CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

MAY/JUNE 2014

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

GENERAL COMMENTS

This subject consists of two units — Unit 1 and Unit 2. Each unit comprises two papers.

Papers 01 and 02 in Unit 1 each comprise three sections: Section A (Module 1), Plane Geometry; Section B (Module 2), Solid Geometry; Section C (Module 3), Mechanical Engineering Drawing.

In Unit 2, Papers 01 and 02 also consist of three sections: Section A (Module 1), Mechanics of Machines; Section B (Module 2), Engineering Materials and Processes; Section C (Module 3), Engineering Design Elements.

Paper 01 in each unit consists of nine compulsory questions each worth 10 marks, making a total of 90 marks for each paper.

Paper 02 in each unit consists of nine questions each worth 25 marks. Candidates are expected to answer six questions (two of three from each section) for a total of 150 marks.

In 2014, the mean mark on Unit 1, Paper 01 was 36.12 per cent which was below the 2013 figure by approximately 16 per cent. The Unit 1, Paper 02 mean was 35.98 per cent which was lower than the 2013 figure by 3 per cent.

In 2014, the mean mark on Unit 2, Paper 01 was 44.44 per cent which was 1 per cent lower than the 2013 figure. The Unit 2, Paper 02 mean was 42.21 per cent which was 3 per cent higher than in 2013.

Overall, on Unit 1, there was a reduction of about nine per cent in the mean when compared with 2013. Overall, on Unit 2, the 2014 mean performance was comparable with 2013. With respect to grade levels, the percentage of candidates receiving Grades I–V for Unit 1 was 69.55 while on Unit 2 the corresponding percentage was 85.71.

According to the examiners, the standard of work in Unit 1 was satisfactory for Modules 1 and 2; the majority of candidates did not perform well on the design question in Module 3.

On Unit 2, the standard of work produced was moderate, with only about 7 per cent of candidates obtaining Grades I and II and 17 per cent being awarded Grades I–III.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

Module 1: Plane Geometry (Questions 1-3)

Question 1

Candidates' knowledge, application of knowledge and drawing skills were tested in this question. The question had two parts. Part (a) asked candidates to name the four motions a radial plate cam would produce to a follower in relation to the four intervals labelled in Figure 1. Part (b) tested candidates' ability to sketch an isometric view of the given radial plate cam with a roller follower in contact. This sketch was to be drawn freehand and in good proportion, with labels; the direction of motion of each part was to be shown.

This was a very popular question with 91 per cent of candidates attempting it. Many candidates had difficulty correctly naming any of the motions produced by the cam. Although most candidates were able to sketch the cam and the roller follower in contact, some did not produce the requested isometric drawing or provide the labels and direction of motion for each drawing component. Candidates should pay attention to what is specifically asked for in each question.

Question 2

The question was divided into two parts. Part (a) required candidates to draw an involute to a given circle while Part (b) required them to construct the normal and tangent to the involute drawn in Part (a).

Seventy per cent of candidates doing this question demonstrated good knowledge and drawing ability in completing the circle, plotting the points correctly to achieve the involute and drawing the smooth curve.

The remaining 30 per cent of candidates had challenges plotting the points, drawing smooth curves, selecting the specific point on the circle and using this focal point to construct the normal and tangent. Candidates should be encouraged to do more practice drawings especially when constructing a tangent to a curve on an involute.

Question 3

This question consisted of two parts. Part (a) was designed to test candidates' ability to locate the centroid of a lamina. In Part (b), candidates were required to state the distance of the centroid from the right-hand side of the given figure. Candidates were allowed to use any of

the several methods to find its centre of gravity. Approximately 95 per cent of candidates attempted this question, with over 80 per cent of them giving favourable responses. Many of them correctly reproduced the figure and were able to easily find the centroid of the square portion. However, approximately 60 per cent of those who answered the question had difficulty locating the centroid of the isosceles triangle portion. Candidates either divided the two base angles or they divided the side of the triangle into three parts.

Teachers must provide instructions to all students using AutoCAD to include the scale used as well as all construction lines, since many students submitted responses of completed drawings without construction lines.

Module 2: Solid Geometry (Questions 4–6)

Question 4

This question tested candidates' ability to draw a surface development and convert that view to orthographic projection by drawing a front and end elevation. Approximately 65 per cent of candidates attempted this question with approximately 85 per cent of them correctly drawing the development and inserting the folding lines.

Part (a) was generally well done by candidates even though some of them lost marks for either not drawing the development to the correct scale and proportion or not stating the scale used. Most candidates, however, were able to correctly show where the folding lines would be in the development.

