CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2011

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

GENERAL COMMENTS

This subject consists of two units: Unit 1 and Unit 2. Unit 1 comprises two papers and so does Unit 2.

Unit 1, Paper 01 and Unit 1, Paper 02 have three sections — Section A (Module 1), Plane Geometry; Section B (Module 2), Solid Geometry; Section C (Module 3), Mechanical Engineering Drawing.

Unit 2, Paper 01 and Unit 2, Paper 02 have 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 ten 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 2011, the mean mark on Unit 1, Paper 01 was 37.64 per cent which was in excess of the 2009 figure (30.32 per cent) but lower than the 2010 figure (50.42 per cent), while the Unit 1 Paper 02 mean was 34.59 per cent which was in excess of the 2010 figure (32.91 per cent), but smaller than the 2009 figure of 39.34 per cent.

In 2011, the mean mark on Unit 2, Paper 01 was 42.85 per cent which was in excess of the 2010 figure (40.84 per cent) but lower than the 2009 figure (45.01 per cent), while the Unit 2 Paper 02 mean was 45.90 per cent which was in excess of the 2010 figure (39.46 per cent), but smaller than the 2009 figure of 47.37 per cent.

Overall, on Unit 1 there was a slight reduction in performance over the three-year period, while on Unit 2, there was an improvement (six per cent) in performance over 2010 but a very slight reduction (1.69 per cent) over 2009.

With respect to grade levels, the percentage of candidates receiving Grades I–V was 68.85, while on Unit 2 the corresponding percentage was 88.93.

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 ten per cent of candidates being exceptional. Candidates appeared not to have followed the syllabus or were not aware of what was required of them.

In 2011, the SBA continued to show improvement over previous years as teachers and students become more familiar with the content of the syllabus and what is required of them. Continuing in this trend will only yield very good results.

There were instances of very high quality work in both Unit 1 and Unit 2; however, too many schools are producing substandard work. Evidence suggests that a better understanding of the syllabus will improve overall results across the Caribbean.

The standard of work produced was satisfactory for Modules 1 and 2; however in Module 3, approximately 60 per cent of the candidates did not perform well on the design question. Nevertheless, the work produced overall was fairly satisfactory.

Teachers and students are encouraged to follow the syllabus and the mark scheme in terms of ascertaining what is required and how it should be done. Over 50 per cent of the candidates lost marks because they either did not follow the syllabus or were not aware of what was required. The standard of work produced was moderate with about ten per cent being exceptional.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short-Answer Questions

Question 1

This question was designed to test candidates' ability to distinguish between cam profiles and associated displacement diagrams.

About 99 per cent of candidates attempted this question and most completed the graph correctly (which was simply reproducing the given figure). While many candidates attempted and completed the cam profile, a significant number of them incorrectly measured the minimum cam diameter, resulting in too large a cam profile. Candidates should be more careful with measurements when transferring and producing a drawing. Drawing skills continue to be a problem in producing accurate drawings, correct line types and neat sketches.

Question 2

This question was designed to test candidates' ability to construct a spiral and use orthographic views to show details of the spiral.

This question was attempted by over 75 per cent of the candidates and 65 per cent of those gave satisfactory responses. Candidates who completed the question understood that the construction of the conical spiral included the division of the vertical height of the conical view into the same number of parts as the base circle. These were also the same candidates who understood that the base circle was also to be divided into the same number of parts with radii taken from the cone. Many of the weaker candidates failed to demonstrate this knowledge. It is suggested that more attention be paid to ensuring that all divisions and construction lines be clearly outlined when drawing a conical spiral.

Question 3

This question was designed to test candidates' ability to determine the centroid of an irregular shape.

About 99 per cent of candidates attempted this question. While most reproduced the figure correctly, a significant number drew the height of the triangle incorrectly (90 mm as opposed to 30 mm) as they misinterpreted the dimensioning method employed on the question paper. Candidates should be made aware of the different dimensioning methods in use and be careful when interpreting dimensions. A significant number of candidates attempted this question using the graphical integration method. Most candidates ignored the area of the two semi-circular ends of the figure in their computation of the total area

resulting in different centroid values. A significant number of candidates found the area of the triangle incorrectly — they found the centroid by bisecting two angles as opposed to the correct method which is bisecting the side opposite each angle.

Question 4

This question was designed to test candidates' ability to draw the true shape of the sectioned face of a right hexagonal pyramid, cut by an inclined plane, by projecting a plan and an auxiliary plan.

