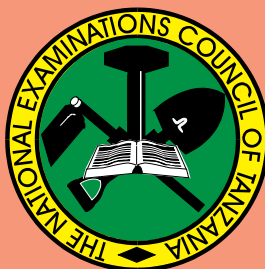


THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**STUDENTS' ITEM RESPONSE ANALYSIS
REPORT FOR THE FORM TWO NATIONAL
ASSESSMENT (FTNA) 2015**

090 MECHANICAL ENGINEERING

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



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ON THE FORM TWO NATIONAL ASSESSMENT
(FTNA) 2015**

090 MECHANICAL ENGINEERING

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FOREWORD

The Students' Items Response Analysis report in Mechanical Engineering subject for Form Two National Assessment (FTNA) 2015 was prepared in order to provide feedback to students, teachers, parents, policy makers and the public in general on the performance of the students.

The Form Two National Assessment is a two years formative evaluation which among other things shows the effectiveness of education system in general and education delivery system in particular. Essentially, students' responses to the assessment questions is a strong indicator of what the education system was able or unable to offer to students in their two years of secondary education.

The analysis presented in this report is intended to contribute towards understanding some of the reasons behind the performance of students in Mechanical Engineering subject. The report highlights some of the factors that made some students score low marks in the questions. Such factors include lack of knowledge in relation to a particular concept, failure to interpret the requirement of the questions, poor command of English language and inability to answer questions which demand explanations, formula and symbols. The feedback provided will enable the educational administrators, school managers, teachers and students to identify proper measures to be taken in order to improve students' performance in future assessments administered by the Council.

The National Examinations Council of Tanzania (NECTA) will highly appreciate comments and suggestions from teachers, students and the public in general, that can be used to improve future Assessors' Reports.

The Council would like to convey thanks to the Assessors, Examination Officers and all others who participated in preparation of this report. We would like also to express sincere appreciation to all staff of the Department of Information and Computer Technology who participated in the analysis of the data used in this report.



Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report is based on the analysis of individual questions for students who sat for Mechanical Engineering paper in FTNA 2015. The paper was set in accordance with the form one and two Mechanical Engineering syllabi of 1994.

There were eight (8) questions in this paper, grouped into sections A, B and C. Sections A and B had a total of three compulsory questions whereas section C had a total of 5 questions of which the students were required to answer only one question. Section A had 10 marks, section B had 30 marks and section C had 60 marks.

A total of 388 students sat for the Mechanical Engineering National Assessment. The results show that 119 (30.67%) students passed while the remaining 269 students (69.33%) failed.

This report provides the analysis of each question. It highlights the demand of the question, the general performance and finally the possible reasons for good/poor performance and the misconceptions that were observed. In this analysis, a question was categorized as either weakly performed, averagely performed or good performed if the percentage of students who scored 30 percent or above, out of the allocated marks lies in the intervals of 0 – 29, 30 – 49 and 50 – 100 respectively.

2.0 ANALYSIS OF INDIVIDUAL QUESTIONS

2.1 Section A

2.1.1 Question 1: Multiple Choice Items

The question consisted of five (5) items (i) - (v), which were set from various topics within the syllabus. The students were required to choose the correct answer for each item from the given four alternatives.

A total of 387 students (99.7%) attempted this question, out of which 5.7 percent scored 0 mark, 46.4 percent scored from 1 to 2 marks, 42.5 percent scored from 3 to 4 marks and 5.2 percent scored 5 marks.

The data indicate that the students' performance was good as 78.4 percent of the students scored from 2 to 5 marks and among them 20.1 percent scored high marks

i.e from 4 to 5. Many students were able to identify the correct answer from the given alternatives. Those who poorly performed failed to make correct choice of answers in items (i), (ii) and (iii).

In item (i), the students were required to identify the part of the blast furnace at which the highest temperature occurs. The students chose option D 'hopper' instead of the correct answer B 'bosh' because they failed to recall the structure of the blast furnace and its sequence of operation for the production of pig iron.

In item (ii), the students were required to identify the property of rubber which allows it to be used for vibration dampers of machines. Many students chose distractor C 'malleability property' instead of the correct answer D 'elastic property.' Such students failed to distinguish between different properties of engineering materials.

Item (iii) required the students to identify the group of instruments under which a divider falls. The correct response was C 'marking tools' but most of the students opted for B 'measuring tools' since they failed to understand that a divider does not have any scale for measurements. In general, such students lacked practical skills in marking or laying out processes.

2.1.2 Question 2: Matching Items

This question required the students to match each item in list A with a correct response in list B by writing its letter below the number of the corresponding item in the table provided.

The question was attempted by 386 students, out of which 35.3 percent scored from 0 to 1 mark, 33.0 percent scored 2 marks and 31.2 percent scored from 3 to 5 marks as shown in Figure 1.