Part (b) appeared to be the more challenging part of the question as candidates provided several variations of orthographic views of the development. In some cases, candidates provided correct front elevations but incorrect end elevations and vice versa, based on their understanding of the direction of the view of the elevation.

Question 5

This question was designed to test candidates' ability to produce a front elevation and a sectional plan of a prism. Approximately 85 per cent of candidates attempted this question and over 50 per cent of them gave favourable responses. Many of the candidates produced a front elevation; however, most of these lacked the hidden detail for the hole. On the other hand, approximately 80 per cent of the candidates who attempted the question did not produce the sectional plan accurately. This was due to the candidates not understanding how the hole was cut in the object. It is suggested that in delivering lessons, teachers emphasize sectioning of various objects containing spaces and holes.

Question 6

This question tested candidates' knowledge, application of knowledge and drawing skills in constructing an oblique cylinder and plotting the path of a helical curve for one revolution along the cylinder. Most candidates were able to reproduce the oblique cylinder. However, plotting the curve formed by point A as it moved towards B in one revolution of the cylinder was not done well. Some candidates plotted the path of the curve rotating in the opposite direction, while others drew a curve without plotting any points.

Most questions on helices normally consist of two-dimensional figures. However, candidates must be familiar with the construction of helices involving three-dimensional figures as well. It is recommended that more exercises be given that require students to plot helices on 3-D figures thus providing them with additional practice and improving their confidence to tackle questions of this nature.

Module 3: Mechanical Engineering Drawing (Questions 7–9)

Question 7

This question was designed to test candidates' knowledge, application of knowledge and drawing skills. Candidates were required to produce freehand sketches of either (i) a C clamp and G clamp or (ii) a Toolmakers' clamp and a V clamp (Vee-Block Clamp). Candidates were also tested on their ability to explain differences between the pair of clamps chosen.

The question was attempted by more than 80 per cent of the candidates but only 30 per cent of the responses were satisfactory. Most candidates were unable to correctly sketch and identify the pair of clamps chosen and some therefore opted to choose a clamp from each pair. A common error made by some candidates, when attempting to sketch the C, G and V clamps, was to start from the basic shape of the letter and develop a design with threaded components. Candidates who used this approach were unable to explain the differences between the two clamps. A few candidates disregarded the instruction to sketch freehand and opted to draw with the assistance of instruments.

It is recommended that more emphasis be placed on the importance of freehand sketching and that students be exposed to types of clamps and other mechanical devices to broaden their knowledge of mechanical devices, thus enabling them to better sketch and explain the function of such devices.

Question 8

Candidates were tested on their ability to sketch and explain the function of one of three types of valves: non-return, gate or globe.

Though this was a compulsory question, approximately only 40 per cent of candidates attempted it. The majority of candidates who attempted the question were able to correctly explain how the valves work and approximately 25 per cent of them produced both correct sketches along with correct explanations.

Approximately 80 per cent of the candidates did not produce enough details in their sketches to show a good understanding of what the valve they selected looks like and, in some cases, candidates stated one valve but sketched a different type.

A small percentage of candidates gave explanations of valves that did not correspond with the name or sketch of the valve they produced. This showed that candidates did not fully understand the differences among the valves and how they work.

Question 9

This question tested candidates' ability to calculate the limit of size or a designated fit, draw a new fit and insert the sizes via extension lines and dimension lines as was illustrated in the question. The candidates were also asked to state the type of fit derived from the calculation of the limit of size and the newly drawn diagram of fit. Candidates were also required to calculate the minimum or maximum clearances or interferences.

The question was attempted by 42 per cent of the candidates. Although the question had shown the designated fit, with reference to the British Standard Data sheet 4500A (Selected ISO Fits – Hole Basis), quite a number of candidates were unable to calculate the limit size for the designated fit and the minimum or maximum clearances in the new fit.

Candidates who did this question performed fairly well. The diagrams were neatly drawn for the most part. However, the majority of candidates did not attempt to calculate the maximum and minimum limits.

Paper 02 – Essay Questions

Module 1: Plane Geometry (Questions 1–3)

Question 1

This question tested candidates' ability to construct the performance curve and profile of a radial plate cam. This question, although optional, was very popular. It was attempted by approximately 90 per cent of the candidates with more than 50 per cent scoring between 21 and 25 marks. Responses to this question showed that the majority of candidates was aware of the topic and its requirements.

Part (a) was fairly well done. Candidates knew how to layout the baseline and construct both the simple harmonic motion and the dwell. However, only a few candidates knew exactly how to construct the uniform acceleration motion; most candidates constructed uniform velocity motion and acceleration and retardation motion instead.