Approximately 98 per cent of the candidates attempted it. Among those responses, the reproduction of the figure was well done. On the other hand, many candidates had challenges in differentiating the true shape of the plan and the auxiliary plan. Cutting planes and directions in which views are to be taken must be clearly shown. Candidates need to be strengthened in the area of auxiliary projection and its applications.

Question 5

This question was designed to test candidates' ability to accurately draw the curve of interpenetration between two solids, in this case a right cone and a cylinder.

Almost all candidates attempted this question, which was compulsory. Of those who attempted the question, 54 per cent gave satisfactory responses.

The reproduction of the drawing in Part (a) was generally well done even though there were a few candidates who had difficulty doing it correctly. In Part (b), alternative methods were used by some candidates in constructing the curve of intersection which gave the desired response.

Even though many candidates were able to solve the problem satisfactorily, some had major difficulty

(i) distinguishing the lines that were common to both surfaces of intersection
(ii) determining the appropriate method of projecting the lines to establish the points for plotting and joining with a smooth curve.

Candidates must be properly exposed to the different methods that can be used to determine the curve of interpenetration, including the use of auxiliary projection.

Question 6

This question was designed to test candidates' knowledge and ability to interpret specific engineering data and draw one and a half turns of a spring.

It was attempted by more than half of the candidates and nine per cent of them gave satisfactory responses. However, the weaker candidates seemed unable to differentiate between the principles of constructing rectangular and circular springs. In addition, some candidates also had difficulty demonstrating that they understood how to calculate the correct pitch when drawing one and a half turns of a spring. It was also seen that some of the students may not have clearly understood what graphical image one and a half turns of a spring should look like (some of them only constructed a diagram showing one turn).

Question 7

This question was designed to test candidates' knowledge and ability to use the B.S. Data Sheet 4500 in determining the limits of sizes and types of fits of a shaft and housing assembly. It also tested candidates' ability to fully dimension a drawing and insert machining symbols.

This question was not a popular one with candidates. Less than 30 per cent of them attempted it. Of the ones who did the problem, about 25 per cent of them scored above the half mark. Candidates appeared to have had difficulty with reading and interpreting the data sheet given, and this led to a number of incorrect calculations. Also, very few of them correctly indicated the machining symbol and chamfer on the drawing. Much greater emphasis should be placed on this topic within the schools.

Question 8

This question was designed to test candidates' ability to draw the front elevation, project an end elevation and fully dimension the drawing as a working drawing.

This question was attempted by 99 per cent of the candidates. Candidates had major difficulties inputting the components of a working drawing which was worth 50 per cent of the total marks.

More work needs to be done to enhance candidates' knowledge of working drawings.

Question 9

This question was designed to test candidates' ability to produce a neat, freehand, isometric sketch of a given clamp, and show the following missing components on the fully assembled clamp: a nut, a washer and a T-stud.

Most candidates who attempted this question had problems drawing the T-Bolt. They seemed to have little or no knowledge of the mechanical component. This may have been due to a lack of exposure. Ninety-nine per cent of the candidates attempted this question.

Paper 02 – Essay Questions

Question 1

This question tested candidates' knowledge of the different types of cam motion and their ability to construct the relevant performance graph. Their ability to transfer (plot) the displacement of the follower to obtain the cam profile was also tested. It was quite popular, with 96 per cent of the candidates attempting it. Based on the scores, approximately 70 per cent of the candidates gave at least a satisfactory response. The plotting of the performance graph proved to be a major challenge; more than 50 per cent of the candidates had challenges selecting the right type of motion (UV, SHM or UAR) along with the accurate plotting of the cam profile.

Candidates should pay close attention to the direction of rotation of the cam, which determines the direction in which the plotting of the cam profile is carried out.

Question 2

This question tested candidates' knowledge and ability to determine the centroid of a figure using graphical integration. It was attempted by approximately 56 per cent of the candidates. Of that number, 20 per cent gained a mark that may be considered satisfactory and nine per cent got a mark that may be considered very good.

On the down side, a considerable number of the candidates (33 per cent) were only able to reproduce the given figure and nothing more. Fifty-four per cent of the candidates scored less than 10 out of 25 marks, which can be considered a poor response. This suggested that too many candidates did not work past the production of the first derived figure and also that candidates are not grasping some critical concepts in this particular topic.

