CARIBBEAN EXAMINATIONS COUNCIL

CAPE®
Building and Mechanical Engineering

SYLLABUS
SPECIMEN PAPER
MARK SCHEME

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CAPE® Building and Mechanical Engineering Drawing Free Resources
(formerly CAPE Geometrical and Mechanical Engineering)

LIST OF CONTENTS

Building and Mechanical Engineering Drawing

Building and Mechanical Engineering Drawing (BMED) provides a significant contribution to the development of the human resources required for the creation of advanced designing and creative solutions to the twenty-first century demands of industrial production and manufacturing in the Caribbean.

The course of study for BMED incorporates aspects of architectural drawings of buildings as well as mechanical drawings for the development and communication of design ideas and concepts. As a form of graphical communication, the course provides the student with the opportunity of visualising and comprehending information presented verbally, graphically and mathematically.

A student who completes this syllabus would be experienced in the use of the latest developments of Computer Aided Drawing (CAD). In addition, the student would become dexterous in the application of the British Standard (BS8888), ISO Standards, Caribbean Uniform Building Codes (CUBiC) and other local codes to building and engineering drawings. By pursuing this course, students will develop twenty-first century skills such as creativity, decision-making, problem-solving, critical thinking and collaboration. This syllabus is designed to provide in depth knowledge, skills and competencies that are required for further studies and for the world of work.

The Building and Mechanical Engineering Drawing Syllabus consists of two Units of 150 hours, each comprising three Modules of 50 hours each. Each Module is compulsory.

Unit 1: Building and Mechanical Engineering Drawing

Module 1 - Geometry 1
Module 2 - Geometry 2

<u>Options</u>

Module 3A - Engineering Drawing
OR
Module 3B - Building Drawing

Unit 2: Building and Engineering Design

Option A: Mechanical Engineering Drawing and Design

Module 1 - Mechanics of Machines
Module 2 - Engineering Materials and Processes
Module 3 - Management and Design

Option B: Building Drawing and Design

Module 1 - Structural Drawings
Module 2 - Building Materials and Processes
Module 3 - Building Design Elements

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination
CAPE®

BUILDING AND MECHANICAL ENGINEERING DRAWING SYLLABUS

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Contents

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Please note that the syllabus has been and amendments are indicated by italics.

First published in 1999
Revised in 2005, 2015

Please check the website www.cxc.org for updates on CXC's syllabuses.

Introduction

The Caribbean Advanced Proficiency Examination (CAPE) is designed to provide certification of the academic, vocational and technical achievement of students in the Caribbean who, having completed a minimum of five years of secondary education, wish to further their studies. The examinations address the skills and knowledge acquired by students under a flexible and articulated system where subjects are organised in 1-Unit or 2-Unit courses with each Unit containing three Modules. Subjects examined under CAPE may be studied concurrently or singly.

The Caribbean Examinations Council offers three types of certification at the CAPE level. The first is the award of a certificate showing each CAPE Unit completed. The second is the CAPE Diploma, awarded to candidates who have satisfactorily completed at least six Units, including Caribbean Studies. The third is the CXC Associate Degree, awarded for the satisfactory completion of a prescribed cluster of *eight* CAPE Units including Caribbean Studies, Communication Studies *and Integrated Mathematics. Integrated Mathematics is not a requirement for the CXC Associate Degree in Mathematics.* The complete list of Associate Degrees may be found in the CXC Associate Degree Handbook.

For the CAPE Diploma and the CXC Associate Degree, candidates must complete the cluster of required Units within a maximum period of five years. *To be eligible for a CXC Associate Degree, the educational institution presenting the candidates for the award, must select the Associate Degree of choice at the time of registration at the sitting (year) the candidates are expected to qualify for the award.* Candidates will not be awarded an Associate Degree for which they were not registered.