Part (b) was also fairly well done. It required candidates to construct the profile of the radial plate cam. Although the majority of candidates knew how to transfer points from the performance curve onto the cam profile, a few of them showed no knowledge of the roller follower. However, most candidates successfully completed the required shape of the cam profile.

Question 2

This question consisted of three parts. In Part (a), candidates were required to draw an ellipse with specified major and minor axes. The arcs of circle method was the required method of construction.

Virtually all candidates who attempted this question successfully produced the required axes to the required lengths, but less than one per cent of them demonstrated an understanding of the specified method of construction.

Part (b) showed the framework for a hyperbola. The relative positions of the focus and the directrix (the eccentricity) were stated. Candidates were required to draw the hyperbola given the stated information. Additionally, candidates were required to draw a tangent to the curve from a specified point on the curve.

Over 80 per cent of candidates who attempted this question were unable to produce the hyperbolic curve conforming to the stated criteria. Some candidates lacked knowledge of the hyperbolic locus, and as a result produced a parabolic curve instead.

Locating the given point on the curve for the production of the tangent was well done, but the accepted geometrical procedure for the production of a tangent proved to be a challenge for approximately 60 per cent of the candidates. There were far too many cases where candidates drew lines tangentially to the curve without any evidence of the construction procedure.

The final section of this question required candidates to produce a sketch of an involute of a circle and label the *generating line* and the *evolute*. About 70 per cent of candidates who attempted this part did the sketch successfully, but less than ten per cent labelled the curve correctly.

Question 3

This question tested candidates' ability to determine the centroid of a symmetrical lamina by finding its areas by graphical means and using its moment of area. This was another popular question. Responses suggested that candidates were well-equipped to deal with the question. Approximately 60 per cent of candidates who attempted this question scored between 21 and 25 marks. These candidates, unlike those from previous years, showed that they knew not only how to reproduce the given figure but how to divide the lamina into a number of parts, setting a pole and projecting lines in order to find its areas by graphical means. It was also encouraging to see a large number of candidates using the correct formula to calculate the centroid of the figure.

Module 2: Solid Geometry (Questions 4–6)

Question 4

This question tested candidates' knowledge, application of knowledge and drawing skills. The question was not very popular amongst candidates. Of the estimated 580 candidates approximately 112 candidates opted to do this question.

Using first or third angle orthographic projection, candidates were required to draw the front and end elevations and plan of two given lines. The correct response required candidates to produce drawings showing the front and end elevations and plan of the two lines then join the mid points of both lines.

Candidates did not interpret the views on the horizontal and vertical planes correctly. Seventy-five per cent of candidates redrew the front elevation as given. The other 25 per cent of candidates incorrectly produced the end elevation or plan. Additionally, candidates failed to label the views: front elevation, end elevation and plan.

Teachers should review the principles of orthographic projection and use teaching aids to demonstrate horizontal and vertical planes to students.

Question 5

Candidates were given a drawing showing part of a pipe duct which comprised two cylindrical pipes of unequal diameter connected by a transition piece. Candidates were required to draw the development of the transition piece.

To successfully complete the development, candidates first had to reproduce the given drawing and recognize that the transition piece was a truncated cone. While several candidates were able to reproduce the drawing, more than 80 per cent either did not attempt

to construct the development, or simply drew compass arcs indicating the beginning of some kind of development.

The mean score for this question was four from a possible 25 marks. This represented those who simply reproduced the front elevation of the cone. There were only two scores above 20 for candidates who attempted this question.

A number of candidates attempted to go beyond the front elevation, by attempting to construct the development. This construction, which required candidates to develop true lengths, found several candidates being unable to successfully complete this task. Some candidates who attempted the development did so incorrectly but showed some knowledge of plotting points for the curve as well as drawing the final curve.

Other common weaknesses included:

- Lack of understanding regarding the procedure to develop a cone versus the development of a cylinder
- Lack of understanding in drawing the plan and dividing it equally
- Inability to decipher the resulting shape or outline of the development
- Inability to use correct arc lengths to construct the development.

Question 6

This question showed a pictorial drawing of a bracket set at an angle of 135º with the bottom section having squared corners and top section showing a semicircle at its end. The candidates were required to produce the front and end elevations, the plan, and an auxiliary elevation in accordance with the given arrows.

The circular upper section of this bracket proved to be a tremendous challenge for more than half the candidates when they attempted to produce the front elevation and plan. The majority of candidates drew perfect semicircles to represent the curved upper section which was clearly at an inclined angle (in Plan and Elevation).

Module 3 – Mechanical Engineering Drawing

Question 7

This question was an orthographic projection question which tested candidates' ability to:

a) Draw in orthographic projection, a bearing fully assembled, showing the required bolts in a half-sectional front elevation.
b) Complete balloon referencing and parts listing for the assembly.

