feedback that teacher, students and other educational stakeholders to improve teaching and learning processes. This analysis shows justification for the candidates' performance in the Mechanical Draughting subject. The analysis shows that the candidates with good performance provided correct responses since they were able to identify the requirements of the questions, had adequate knowledge of the subject content, and good mastery of drawing skills. However, the candidates with weak performance had shown contrary attributes.

This report will help to identify candidates' strengths and weaknesses so as to improve learning before sitting for their Certificate of Secondary Education Examination (CSEE). It will help teachers to identify the challenging areas and take appropriate measures during teaching and learning process.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will enable education stakeholders to take proper measures to improve teaching and learning of Mechanical Draughting subject. Consequently, prospective candidates will acquire knowledge, skills and competence indicated in the syllabus for better performance in future examinations.

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

Dr. Said A. Mohammed

EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses the candidates' performance on the Certificate of Secondary Education Examination (CSEE), 2022 in Mechanical Draughting subject, which was administered in November, 2022. The examination assessed the competencies that the Form Four candidates had gained in accordance with the 1993 Mechanical Draughting Secondary Education Syllabus.

The Mechanical Draughting examination paper had two sections A and B, that comprised of six questions. Section A had two questions (1 and 2). Question 1 was an objective question that consisted of ten multiple-choice items constructed from ten topics; each item carried 1 mark. Question 2 was a structured question constructed from the topic of Orthographic Projection, which carried thirty marks, making a total of fourty marks. Section B had four short-answer structured questions, each carrying 20 marks. The candidates were required to answer all questions in section A and three questions from section B.

A total of 183 (100%) candidates sat for the examination where 144 (78.69%) passed. Further analysis showing the pass grade basing on sex is presented in Table1.

Table 1: Candidates' Performance in Mechanical Draughting Subject in CSEE 2022

Sex	Grades					Passed	
	A	B	C	D	F	Number	Percent
M	5	16	56	54	35	131	78.92
F	0	0	2	11	4	13	76.47
Total	**5**	**16**	**58**	**65**	**39**	**144**	**78.69**

Table 1 shows that there was a large number of candidates who scored grades C, D and F and a small number in those who scored grades A and B.

However, the candidates' performance was interpreted based on the typical ranges of marks earned by candidates. The performance is considered weak if the scores range is from 0 to 29 marks. Furthermore, the performance is regarded as average and good, if the scores are between 30 and 64 and 65 and 100 respectively. Red, yellow, and green are used as

illustrations in figures and tables to show weak, average, and good performance, respectively.

The report also examines the answers given by the candidates to each question by outlining the question's requirements, the percentage of candidates that attempted it, the candidates' scores, and the explanations for these outcomes. To illustrate the given facts, extracts from the candidates' scripts, figures and tables are included. The report also includes appendices A, B, C and D for the year 2022. These appendices show a summary of candidates' performance question-wise, general performance, description of performance in each question, overall performance, and comparison of performance grade-wise.

2.0 ANALYSIS OF CANDIDATES' RESPONSES IN EACH QUESTION

This part outlines the type of question, the subject matter from which it was derived, the competency being tested, the prerequisite for each question, and the percentage of the candidates who performed weak, averagely, or good based on their responses.

2.1 Section A: Objective and Structured Questions

This section is comprised of two questions carrying a total of 40 marks. Question 1 consisted of 10 multiple-choice items constructed from various topics, each item carrying one mark. Question 2 was a structured question from the topic of pictorial drawing, worthing 30 marks.

2.1.1 Question 1: Multiple Choice Items

This question was compulsory which consisted of ten multiple-choice items (i-x), from the following topics: *Orthographic projection; Introduction of Drawing sheet and office; Scales; Abbreviations and Terminologies; Loci and mechanism; Development; Limits and Fits; Auxiliary views; Drawing Instruments and Equipment; Dimensioning and symbols*. Candidates were instructed to choose the correct answer among the given alternatives and writing its letter beside the item number in the booklet provided. Each item carried one mark.

The question was attempted by 183 (100%) candidates, whose scores were as follows: 54 (29.51%) of the candidates scored from 0 to 2 marks, 126 (68.85%) scored from 3 to 6 marks, and 3 (1.64%) scored from 7 to 10 marks. Generally, candidates' performance in this question was good, since

129 (70.49%) of the candidates scored from 3 to 10 marks. This performance is summarized in Figure 1.

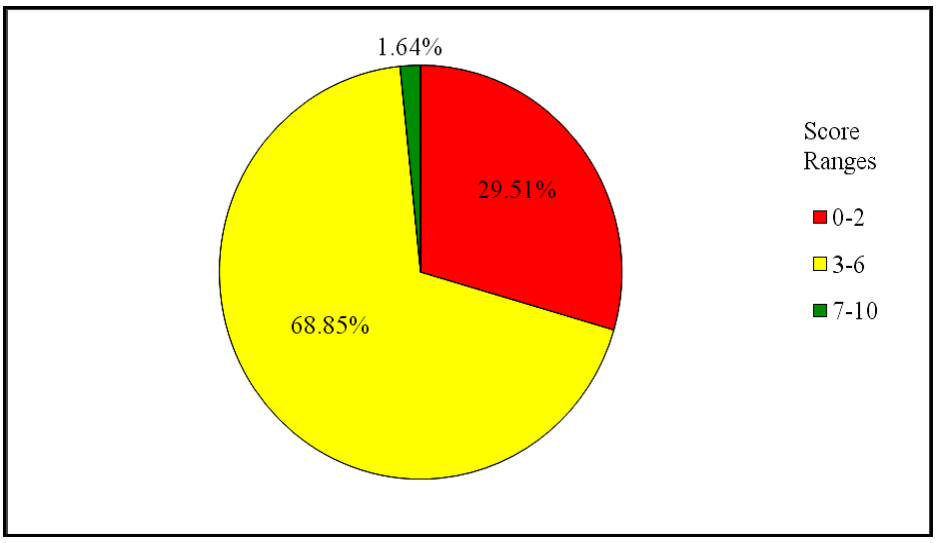


Figure 1: *The Candidates' Performance in Question 1*

Despite of the candidates' good performance on this question, 29.51 percent of the candidates performed poorly due to a number of reasons. The following is the analysis of candidates' responses for each item of this question:

Item (i) was chosen from the *Loci and Mechanism* topic. Candidates were required to apply their knowledge of locus and its mechanism to identify various types of geometrical constructions. The item measured the candidates' ability to analyze different shapes and figures obtained in the construction of locus. The question was: *Which refers to a locus of a point whose distance from two fixed points is constant?*

A Involute *B Cycloid* *C Ellipse*

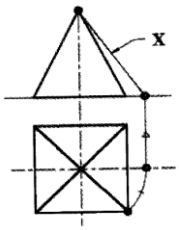
D Hyperbola *E Parabola*

The correct response was *C, Ellipse.* Candidates with knowledge of the ellipse, which is a closed plane curve generated by a point moving in such a way that the sum of its distances from two fixed points is constant. However, those who opted for alternative B, *Cycloid*, did not know that this is the location of a point on the rim of a circle of radius rolling in a straight line. Those who chose distractor A, *Involute*, were unaware that this is the type of curve traced by a point on a tautly thread as it unwound from another curve. For those who chose distractors D, *Hyperbora* and E,

Parapola, did not know that both of them have the same focus, but hyperbora is a set of points in a plane that is evenly spaced from a straight line or directrix and parabola is a group of points in a plane that are equally spaced from a straight line or directrix.

Item (ii) required the candidates to study the orthographic figures of pyramid cone and then to state the stage in which the given true length line can be required. The question measured ability of the candidates on interpreting the function of the true length. It was extracted from the topic of *Development*. The question was:

At what stage is line X shown in the given drawing needed from the following alternatives?



A It is required when drawing of the pyramid is flat.

B It is required when constructing a truncated pyramid.

C It is required when constructing an oblique pyramid.

D When transferring dimensions from plan to the front view of the pyramid.

E When constructing an auxiliary view from the front.

The question demanded the candidates to identify the importance of true length when performing drafting. The correct response was alternative *A, It is required when drawing of the pyramid is flat*. This was chosen by the candidates who were knowledgeable on how to draw the pyramid cone's development. They were aware that in order to illustrate the development of the inclined plane, they must choose the proper length to utilize. On the other hand, there were few candidates who provided wrong answers; by choosing distractors B, C, D, or E. They were unaware that the sides of the pyramid are not exactly of the same length when viewed from the top or the side. As a result, it is used to determine the true size and shape of inclined and oblique surfaces of objects in order to obtain the required length. Choosing incorrect responses indicates that the candidates lacked

content knowledge on importance of the true length when performing drawing.

Item (iii) was created from the topic of *Abbreviations and Terminologies*. It was intended to measure the ability of the candidates to use various principles of the object to represent the actual device.

The item was as follows: *What is the name of the surface of a thread joining two sides at the minor diameter of a screw and nut?*

A Pitch *B Root* *C Crest*
D Axis *E Lead*

The correct response was *B, Root*. This was correctly chosen by the candidates who were knowledgeable about mechanical drawing abbreviations and terminologies, and had thorough understanding of the subject matter. These candidates had enough knowledge of the nomenclature of threads on a part. Those who chose A, C, D, and E were mistaken about the terms Pitch; Crest; Axis and Lead. These are thread terminologies but they differ from roots in the following ways: *pitch* is the axial distance between equivalent points on adjacent threads; *crest* is the topmost point or surface of a thread; *axis* is an imaginary line running through the center of the thread screw and *lead* is the axial distance travelled by the thread during a 360° revolution of the screw.

Item (iv) was extracted from the topic of *Orthographic Projection*. The question required the candidates to mention the minimum number of view (s) used to portray the mentioned projection. It was intended to measure the ability of the candidates to use their knowledge of orthographic projection. The question was:

Depending on the shape of the object, what is the minimum number of view(s) needed to be fully described in orthographic projections?

A Four views *B Two views* *C Three views*
D One view *E Five views*

The correct response was alternative *D, One view*. This correct option could only be chosen by candidates who were knowledgeable with orthographic projections and had an understanding of the views that should be drawn for each projection, as well as its maximum and minimum views. Those who opted for alternatives *A, Four views*; *B, Two views; C, Three views* and *E, Five views* were unaware that orthographic projection is a

common technique for portraying three-dimensional objects. In this technique, the object is represented on a sheet with one to four views having two-dimensional drawings in which the object is viewed along parallel lines perpendicular to the plane of the drawing. This suggests that they lacked adequate knowledge and expertise about orthographic projections.