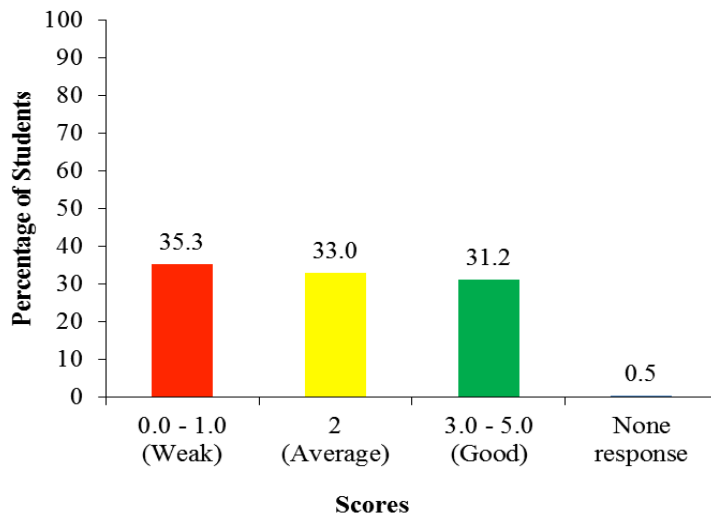


Figure 1: Performance of students in question 2

Figure 1 shows that, majority of the students (64.2%) managed to score 2 marks and above, hence the general grading of performance in this question was ‘Good’.

However, incorrect responses were commonly noted in items (i), (ii) and (iii). Item (i) tested the students’ ability in identifying a material which improves machinability of steel. The correct answer was F ‘Copper’. Most of those who got it wrong wrote D ‘Ductility’. Students were probably attracted to the softness of ductile materials therefore associated it with the task of improving machinability of steel. Students in this category failed to recall the fact that when copper is alloyed with steel it improves machinability.

Item (ii) required the students to identify a metal which have the ability of cutting other metals. The correct answer was H ‘HSS’ but some of the students matched it with G ‘Nodular iron’. These students failed to associate ability of cutting metals with the property of hardness. This indicated that students had inadequate knowledge on properties of HSS and other metals. Such students were supposed to understand that HSS is one of the hardest metals which is used for making cutting tools.

In item (iii), the students were required to identify the material which is suitable for the manufacture of chemical containers. A material possessing corrosion resistance property was to be chosen from the list by the students who could be able to recall the fact that some chemicals are corrosive therefore they need to be

kept in containers which are made from corrosion resistant materials. Few students got the item correct by matching it with the response E ‘Plastic’ but several students went astray by matching it with option A ‘nonferrous metal’.

2.2 Section B: Short Answer Questions

2.2.1 Question 3: Engineering Materials, Lubricants and Coolants and Production of Engineering Materials

This question had three parts: (a), (b) and (c). In part (a), the students were required to (i) mention five main uses of copper and (ii) list five elements which are used for production of alloy steel. In Part (b), the students were required to (i) state five characteristics of a good lubricant, (ii) name two materials which are commonly used to make hacksaw blades and (iii) mention the ores from which aluminium, zinc and lead are extracted. In part (c), the students were required to (i) explain with the aid of sketches the difference between a square bar and a square pipe and (ii) define the terms ‘pig iron’, ‘ingot’ and ‘cementite’.

The question was worth 30 marks. It was attempted by 98.7 percent of all students, out of which 20.4 percent scored a zero mark, 67.9 percent scored from 0.5 to 8.5 marks, 10.4 percent scored from 9 to 14.5 marks and 1.3 percent scored from 15 to 23 marks. There were no students who managed to score above 23 marks. Figure 2 is a line graph which displays the performance of students in question 3.

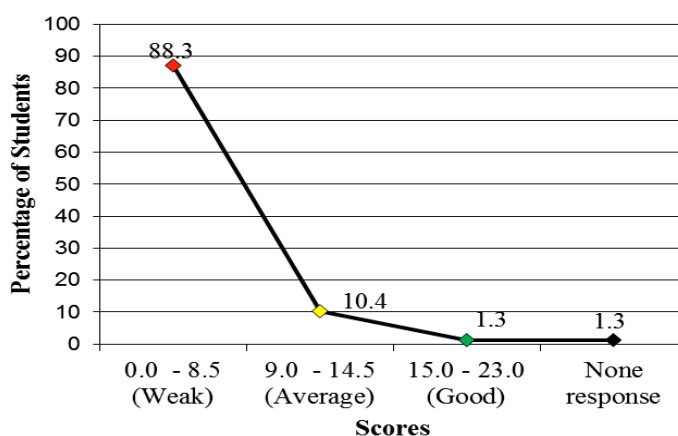


Figure 2: Shows that, majority of the students (88.3%) scored below 9 out of 30 marks, indicating a poor performance in this question.

The students who scored low marks in part (a)(i), failed to give the uses of copper. Some were interchanging the uses with properties of copper while others regarded copper as a raw material for manufacturing iron, which is wrong. In part (a)(ii), the students failed to list all five alloying elements. Few students listed elements which are found as traces in pig iron instead of the elements which are added to steel to improve its properties as required by the question.

In part (b)(i), the students were not able to state all five characteristics of a good lubricant. Some students did not comprehend the meaning of the term 'characteristics' as it was revealed from the answers by some of the students who wrote 'water', 'Air', 'minerals' and 'waxes' which were quite out of the question demand. In part (b)(ii), the students could not name the materials which are used for making hacksaw blades. They failed to recall that high speed steel and high carbon steel are commonly used for making hacksaw blades. The students lacked both theoretical and practical knowledge of the hand tools which are used in the workshop. In part (b)(iii), the students were not able to correctly name the ore from which aluminium and lead are extracted. Many students gave the names of metals such as tin, cast iron and copper instead of the ores.

In part (c)(i), most of the students failed to draw sketches to indicate the difference between a square pipe and a square bar. Some of them gave explanation without sketches while others produced sketches which did not show any remarkable difference. In part (c)(ii), the students also failed to give correct definition of the terms pig iron, ingot and cementite. Some students defined these terms as 'tools which are used in the workshop' instead of defining them as 'the type of iron produced at the first stage in the blast furnace', 'form of steel poured and solidified in the mould' and 'hard form of iron produced by the combination of carbon and steel' respectively. The responses of this kind reflected that the students had limited or lacked knowledge on the production of engineering materials. Extract 3.1 shows a sample of poor response from the script of one of the students.