Building and Mechanical Engineering Drawing Syllabus

♦ RATIONALE

Building and Mechanical Engineering Drawing (BMED*)* is the universal *graphic language of communication for individuals in the field of engineering and architecture as well as for technicians and craftsmen.* This type of universal communication is facilitated by the use of standards published by the International Organization for Standardization (ISO) for Engineering Drawing*. Building and Mechanical Engineering Drawing provides a significant contribution to the development of the human resources required for the creation of advanced designing and creative solutions to the twenty-first century demands of industrial production and manufacturing in the Caribbean.*

The course of study *for BMED incorporates aspects of architectural drawings of buildings as well as mechanical drawings for the development and communication of design ideas and concepts. As a form of graphical communication, the course provides the student with the opportunity of visualising and comprehending information presented verbally, graphically and mathematically*.

A student who completes this syllabus would be experienced in the use of the latest developments of Computer Aided Drawing (CAD). In addition, the student would become dexterous in the application of the British Standard (BS8888), ISO Standards, Caribbean Uniform Building Codes (CUBiC) and other local codes to building and engineering drawings. By pursuing this course, students will develop twenty-first century skills such as creativity, decision-making, problem-solving, critical thinking and collaboration. This syllabus is designed to provide in depth knowledge, skills and competencies that are required for further studies and for the world of work.

This syllabus will contribute to the development of the Ideal Caribbean Person, as articulated by the CARICOM Heads of Government, who: is emotionally secure with a high level of self-confidence and self-esteem; sees ethic, religious and other diversity as a source of potential strength and richness; is aware of the importance of living in harmony with the environment; values and displays the creative imagination in its various manifestations and nurtures its development in the economic and entrepreneurial spheres in all other areas of life (Caribbean Education Strategy, 2000). Based on the UNESCO Pillars of Learning, this course of study will also contribute to a person who will learn to know, learn to do, learn to live with others, learn to be and learn to transform oneself and society.

The Units, in the syllabus, integrate the principles of Competency-Based Education, Training and Assessment (CBETA) in the School-Based Assessment component. This strategy is consistent with the seamless articulation among CXC's qualifications to facilitate an appropriate balance between the academic and technical subjects and to improve work-based performance.

♦ AIMS

The syllabus aims to:

1. develop proficiency in *technical communication* and production of building and mechanical engineering drawings which conform to BS and ISO Standards, CUBiC and local codes;

2. develop skills in the preparation of working and assembly drawings conforming to BS and ISO Standards, CUBiC and local codes;

3. *develop an understanding of the properties, uses and production of materials used in the* manufacture of *building and* engineering components;

4. provide knowledge of the different methods of production of building and engineering components;

5. *develop skills in communicating technical information using illustrations, scaled models and working drawings* to solve engineering *design* problems;

6. develop skills in applying and drawing principles to facilitate product development and manufacture;

7. develop *proficiency* in the use of Computer-Aided Drafting (CAD) software, *instruments, media and reference materials* to produce engineering drawings;

8. develop an interest in *architectural or* mechanical engineering as disciplines and careers; and,

9. *develop the capacity for critical and creative thinking, problem-solving, leadership and cooperative behaviours through authentic learning experiences.*

♦ SKILLS AND ABILITIES TO BE ASSESSED

The skills and abilities which students are expected to develop on completion of the syllabus have been grouped under three headings:

(a) Knowledge;
(b) Application;
(c) Drawing Skills.

Knowledge:	The ability to identify, recall and grasp the meaning of fundamental facts, concepts and principles.
Application:	The ability to use facts, concepts, principles and procedures in unfamiliar situations; transform data accurately and appropriately; use common characteristics as a basis for classification; use formulae accurately for computations.
Drawing Skills:	The ability to produce neatly organised, clean and accurate drawings according to specification.

♦ PREREQUISITES OF THE SYLLABUS

It is expected that persons with a good grasp of either the Building or Mechanical Engineering Drawing Option of the CSEC Technical Drawing or Industrial Technology Syllabuses or the equivalent should be able to successfully pursue this course.

♦ STRUCTURE OF THE SYLLABUS

The syllabus is divided into two Units. Each Unit consists of three Modules. The Units are independent of each other. *The syllabus consists of two Units of 150 hours each. Each Unit consists of three Modules of 50 hours each. Each Module is compulsory*. Together they provide a comprehensive post-secondary course in the field of Building and Mechanical Engineering Drawing.