This was a fairly popular question, with 67 per cent of candidates attempting it. Most candidates were not sure if they were required to draw all views or just the half-sectional front elevation.

Part (a) revealed that over 90 per cent of candidates were reluctant to construct all the views of the orthographic projection. Only the front elevation was attempted in most cases and very few candidates knew how to properly construct a half-section that was fully assembled with the bolt in place.

In Part (b), over 95 per cent of candidates were unable to show the correct procedure for completing balloon referencing. The alignment of the balloon and direction of arrows were not well done. Completing the parts listing to required standards was also poorly done, with most candidates omitting it, doing it incorrectly or presenting an incomplete parts listing. This was despite being given the name, number of parts and type of material.

Question 8

This question was attempted by less than half of the candidates who sat the examination. Of those who attempted it, the highest score was 17; the question was very poorly done. Candidates were required to sketch the given drawing of a slider crank mechanism using a pictorial view. The majority of candidates was unable to draw in the three-dimensional mode; they either produced single line or two-dimensional drawings in their responses.

More than 80 per cent of those who attempted this question scored below 10 marks with some scoring zero. Weak responses suggest that candidates had little or no knowledge of what was required by the question, or simply did not know how the mechanism should function.

Some candidates seemed not to understand terms such as *slider* and *piston* which appeared to cause them to think only of a car engine. Other common weaknesses included:

- Inability to visualize an actual mechanism which functioned as indicated in the question
- Inability to draw or sketch in a three-dimensional view, for example, isometric
- Confusion between Parts (a) and (d) which both required sketches.

Question 9

This question was designed to test candidates' ability to:

a) Draw the sectional front elevation and plan of a plate with its elevation sectioned through X-X.
b) Fully dimension the drawing, noting all the features of the gauge plate including: dimensions, all holes, slot, chamfer, and machining and welding symbols.
c) Completely label the drawing including the part name, scale and projection symbol.

This was a very popular question with over 95 per cent of candidates attempting it. Candidates' responses to Part (a) revealed a few areas of concern in sectioning. Over 90 per cent of candidates did not show the symbol for a threaded hole on the sectional front elevation.

Responses to Part (b) revealed that over 80 per cent of candidates were able to correctly dimension the drawing. However, a small number of candidates chose to use open arrow heads as opposed to the recommended closed arrow heads on their dimension lines. Most of the holes were drawn, but a large percentage omitted the threaded details of the centre hole. Over 90 per cent of candidates, however, were unable to show the welding and machining symbol on the drawing.

Part (c) was attempted by most candidates, many of whom correctly identified the scale used.

UNIT 2

Paper 01 – Short Answer Questions

Module 1: Mechanics and Machines (Questions 1–3)

Question1

This question tested candidates' knowledge, application of knowledge and drawing skills. In particular, it tested the ability of candidates to draw orthographic views from a three-dimensional drawing of a flagpole with anchor cable and stake. Candidates were expected to show, by construction, the true length of the anchor cable and state the true length of the cable.

The question was very popular with candidates. Of the 322 candidates who wrote the paper, 72 per cent attempted this question. Approximately 50 per cent of the candidates reproduced the diagram in its three-dimensional form; however, they were unable to find the solution.

Approximately 10 per cent of the candidates failed to read and interpret the correct dimensions from the three-dimensional to the two-dimensional drawing. In addition, the majority of the candidates failed to state the true length of the cable.

Teachers need to focus on methods by which true length can be found; for example, using rotational and auxiliary methods.

Question 2

This question tested candidates' ability to determine, graphically, the magnitude of the reactions of a simple supported beam with point loads located at specific intervals. This question was attempted by approximately 71 per cent of the candidates, with approximately

30 per cent of them obtaining full marks. A large number of candidates failed to apply Bow's notation to their framing diagram. They were unable to interpret the forces acting on the beam or convert the total resultant on the beam into a force diagram with a pole.
Some candidates were also unable to accurately construct the link polygon. They were unable to draw parallel lines from the force diagram to construct the link polygon. Most candidates failed to state the magnitude of the reactions.

It is recommended that more emphasis be placed on the use of Bow's notation and that fundamental drawing skills be practised and reinforced at this level whether candidates are using traditional or CAD methods of drawing.

Question 3

This question required candidates to produce a freehand sketch of the profile of four consecutive teeth of an involute gear. Of the number of candidates who wrote the examination, 78 per cent attempted this question. Of that number, 50 per cent were able to accurately sketch the required figure, showing the teeth correctly proportioned. The labelling of parts was well done for the most part. Some candidates were not able to correctly represent the pressure angle, while others interchanged the dedendum circle with the base circle.