Question 3

This question tested candidates' knowledge and ability to construct a helix and apply it to the construction of a single start square screw thread. The question was not very popular. Only 25 per cent of candidates attempted it. Of those, only 20 per cent achieved a score of 20 and above out of a possible 25 marks. Fifty per cent of the candidates received a score of 13 marks and below. Approximately 80 per cent of the candidates showed no knowledge of the relationship between the square thread and the pitch. The same number of candidates also showed no knowledge of the difference between a spring and a thread. When introducing helical curves, candidates should be made aware of the similarities and differences between springs and screw threads. Again, drawing skills continue to pose difficulties for candidates.

Question 4

This question tested candidates' knowledge of and ability to produce perspective drawings from a given orthographic projection. It was attempted by just over 33 per cent of them. Fifteen per cent of those candidates scored at least 75 per cent. Thirty per cent were satisfactory, with 40 per cent scoring below ten per cent. The candidates who scored in the higher range were able to demonstrate knowledge of perspective drawings and were able to produce the eye and project lines relative to the eye.

The majority of candidates, however, were unable to distinguish between perspective and isometric drawings. This resulted in their solutions being presented as isometric representations.

It is recommended that, at this level, candidates be given greater exposure to the varied types of pictorial drawings and their uses.

Question 5

This question tested candidates ability to construct an ellipse by auxiliary circle method (concentric circle), in addition to plotting the locus of a point on a link.

This question was attempted by approximately 81 per cent (369 of 455) of the candidates. Of the 81 per cent of those who attempted the question, about 37 per cent (137) received a score of 13 or more. Of this 37 per cent, 71 per cent received a score of 20 or more out of 25 marks.

Candidates were generally able to construct an ellipse by the method outlined so that only two candidates received zero. Most of these candidates were able to draw the circle traced out by the

rotating arm and to divide it up. Generally, candidates who did well understood that the circle which held the link AB had to be divided, and that the roller moved along the base of the ellipse. In this group of 137, at least 40 candidates did not use the centre of the roller as the end of the link, rather they used the base of the roller.

On average, candidates continue to display poor drawing skills (accuracy, line-type, freehand sketch).

Question 6

This question was intended to test candidates' knowledge of two of the topics in the syllabus — auxiliary projection and intersections of solids. However, of the 455 candidates who sat this exam, 67 per cent or 307 candidates attempted this question with less than ten per cent being able to achieve a satisfactory result. This clearly suggests that these areas of the syllabus must not have been covered well enough. It appeared as though the majority of candidates could not apply the use of auxiliary views to locate the points for the curve of intersection as was needed for this particular question. The application of auxiliary views to solve problems must be emphasized.

Teachers and students must be reminded that these areas do form part of the required syllabus and more time and effort must be spent on these topics to improve performance at this level.

Question 7

This question tested candidates' ability to correctly assemble the given components, and to draw a plan and front elevation of the assembled components accurately. Generally, candidates demonstrated a good understanding of the assembly of the components and approximately 129 of the 247 (63 per cent) candidates assembled the components correctly. However, the major challenge of this question related to the orientation of the device, that is, which view constituted the front elevation and hence, the direction from which the plan was to be drawn.

As a direct result of this, the question provided good scope for the use of candidates' discretion and most of them did so creditably. For example, no direction was given as to whether the legs should be turned inwards or outwards. Thus, candidates were not penalized for turning the legs in either direction.

Approximately one-third of the candidates produced drawings of the end elevation which was not required. Accuracy (exact measurement) was also a challenge for a large number of the candidates.

Question 8

This question tested candidates' ability to produce accurate working drawings and their knowledge of welding and machining symbols.

Approximately one-third of the candidates attempted this question, with most of them giving unsatisfactory responses. Most of the candidates reproduced the pictorial (isometric) drawing of the 'shaft pivot support' that was given, rather than the working drawing (orthographic projection) that was required.

In most instances, the responses showed that candidates' attempts at producing the required working drawings had the views incorrectly positioned and named, no welding or machining symbols and no dimensions.

In a few cases, candidates also produced drawings of the component parts of the support rather than of the assembly.

Most candidates who responded to this question scored less than half of the total marks. Candidates' lack of knowledge of working drawings as expressed by the nature of the responses suggests a need for emphasis on the distinction between working drawings and pictorial drawings, as well as the application of welding and machining symbols on a drawing. Drawing is a means of communication and symbols are instructions that are placed on drawings.