Unit 1: Building and Mechanical Engineering Drawing contains three Modules of approximately 50 hours each. *Unit 1 is designed to provide the students with an all-round development experience in building and engineering drawing. Candidates are required to complete Modules 1 and 2 which are compulsory and either Module 3A or Module 3B. The total time for the syllabus is approximately 150 hours.*

Module 1 - Geometry 1
Module 2 - Geometry 2

<u>Options</u>

Module 3A - *Engineering Drawing*
OR
Module 3B - *Building Drawing*

Unit 2: Building and Engineering Design contains three Modules of approximately 50 hours each. The total time for the syllabus is approximately 150 hours. Unit 2 offers two options: Option A, Building Drawing and Design, and Option B, Engineering Drawing and Design. Candidates are required to select **either** Option A **or** Option B. The total time for the syllabus is approximately 150 hours.

Option A: Mechanical Engineering Drawing and Design

Module 1	-	Mechanics of Machines
Module 2	-	Engineering Materials and Processes
Module 3	-	Management and Design

Option B: Building Drawing and Design

Module 1	-	Structural Drawings
Module 2	-	Building Materials and Processes
Module 3	-	Building Design Elements

♦ UNIT 1: BUILDING AND MECHANICAL ENGINEERING DRAWING
MODULE 1: *GEOMETRY 1*

GENERAL OBJECTIVES

On completion of this Module, students should:

1. demonstrate the ability to produce two-dimensional drawings; and;
2. develop basic Computer-Aided Drafting (CAD) skills.

SPECIFIC OBJECTIVES

Students should be able to:

1. construct standard engineering curves;
2. determine centroids of plane figures by simple calculations and graphical methods;
3. *project solids in orthographic projection*; and,
4. use Computer-Aided Drafting software to produce drawings.

CONTENT

1. **Standard Engineering Curves**

   (a) *Definition of engineering curves.*

   (b) *Types of engineering curves to include:*

   (i) *ellipse;*

   (ii) *parabola;*

   (iii) *hyperbola;*

   (iv) *cycloids;*

   (v) *trochoids (inferior and superior);*

   (vi) *involutes;* and,

   (vii) *Archimedian spirals.*

(c) *Methods of construction of these curves to include true methods.*

(d) *Constructing tangents to these curves.*

2. **Centroids**

(a) *Lines of symmetry.*

(b) *Integration of areas.*

(c) First and second moments.

3. **Orthographic Projection**

(a) *First angle projection.*

(b) *Third* angle projection.

4. **Computer-Aided Drafting (CAD)**

(a) Polar and *Direct* co-ordinates.

(b) CAD features:

(i) menus;

(ii) *drawing; and,*

(iii) *toolbars (draw, modify, dimension).*

(c) *Draw Toolbar:*

(i) draw – line;

(ii) construction line;

(iii) polygon;

(iv) rectangle;

(v) arc;

(vi) circle;

(vii) donut;

(viii) spline;

(ix) ellipse;

(x) block;

(xi) hatch; and,

(xii) boundary.

(d) Modify Toolbar:

(i) mirror;

(ii) array (rectangle, polar);

(iii) copy;

(iv) rotate;

(v) scale; and,

(vi) stretch.

(e) Dimension Toolbar:

(i) linear;

(ii) aligned;

(iii) co-ordinate;

(iv) radius;

(v) diameter;

(vi) angular;

(vii) baseline;

(viii) continue;

(ix) leader;

(x) tolerance;

(xi) centremark;

(xii) dimension text edit;

(xiii) dimension style.

(f) *CAD* software to produce plane geometry drawings.

<u>Suggested Teaching and Learning Activities</u>

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. Use real life examples to promote class discussion and illustrate the use and purpose of Plane Geometry in Mechanical Engineering.

2. *Sensitise students to* the fundamentals of Mechanical Engineering science with emphasis on definitions and the graphical approach.

3. Emphasise freehand sketching and different drawing methods.

4. Have students perform relevant calculations where required.

5. Have students use CAD software to produce Plane Geometry drawings.

RESOURCE

Jensen C., Helsel, J., and, Short, D. *Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

UNIT 1
MODULE 2: ***GEOMETRY 2***

GENERAL OBJECTIVES

On completion of this Module, students should*:*

1. demonstrate the ability to produce three dimensional drawings;

2. develop Computer-Aided Drafting (CAD) skills.