In attempting the question, approximately 5 per cent of candidates drew the gear using the three-dimensional format. Of this number, only four candidates produced accurately proportioned, three-dimensional drawings. Some candidates were unable to accurately label the drawn three-dimensional figure.

Candidates in answering this question should follow the guidelines listed below:

1. Draw the profile in 2D rather than 3D, thus being able to accurately label required parts.
2. Use leader lines pointing specifically to the section being labelled to enhance labelling of figures.
3. Practice sketching proportional freehand drawings.

Module 2: Engineering Materials and Processes (Questions 4–6)

Question 4

The question tested candidates' ability to sketch freehand the construction of a worm and worm wheel and to show how the worm would be lubricated by running in an oil bath. In addition, candidates were required to state two conditions under which it would be better to use oil instead of grease or vice versa for lubrication purposes.

This question was attempted by 75 per cent of the candidates. Sixty per cent of them produced responses which ranged from satisfactory to being comprehensively done.

In Part (a), candidates demonstrated some knowledge of the worm and worm wheel, but lacked the ability to sketch the assembly of the worm/worm wheel and the worm being lubricated in the oil bath.

In Part (b), a significant number of candidates confused the conditions for the use of grease and oil as lubricants.

Recommendations for Teachers

- It is recommended that teachers place more emphasis on freehand sketching of engineering components.
- Students need to be exposed to the forms of lubrication via work shop experience.

Question 5

This question tested candidates' knowledge of types of welding joints. Candidates were required to sketch and label the welding joints. In addition to this, they were asked to state two safety precautions that are necessary while arc welding.

Eight per cent of candidates attempted this question. In answering the first part of the question, approximately 30 per cent of respondents drew welding symbols instead of the joints requested. More than 50 per cent of the candidates labelled the joints incorrectly and their proportioning was not accurately done.

The majority of candidates who attempted this question were able to correctly state the safety precautions that were necessary while arc welding.

To improve performance on questions requiring sketching, it is recommended that students be exposed to opportunities for freehand sketching of welding joints and other mechanical components in classroom sessions.

Question 6

This question tested candidates' ability to identify types of bearings and to indicate the types of loading and the direction of the load/s.

This question was attempted by approximately 70 per cent of candidates, with roughly 50 per cent giving satisfactory responses. Most candidates failed to identity Figure 4 (i) which was a Deep Grooved Ball Bearing. In addition, 40 per cent of candidates were unable to name the type of loading for the Tapered Roller Bearing (combined radial and thrust load) as required for Part (b).

Part (c) required candidates to show the direction of the loading that acts on the system. Candidates were able to correctly sketch the direction for loading of the Radial and Thrust loads. However, the indication of loading for the combined load bearing was done unsatisfactorily. Many students showed the resultant of the horizontal and vertical forces.

It is recommended that greater emphasis be placed on the identification of different types of bearings in application and the loading for such bearings.

Module 3: Engineering Design Elements (Questions 7–9)

Question 7

This question was designed to capture candidates' knowledge and application of knowledge as it relates to Engineering Design. Over 95 per cent of candidates attempted this question. The question, however, was poorly done by candidates as they failed to identify ergonomic factors directly related to the gear lever. Candidates commonly highlighted aesthetic features of the lever such as colour, shine and the fact that welded areas should be covered. Additionally, candidates often referred to the function of the gears such as speed control and braking. In addition, some candidates listed ergonomic features relating to the operation of the lever such as length of lever but did not apply it to the operation of the gear lever.

Candidates who did well on this item were generally able to identify the ergonomic features and relate those features directly to the use of the gear lever. Teachers and students are therefore advised to pay attention to key words in a question because most students failed to correctly interpret the question. Furthermore, students must be exposed to a wider range of ergonomic factors to be considered when formulating engineering designs.

Question 8

This question was designed to test candidates' ability to apply engineering processes (recognition, definition, synthesis, optimizing, evaluation and presenting final product) to designing and building a product. Over 90 per cent of candidates responded to this item. Candidates who did well on this question were able to list in sequential order the six stages in the engineering design process and relate each stage directly to the design of the pump, as required. Over 60 per cent of candidates were, however, unable to relate various engineering design stages to the given context of designing and building a pump, hence, they were not able to achieve a comprehensive mark in this question.

Teachers and students must place greater emphasis on applying the engineering design stages to given design requirements/context. Additionally, students should ensure that they are familiar with the activities carried out in each stage of the design process, as some could not accurately relate the activities required.

Question 9

This question required candidates to draw a chain drive system and include an idler sprocket to prevent slackness. In addition, candidates were required to label the driven sprocket, driver sprocket, idler sprocket and adjustment for the idler sprocket.