Extract 3.1

- (b) (i) State five characteristics of a good lubricant.

produce heat
produce friction
it produce rust
it produce rusting

- (ii) Name two materials which are commonly used to make the hacksaw blades.

it reduce friction
it reduce agent of material

- (iii) What are the ores from which the following metals are extracted?

Aluminium... produce the lumenity
Zinc... it contain the Heme
Lead... it contain the magneety

- (c) (i) With the aid of sketches explain the difference between a square bar and a square pipe.

is the process of material that occur
in produce tools

- (ii) Define the following terms.

Pig iron... is the process that produce coal
Ingot... it the papers the occur in the
mechanical material
Cementite... it contain 65% in the
work shop best produce iron

Extract 3.1 shows that the student could not state, name, explain, draw and define the given materials/terms indicating that he/she had no knowledge on the subject matter and also had poor English proficiency.

Few students (1.3%) who scored above 14.5 marks exhibited knowledge on the topics comprised in this question. The students were able to mention the

characteristics of a good lubricant, name materials for making hacksaw blades, write the names of ores from which aluminium, zinc and lead are extracted. They were also able to differentiate a square bar from a square pipe and define the terms pig iron and ingot. The students demonstrated adequate knowledge on the topics of production of engineering materials and properties of metals. Extract 3.2 portrays such a response.

Extract 3.2

- (b) (i) State five characteristics of a good lubricant.

- should carry away all heat generated during machining.
- It should not be poisonous and irritant.
- It should provide a good lubrication between tool and workpiece etc.
- It should not discolour the finished work.

- (ii) Name two materials which are commonly used to make the hacksaw blades.

- High carbon steel
- High speed steel.

- (iii) What are the ores from which the following metals are extracted?

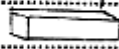
Aluminium Bauxite

Zinc Zinc tetra oxide

Lead Galena

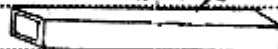
- (c) (i) With the aid of sketches explain the difference between a square bar and a square pipe.

- Square bar is the bar that have no central hole and it's square in shape while square pipe have central hole.



(square bar).

while



(square pipe).

- (ii) Define the following terms.

Pig iron is the product obtained after reduction of iron ore into iron in blast furnace

Ingot is the product obtained when pig iron cool and is going to be put into different shapes and sizes.

Cementite

In Extract 3.2 the student managed to write four characteristics of a good lubricant, name correctly the materials for making hacksaw blades and the ores for production of aluminium, zinc and lead. He/she also drew correct sketches to differentiate the square bar from a square pipe and defined the terms pig iron and ingot but failed to define the term cementite.

2.3 Section C

2.3.1 Question 4: Common Tools, Drilling Machine, Lathe Machine and Safety

This question had three parts: (a), (b) and (c). In part (a), the students were required to: (i) Show by means of a sketch how a try square is used to produce parallel lines on work piece. (ii) Outline four operations which can be done using a lathe machine. (iii) Give three methods on how the drill is held and three on how the work is held when drilling.

In part (b), the students were required to: (i) Define the terms cutting speed and feed as used in relation to turning operations. (ii) Explain the function of chuck, tailstock, carriage and tool post of the lathe machine. (iii) Name three taps comprised in a set of hand taps.

In Part (c), the students were required to: (i) Differentiate between single cut file and double cut file, cross filling and draw filling. (ii) List four types of chisels. (iii) Write four general causes of accidents in a fitting and turning workshop.

This question was attempted by 113 students whose area of specialization was Fitting and Turning. Seven (7) percent of them scored 0 mark, whereas 57.6 percent scored from 1.5 to 17.5 marks, 23.9 percent scored from 18 to 29.5 marks and 11.5 percent scored from 30 to 52 marks. The students' performance is presented in Figure 3.

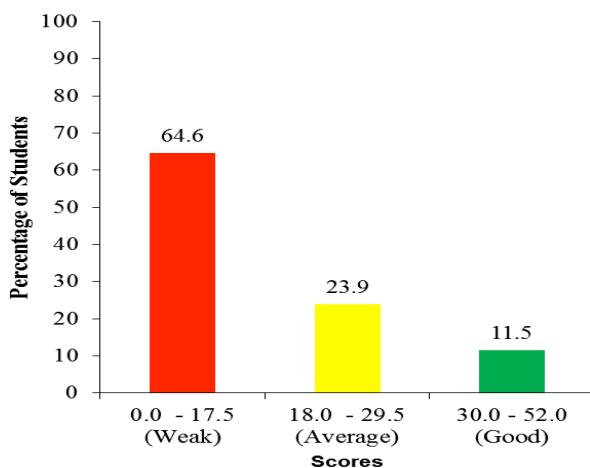


Figure 3: The performance of students in question 4.

Figure 3 shows that more than half of the students (64.6%) who attempted this question scored below 18 marks, whereas 35.4 percent managed to score 18 marks and above. Therefore this question is classified as averagely performed.

The students who scored low marks in part (a), failed to produce a proper sketch to indicate the application of a try square for drawing parallel lines. This part was the most omitted in the question, indicating that the students were not conversant with the practical use of a try square. Some of the students managed to outline the four operations carried out using the lathe machine but failed to explain how drills and workpieces are held during drilling operation.