Question 9

This question tested candidates' knowledge and ability to transfer a working drawing (front and end elevation) to a freehand (sketch) isometric drawing. Candidates were also required to label and name the sketch.

Approximately 70 per cent of the candidates attempted this optional question, however, only about 40 per cent of them gave satisfactory responses.

Part (a) was generally well done by the candidates, with most of them being able to draw the device freehand and in isometric projection. Many candidates, however, did not draw all the components correctly or excluded key components from their drawing.

Parts (b) and (c) that required candidates to name and label the device were poorly done. The parts of the device were incorrectly labelled and many candidates did not know the correct name of the device.

Paper 03 – School-Based Assessment

There were 59 centres registered; samples from 53 of them were received and moderated. Those centres unaccounted for did not submit any samples. Generally, five samples are submitted over 60 per cent of the time, differing mostly based on the number of students registered by the centre. In some instances, marks were submitted for students who had no portfolios or there were portfolios for students who were not on the moderation form.

Folder presentations were fair with about 20 per cent of the schools producing excellent work. Students should be encouraged to strive for excellence not only in the content of their work but also in the presentation of the work they have done.

Centres are reminded that the GMED 1-1 form which gives the breakdown of the marks should be submitted along with the GMED 1-3 form which gives the module score. If the GMED 1-1 form is not available, then a copy of the mark scheme provided in the syllabus should be submitted. This form provides valuable information needed in the moderation process. Below is a check list of the items to be submitted for the moderation procedure.

- GMED 1-1 form
- GMED 1-3 form
- GMED 1-4 form
- 5 samples per school
- Six assignments per student, two from each module. (At least **one** assignment per module must be **CAD** based.)

- Electronic copy of all CAD-based drawings
- List of Commands used in the CAD software (Do not use F2 to generate command list, simply state the commands used.)

When submitting work in AutoCAD, students are encouraged to save the file as an ***AutoCAD 2004 Drawing (*.dwg)*** file type, simply for compatibility reasons. Also AutoCAD drawings should be printed in the event that the floppy disc, CD or flash drive gets damaged in transit, which happened before in approximately 40 per cent of cases.

It is necessary, when moderating, to have an idea of the questions given to the students to complete for the SBA. Therefore, all schools must submit these questions along with the portfolio to CXC to allow for transparency during the moderation process.

It was very evident that there was a disparity in the level at which marking is done across the Caribbean. Some teachers were very lenient while others were extremely severe. There needs to be some kind of standardizing in teacher marking across the Caribbean.

A few students used Assignment 6, if done in AutoCAD, as Assignment 4 in this SBA session. Teachers are reminded that they are required to submit six original/unique drawings for the Unit 1 SBA.

Assignment 1 – Centroids

Students are generally answering Centroid type questions with better accuracy than in previous years, however what is lacking is the process (calculations, etc.) in obtaining the centroid, especially when it is done in AutoCAD.

Teachers must also bear in mind the standards required at the CAPE level. Some centroid questions were definitely too simple.

Assignment 2 – Cams

Approximately 70 per cent of the Cam drawings were well done and displayed a reasonable level of difficulty. However, students must be encouraged to show the direction in which the Cam is rotating and a means of securing the cam to the shaft. Some students labelled the profile incorrectly thus causing the profile to be inverted.

In a few cases (approximately 15 per cent), some students produced a simple displacement diagram as Assignment 2, which is not acceptable.

Seventy-five per cent of the CAD drawings of cams were well done but were often small in orientation when printed on A4 paper.

Assignment 3 – Development and Interpenetration

The work produced for this assignment was generally good, about 80 per cent of the submissions satisfactory. Line work was a major issue for the students who did not use CAD software to answer the question.

Students correctly grasped the concept of the development of solids as well as how solids meet.

Assignment 4 – CAD

One major issue here was software compatibility as was mentioned before, but having said that, a large number of schools are getting very proficient in AutoCAD. However, it was noted that the level of the CAD drawings were too low albeit recognizing that the syllabus just states "Use of CAD software to produce solid geometry drawings".

Generally, students did not submit the list of commands as requested. In some instances, since the drawings for this assignment were the same for everybody, there was evidence of cheating in the form of copying drawings and changing names (about 45 per cent).

Many of the floppy discs, CDs or flash drives submitted did not open because either they were damaged or had files in a version not supported by our systems.

Assignment 5 – Design

The design process continues to be challenging for most (approximately 75 per cent) of the students. Though what is required is not as detailed as Unit 2, a brief outline of the design process is still required.