SPECIFIC OBJECTIVES

Students should be able to:

1. represent solids in pictorial projections;

2. project auxiliary views;

3. draw lines of intersection between solids;

4. *produce* surface developments;

5. *construct helices*;

6. *use CAD software to produce drawings*.

CONTENT

1. Pictorial Projections

(a) Projections:

(i) oblique;

(ii) planometric;

(iii) isometric:

- application of the isometric scale.

(iv) *perspective:*

- *one-point angular;*

- *two*-point angular.

(b) *Constructing* circles and curves in pictorial drawings.

2. Auxiliary Views

(a) The projection of sections of solids cut by inclined planes.

(b) True shapes of sections.

(c) First and second auxiliary views.

3. Intersection of Solids

Intersection and interpenetration of solids.

4. Surface Development

(a) Surfaces of right or skewed three-dimensional objects.

(b) Surfaces composed of multiple geometric shapes.

(c) Transition pieces (square-to-round, round-to-round).

(d) Economical use of materials (seam line location).

5. Helix

(a) Helices on cylindrical forms (screw threads and springs).

(b) Helices on conical forms.

6. Use of CAD to Produce Drawings

(a) Drawing environment.

(b) Create objects with model space.

(c) Create annotations and dimension in paper space.

(d) Plot drawing.

<u>Suggested Teaching and Learning Activities</u>

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. *Use real life examples to promote class discussions and illustrate the use and purpose of Solid Geometry in Mechanical Engineering.*

2. *Place emphasis on definitions, freehand sketching and different drawing methods.*

3. *Have students perform relevant calculations where required.*

4. *Have students use CAD software to produce Solid Geometry drawings.*

RESOURCES

Jackson, E.	*Advanced Level Technical Drawing, Revised Metric Edition*. London: Longman Group Limited, 1975.
Jensen C., Helsel, J., and, Short, D.	*Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

UNIT 1
MODULE 3A: ENGINEERING *DRAWING*

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *demonstrate the ability to use traditional methods and CAD software to produce engineering drawings*; and,

2. develop the ability to draw, sketch freehand and design machine *components to specifications and engineering standards.*

SPECIFIC OBJECTIVES

Students should be able to:

1. prepare detailed freehand sketches of machine parts and components;

2. *produce* working and assembly drawings;

3. prepare drawings with sectional views;

4. prepare detailed drawings;

5. *produce dimensional* drawings of machine components for *manufacturing purposes;*

6. *synthesise* solutions to engineering problems; and,

7. *construct displacement diagrams for edge, face and cylindrical Cams.*

CONTENTS

1. Freehand Sketching

(a) Orthographic views of machine parts and components.

(b) Pictorial views of machine parts and *components*.

2. Working and Assembly Drawings

(a) Working drawings:

(i) machine parts and components;

(ii) *using* welding and machining symbols; and,

(iii) *drawing notations.*

(b) Assembly drawings:

- machine parts and components.

3. Drawings with Sectional Views

(a) Machine components.

(b) Fasteners including nuts, bolts, pins, washers.

4. Detailed Drawings

(a) Machine parts.

(b) Assembly drawings.

(c) Working drawings.

5. *Dimensioned Drawings*

(a) General.

(b) Manufacturing.

(c) Geometric and positional tolerances: finishes, limits and fits (BS 4500).

(d) Balloon referencing and part listings:

(i) cross-reference; and,

(ii) item list and materials specification.

6. Solutions to Engineering Problems

(a) Accessories:

(i) gauges;

(ii) small tools; and,

(iii) clamping devices.

(b) Mechanisms:

(i) slide crank and pin;

(ii) rack and pinion; and,

(iii) ratchet.

(c) Fasteners:

(i) bolts and nuts;

(ii) screws;

(iii) studs; and,

(iv) keys, pins, rivets and locking devices.

(d) Hydraulic Systems

(e) Pumps:

(i) centrifugal; and,

(ii) reciprocating.

(f) Valves:

(i) non-return;

(ii) isolating;

(iii) expansion;

(iv) safety;

(v) gate; and,

(vi) globe.