Students who performed poorly in part (b) failed to define ‘cutting speed’ and ‘feed’ in relation to turning operation as well as to name three taps comprised in a set of hand taps. Some students gave functions of a drilling machine instead of mentioning the ways the drills are held ready for drilling. One of these students provided answers to (b) (ii) by writing the functions of lathe chuck, tailstock, carriage and tool post as to produce ‘heat and melting’, ‘to produce lathe machine in the workshop’, ‘to produce more heat’ and ‘to prevent accident in the workshop’. Such obviously incorrect answers are indicators that, the students lacked adequate knowledge on the tested topics.

Furthermore the students who did not perform well in part (c) could not differentiate a single cut file from a double cut file. They were also unable to mention the four common types of chisels. Most of them did well on sub item (iii) of part (c) which required them to write the general causes of accidents in the workshop. Extract 4.1 is a sample of poor response from one of the students’ script.

Extract 4.1

- (b) (i) Define the following terms as used in relation to turning operation.

Cutting speed... it the instrument that is contain the coating fluid

Feed... is the measured by many compo net or pig iron ore

- (ii) Explain the function of the following parts of a lathe machine.

Chuck... is the process that occur in produce the tools

Tailstock... The tailstock that produce the generation to perform the materials

Carriage... The carriage that is the gear in contain the magnety and lime rite

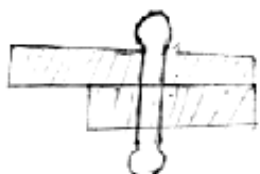
Tool post... it contain the general materials to perform mechanical tools

- (iii) Name three taps comprised in a set of hand taps.

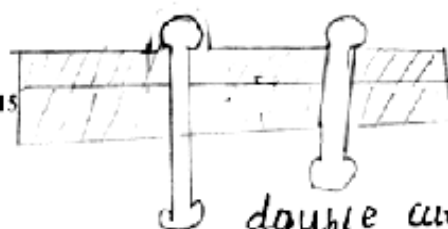
flaring tap
taper tapping
taper turning

- (c) (i) Differentiate between the followings:

Single cut file and double cut file



Single cut file



double cut f

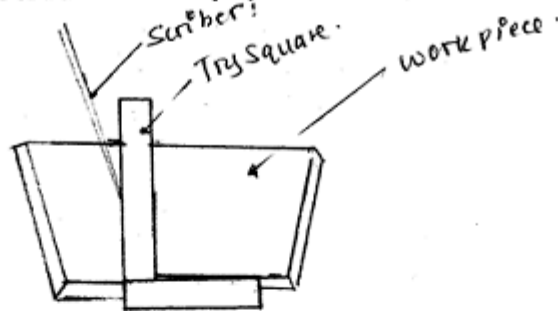
Extract 4.1 shows that the student could not comprehend the demand of the question as he/she gave wrong answers to all parts of the

question. In part (c), he/she drew sketches of one file and two files as definitions of single cut file and double cut file which is not true. Moreover the sketches do not portray the features of the files.

However, there were few students (5.31%) who scored high marks from 43 to 52. These students were able to provide relevant responses such as drawing a sketch to show the application of a try square for drawing straight lines on a workpiece, defining the terms 'speed' and 'feed', explaining the functions of lathe parts and listing the types of chisels. They also managed to name the taps comprised in a set of hand tap. Their good performance indicated that they had enough knowledge and skills, thus they were able to interpret the questions and use their knowledge to solve the questions involving functions of machines and uses of tools in a fitting shop. Extract 4.2 shows a sample response from one of the students who was able to provide correct answers.

Extract 4.2

4. (a) (i) Show by means of a sketch how a try square is used to produce parallel lines on a workpiece.



- (ii) Outline four operations which can be done using a lathe machine.

(i) Facing operation:

(ii) Parallel turning operation:

(iii) Boring operation:

(iv) Taper turning operation:

- (iii) How are drill bit and workpiece held when drilling? Give three methods for each case.

Drill bit in the drilling

machine. (i) drill bit is held in the drill

shank:

(ii) drill bit held in the drill chuck:

Workpiece for drilling

(i) By means of drill vice.

(ii) By the hand vice

(iii) By the machine vice → it is mounted on the drilling machine table

- (b) (i) Define the following terms as used in relation to turning operation.

Cutting speed... is the distance moved by a rotating tool on the work or tool on the rotating work per minute.

Feed... is the distance moved by a tool per each revolution.

(ii) Explain the function of the following parts of a lathe machine.

Chuck. it is used to hold the work to be machined also rotating it.

Tailstock Used to support work when work is held between centres, also used when drilling, reaming and taper turning method by tail stock offset.

Carriage. This is used to carry the tool by moving along the bed. apron, ramble, compound slide, tool post

Tool post. This is where tools are inserted and held or mounted on a lathe machine.

(iii) Name three taps comprised in a set of hand taps.

i) Taper tap.

ii) Intermediate tap.

iii) Bottoming tap.

(c) (i) Differentiate between the followings:

Single cut file and double cut file. Single cut file is the one which has only one type of teeth with the same pitch so only these teeth cut the work but double cut file is the one which has two different teeth at certain angles so different cut are being made on the work.

Cross filing and draw filing

Cross filing is when the whole file is moving along the work and it is commonly used while draw filing, the file is moved across the work, and it is used when good finish is required.

(ii) List four types of chisels.

i) Flat chisels.

ii) Diamond chisels.

iii) Half round chisels.

iv) Square chisels.