Approximately 30 per cent of the submissions were absolutely not adequate and the other 45 per cent or so were weak. Sketches were poor and the presentation of the portfolios lacked order.

Assignment 6 – Assembly/Engineering Drawing

This assignment was done well. The level of the questions given was appropriate and displayed a level of skill commensurate with CAPE standards.

What was noted, however, was that many questions given were from a popular textbook known for having the solutions to the assembly drawings so a true sense of the students' ability to assemble a drawing could not be gleaned.

Students who did CAD for this assignment did a good job; they missed out only on centre lines, dimensioning, labels and so on.

Recommendation

For Assignment 4, students should be given a bank of questions to choose from with two students at most doing one question. This would minimize the likelihood of mass copying.

UNIT 2

Paper 01 – Short Answer Questions

Question 1

This question tested candidates' knowledge of the types of forces exerted on a point, a plane or a solid object.

It was compulsory and was attempted by most candidates with more than 70 per cent of them giving satisfactory responses. Part (a) was generally well done; however, the weaker candidates confused concurrent and coplanar forces and also resultant and equilibrant forces.

Part (b) was also generally well done; however, about 25 per cent of the candidates, even though they completed the drawing correctly, failed to use the scale to convert the length of the resultant line and state the magnitude and direction of the overall load on the barge.

Question 2

This question tested candidates' knowledge of the different types of gears and gear arrangements. It required candidates to explain the different types of gears with the aid of sketches; however, most candidates used only text or drawings to explain. Only about ten per cent of the candidates used both text and drawings to explain the different types of gears. Most candidates seemed to have the knowledge of straight spur gears but about 50 per cent of them confused the helical and double helical gears. Some candidates were confusing the helical gears with the worm and worm wheel.

Part (b) required an arrangement of gears to show the driver and driven gears moving in the same direction; however, more than 50 per cent of the candidates showed a bicycle gear and chain arrangement (chain drive) which is incorrect.

Question 3

This question required candidates to reproduce two given incomplete views of a line and plane as they converge, to generate an auxiliary view, and to locate the point of convergence on the original views.

Most candidates were able to reproduce the views with good skill. Few candidates proceeded beyond initial reproduction of the given views. Of those who did, the majority were only able to correctly locate X_1 Y_1. A few of these candidates generated accurate auxiliary views. A minority was indeed able to locate the converging point within the auxiliary view but did not reverse operations in order to locate the piercing points on the original elevations. Less than 20 per cent of the respondents presented a complete, accurate solution. This suggests some unfamiliarity with auxiliary operations and therefore candidates were challenged to reverse these operations effectively.

Question 4

Candidates were given a two-part question with pictures of two devices (not drawn to scale) to test their ability to give illustrations and explain how these devices are used to lubricate a machine, and to give two reasons why it's important to grease a machine.

This question was compulsory; approximately 90 per cent of the candidates attempted it. Many candidates were not aware of the purpose of the grease nipples, also some candidates' explanation of oiling a machine was given for greasing a machine (changing the grease gun for oil pan).

Candidates were able to give two reasons why greasing is important to a machine. Some candidates explained the terms, *wearing*, *seizure*, *overheating*, *lubricating* instead of merely stating these terms.

Overall, this question was a good one with scores ranging from five or seven to ten with an average score of about seven (out of a possible ten marks).

With these strengths and weaknesses in mind, it is recommended that teachers give more exposure to students on using the grease gun to grease a machine, using the oil pan to oil a machine and the types of grease nipples and their uses.

This could be achieved by field trips or lesson videos from the Internet as well as practicals.

Question 5

This item tested candidates' ability to sketch and recall five areas on the component illustrating a cross-section of an 'O' ring installed and under pressure and also to make a sketch of the 'O' ring when it's not under pressure. Candidates were also asked to state the purpose of using an 'O' ring.

Candidates showed weakness in the labelling of five parts of the components which was worth five points; most candidates lost scores for poor labelling and guessing. A few candidates were not sure how to sketch the 'O' ring when it's not under pressure and lost three marks here also. Their strengths were in stating the purpose of using 'O' rings and a few explained the term *seal* which was just as good for the purpose.

This item was a compulsory item and approximately 85 per cent of the candidates attempted it. Scores ranged from zero to ten marks with an average score of five. From the responses given, candidates showed signs of guessing at labelling the components.