Item (v) was set from the topic of *Introduction of Engineering Draughting Office and Equipments*. The question asked the candidate to name the office in charge of initiating the use of engineering materials. The question was: *In an Engineering industry which office makes decision on the materials to be used, method of manufacturing and heat treatment?*

A Maintenance office *B Fittings and turning office*
C Welding and fabrication office *D Production office*
E Design and Draughting

The candidates were required to recall engineering jobs and occupation to identify the correct response. The correct response was *E, Design and Draughting.* The candidates who had enough knowledge and skills on engineering jobs and occupation managed to give correct response on the item. On the other hand, candidates who choose alternative *A, B, C* and *D* had insufficient knowledge on the subject matter.

Item (vi) was set from the topic of *Limit and Fits*. The candidates were required to identify the difference between the maximum shaft size and the minimum hole size as applied in the limits and fits. The question was designed to assess the candidates' knowledge on mechanical part mating systems. The question was:

Which one among the following is an international difference between the maximum material limits of mating part?

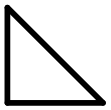
A Allowance *B Minimum size* *C Upper deviation*
D Bilateral limits *E Maximum size*

The correct response was alternative A, *Allowance.* The candidates who opted for the correct response had adequate knowledge of the terminologies used in limit and fit. Those who opted for alternatives B and E (*Minimum* and *Maximum sizes*) were unaware that these measurements were used to indicate the greater and smaller amounts of two parts in the mating system. Those who chose C, *Upper deviation*, were misled by the term "maximum material limit," which corresponds to the word "upper."

These candidates failed to know that the upper deviation is the algebraic difference between the maximum limit of size and the corresponding basic size. Furthermore, the candidates who chose Alternative D, *Bilateral Limits*, were unaware that this was the term used to describe the tolerance distribution on either side of the basic size. These candidates lacked knowledge of the terminologies used to describe the mating system.

Item (vii) was composed from the topic of *Symbols in Machine Drawing*. The question required the candidate to illustrate the symbol that represents the welded part as shown in the question below:

Which one of the given symbols represents a fillet weld?

A  B  C 

D  E 

The correct response was *C*. This option was chosen by the candidates who had knowledge of symbols in machine drawing. Those who chose other distractors were unaware that only the distractor listed in alternative D is used in welding, while others were not. Opting for incorrect responses suggests that the candidates had inadequate knowledge of the symbols used in drawing.

Item (viii) was composed from the topic of *Scale*. In this item the candidates were required to identify a type of scale which is used to accommodate the larger object in the drawing sheet: The question was: *Which one of the following represents a reducing scale?*

A 1:1 B 1:2 C 2:1

D 10:1 E 50:1

The item tested the candidates' ability to use their knowledge and skills on reading and presenting scales during drawing and sizing objects. The correct response was *B, 1:2.* Majority of the candidates who had enough knowledge provided the correct response. However, those who opted for alternative A, *1:1,* failed to know that this is the full-size scale that represents the actual size of the object in relation to the dimension used in

the drawing sheet. On the other hand, the candidates who opted for alternatives *C, D,* and *E* were misled by the reducing and enlarging types of the scale. These candidates lacked a clear understanding of the subject matter.

Item (ix) required the candidates to identify the angles which may be drawn using compass and ruler only. The question was extracted from the topic of *Geometrical construction in plane geometry*. The question was:

Which angles can be constructed by using a compass and a ruler only?

A 10^0, 44^0, 70^0 *and* 80^0. *B* 10^0, 17^0, 60^0 *and* 70^0.

C 15^0, 30^0, 80^0 *and* 150^0. *D* 30^0, 45^0, 90^0 *and* 135^0.

E 15^0, 45^0, 95^0 *and* 111^0.

The candidates were required to recognize how dimensions can be indicated in general drawings. The majority of the candidates provided the correct responses D, 30^0, 45^0, 90^0 *and* 135^0, implying that they were competent in the methods of constructing angles using a compass and a ruler. A considerable number of candidates provided the correct response, indicating that they had adequate knowledge of constructing angles by using a compass and a ruler only. However, those who were not conversant with placing dimensions in general drawings opted for the incorrect responses A, B, C, and E. This implies that the candidates lacked the skill to draw the various geometrical constructions without using a template.

Item (x) was composed from topic of *Loci and mechanism*. The candidates were required to identify the type of shape whose description was given after the intersection of the plane and the cone. The question was*:*

What shape of the curve is obtained if a curve is created by the intersection of a plane with a cone and makes an angle with the axis greater than the angle between the sides of the cone?

A Parabola *B Hyperbola* *C Ellipse*

D Roulette *E Involute*

The correct response was *C, Ellipse.* The candidates who provided correct response implying that they were competent and had enough knowledge and skills on constructing different type of loci. However, those who were not conversant with general construction of ellipse opted for incorrect

responses A, B, D, and E. These candidates were unaware that an ellipse is the shape of a curve when a plane intersects a cone and makes an angle with the axis greater than the angle formed by the cone's sides. This implies that the candidates were not familiar with the subject matter.

2.1.2 Question 2: Orthographic Projection

This question was compulsory and it was set from the topic of *Orthographic Projection*. In this question, candidates were instructed to convert the given views into pictorial projection using isometric projection. The question measured a higher level of cognitive ability, whereby the candidates were required to study the drawing, understand the logic of the question, observe the hidden details, and know the correct steps to follow.

The question was: *Figure 1 shows three views of machine brackets drawn in first angle projection. Using full size scale, draw it in isometric projection with FRONT view looking to direction A.*

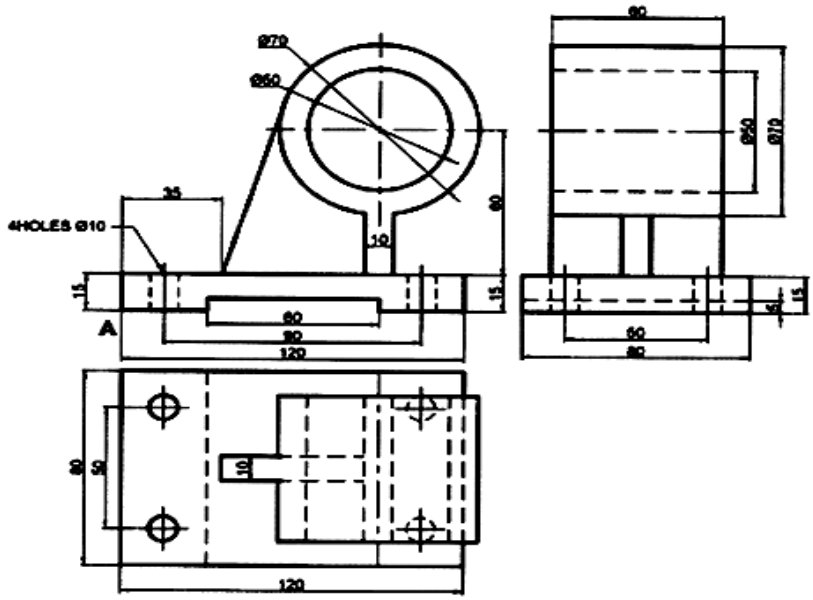


Figure 1

The analysis indicates that the question was attempted by 183 (100%) candidates and their scores were as follows: 106 (57.92%) scored from 0 to 8.5 marks, 45 (24.59%) scored from 9.0 to 19.0 marks and 32 (17.49%) scored from 19.5 to 30 marks. These data are summarized in Figure 2.

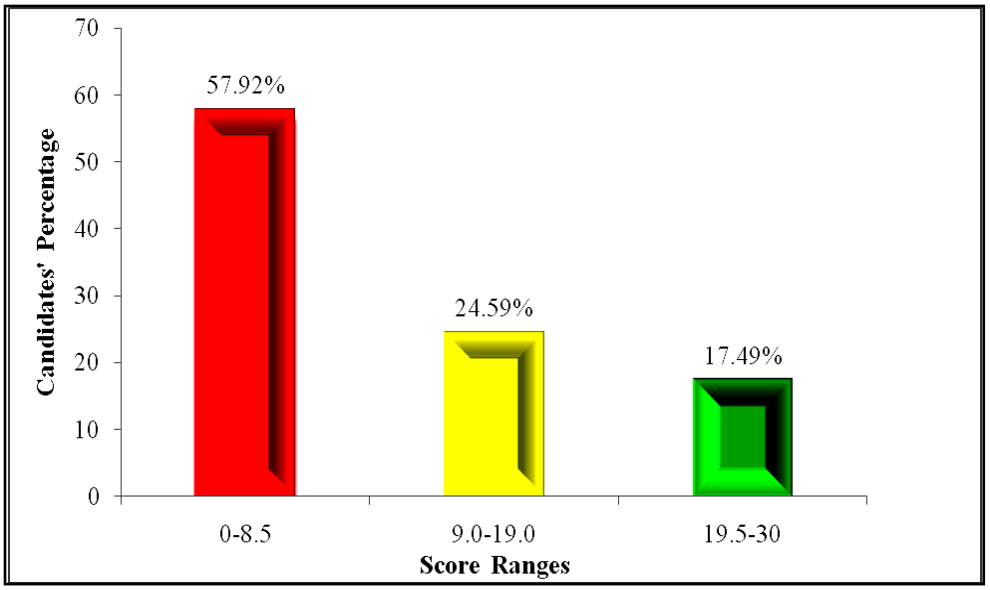
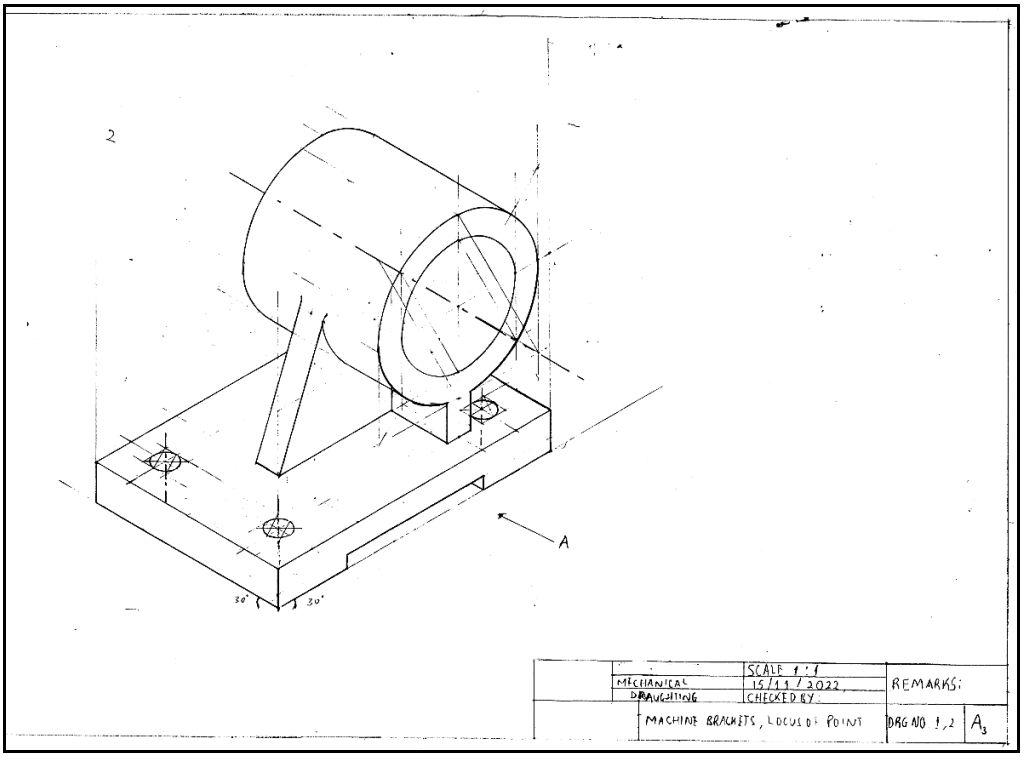