(iii) Write four general causes of accidents in a fitting and turning workshop.

i) Ignorance

ii) Careless

iii) Lazy

Extract 4.2 shows that the student adhered to the demand of the question as he/she drew a correct sketch to indicate the use of try square, defined the terms cutting speed and feed, explained the functions of some parts of a lathe and named correctly the taps which are comprised in a set of taps.

2.3.2 Question 5: Introduction to Welding, Gas Welding Accessories, Soft Soldering, Arc Welding Accessories, Welding Joint and Resistance Welding.

This question had three parts: (a), (b) and (c). In part (a), students were required to (i) state two functions of the welding regulators and welding touch, (ii) give four precautions to be taken in storing oxygen and acetylene cylinders and (iii) state the four functions of the soldering flux.

Part (b) required the students to (i) write two examples of permanent joints and four examples of temporary joints, (ii) identify the colour codes given for the cylinders carrying acetylene, propane, oxygen gases and (iii) differentiate between low pressure welding system and high pressure welding system.

In part (c), they were required to (i) name five tools used in arc welding, (ii) define the terms fusion welding, tack welding and resistance welding and (iii) differentiate between carburizing flame and oxidizing flame by using sketches and give one use for each.

The question was attempted by 147 students whose area of specialization was Welding and Metal Fabrication. Out of them, 10.88 percent scored 0 mark, 53.72 percent scored from 1 to 17.5 marks, 25.9 percent scored from 18 to 29 marks and 9.5 percent scored from 30 to 40.5 marks. The pie chart in Figure 4 illustrates the relative proportions of students' performance percentagewise.

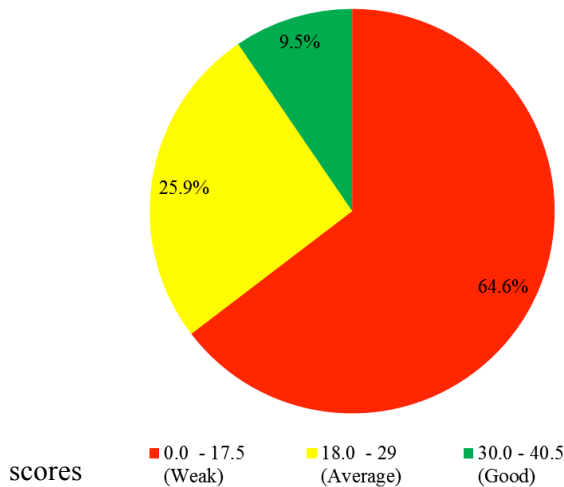


Figure 4: Shows the performance of students in question 5

This question falls under the category of averagely performed questions because the total percentage of students who scored 18 marks and above is 35.4 percent. Students who scored low marks, including those who scored a zero mark, failed to give the functions of the welding regulators and the welding torch, which are common tools in gas welding. Students were also unable to name tools used in arc welding. The poor performance of students indicates that they did not have enough knowledge in both gas welding and arc welding. Some students did not comprehend the question requirements, there were some misconceptions. For example one student mentioned *human body* and *animal body* as examples of permanent joints in metal works and *leg*, *shoe* and *skeleton* as examples of temporary joints. The correct answers for this part were, *welded joints* and *riveted joints* as examples of permanent joints and *bolted*, *pinned*, *soldered*, *hooked* and *screwed joints* as examples of temporary joints. This student associated the term joint with the human biological body structure instead of metal fabricated structures.

Some students had poor command of English language, as a result they could not express themselves clearly and construct meaningful sentences. Also, there were misconceptions of the term ‘welding torch’ in the question. For example, one student wrote the function of a welding torch as ‘to give light in the workshop’. This student considered ‘torch’ as the one used in normal lighting for domestic purposes. In actual fact, the preceding word ‘welding’ in the question specified the

type of torch as that which is used for heating and melting metal during welding processes. A sampled answer from one of the students who performed poorly is shown in Extract 5.1.

Extract 5:1

- (ii) Give four precautions to be taken in storing oxygen and acetylene cylinders.
- i/ To be taken chemical cleaning flux
 - ii/ To be taken chemical cleaning soldering
 - iii/ To be taken chemical cleaning tinning
 - iv/ To be taken chemical cleaning oxygen
- (iii) State the four functions of the soldering flux.
- i/ Soldering flux is uses chemical
 - ii/ Soldering flux oxidation
 - iii/ Soldering flux are
 - iv/ Soldering flux to filler in the solder
- (b) (i) Write two examples of permanent joints and four examples of temporary joints.
- Permanent joints... examples are technology, mechanic, technician, technologist etc
- Temporary joints... examples are ductility, elasticity, plasticity, hardness etc.
- (ii) What are the colour codes given for the cylinders carrying the following gases?
- Acetylene... Acetylene is use to the chemical from colourⁱⁿ
- Propane... Propane is use to the from acetylene
- Oxygen... Removal oxidation other colour

Extract 5.1 continues

(iii) Differentiate between low pressure welding system and high pressure welding system.

Low pressure welding is the pressure of system gas flowing through get small oxygen when a high pressure welding is the pressure of system gas flowing through get its is big oxygen of pressure.

(c) (i) Name five tools used in arc welding.

1. Soldering
2. Flux
3. Tinning
4. Filler in the solder
5. Filler

Extract 5.1 shows that the student failed to adhere to the need of the question. Some words and sentences given by the student as answers are not related to the question while some are related but not organised to bring the intended meaning.