Candidates need exposure to labelling components sketches. Video lessons on functions and labelling of components from the Internet may be of great help in this regard. Getting samples of various components and assembling and disassembling them could be good practice for candidates. Putting these recommendations to practice could result in better scores on this type of question in the future.

Question 6

This question was designed to test candidates' ability to name and sketch the appropriate eye protection gear that should be worn when visiting a factory, drilling a hole on a drilling machine, doing electrical arc welding or handling chemicals and hazardous liquids.

Part (a) was generally well done. Some candidates used the term *description glasses* instead of *safety glasses* (which is the desired term) and the sketches these candidates produced were very poor.

Part (b) indicated that 90 per cent of the candidates were able to answer this question in terms of providing the correct name for the gear (goggles), however the sketches from some of the candidates did not show full protection, as it relates to flying particles which is normally the case when drilling on a drilling machine.

Part (c) revealed that a significant number of candidates were unable to provide a name or even a correct sketch for this face gear. Candidates were not sure of the gear, and most of them selected goggles. However, 40 per cent of the candidates selected a gas mask which revealed they were actually thinking, as this type of gear not only protects the eyes but also protects the whole face and nose from harmful vapours.

Part (d) was generally well done by candidates. A large percentage of them knew the name of the protective eye gear and were able to provide a suitable but not always accurate sketch. Some candidates selected what was termed a 'Flip able' gear which was quite creative.

Recommendation

Candidates need to have a greater appreciation of the purposes of the various types of eye protection gear used in the workshop. The weaker candidates were only aware of the goggles and the face shield as safety gears. These candidates also lacked the necessary drawing skills which are required in producing neat and accurate sketches in most cases.

Question 7

This question tested candidates' ability to select and sketch suitable coupling for two design situations. It was a popular question; 71 per cent of the candidates who sat the examination attempted this question.

The question was poorly done. A large majority of the candidates who attempted it scored between zero and two marks. However, approximately ten per cent of the small majority of candidates who performed well at this question scored between eight and ten marks.

Most of the candidates knew the names of couplings but could neither select the correct one for each design situation nor produce an appropriate sketch.

Question 8

This question tested candidates' ability to produce a development of a lunchbox and explain how the box would be folded and held in form. Ninety-seven per cent of the candidates who sat the examination attempted this question. Approximately 70 per cent of the candidates scored between five and ten marks.

The question was fairly well done, in that, a large majority of the candidates could produce a development for the lunch box. However, quite a few candidates did not use the appropriate folding line type. Also, a substantial number of candidates did not produce any snaps on their development in order for the lunchbox to be held in form. Some of the candidates who interpreted the material of the lunchbox to be paper used glue or some other adhesive to hold the box in form.

A large majority of candidates interpreted the lunchbox as a lunch pan that is made out of sheet metal; thus, they opted to weld the joins in order for it to be folded and held in form.

Question 9

This question was designed to test candidates' knowledge and application of the design, selection of materials and manufacture processes.

Part (a) was well done with most candidates being able to sketch and assemble a suitable device and name all components. Approximately 90 per cent of all candidates obtained full marks.

Part (b) was fairly well done with approximately 50 per cent of the candidates being able to select suitable materials for each component. Some candidates' selection of materials was not suitable for the component nor was it feasible to use the material selected.

For Part (c), candidates were required to explain an appropriate manufacturing process for each component based on the material selected. The problem encountered by approximately 50 per cent of the candidates was their inability to identify the appropriate manufacturing process best suited for the component and material selected. Some candidates went on to explain the design/assembly process rather than the manufacturing process for each component. However, approximately 20 per cent of the candidates explained the manufacturing process.

Recommendations

Teachers should consider conducting field trips to engineering plants/factories. This will allow students to observe the manufacturing of components and products, using various processes and materials. Additionally, field trips would allow students to get an overall idea of the development of a product from its initial stages to the end. Further to the above, teachers should employ the use of technology in the classroom through the form of videos, and Internet research with student presentations.

Paper 02 – Essay Questions

Question 1

This question was set to test candidates' knowledge of simple frameworks and also their ability to determine graphically, the reactions, the magnitude and the type of forces acting in each member.

This question was attempted by a little over 60 per cent of candidates, with approximately 20 per cent performing reasonably well and a further nine per cent giving excellent responses.

Approximately 60 per cent of the candidates who attempted the question displayed insufficient knowledge and ability to find graphically, the magnitude and the type of force acting in the members, giving a completely different response. There was a general weakness in the use of BOW's notation, and the use of upper case letters on the space diagram and lower case letters on the force diagram. The link polygon used in finding the reactions posed quite a problem for many candidates.