The third part of the question tested candidates' knowledge and sketching ability of roller and inverted tooth chain drives.

This question was attempted by 76 per cent of the candidates. Most candidates showed good knowledge of the chain drive system while some failed to draw and indicate the idler sprocket and the adjustment for the sprocket.

The third part of the question had fewer responses and these were generally poor due to candidates' lack of knowledge of the roller and inverted tooth chain drives. Some candidates showed some degree of knowledge but demonstrated poor sketching ability.

Paper 02 – Essay Questions

Module 1 – Mechanics of Machines

Question 1

This question tested candidates' knowledge, application of knowledge and drawing skills. In particular, it tested the ability of candidates to calculate and construct two gear teeth given the pressure angle for each gear. There was no specific method given to construct the teeth; therefore, candidates used several methods to achieve the required result.

The question was very popular with candidates. Approximately78 per cent of the candidates responded to this item; however, in producing the gears, a few candidates left out the pressure angle but went on to construct the teeth. Some of the candidates who used AutoCAD seem to have either left out or turned off some layers before printing, and failed to print the scale used.

Part (b), which asked candidates to state the difference between the teeth profiles constructed, was not well answered by most candidates. Candidates may do well practise one method and acquaint themselves with an actual sample of a gear.

Question 2

The question tested candidates' knowledge of determining the reactions of a simply supported roof truss with different imposed loads. As the structure was symmetrically loaded, candidates could simply divide the total load by two to determine each reaction.

Candidates were also required to construct a vector diagram and determine the magnitude and nature of the stress in each member by graphical means.

This question was attempted by about 80 per cent of candidates. A significant number of candidates failed to determine the reactions on the structure and to successfully construct the vector diagram. It appears as though these candidates could not solve problems with reactions set in from the corners of the roof truss.

Teachers must therefore ensure that emphasis is paid to determining reactions and magnitude of forces acting on structures with reactions set in from the edges as well as to ensuring that students apply the principles of Bow's notation in such problems.

Question 3

This question tested candidates' knowledge, application of knowledge and drawing skills in determining the closest point at which two lines would pass using the auxiliary view method and in correctly labelling the diagram. Generally, the question was well done.

Over 75 per cent of candidates were able to construct the given views with correct dimensions. The construction of the first auxiliary view had minor problems. For example, over 50 per cent of candidates had problems projecting the first auxiliary view to show one line in true length. Additionally, 15 per cent of candidates had problems constructing the true length as a point in the second auxiliary view.

Candidates should pay particular attention to the following:

- Projecting the first auxiliary view to determine the true length of one line
- Determining the point view in the second auxiliary view, lines are projected from the true length of the first auxiliary
- The common perpendicular that passes through the point view is always at right angles to the other line in the second auxiliary view
- At every stage of the construction process, all lines must be labelled to avoid confusion
- All projected lines must be at right angles to the axis or reference plane.

Module 2: Engineering Materials and Processes (Questions 4–6)

Question 4

This question tested the candidates' knowledge of general safety procedures in the workshop or factory setting as well as their drawing skills. It required candidates to list safety precautions and equipment and state what each would be best suited for and in which situations they would be used. Most candidates answered the safety aspect of the question

well but found difficulty designing and applying the design to fit the pulley system given. Although it was an optional question, it was answered by about 85 per cent of candidates with more than 50 per cent scoring over half of the marks.

Question 5

This question tested candidates' knowledge, application of knowledge and drawing skills of bearings. It was divided into two parts. In Part (a), most candidates could not produce suitable sectional views for the bearings, especially the journal bearings. Since sectional views could give more clarity to sketches that were required, some candidates who attempted this approach lost marks because of their poor drawing skills. Some of these candidates failed to show the direction of force in the bearing and the direction of the roller elements.

Part (b) posed a great deal of difficulty. Candidates had difficulty sketching a sectional view for a trust roller bearing assembly, showing the correct positioning of the thrust roller bearing in relation to the vertical load shaft and correctly labelling the rotating parts and the bearings.

In Part (c), most candidates could not produce adequate sketches of a self -lubricating bearing with seals for retaining grease; however, the majority of candidates was able to state the benefits of bearings.

Question 6

The first part of this question tested candidates' ability to design and draw machine components, add several design features and identify their correct usage. While this section was attempted by about 30 per cent of candidates, they did not score well. Most design features were omitted from drawings. Part (b) tested candidates' ability to calculate tolerances and apply these correctly to an orthographic drawing. About 30 per cent of those who answered this question attempted this part with about 1 per cent of them answering it correctly.