There were some students who gave correct responses to most parts of the question hence scored good marks from 30 to 40.5. Most of the students in this category managed to correctly write the precautions to be observed when storing acetylene and oxygen cylinders. These students demonstrated their knowledge of the safety rules practiced in welding shops. Furthermore, their answers were presented in a clear language. A sample answer from a student who had a relatively good performance is shown in Extract 5.2.

Extract 5.2

(ii) Give four precautions to be taken in storing oxygen and acetylene cylinders.

- Cylinders should be stored upright
- Cylinders should be stored away from direct heat.
- Cylinders should be labelled to distinguish them.
- Empty cylinders should be put away from full cylinders

(iii) State the four functions of the soldering flux.

- It removes impurities from the soldering area.
- It enable capillarity of solder between two pieces of metals
- It enable adhesion of solder between two pieces of metals.

(b) (i) Write two examples of permanent joints and four examples of temporary joints.

Permanent joints. welding

Temporary joints. bolts and nuts screw machine tapping

(ii) What are the colour codes given for the cylinders carrying the following gases?

Acetylene. Maroon

Propane. _____

Oxygen. Black

(iii) Differentiate between low pressure welding system and high pressure welding system.

- High pressure welding system use acetylene from the cylinders while low pressure welding system use generated acetylene
- acetylene gases come from cylinders at high pressure during high pressure system while low pressure welding system do not so.

Extract 5.2 continues

- (c) (i) Name five tools used in arc welding.

- Wire brush.

- Face shield

- clamp.

- Chipping hammer

- Hand gloves.

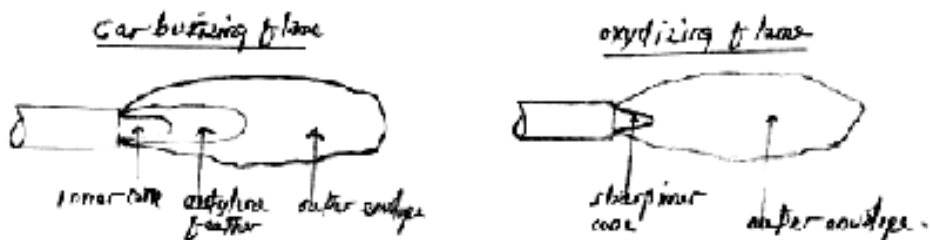
- (ii) Define the following terms:

Fusion welding is the type of welding that involves melting of the base metals and filler rod to hold base metals together.

Tack welding

Resistance welding is the type of welding in which heat is obtained from the resistance to the flow of electric current.

- (iii) With the aid of sketches differentiate between carburizing flame and oxidizing flame. Give one use for each.



Extract 5.2 shows that the student was able to state the functions of the given devices, identify the colour codes of the gas carrying cylinders, name the tools used in arc welding, define the terms and draw a sketch to differentiate between carburizing flame and oxidizing flame.

2.3.3 Question 6: Power Unit (Engine) and Fuel System.

The question comprised of three parts: (a), (b) and (c). Part (a) required the students to (i) give the number of revolutions a crankshaft makes in order to complete one cycle for a two strokes cycle engine and for a four strokes cycle engine, (ii) explain what happens in a cylinder of a diesel engine during compression stroke, (iii) mention four parts in the engine which rotate when the

engine is working and (iv) write four advantages of a two stroke compression ignition engine over a four stroke compression ignition engine.

In part (b), the students were required to: (i) state engine classification according to fuel, cooling and ignition system and give two classes in each case, (ii) write three functions of an engine flywheel and (iii) list four main components of the fuel supply system of a compression ignition engine.

Part (c) required the students to: (i) calculate the volume of the combustion chamber if a petrol engine has a cylinder bore of 95 mm and a stroke of 120 mm and the compression ratio is 9 to 1 and (ii) explain the meaning of thermal efficiency, firing order, combustion and carburation.

The question was attempted by 117 students (30.15%) whose area of specialization was Motor Vehicle Mechanics. Out of them, 9.4 percent scored a zero mark, 57.3 percent scored 1 to 17.5 marks, while 23.04 percent scored 18 to 26 marks, 10.26 percent scored 30.5 to 47.5 and no students scored full marks. Table 1 summarizes the students' performance in this question. This question is also of average performance.

Table 1: Performance of students in question 6

Scores	0 – 17.5	18 – 29.5	30.5 – 47.5	Total
Performance	Weak	Average	Good	
Number of students	78	27	12	117
Percentage	66.7	23.04	10.26	100

The students who scored a 0 mark, failed to interpret the questions and therefore gave answers that were not related to the question. For example, in part (c) (i), some students were unable to extract data from the given information and apply the engine compression ratio formula to calculate the required clearance volume (V). Extract 6.1 shows a poor response from one of the students.

Extract 6.1

6. (a) (i) How many revolutions does a crankshaft rotate in order to complete;
One cycle of a two stroke cycle engine. 1348
One cycles of a four stroke cycle engine. 1324
- (ii) What happens in a cylinder of a diesel engine during compression stroke?
Piston moves for TDC to BDC
Mixture, air and fuel enters engine
Burning the fuel in the engine
- (iii) Mention four parts in the engine which rotates when the engine is working.
Induction
Compression
Power
Exhaust
- (iv) Write four advantages of a two stroke compression ignition engine over a four stroke compression ignition engine.
- (b) (i) State engine classification according to fuel, cooling and ignition system. Give two classes in each case.
By Arranged of cylinder
By Cooling system
By Arranged of valve
By combustion chambers
- (ii) Write three functions of an engine flywheel.
It used to stop the vehicle when before starting
It help to accelerate motor vehicle
It help to determine fixed shape for the vehicle
- (iii) List four main components of the fuel supply system of a compression ignition engine.
Batter
Ignition condenser
Ignition Coil
distributor body

Extract 6.1 continues

- (c) (i) A petrol engine has a cylinder bore of 95mm and a stroke of 120mm. If the compression ratio is 9 to 1, calculate the volume of the combustion space or clearance volume.