When teaching this topic, it must be emphasized that the scale chosen for the force diagram must be stated and, at the completion of the force diagram, the length of the vectors representing the members of the framework should be converted to a force using the chosen scale and recorded in a table along with the type of force.

Question 2

This question tested candidates' ability to draw the profile of an involute spur gear tooth, using given and calculated parameters. It was attempted by 80 per cent of the candidates with more than 50 per cent of them giving satisfactory to excellent responses. A few candidates were not able to perform the necessary calculations, but it was well done by those who were able to perform them.

Candidates' ability to step off pitch points accurately posed a challenge. A few candidates were only able to draw the pitch, base, addendum and dedendum circles and could not produce the gear tooth.

A few candidates misinterpreted the question and produced freehand sketches for the solution. Some were able to produce the profile of the gear tooth without completing the shape by drawing the root radii.

Attention should be paid to the calculations to obtain the parameters for constructing the gear tooth profile along with emphasis on the methods of procedures to obtain such.

Question 3

This question tested candidates' ability to produce two auxiliary views and then determine the 'true angle' between the planes. In addition, they were required to label the drawing and state the derived dihedral angle.

It was attempted by approximately 40 per cent of the candidates of which about 20 per cent of them made errors in phase one of the construction processes. Candidates simply copied the given views, and thus, started with a disadvantage. Misinterpretation of what was required was also clearly evident. About 15 per cent of the candidates opted to produce the true shapes of the two triangles instead. Sixty-four per cent of those who attempted the question were unable to achieve half of the marks awarded to this question and 13 per cent achieved scores which can be considered excellent.

It is recommended that candidates be encouraged to double-check the measurements of their reproduced drawings and minimize these simple errors. Teachers also need to emphasize to students the importance of reading questions carefully and paying close attention to the terms/expressions used in a question to ensure that there is no misunderstanding of what is required.

Question 4

This question tested candidates' knowledge of engineering materials and processes as they relate to safety equipment and material in the electric arc welding process.

This question proved to be very popular with 82 per cent of the candidates attempting it. Of those who attempted the question, 95 per cent gave an acceptable response.

The naming of the protective gear was well done; however, the section dealing with the materials was unsatisfactorily attempted. The section which highlighted the hazards was generally well done. The drawing aspect of the solution proved to be difficult for some candidates and should have been better. The candidates whose performance was excellent possessed an understanding of the types of materials used in the safety apparel for electric arc welding.

Question 5

This question tested candidates' knowledge of a cylinder head gasket and their ability to sketch the gasket, name it and list the steps involved in the installation of the gasket.

This was not a popular question. Less than 30 per cent of the candidates attempted it.

Part (a) was very well done by most of the candidates who were able to correctly sketch the gasket.

Part (b) was also well done; however, weaker candidates were unable to state the type of gasket to be used.

Parts (c) and (d) required candidates to state the material to be used as well as the installation steps to follow. This part of the question was not done well and many candidates scored poorly in this section. The candidates gave either a plastic or other unsuitable material as their response and did not give relevant steps for installing the gasket.

Question 6

This question was designed to test candidates' ability to apply the appropriate bearing for radial and thrust loads, design an appropriate cover for a simple transmission system, and select and apply appropriate seals.

Approximately 33 per cent of the candidates attempted this question.

Though the majority of candidates was able to indicate that a bearing would be used, only five per cent of them represented the correct type of bearing.

It was evident that candidates had an understanding of the use of seals and gaskets; however, more than 50 per cent of the responses were unclear with regard to the correct application for these components.

A large percentage of the respondents failed to score any marks for this question.

The respondents who scored highly demonstrated a fairly good knowledge and understanding of the application of the end cover as well as the method of sealing the shaft.

It is recommended that more practical exposure be given to students with regard to the application of mechanical components in drive systems — transmission of motion and power.

Question 7

This question was attempted by approximately 40 per cent of the candidates. Of these, only 15 per cent obtained a mark of 60 per cent or above.

Most candidates lost considerable marks because of the absence of labelling. In technical drawings, diagrams are almost useless without labels.

A clear sketch of the drive train of a bicycle was required. Some candidates got the drive gear and the driven gear confused. The most common method suggested by candidates for adjusting the chain was to remove links.

Students should be exposed to practical examples when transmission and power are being taught.