Figure 2: *The Candidates' Performance in Question 2*

Figure 2 shows that the general candidates' performance on this question was average because 42.28 percent scored from 9.0 to 30 marks. Among them, 24.59 percent managed to draw the required figures but failed to complete the figure or missed some steps such as erasing construction lines, and to draw and connect correctly the isometric circles and arcs.

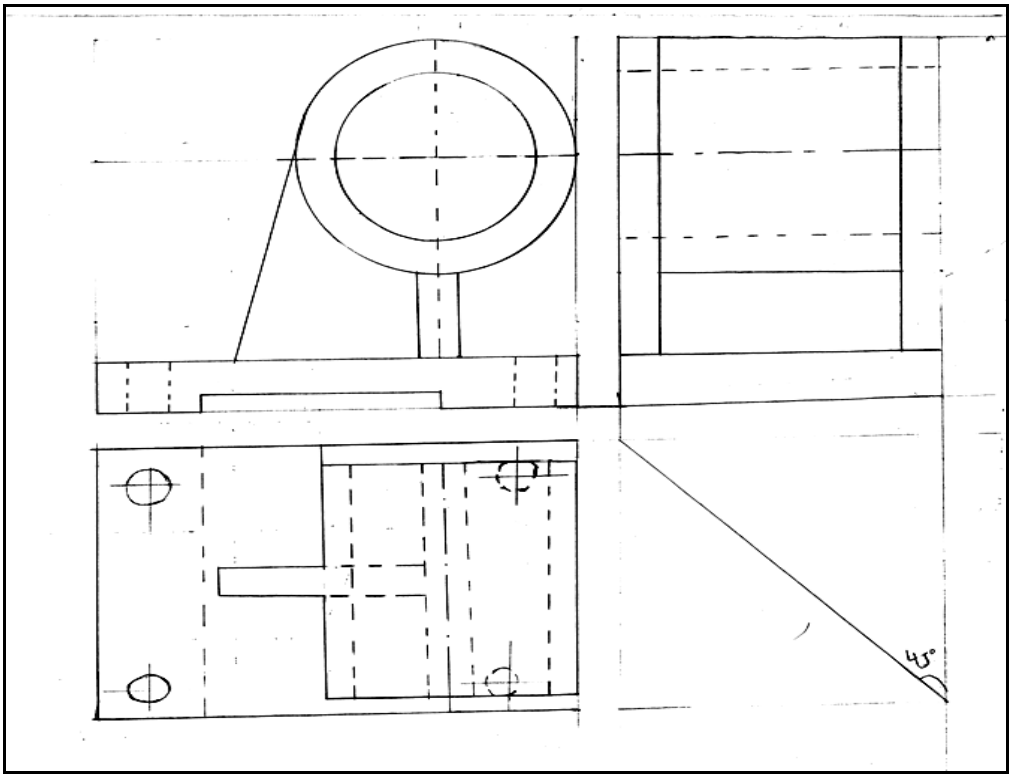
On the other hand, 17.49 percent scored higher marks, that is, 19.5 to 30 marks. These candidates were able to interpret the requirements of the question. They used their knowledge to draw the required object in isometric projection. They were able to follow the steps, which include making a paper layout and drawing the required isometric views, isometric circles, arcs, holes, and webs. Lastly, the candidates were required to make visible lines of the required figure by considering the sketches, hidden details, and neatness. Extract 2.1 provides a sample of correct responses from one of the candidates.



Extract 2.1: A sample of candidates' good responses to Question 2

In Extract 2.1, the candidate managed to convert the isometric drawing from the given orthographic views as required by the question. She/he followed the procedures by constructing the isometric block, isometric cycles, and center lines. In addition, full size scale, visibility, and exact dimensions were used. Also, the candidate leaves the visible and construction lines, which identify the visibility of the object. This indicates that she/he had sufficient knowledge of drawing isometric objects.

On contrary, 106 (57.92%) candidates scored from 0 to 8.5 marks. These candidates failed either to draw or complete the required isometric figure. They failed to realise that in mechanical drawing, the objects are presented in orthographic views in order to improve visualization of designs, clarify multiviews, and facilitate dimensioning of drawings. Some of them were able to create a paper layout and draw the title block but were unable to use appropriate scale or make the views visible. What is worse, one candidate copied the full question. These candidates lacked knowledge and skills about the subject matter. Extract 2.2 is a sample of an incorrect response from the script of one of the candidates.



Extract 2.2: A sample of candidates' incorrect responses to Question 2

In Extract 2.2 the candidate redrew the question instead of constructing the section views. This indicates that the candidate lacked knowledge and skill in orthographic projection.

2.2 Section B: Optional Questions

This section consisted of four (4) short-structured questions that were constructed from the following topics: *Loci of Mechanism, Auxiliary views, Development* and *Free Hand sketches.* Each question carried 20 marks, and the candidates were required to attempt three (3) questions, making a total of 60 marks.

2.1.3 Question 3: Loci and Mechanism

This was optional question composed from the topic of Loci and Mechanism. The candidates were given the link mechanism of a machine. They had to draw a locus of points given the fixed cranks and make one complete revolution within the given distances to the links.

The question was attempted by 117 (63.9%) of the candidates out of those who sat for the examination. Analysis shows that 60 (51.28%) of the

candidates scored 0 to 5 marks, 27 (23.08%) scored 6 to 12.0 marks, and 30 (25.64%) scored 13 to 20 marks. Figure 3 illustrates the candidates' performance in this question.

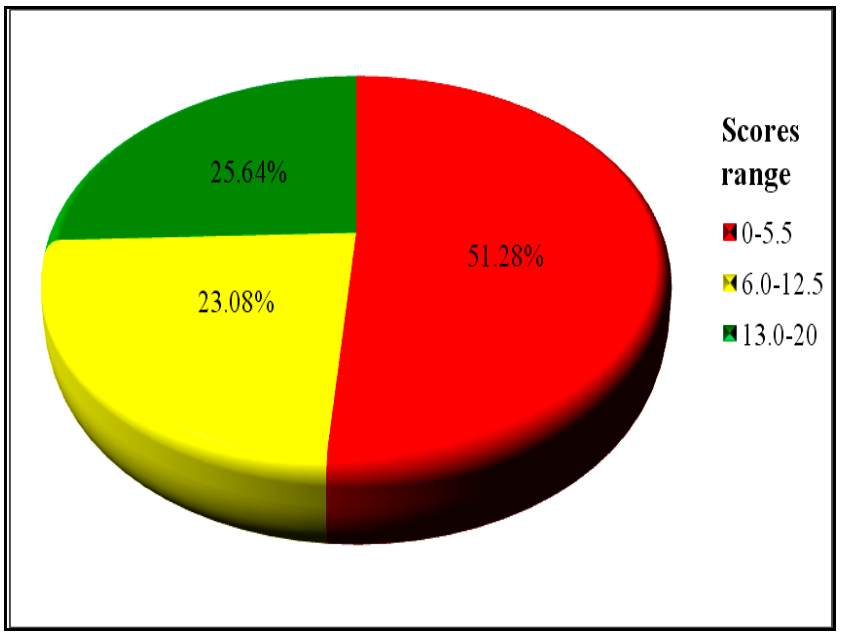
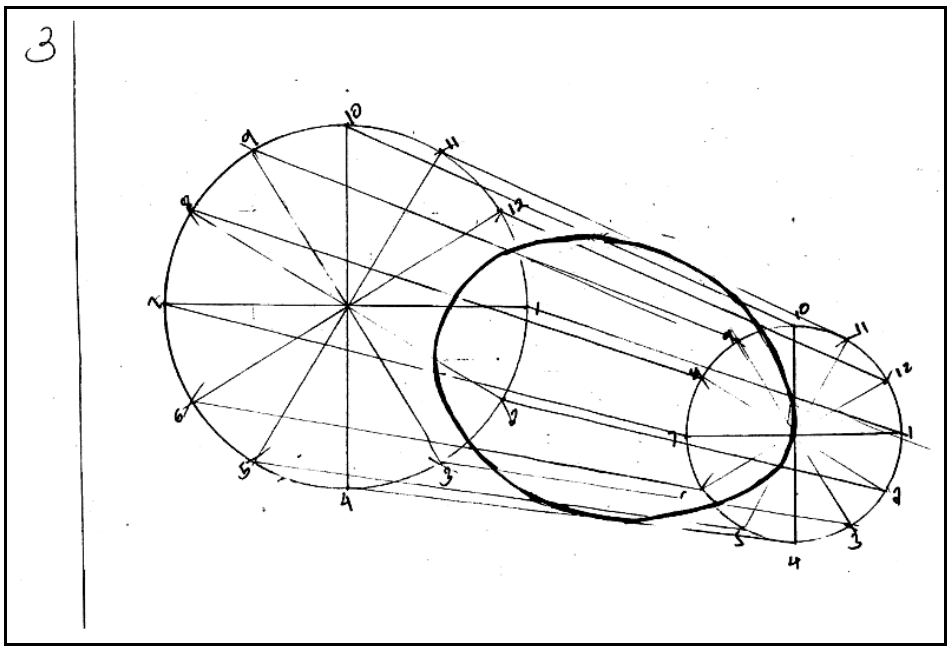


Figure 3*: The Candidates' Performance in Question 3*

Figure 3 shows that the general candidates' performance on this question was average because 48.72 percent scored from 6.0 to 20 while 51.28 percent scored from 0 to 6 marks. The candidates who scored low marks (0–6) failed to draw the required locus. These candidates failed to know that, in attempting this question, they were required to follow various stages. Firstly, they were required to draw the circle, bisecting it into equal parts, taking CE as the radius. Then, with the links connected, they should mark and draw a line connecting the points marked in the circle with point ABCE. Also, they failed to draw an arc for the given radii BD and BC. Lastly, connect the points and make the visibility clear by leaving the construction lines. Failure to follow these steps led to loss of marks.