Handwritten calculations:

Left side:

$$3.14 \times 95 \times 120 \times \frac{1}{4}$$

$$= 2983.8$$

$$2983.8 \times 10 = 29838$$

$$29838 - 17898 = 11940$$

Right side:

17898 volume mm.

$$\frac{9}{10} \times 17898 = 16108.2$$

$$\frac{1}{10} \times 17898 = 1789.8$$

$$16108.2 - 1789.8 = 14318.4$$

The volume of 9:1

$$= 14318.4 \text{ mm}^3$$

- (ii) Explain the meaning of each the following terms:

Thermal efficiency.....

Firing order.....

Carburation..... *13/12 part of the vehicle which are used to receive petrol from tank via lift pump.*

Extract 6.1 shows that the student could not calculate correctly the clearance volume of the engine cylinder. He/she also provided irrelevant answers to other two parts (a & b) of the question.

On the other hand, most of the students (33.3%) who scored good marks from 30.5 to 47.5, to a large extent, they correctly interpreted the requirements of the question. They managed to identify the events which occur in a compression stroke of a diesel engine, the main components which make the fuel system of a compression ignition engine and the formula which enabled them to use the extracted data in calculating the swept volume and finally correctly calculated the clearance volume. Extract 6.2 shows a sample of good response from one of the students who scored good marks.

Extract 6.2

6. (a) (i) How many revolutions does a crankshaft rotate in order to complete;

One cycle of a two stroke cycle engine..... one revolution
One cycle of a four stroke cycle engine..... two revolution

- (ii) What happens in a cylinder of a diesel engine during compression stroke?

During compression stroke piston move from
bottom dead centre to Top dead centre
to compress Air and inlet and outlet valve both closed.

- (iii) Mention four parts in the engine which rotates when the engine is working.

Crank shaft
Cam shaft
flywheel

- (iv) Write four advantages of a two stroke compression ignition engine over a four stroke compression ignition engine.

It's not heavier than four stroke engine easily to convert
It's easier and not expensive to do maintenance
once of engine than in four stroke engine.

- (b) (i) State engine classification according to fuel, cooling and ignition system. Give two classes in each case.

to state engine classification according to
(a) fuel example petrol fuel and diesel fuel
(b) Cooling example Air cooling and liquid cooling
(c) Ignition example. Coil Ignition and Magneto Ignition system

Extract 6.2 continues

- (ii) Write three functions of an engine flywheel.

Carry the engine over - non working stroke
Carry starter ring which assist in starting the vehicle.
Provide anti driving force to the clutch.

- (c) (i) A petrol engine has a cylinder bore of 95mm and a stroke of 120mm. If the compression ratio is 9 to 1, calculate the volume of the combustion space or clearance volume.

Solu

$$C.R = \frac{TV}{CV}$$

but

$$SV = \frac{\pi d^2 h}{4}$$

$$= \frac{3.14 \times (95)^2 \times 120}{4}$$

$$= 3.14 \times (95)^2 \times 30$$

$$3.14 \times 9025 \times 30$$

$$SV = 850155 \text{ mm}^3$$

but

$$C.R = \frac{SV}{CV} + 1$$

$$CV \times 9 = \frac{850155}{CV} + 1 \times CV$$

$$9CV = 850155 + CV$$

$$9CV - CV = 850155$$

$$8CV = 850155$$

$$CV = \frac{850155}{8}$$

$$CV = 106269.375 \text{ mm}^3$$

∴ Clearance volume is 106269.375 mm³.

Extract 6.2 shows that, the student was able to: mention the number of revolutions for one cycle in diesel engine, explain what happens in an engine cylinder during compression stroke, name parts of the engine which rotates when the engine is working, state engine classification and calculate clearance volume of the engine.

2.3.4 Question 7: Charging System, Battery and Ignition System.

This question had three parts namely: (a), (b) and (c). In part (a), the students were required to (i) define the terms: generator, insulator and e.m.f., (ii) identify the type of battery which is mostly used in automobiles and (iii) state the functions of spark plug, condenser, ignition coil, alternator and contact breaker point.

Part (b) required the students to: (i) mention four main electric circuits of a car and (ii) calculate the equivalent resistance, the total current flowing in the circuit and the voltage across each resistor, given three resistors of 2, 3 and 4 ohms which are connected in parallel to a battery of 12 volts.

In part (c), the students were required to: (i) define the term ‘relay’ as used in auto electrics, (ii) name five parts of the ignition coil and (iii) identify the names of components represented by the given symbols.

This question was attempted by one student whose area of specialization was Autoelectrics. The student did not perform well as he attempted few items in three parts of the question of which all were wrong answers except one part where he/she obtained 1 mark. This indicates that the student had no knowledge on the subject matter.

2.3.5 Question 8: Heat, Temperature and Pressure, Refrigeration and Refrigerants, Air Conditioning, Brazing, Refrigeration Tools and Equipment

This question had three parts: (a), (b) and (c). In part (a), the students were required to: (i) define the terms heat and pressure, (ii) name two instruments which are used to measure temperature and (iii) mention four methods which are used to preserve foods apart from refrigerators and (iv) convert -20°C and 35°C to kelvin scale.