Module 3: Engineering Design Elements (Questions 7–9)

Question 7

Candidates' knowledge and drawing skills were tested as they were required to use a labelled sectional sketch to explain the construction of a rigid coupling. In Part (b), they were required to state four reasons why the rigid coupling could be used to connect a motor to a gearbox. In Part (c), candidates were asked to explain the operation of the clutch in a given clutch system, explain how the brake differs from the clutch and explain the principle involved in the operation of a centrifugal clutch.

This question was not a high response question as only approximately 33 per cent of candidates attempted this question. Most candidates were able to produce a sketch of a rigid coupling but some failed to give details of the sectional view. In response to Part (b), candidates showed that they had an idea of why the rigid coupling could be used to connect a motor to a gearbox, but lacked the ability to express the answer in their own words. Parts (c) (i) and (ii) were attempted by most candidates; a few of them unsuccessfully attempted Part (c) (iii).

It is recommended that more teachers place greater emphasis on the design section of Unit 2, Module 3, where candidates do more sketching and explaining in their own words as this should lead to improved candidate responses and scores.

Question 8

This question tested candidates' knowledge of:

i. The types and properties of plastics and their application
ii. The manufacturing processes in the fabrication of plastic products
iii. Ergonomic and aesthetic considerations in the design of products.

This question was attempted by 9 per cent of candidates. A significant number of candidates were unaware of the processes involved in the fabrication of plastic products; they applied the terminology of metal casting to plastics.

Since many candidates may come from mechanical engineering backgrounds, they would need to pay attention to the plastics component of the syllabus. Emphasis is also needed in the areas of ergonomics and aesthetics, especially as they relate to the designing of products.

Question 9

This question tested candidates' knowledge of the ergonomic control loop and applying it to a given situation. It also tested candidates' knowledge of a design feature pertaining to one aspect of the braking system of a vehicle. About 35 per cent of candidates answered this question. Part (a), which focused on the ergonomic control loop, was answered correctly by about 5 per cent of those attempting the question. Based on responses, this is obviously a weak area for many candidates; however, it is one that needs to be understood by teachers and students alike. Most sketches could have been better; students need to concentrate more on the manufacturing processes and materials' properties.

Paper 03 – School-Based Assessment (SBA)

The 2014 SBAs for GMED again portrayed a vast range of skill and technical competences that would ensure we are on the right track.

Unit 1

The difficulties this year shifted to Solid Geometry where students had some challenges developing some of the solids selected. It was also observed that the difficulty level fell below CAPE to CSEC too regularly. Teachers are reminded to set questions at a level suited for the CAPE GMED.

It was observed that too many schools are not adhering to the rule that for each module, at least one drawing must be CAD-based. This resulted in much discussion as to whether the student should be penalized. This is an area requiring further discussion and consensus.

It was decided and requested again this year that teachers must submit a breakdown of the marks awarded using the mark scheme set by the CXC. The old form GMED 1-1 facilitates this and can be modified to show the module scores as is currently done.

Regarding CAD-based software, a standard must be reached where versions and programmes are concerned. Whether we use one standard program across all centres or whether we provide a list of accepted programmes must be established and relayed to the schools. That said, improvement was evident and better is expected in forthcoming moderation sessions.

Unit 2

Though the write-up and research of the design situations given were elaborate, many students fell down when it came to linking the findings with the design process. Too few students provided three or more alternative designs from which they chose the best and developed it. This is an integral process when designing or modifying a component and so must not be treated lightly.

The level of CAD-based drawing is gradually improving with some schools being far more advanced than others, but mediocrity will and cannot be tolerated. Students are encouraged to take pride in their designs and work diligently to see them completed. The Unit 2 checklist is again a viable tool for ensuring that all criteria are met before submission.

General Remarks

In this 2014 SBA moderation, 64 centres were registered of which two made no submissions. This year, 242 candidates were submitted for moderation and 63 per cent of them submitted the requested five samples per centre. It must be stated that 71 per cent of those who submitted less than five samples had less than five students enrolled in the GMED program.

Most students are submitting samples at the level set out by CXC CAPE; however, there is an increase this year of students supplying solutions suited for CSEC and this is unacceptable. Teachers are again encouraged to supply students with assignments that reflect an advanced nature especially in Solid Geometry (Module 2) of the syllabus.

CAD-based solutions continue to pose a challenge in terms of the standard/level of the drawing. It must be noted that the use of any CAD-based drawing for Assignment 4 is unacceptable. Drawings must be at a level suited for CAPE, which rules out, for example, block diagrams with no circles or curves. It is also recommended that CAD-based drawings be saved in earlier versions, for example 2012, since the centre where marking and moderation takes place does not have software beyond that.