Moreover, lack of competence in interpreting the requirement of the question and drawing the required object was another limitation noted in some of the candidates' responses. For example, one candidate drew the given sketch and made the locus of the point B instead of point D as the requirement of the question. This was evidenced by a candidate who copied the given link and drew views instead of converting them into

three-dimensional objects. Extract 3.1 illustrates a poor response from one of the candidates.

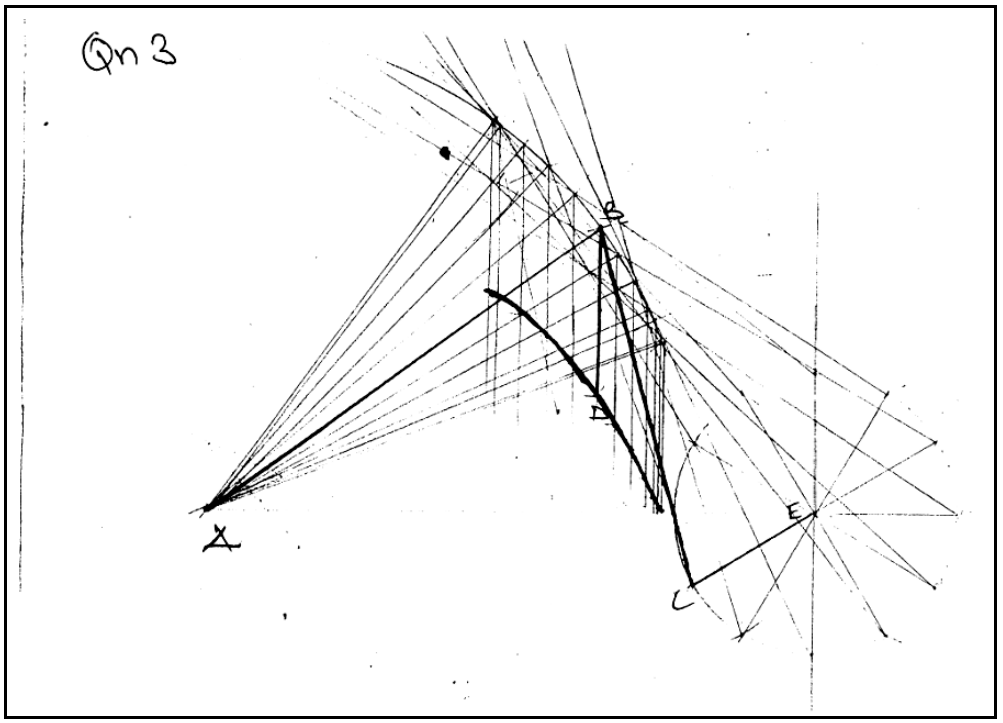


Extract 3.1: A sample of incorrect responses to Question 3

The candidate drew the wrong locus of the point in Extract 3.1. She/he created a locus of connections as if both links were fixed instead of a few free links, which is comparable to a locus with fixed endpoints but a single hinge in the middle. This means that she/he did not have sufficient knowledge of the necessary forms of loci to draw the specified links, which have both pivoting ends and hinges at the center and one link that is free.

However, the candidates who scored average marks (6 to 12.5) had partial knowledge about the locus and its mechanisms. Some of the candidates in this category were able to provide the correct sketches of the crank's circle, but they were not able to bisect the circles, mark and connect the points of the circle, or draw the locus of point. Other candidates managed to draw the circle and the line that bisects the circles but failed to plot the passage of point D as required. This implies that the candidates had partial knowledge and skills about the locus and its mechanism but did not comprehend the requirements of the question due to a lack of technical skills.

However, out of the candidates' scores, 25.64 percent were able to draw the correct type of locus. The candidates in this category had a greater understanding of the question's demand, so they provided genuine explanations and relevant examples. Nevertheless, variations were noted in their scores. These variations were caused by differences in the degree of clarity, neatness, comprehensiveness, and leaving the construction lines, as well as the visibility of the required locus. Extract 3.2 is a sample of a response from a candidate who responded well to the question.



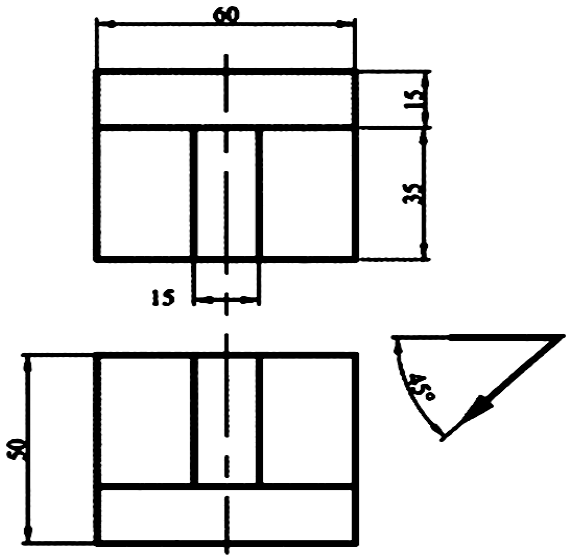
Extract 3.2: A sample of correct responses to Question 3

In Extract 3.2, the candidate provided relevant responses to Question 3. The responses show that the candidate was familiar with the topic and understood the requirements of the question.

2.1.4 Question 4. Auxiliary Views

This was an optional question from the topic of Auxiliary Views. The question required the candidates to use a third angle and full scale to draw views of machine parts projected at an angle of 45^{o}. The question was:

The figure below shows two views of machine parts in first angle projection. Using full size scale and third angle projection draw an auxiliary view of the plan to the angle of 45^{0}.



The data analysis indicates that this question was attempted by 150 (82.0%) candidates. Out of them, 72 (48.0%) scored from 13 to 20 marks, 50 (33.33%) scored from 6 to 12.5 marks, and 28 (18.67%) scored from 0 to 5 marks. Figure 4 portrays the candidates' performance in this question.

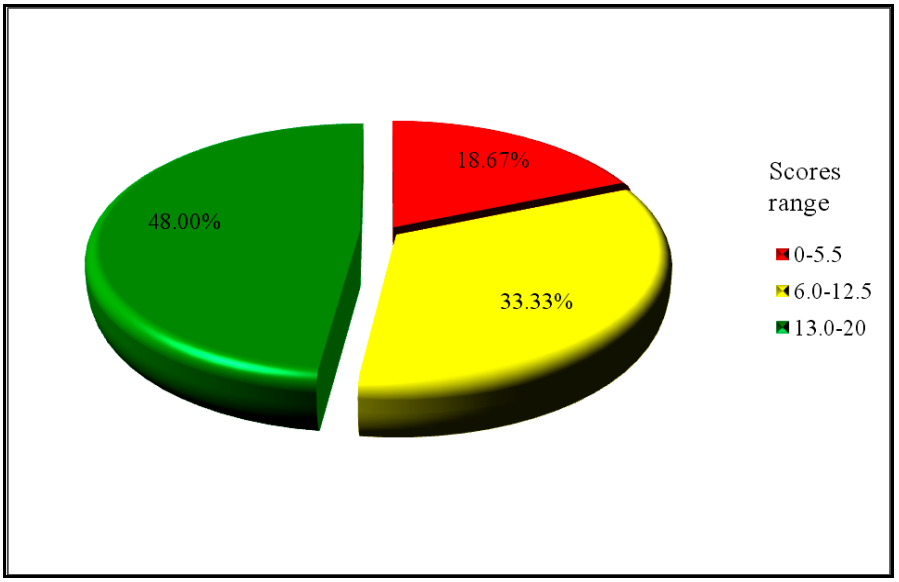
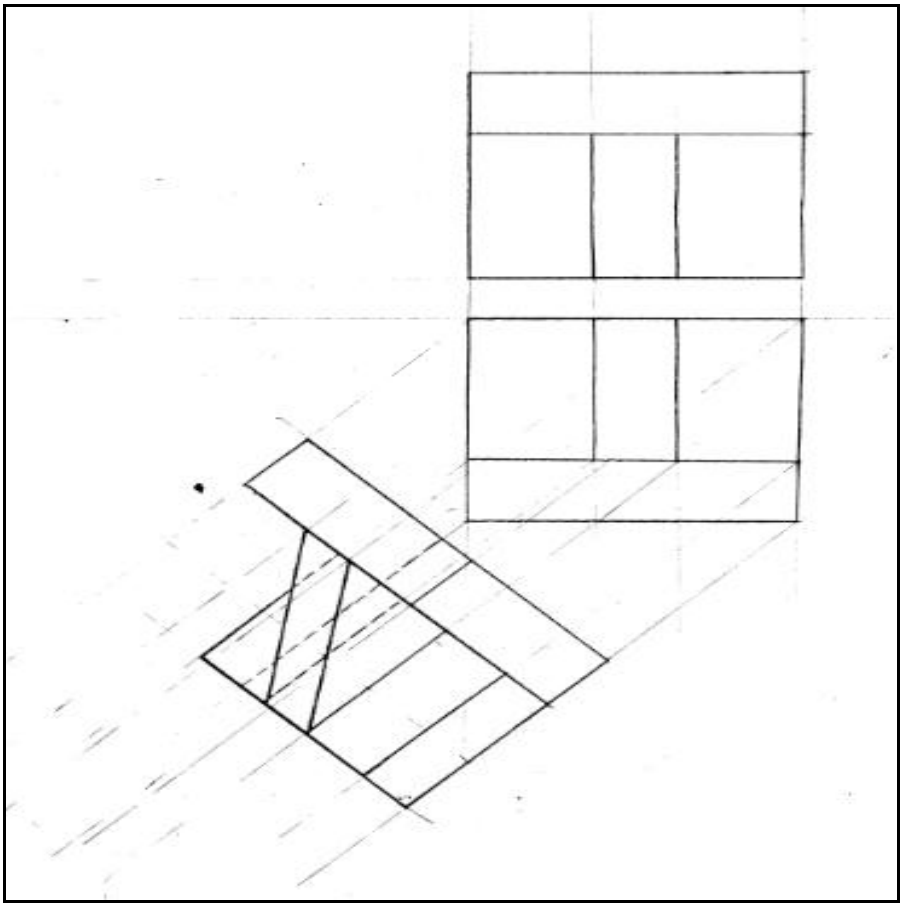