Question 8

This question tested candidates' ability to design a means for a motor to drive a pump, show details of how the components will be affixed to the shafts, use labels to identify the components, explain how the components affect the output speed of the pump and identify a safety device which could be installed to prevent the component from causing injury.

Part (a) was generally well done. Over 90 per cent of candidates were able to show a design for the motor to drive the pump.

Part (b) revealed that a significant number of candidates (65 per cent) were unable to show a means of affixing the device to the shafts of the motor and pump.

Part (c) was well done. Over 95 per cent of the candidates did not have any challenge in the section.

Part (d) was generally difficult for candidates, with over 70 per cent of them being unable to satisfactorily explain the output speed, especially as it relates to pulley ratio.

Part (e) was generally well done. Over 80 per cent of candidates were able to draw a safety device that could be installed to prevent the components from causing injury.

Question 9

This question tested candidates' ability to define a design problem given the scenario of a rigid stool requiring a means of swivel. Candidates were also required to suggest three possible solutions, give details of a possible solution explaining its special features and select an appropriate material for construction of the stool.

Approximately 66 per cent or 207 candidates responded to the question, with the majority scoring 13 or more out of 25 on the question.

Part (a) was not well done: candidates had difficulty articulating a well stated design brief. It is suggested that more work be done in schools/institutions in formulating design briefs.

Part (b) was generally well done. Candidates were able to sketch three possible solutions. However, some of the sketches were below the drawing skills required for candidates at this level.

Part (c) was satisfactorily done but the use of wheels was generally suggested to be the means for allowing swivel. It was as if candidates just defaulted to the use of wheels rather than other swivel mechanisms such as bearings or swivel devices.

Part (d) was also well done and candidates were able to select an appropriate material to construct the stool in addition to supplying reasons for choice. Candidates were therefore able to give qualities of materials. For example, some candidates who said aluminum indicated that this was malleable and durable.

Paper 03 – School-Based Assessment (SBA)

There were 44 centres registered: submissions from 40 of them were received and moderated. The centres unaccounted for did not submit any samples to CXC. Fifty-five per cent of the centres received submitted the five samples as required, 23 per cent submitted four samples which was also adequate in conveying the range of marks at the particular centre. Centres with less than five students registered for the unit fell short of the five samples.

The quality of the design portfolio was generally good with approximately 20 per cent of the schools doing exceptionally well. In about five per cent of the centres, excellent research information and a comprehensive report on the design process were seen; there were only minor mistakes or oversights in the drawings, whether CAD or paper-based. A wide variety of engineering concepts were explored that involved pumps, gears, cams, pulleys and so on. However, about 15 per cent of the portfolios moderated did not meet CAPE standards and often had nothing to do with engineering or design.

Students often lost marks because in the design process, they submitted less than three alternative sketches to a design concept. Final drawings were generally very well done whether they were done in AutoCAD or by traditional drawing methods — they were very clean and well presented.

The reporting aspect of the design process was often below satisfactory levels. Students appeared to have difficulty researching, compiling findings in a logical way, and preparing comprehensive technical reports. Thirty-five per cent of the centres did not submit a technical report and cases where reports were submitted, about five per cent of them were very fragmented or incomplete.

Twenty per cent of the reports done did not reflect the concept outlined in the design brief and were therefore not comprehensive. Another ten per cent of the centres just submitted drawings and not reports.

Approximately 30 per cent of the centres submitted portfolios that were the same in every aspect, even in the reporting. This is not acceptable and must be discouraged. If students are given the same design question to do, care must be taken to ensure that the portfolios submitted are individual efforts (differing solutions) and not photocopies.

The mark scheme was followed by approximately 70 per cent of the centres.

Approximately three per cent of students submitted CAD drawings that were not related to the design question.

When submitting work in AutoCAD, students are encouraged to save the file as an ***AutoCAD 2004 Drawing (*.dwg)*** file type, simply for compatibility reasons. Also, AutoCAD drawings should be printed in the event that the floppy disc, CD or flash drive gets damaged in transit.

Recommendations

- Students should be given a bank of design questions to choose from.

- Preferably students should be given their own design question; however, if group work is to be done in researching and so on, the final portfolios must be the individual effort of each student.

- Although good sketching skill is commendable, this section focuses on the design process and reporting. More time and effort need to be placed on the reporting phase of the design portfolio.

- Teachers must set questions in design that are appropriate for students at this level.