More inconsistencies were noted this time around and the standard has clearly fluctuated from last year. This must be addressed as it is critical that we reach a standard across all centres in the Caribbean for quality assurance purposes.

Students are also encouraged to take pride in their work and the quality of the samples they submit. In addition, teachers need to ensure that the work students are submitting is their own and that there are two assignments for each module; a total of six assignments.

It was pleasing to see that many more centres submitted the questions given to the students as part of their portfolio. This removes the guess work and the assumptions when trying to determine what students were asked to do that led to the solution being moderated. Attention must be paid to labelling drawings in all cases.

Assignment 1 – Centroids

Better work was done this year when compared with last year and it seems as though more effort was placed on how it was delivered. However, in instances where calculations were done, many of them were incorrect. There were a few cases where simple blocks were given and almost full marks awarded as a result. This poses a challenge for quality assurance. Again more time needs to be spent explaining to students the concepts of 1st and 2nd moments and their derived shapes. It would certainly improve the quality of the solutions for this assignment once concepts are understood and applied.

Assignment 2 – Cams

This assignment was generally well done this time around with only a few incorrect solutions and incomplete profiles. The assignment was mostly done using CAD software which yielded very well-drawn profiles and graphs. One thing to note however, is that it is important that the cam data be either sent as a separate document or written on the solution. As was mentioned before, labelling is important!

Assignment 3 – Development and Interpenetration

It was observed that many of the solutions for this assignment fell into the CSEC level as opposed to the CAPE level. Assignments were very basic and posed no real challenge for a CAPE level student; more areas such as triangulation and auxiliary projections should be explored. Teachers are reminded that they must set questions that reflect an advanced level qualification.

Assignment 4 – CAD

Though the syllabus only states that students must produce drawings using CAD software, consideration must be given to the level of difficulty in producing these drawings. Therefore, no isometric blocks without circles or curves should be entertained. Students can produce *solid geometry solutions* and the options are many. Choices include: pictorial projections, orthographic projections, auxiliary views, interpenetration, developments and helical threads and springs.

Assignment 5 – Design

About 60 per cent of the design questions this year were adequate in terms of their content which is a vast improvement in comparison to last year. However, those that were not well done were really off the mark in terms of content, layout and drawing skills. Every design concept should have alternative designs/sketches from which the best design that meet the design specifications is selected and developed into the final design solution. This process is important and must be drilled into the minds of students. Submitting drawings *only* does not constitute a design process; there must be dialogue (write-up) which details the process the drawings have taken. The checklist idea is revisited here as a viable instrument for verifying that all aspects of the design process have been met.

Assignment 6 – Engineering Drawing

This assignment continues to be well done by approximately 90 per cent of the candidates. Again, labelling is important and care/attention must be given to line work (line quality). Most samples demonstrated good understanding of orthographic, sectioning, working drawings and balloon referencing. However, it must be stated that errors such as sectioning bolts and webs, and such like, cannot be overlooked. Teachers must be vigilant enough to capture these mishaps and address them.

Recommendations

When submitting marks for moderation, the breakdown of each mark should be submitted. Tabulation of module scores needs to be revisited for Unit 1. Adding all the marks and dividing by 3 is a skewed method and does not reflect true module scores. For example, when a student does not attempt Assignment 5 or 6 (Module 3) but then the marks are divided by 3, that student will get a score for a module that was not attempted; this results in

incorrect module data. It is therefore recommended that the module scores are calculated as follows:

Module 1 – Assignments 1 and 2 only
Module 2 – Assignments 3 and 4 only
Module 3 – Assignments 5 and 6 only

This method would provide true and accurate module data for analysing.

It is recommended that a standard version for CAD-based drawings be identified and made mandatory for the submission of all CAD-based drawings. This would remove the dilemma of having files that cannot be opened on the current computer system available to us. An alternative would be to provide markers with a laptop that is running the latest version of the various CAD-based programs. Currently, the marking centre uses AutoCAD 2012 software on their machines.

Teachers are reminded that students are required to produce drawings using CAD software. They are not to visit a website, download an existing drawing and then edit it. All construction lines must be shown, whether or not the drawing is CAD-based.

The write-up in the design assignment is important since it communicates to the reader a logical thought process. Students should follow the design process to completion by creating a checklist of the things to be included in the design. For example, three alternative designs are necessary before a final drawing is produced. Also, the information must flow and be related to the design. Trying to fit everything on one sheet including the write-up does not help the readability and in many cases causes confusion.

If an entire class works on the design of a concept, each student must then go and prepare his/her own solution. The data will be the same but the sketches, the write-up and the final drawings must be the students' own work. No group submission of portfolios/projects is allowed.