Figure 4: *The Candidates' Performance in Question 4*

Figure 4 shows that the performance for this question was good since the majority (81.33%) of the candidates scored from 6.0 to 20 marks. This performance could be attributed to the fact that the candidates were familiar with the auxiliary views content. Out of that, 48 percent who scored higher marks managed to draw the correct view by providing proper

position and angle of the plan, exactness of dimensions, visibility of the required views, neatness as well as good arrangement of the drawing. These candidates knew that auxiliary views are generally used to show the true shapes of sections and objects that are not projected on the main horizontal and vertical planes. This indicates that the candidates had adequate knowledge of auxiliary views. Extract 4.1 provides a sample of correct responses from one of the candidates.



Extract 4.1: A sample of candidates' correct responses to Question 4

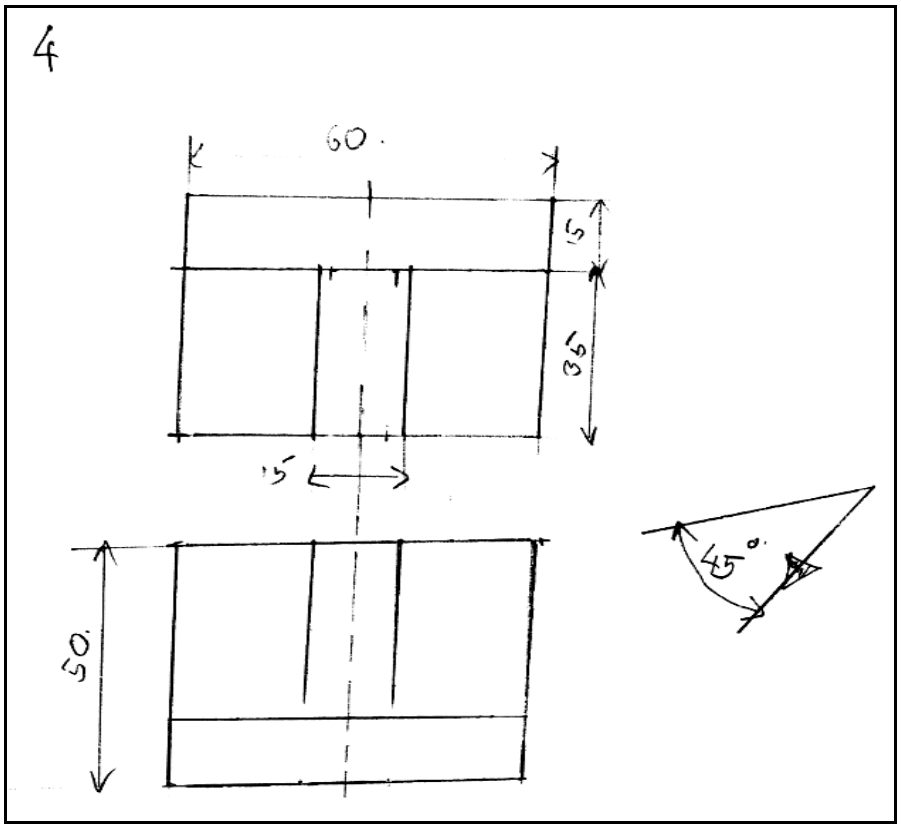
Extract 4.1 is a sample of responses from the candidate who correctly drew the plan view. She/he managed to show clearly the procedures by leaving the construction lines, the light position and angle of the plan, the neatness, and the exact dimensions of the views. The responses imply that the candidate had adequate knowledge on the topic of auxiliary views.

On the other hand, 33.33 percent of the candidates who received marks between 6 and 12.5 (the average score) were able to complete the drawing

but skipped some views and steps. Some of them rearranged the plan view and deleted the construction lines. Other candidates made an effort to portray the required views but were unable to demonstrate their visibility.

On the contrary, those candidates who scored low marks proved that they had very little understanding of the concept of auxiliary views. The majority drew wrong diagrams or drew orthographic views with projection lines without following the required angle of direction and position of the views. They failed to understand that auxiliary views are projected from existing principal views. Marking and mark allocations in mechanical draughting were based on steps and stages of drawing. Hence, these candidates failed to follow properly drawn steps and stages.

For example, one of the candidates copied the given views without using drawing equipment, in the same position as the first angle projection instead of the third angle projection, and with improper dimensions. She/he had no idea that changing the views from first-angle projection to third-angle projection was required before attempting this type of question. Secondly, she/he was required to draw the projected lines of the plan edges looking at the angle of 45^0 using construction lines. Another step was to draw perpendicular lines to cut the projected line at the given dimension. Lastly, the candidate was required to make visible all parts that are required to be seen without forgetting applications of various types of lines such as hidden lines, center lines, etc. Most of them received low grades because they failed to complete or follow these stages. This implies that the candidates were not familiar with the subject matter. Extract 4.2 is a sample of responses from one of the candidates who did not perform well in this question.



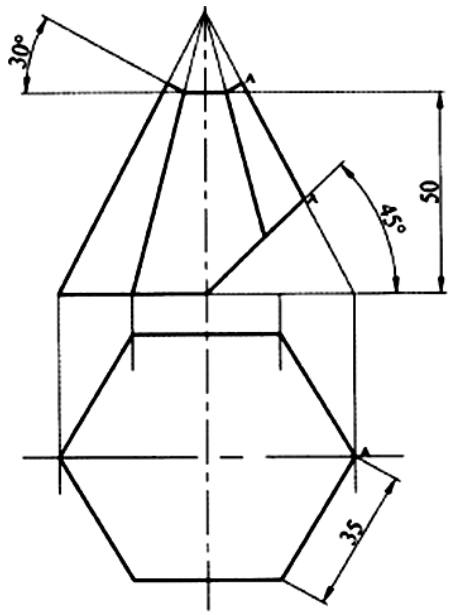
Extract 4.2: A sample of candidates' poor responses to Question 4

In Extract 4.1, the candidate failed to provide the appropriate auxiliary plan that was required and projected at an angle of 45^0; rather than sketching the auxiliary, by copying the question. This demonstrated that he/she did not comprehend the question's requirements.

2.1.5 Question 5. Development

The question was composed from the topic of *development.* The candidates were required to complete the plan and develop the front views. It was intended to measure the ability of the candidates to apply their knowledge of the true length and triangular methods of development.

The question was: *Two views front and plan of hexagonal pyramid cuts on top and oblique is drawn in first angle projection as shown in the figure below. Using full size scale, complete the plan and development of front elevation taking A-A as the cutting plane.*



The question was attempted by 173 (94.5%) candidates. The candidates who scored 0 to 5.5 marks were 24 (13.87%), out of whom 12 (6.6%) scored zero. The candidates who scored marks ranging from 6 to 12.5 marks were 70 (40.46%), while 79 (45.67%) candidates scored from 13 to 20 marks. Figure 5 presents the candidates' performance in Question 5.