Part: (b) required the students to (i) state Boyle’s law of gases, (ii) define the term secondary refrigerant and (iii) define the terms: air conditioning, humidity, pressure and psychrometer.

In part (c), the students were required to (i) mention five places where air conditioning systems are commonly used and (ii) write the purpose of using a spanner, hacksaw, pinch off tool, flaring tool, pliers and tongs in refrigeration and air conditioning.

The question was attempted by 9 students whose area of specialization was Refrigeration and Air Conditioning. There was no zero score for this question. The students who scored from 2.5 to 13.5 marks were 7 (77.8%) while 2 students (22.2%) scored from 20 to 26 marks. These ranges of scores indicate that the question had poor performance since many students scored below 18 marks which is the minimum average score for this question.

Students were not able to answer all items. Instead they attempted few items in each part; thus many parts remained blank. Some failed to define the terms ‘heat’ and ‘temperature’, name two instruments which are used to measure temperature

as well as to convert the given temperatures of -20°C and 35°C into Kelvin scale. Few of them managed to state Boyle's law, but could not define the terms refrigerant, air conditioning, humidity, pressure and psychrometer. It was probably easy for them to recall Boyles' law because it is also taught in one of the topics for Engineering Science subject. The analysis of the students responses shows that, they had no sufficient knowledge on the topics comprised in this question.

3.0 PERFORMANCE OF STUDENTS IN EACH TOPIC

The analysis of the students' performance in FTNA 2015 in Mechanical Engineering for each topic indicates that the performance was good in the topic of Production of Engineering Materials as the percentage of students who scored 30 percent or more was 51.3. The analysis also reveals that, 35.39 percent of the students had an average score of 30 marks and above in the topic of Drilling Machine so this topic falls under average score. Further analysis shows that, the topics of Gas Welding Accessories, Arc Welding Accessories, Soldering and Resistance Welding had average performance because the percentage of students who scored 30 percent or above was 35.37. There was also an average performance in the topics of Power Unit (Engine) and Fuel System whereas 33.3 percent of students in these topics scored 30 percent or above.

However, the analysis of students performance indicated that, 25 percent of the students scored 30 percent or above in the topics of Heat, Temperature and Pressure, Refrigeration, Refrigerants, Air Conditioning, Brazing and Refrigeration Tools and Equipment. This indicates that these topics were performed weakly. Moreover, weak performance was observed in the topics of Charging System, Ignition System and Battery where the percentage of students who scored 30 percent and above was zero, (see appendix).

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the students in Mechanical Engineering for Form Two National Assessment (FTNA) 2015 was average as 30.67 percent of the students passed the assessment and the rest (67.33 percent) failed. The questionwise analysis shows that students had good performance in question 1 (multiple choice items), that was set from Production of Engineering Materials and question 2 (matching items) that was set from Properties of Engineering Materials topic, (see

appendix). The students exhibited relatively good performance on these types of questions as compared to short answers questions such as question 3 which was from the same topics.

Further analysis shows that the students averagely performed on questions 4, 5 and 6. However, students had poor performance in question 3, 7 and 8 whereby, most of the students seemed to have inadequate knowledge on the respective topics. Some of the students lacked drawing and computing skills and proficiency in English Language.

It is our hope that the feedback provided in this report will be useful to all educational stakeholders including teachers, students, parents, guardians, employers, educational policy makers and finally the government as a whole to take the necessary measures which will help to improve the students' performance in Mechanical Engineering Subject national-wise.

4.2 Recommendations

Recommendations to students

The students should:

- (a) Read properly the given instructions on each section as well as on individual questions so as to understand clearly the requirements of each question and each area of specialization.
- (b) Be encouraged to read variety of materials so as to broaden their knowledge and skills in Mechanical Engineering.
- (c) Be assisted to improve their writing skills in English Language

Recommendations to Teachers

- (a) Teachers should provide enough exercises and tests to students in order to improve their ability to answer questions.
- (b) Tests and all other modes of assessments given at school need to comply with the NECTA assessment format.
- (c) More practical should be provided to students so as to help them relate practical knowledge with theories covered in the classroom.

Recommendations to the Ministry of Education, Science, Technology and Vocational Training.

- (a) In order to improve the standard of performance on this subject in the future, the Ministry should supply the Technical Secondary Schools with enough training materials in order to raise students practical skills and competences.
- (b) Common text books for this subject should be established and directed to all Technical Secondary Schools so as to avoid disparities among subject masters. This will enable students get common understanding on the content of the subject.

Appendix

Summary of Performance of the Students – Question-Wise

S/N	Topics	Question Number	Percentage of Students Who Scored an Average of 30% or More	Remarks
1	Production of Engineering Materials	1	78.1	Good
2	Production of Engineering Materials, Properties of metals	2	64.2	Good
3	Lathe Machines Drilling	4	35.39	Average
4	Gas Welding Accessories, Arc Welding Accessories, Soldering, Resistance Welding	5	35.37	Average
5	Power Unit (Engine) Fuel System	6	33.3	Average
6	Heat, Temperature and Pressure, Refrigeration, Refrigerants, Air Conditioning, Brazing, Refrigeration Tools and Equipment.	8	25	Weak
7	Production of Engineering Materials, Lubrication	3	11.6	Weak
8	Charging System, Ignition System and Battery	7	0	Weak