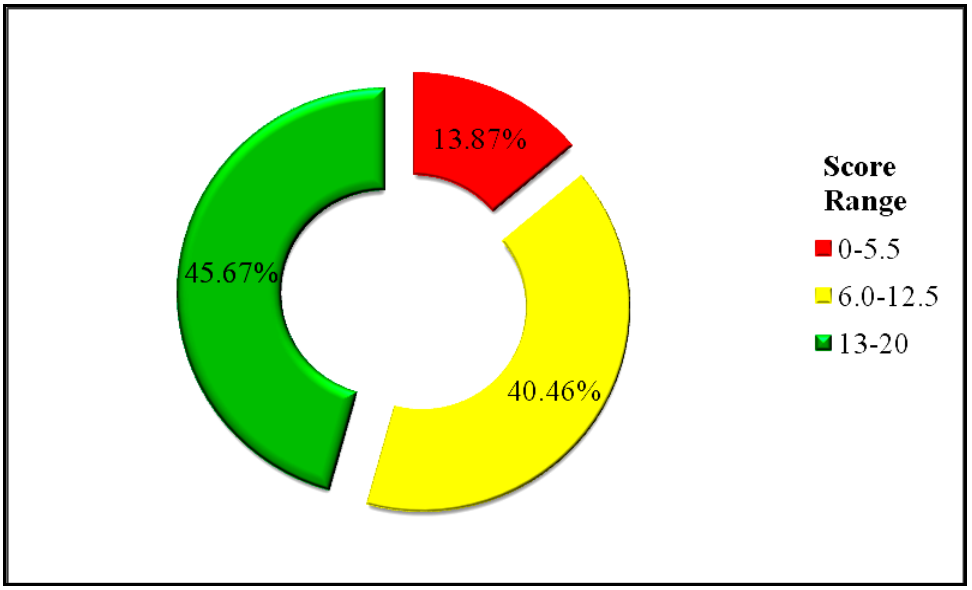
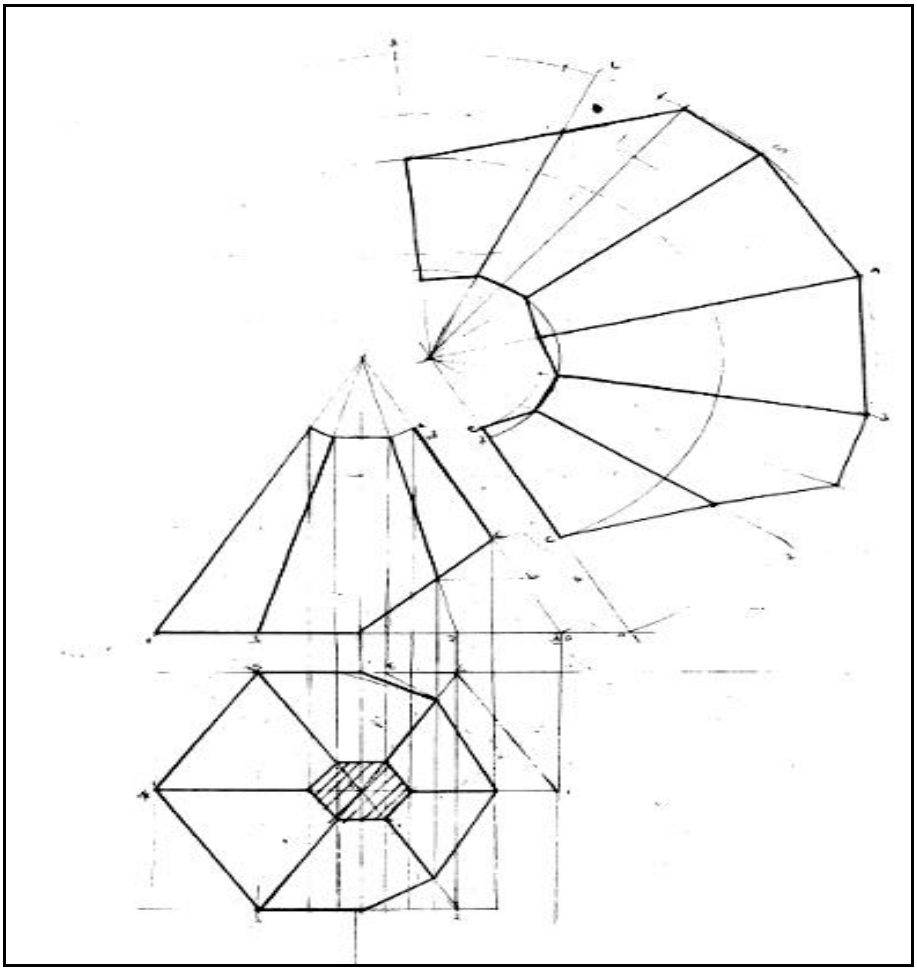


Figure 5: *The Candidates' Performance in Question 5*

The analysis in Figure 5 indicates that the candidates' performance in this question was good since 149 (86.13%) of the candidates scored from 6 to

20. These candidates managed to interpret the requirements of the question. Those who scored from 6 to 12.5 marks managed to follow the steps in drawing the development of the hexagonal pyramid and complete the plan. However, some of them skipped some procedures or forgot to make the required view edges visible. For example, one of the candidates managed to develop the front views and plans but failed to shade the truncated parts. This shows that he/she had partial knowledge of the task.

On the other hand, candidates who received 12.5 to 20 points demonstrated their knowledge by interpreting the requirement of the question and followed the required steps of drawing the development using triangular methods. They were able to use true length and make the views visible. Extract 5.1 shows a sample of correct responses provided by one of the candidates.

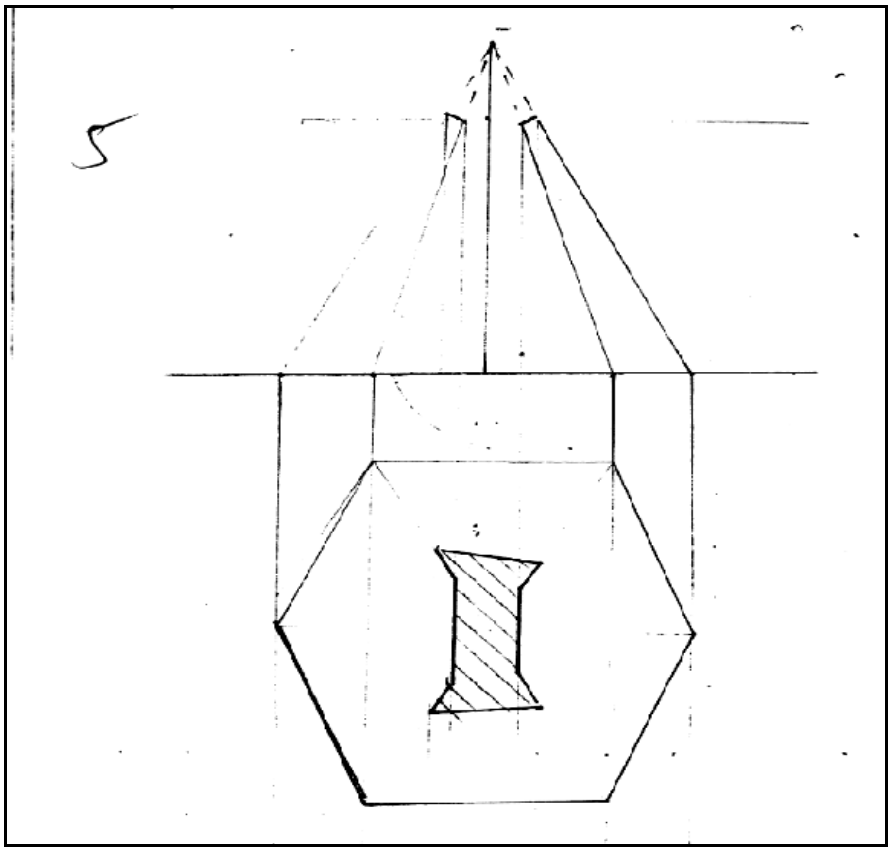


Extract 5.1: A sample of candidates' good response to Question 5

Extract 5.1 shows the candidate who managed to correctly draw the development views. She/he also demonstrated a good mastery of drawing skills by providing relevant views, left construction lines, correct positions of views and their visibility.

Despite the good performance, 13.87 percent of the candidates scored low marks, ranging from 0 to 5.5. They did not show the steps required to attain the desired triangular method used for the development of the cone, prism, and pyramid. Also, most of the candidates did not understand the application of "true length" as the type of line used to obtain the true shape of the inclined views. As per question given, each step and procedure was given marks.

The candidates who scored zero failed to; draw the given views, complete the hexagonal plan through proper drawing and using a true length, fail to draw the semi-circle and bisect it into equal parts, mark the required edges and points; and leave construction lines. The majority failed this question due to lack of knowledge on how to use true length to obtain the true dimension of the front view. For example, one candidate copied the given views and drew construction lines without drawing a development plan. This shows that she/he had insufficient knowledge about the topic of development. Extract 5.2 shows a sample of incorrect responses provided by one of the candidates.



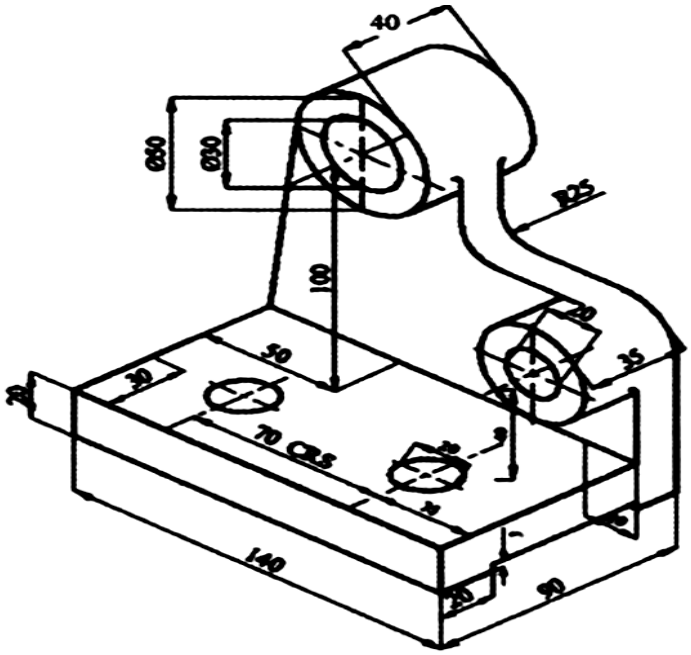
Extract 5.2: A sample of candidates' poor responses to Question 5

Extract 5.2 shows a sample of responses from a candidate who drew an improper elevation. He/she failed to draw the exact front elevation as indicated in the question. Instead of using a semicircle to cut the triangle's part, straight lines were used, which is incorrect. Also, she/he failed to complete the required plan with proper shape and dimensions. This implies that she/he lacked drawing skills and misunderstood the requirements of the question.

2.1.6 Question 6. Orthographic Projection and Free Hand Sketching

This was an optional question from the topic "*Free Hand Sketching*." The question required the candidates to apply their skills of freehand sketching to convert the pictorial drawing to orthographic projection by drawing three views in third-angle projection. The purpose of the question was to measure a candidate's ability to draw different views by using basic sketching techniques without the use of any tools or other measuring equipments. The question was:

The figure below shows a component drawn in isometric projection. At approximately full size scale, free hand sketch and orthographic views; draw it in third angle projection. Take long distance as front view. Leave all constructions lines and do not indicate the dimensions.



This question was attempted by 59.6 percent of all candidates who sat for this examination. The candidates' performance in this question can be categorized as weak since 12.84 percent of all the candidates who attempted the question scored from 6.0 to 20 marks. Furthermore, 95 (87.16%) candidates scored from 0 to 5.5 marks, indicating poor performance; 11 (10.09%) scored from 6 to 12.5 marks, which is an average performance; and 3 (2.75%) scored from 13 to 20 marks, which is a good performance. Figure 6 shows the summary of the candidates' performance in this question.

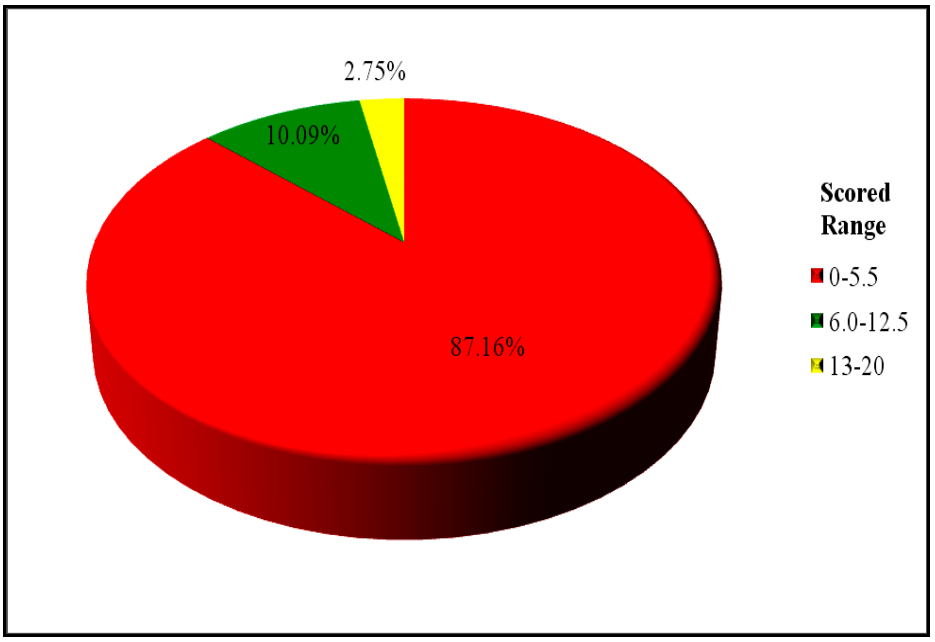


Figure 6: *The Candidates' Performance in Question 6*

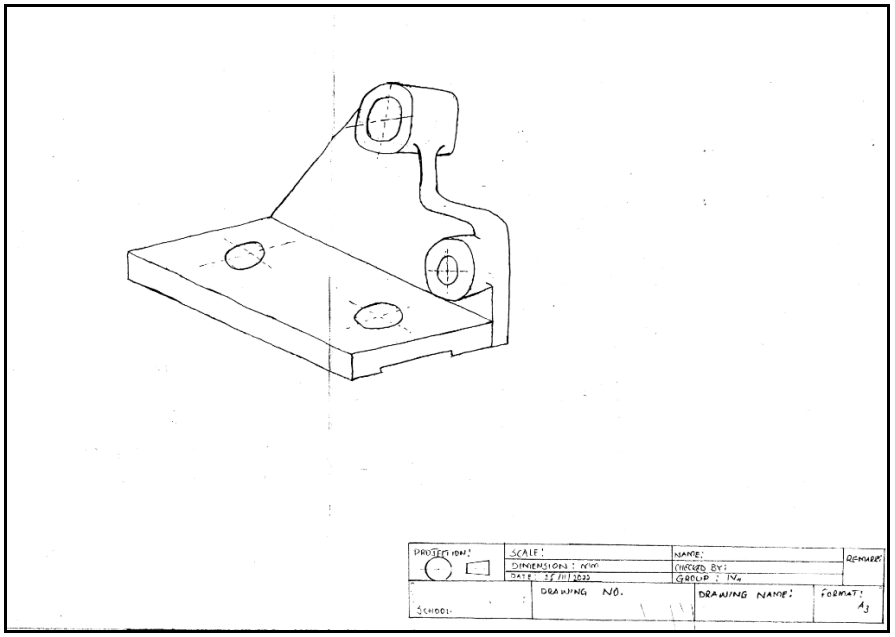
The performance trend in Figure 6 shows that candidates' performance were weak since 87.16 percent of the candidates scored from 0 to 5.5. The response analysis reveals that the poor performance was attributed to inadequate knowledge of converting pictorial drawings to an orthographic projection.

On the other hand, 88 candidates, which is 80.7 percent, scored zero. These groups failed to follow principles of the free hand sketches such as making sure the object could be seen thoroughly and pondering over its objectives and concepts; consideration of a more detailed selection of a view; paper layout of the required sketching pending with sizes of views; consideration of views' dimension and scale ratio and proportionality; making the required figure visible; and omitting unrequired lines.

Furthermore, the candidates failed to know that the question included and required the candidates to follow the principles of sketching a straight line, curve, circle, square box, and irregular edge. Candidates had to start with a dash or dot that was sufficiently far to the right on the paper while responding to this question, and then maintain focus on the point as if drawing a straight line. Additionally, they had to plot a few spots that were not too far apart at various levels, combine the dashes or dots to construct curves, and then draw lines with diameters that were close to or equal to

the diameter of the circle. The lines must cross at a central location and be as thin and straight as feasible. Candidates had to first draw a regular or square block that could completely contain the object, and then carefully shape it with dotted lines to join the desired shape of appropriate curves or lines. Failure to follow the required steps indicates that these candidates lacked knowledge of free-hand sketching.

Moreover, those candidates who scored from 2 to 5.5 marks were able to initiate the procedure of attempting the question, but failed to show their ability to adhere to the procedure. For example, one of the candidates managed to make a paper layout and construct the required views but failed to use the method of freehand sketching. She/he drew the views using drawing tools and equipment. This implies that she or he lacked the fundamental skills of freehand sketching. Extract 6.1 is a sample of a poor respond taken from the script of one of the candidates.



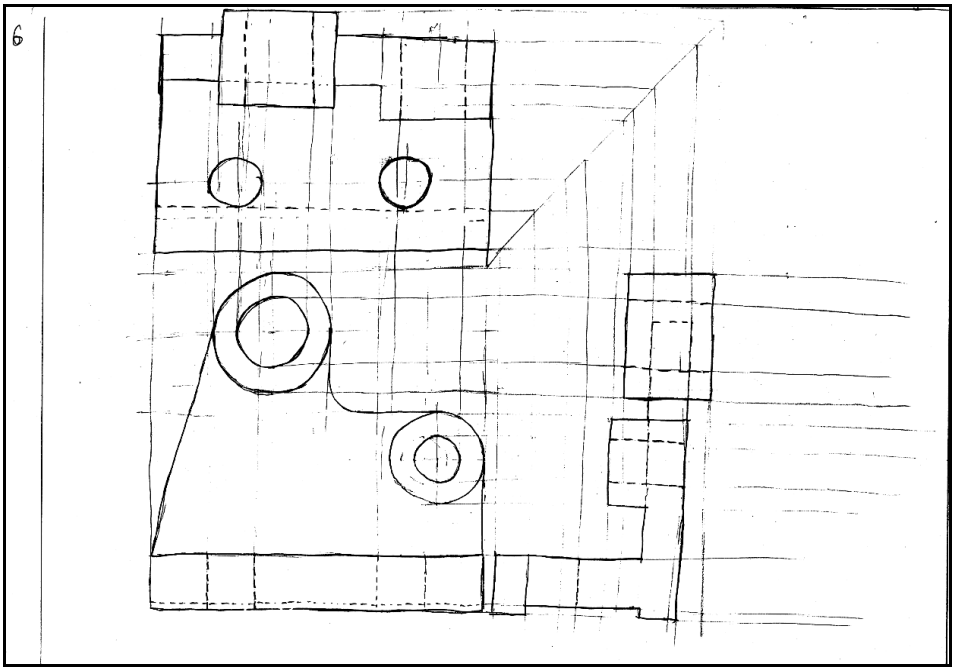
Extract 6.1: A sample of candidates' poor responses to Question 6

In Extract 6.1, the candidate failed to draw the required orthographic views as instructed. Instead of drawing the view in orthographic projection, she/he copied the question as it was.

Despite the poor performance, 14 (12.84%) of the candidates scored from 6.0 to 20 marks; out of them, 10.09 percent scored 6 to 12.5 marks. These candidates managed to sketch the appropriate views in orthographic

projection but missed a few steps, either because they failed to complete the figures or missed some lines. Other candidates failed to indicate internal parts and centres of the circle. They used thick and continuous lines instead of thick and short dashed lines for hidden parts, as well as thin and long continuous lines instead of thin and long-short-long types of lines for cylindrical parts. This indicates that those candidates had partial knowledge of mechanical drafting techniques.

On the other hand, 3 candidates who scored from 12.5 to 20 marks were able to interpret the orthographic views as the drawing process used to clarify the interior construction of a part that cannot be clearly described by pictorial drawing. This group knows that freehand drawing enables the visualization of an idea in the form of a sketch, which can be used as an inherent element of a design process, especially in the first conceptual stage. Most of the candidates who scored higher marks knew the important rule in freehand sketching which is to keep the sketch in proportion, which means to accurately represent the size and position of each part in relation to the whole. No matter how brilliant the technique or how well drawn the details are, if the proportions are off, the sketch will not look right. This indicates that these candidates had knowledge and skills of the subject matter. Extract 6.2 is a sample of a good respond taken from the script of one of the candidates.



Extract 6.2: A sample of candidates' good responses to Question 6

In Extract 6.2, the candidate was able to depict the orthographic views of the provided figure that use the free-hand technique. She/he converted visual items to orthographic views by applying the third-angle projection techniques. Additionally, she/he was able to use a variety of projection angles that were appropriate, different types of lines, and approximate dimensions to show views, their locations, visibility, and the accuracy of the needed views.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

The Certificate of Secondary Education Examination (CSEE), 2022, in the Mechanical Draughting subject had six (6) questions from topics covered in the Form IV Mechanical Draughting syllabus. The topics covered in the paper were *orthographic projection, standard ISO and drawing sheets, scales, abbreviations, and terminologies, loci and mechanisms, limits and fits, auxiliary views, intersection of cylinders, dimensioning, and symbols.*

Analysis of statistical data on candidates' performance reveals that good performance were in Questions 1, 4, and 5 from the topics of scale combination and geometric construction, respectively. The performance was average in Questions 2 and 3, and weak in Question 6, extracted from the topics of orthographic projection, loci, and free hand drawing, respectively. As for good performance, the topics that had this level attainment were "development," whereby 149 (86.13%) of the candidates passed in Question 5, followed by Question 4, set from the Auxiliary, where 122 (81.33%) candidates passed, and Question 1, composed of various topic sets for objective questions, where 129 (70.49%) candidates passed. This good performance on these questions resulted from the fact that candidates demonstrated enough knowledge and skills about the tested topics, good English language proficiency, and their ability to understand the requirements of the questions. On the other hand, questions 2 and 3 were marked as average. Conversely, weak performance was observed in question 6 in which only 14 (12.84%) of the candidates scored above 30% out of the 109 who attempted this question. The question was derived from the topic of free-hand drawing.

In a nutshell, the candidates' weak performance on these questions was caused by their inadequate knowledge and skills about the subject matter, their failure to correctly interpret and identify the requirements of the question, and their limited drawing skills. The candidates’ performance per

topic is summarized in the appendices whereby green, yellow and red represent good, average and weak performance respectively.

4.0 CONCLUSION AND RECOMMENDATIONS

This section provides conclusion and recommendations after the analysis presented in the previous sections. The given conclusion and recommendations are based on the responses' analysis of each question and each topic in the Mechanical Draughting subject of CSEE 2022.

4.1 Conclusion

Based on the candidates' responses, the overall performance in the Mechanical Draughting subject for the Certificate of Secondary Education Examination (CSEE) 2022 was weak. This is because only 144 (78.69%) candidates who sat for the examination obtained grades A to D. In addition, 39 (21.31%) candidates failed the examination. The majority of the candidates performed well in three (3) questions, average in two (2) questions and poorly in one (1) question. The performance of candidates question-wise, topic-wise, and grade-wise with respect to the topics extracted from the Mechanical Draughting Syllabus is summarized in Appendices A, B, C and D, respectively.

Furthermore, the analysis of the candidates' performance for each question shows that the good performance observed was the result of the candidates' ability to understand the demand of the questions, their adequate knowledge of technical drawing concepts, and their adequate drawing skills. Conversely, the weak performance in question six was a result of a candidates' failure to understand the demand of the question and having inadequate knowledge and skills in free-hand technique. Furthermore, the candidates' average performance was caused by either provision of incomplete and irrelevant responses or skipping several steps of the questions.

4.2 Recommendations

For future improvement in this subject, there were areas of noted weakness and maintenance in areas of noted strength. That being the case, the following are the recommendations thought to be very important for improvement:

(a) School administrators and subject teachers should promote learning by ensuring the availability of learning and teaching facilities. Practice will foster knowledge and competence attained by students, thus improving their performance both at the school and national levels.

(b) Teachers should establish subject clubs, provide regular classroom based exercises, and provide immediate feedback to students to learn how they can identify the requirements of the questions and the best way of presenting their responses, whether in drawing or description, in relation to engineering.

(c) Students should be guided and encouraged to read various and relevant subject materials (books, past papers, journals, and pamphlets) in order to broaden their knowledge and skills. Teachers are urged guide them in identifying the tasks or requirements of the question(s).

(d) In order to become familiar with mechanical drawing, students must practice using drawing tools and other equipment.

Appendix A

Table 2: A summary of candidates' performance (question-wise) in Mechanical Draughting in 2022

S/N	Topics	Question Number	Percentage of candidates who scored 30% or more	Remarks
1	Development	5	86.13	Good
2	Auxiliary views	4	81.33	Good
3	Orthographic projection, Introduction of Drawing sheet and office, Scales, Abbreviations and Terminologies, Loci and mechanism, Development, Limits and Fits, Drawing Instruments and Equipment, Dimensioning and symbols	1	70.49	Good
4	Loci and mechanism	3	48.72	Average
5	Orthographic Projection	2	42.08	Average
6	Free hand sketches	6	12.84	Poor

Appendix B

A Summary of Candidates' Performance Topic-wise

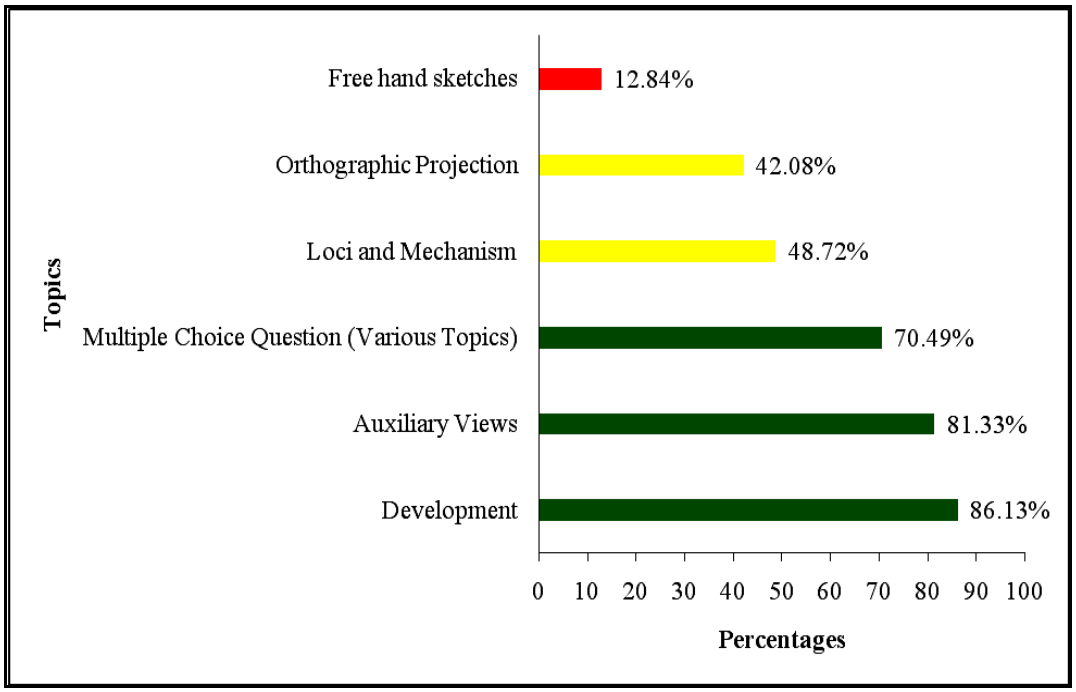


Figure 7: Students' Performance Grade-wise

Appendix C

Table 3: Summary of Candidates Performance Grade-wise

GRADE	A	B	C	D	F	TOTAL
2022	5	16	58	65	39	183

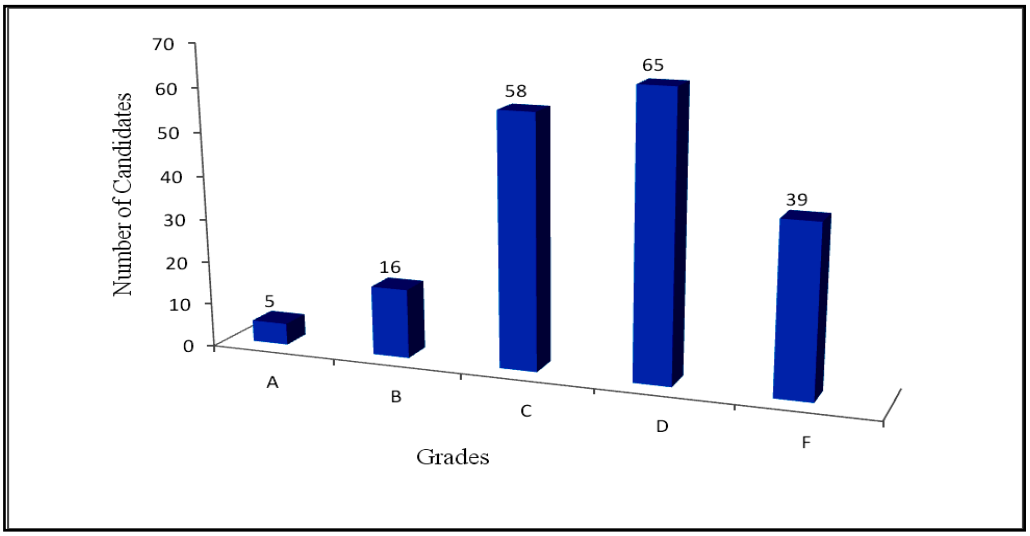


Figure 8: Candidates' Performance Grade-wise

Appendix D

Table 4: Description of candidates' performance in each question

Questions		Qn 1	Qn 2	Qn3	Qn 4	Qn 5	Qn 6
Number of Candidates	Weak	54	106	60	28	24	95
	Average	126	45	27	50	70	11
	Good	3	32	30	72	79	3
	Total	**183**	**183**	**117**	**150**	**173**	**109**

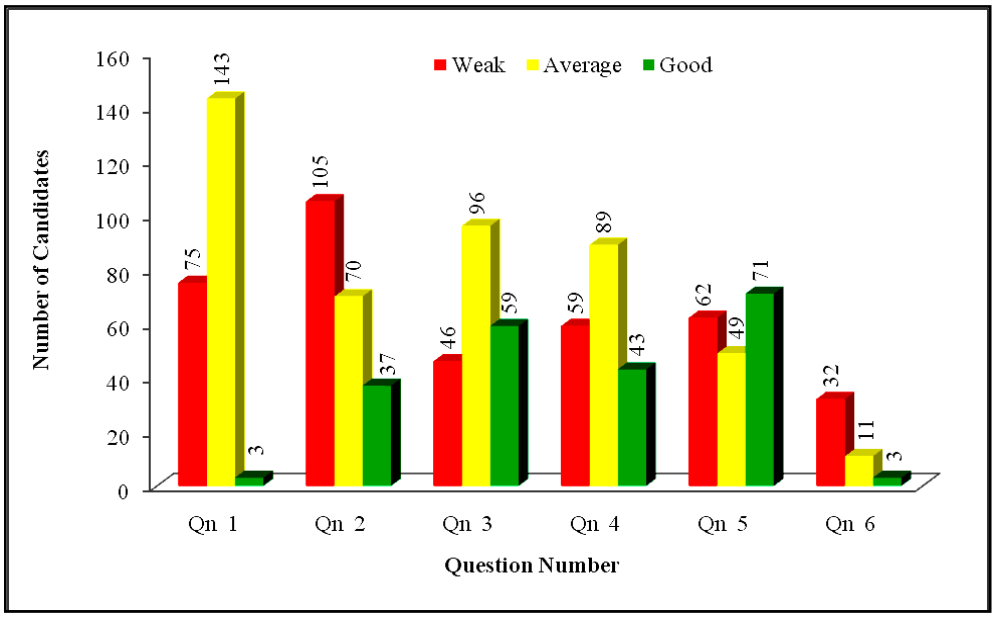


Figure 9: Candidates' Performance Question-wise