(g) Piping and joints:

(i) flanged; and,

(ii) hydraulic.

(h) Seals:

(i) dynamic; and,

(ii) static.

(i) Machines:

Parts of the following machines

(i) drilling;

(ii) grinding;

(iii) lathe;

(iv) milling; and,

(v) shaping.

7. Displacement Diagrams for Cams

(a) Cam profiles and displacement diagrams to produce:

(i) dwell;

(ii) uniform velocity;

(iii) uniform acceleration or retardation; and,

(iv) simple harmonic motion.

(b) Cam profiles and displacement diagrams with various types of followers, namely:

(i) knife-edge;

(ii) roller;

(iii) flat; and,

(iv) spherical.

UNIT 1
MODULE 3A: ENGINEERING DRAWING (cont'd)

(c) *Cam profiles and displacement diagrams with different follower paths:*

  (v) *straight line;*

  (vi) *circular arc;*

  (vii) *on-centre; and,*

  (viii) *off-centre.*

<u>Suggested Teaching and Learning Activities</u>

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. Use articles from current periodicals on relevant Mechanical Engineering topics to assist students in adequately covering the design sections of the Module.

2. Have students complete several working and assembly drawings of machine parts and components.

3. Place emphasis on the importance of freehand sketching in enabling students to become familiar with the complexity in the theory and construction of various machine parts and components.

4. Visit mechanical engineering drawing offices to familiarise students with the different conventional representation on drawings and the use and importance of drawing standards.

5. Visit machine and mechanical engineering workshops to familiarise students with the operations.

6. *Arrange for experts to present on trends in the field that have influenced changes in the way the industry operates*. *Have student make presentations on the three most important lessons learnt.*

RESOURCES

Jackson, E.	*Advanced Level Technical Drawing, Revised Metric Edition*. London: Longman Group Limited, 1975.
Jensen C., Helsel, J., and, Short, D.	*Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

UNIT 1
MODULE 3B: BUILDING DRAWING

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *develop proficiency in the use of conventional and CAD methods to produce drawings with construction details to building standards; and,*

2. *develop an awareness of the creative and innovative graphic and visualisation skills used for communication in the construction industry.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *prepare orthographic and pictorial sketches;*

2. *prepare drawings with sectional views;*

3. *produce a complete set of drawings using suitable scales; and,*

4. *prepare utility drawings.*

CONTENT

1. Sketches or Drawings

(a) Perspective.

(b) Exploded isometric.

(c) Orthographic.

2. Drawings with Sectional Views

Sectional views of:

(a) a flat roof (concrete and timbers); and,

(b) joint details in windows and doors.

UNIT 1
MODULE 3B: BUILDING DRAWING (cont'd)

3. Producing and Modifying Building Drawings

(a) *Floor Plans:*

(i) *two storey buildings using appropriate scales:*

- *commercial building;*
- *residential (single dwelling);*
- *townhouse/apartment; and,*
- *split-level structure.*

(ii) *buildings outfitted with access for the physically challenged; and,*

(iii) *window and door schedules.*

(b) *Roof plans:*

(i) *gable or v-shaped roof;*

(ii) *hip roof;*

(iii) *bow string or dome roof; and,*

(iv) *reinforced concrete roof.*

(c) *Elevations for two-storey building:*

(i) *east elevation;*

(ii) *west elevation;*

(iii) *south elevation; and,*

(iv) *north elevation.*

(d) *Sectional elevations:*

(i) *latitude;*

(ii) *longitude; and,*

(iii) *offset.*

(e) *Site plans:*

- (i) *position of building on site;*
- (ii) *setback dimension from building to boundaries;*
- (iii) *septic tank and soak away pit/ sewer system waste line;*
- (iv) *drainage (surface and main drain);*
- (v) *north position;*
- (vi) *driveway, lawn and vegetation;*
- (vii) *commercial parking;*
- (viii) *loading and off-loading bay;*
- (ix) *handrail from car park to building; and,*
- (x) *walkway from car park to building.*

(f) *Location plans:*

- (i) *street names;*
- (ii) *business places;*
- (iii) *electricity poles; and,*
- (iv) *landmarks.*

(g) *Staircase (timber)*

Types:

- (i) *Straight flight:*
  - *with landing;*
- (ii) *'U' Shape;*
- (iii) *L- flight; and,*
- (iv) *Spiral.*

(h) *Foundation Plans:*

(i) *footing details;*

(ii) *strip footing; and,*

(iii) *pad footing.*

(i) *Ground Beam Details.*

(j) *Ground floor slab plan and details.*

4. ***Utility Drawings***

(a) *Electrical:*

(i) *symbols and components; and,*

(ii) *layouts.*

(b) *Plumbing:*

(i) *fixtures and fittings;*

(ii) *flow diagrams and symbols;*

(iii) *pipe drawing layouts; and,*

(iv) *sewer line diagram.*

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. *Have students visit the Town and Country Planning office for policies and regulations on Building Codes of Two-Storey Building. Have students use the policies to evaluate drawings.*

2. *Have students research and deliver presentations on topics contained in the Module.*

3. *Have students visit construction sites (residential and commercial) to observe the use and application of construction materials.*

UNIT 1
MODULE 3B: BUILDING DRAWING (cont'd)

4. *Have students visit drawing offices and architectural firms to observe the process in which drawings are produced.*

RESOURCES

Chudley, R. and Green, R.	*Construction Technology, 4th edition*. Essex: Pearson Prentice Hall, 2005.
Krishna N.	*Structural Design and Drawing: Reinforced Concrete and Steel.* Chicago: Universities Press, 2005.
Kubba D.	*Blue Print Reading: Construction Drawing for the Building Trade.* New York: McGraw Hill, 2008.
Marshall D. et al	*Understanding Housing Defects, 3rd edition*. London: Estates Gazette, 2009.
Newton, P.	*Structural Detailing: For Architecture, Building and Civil Engineering Students (Building and Surveying Series) 2nd edition*. London: Macmillan Publisher, 1991.

♦ UNIT 2: BUILDING AND MECHANICAL ENGINEERING DRAWING

2A: MECHANICAL ENGINEERING DRAWING AND DESIGN

MODULE 1: MECHANICS OF MACHINES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. develop a working knowledge of the characteristics of the operating principles of the mechanics of machines; and,

2. develop the ability to communicate, graphically and visually, the fundamentals of mechanics in different machine components using *conventional* and Computer-Aided methods.

SPECIFIC OBJECTIVES

The students should be able to:

1. determine forces in structures using graphical methods;

2. construct shear force and bending moment diagrams in beams;

3. calculate the various parameters of the involute spur gears;

4. locate lines and planes in space; and,

5. *produce drawings using Computer-Aided Drafting (CAD) software.*

CONTENT

1. Determining forces using graphical methods

(a) Triangle, parallelogram and polygon of forces to find:

(i) resultant equilibrium; *and,*

(ii) resolution of forces in members of simple framework.

(b) Space and polar diagrams and funicular (link) polygons to find the position of the resultant or equilibrium.

2. Beams

(a) Types of beams:

(i) simply supported:

- *with point load*

- *with distributed load*

(ii) *cantilever.*

(b) Beam sign conventions.

(c) Shear Force Diagram (SFD) and Bending Moment Diagram (BMD) of beams.

3. *Involute Spur* Gears

(a) Defining terms:

(i) pitch circle diameter;

(ii) pitch point;

(iii) pressure angle;

(iv) addendum;

(v) dedendum;

(vi) clearance;

(vii) circular pitch;

(viii) circular tooth thickness;

(ix) number of teeth;

(x) diametrical pitch;

(xi) module;

(xii) *base circle diameter*;

(xiii) *root diameter.*

(b) Calculating parameters necessary to construct gear tooth profiles.

(c) Construction of gear tooth profiles by involute and approximate methods.

(d) Construction of gear tooth in mesh.

(e) Using ISO conventional systems and British Standards (BS 8888).

4. Lines and Planes in Space

(a) True angles between intersecting lines.

(b) True angles between intersecting planes.

(c) True angles between lines and planes.

(d) Traces of lines on planes.

(e) Traces of planes on planes.

(f) Traces of perpendicular planes and their inclination to the planes of reference.

(g) Skewed lines.

5. Use of CAD software to produce drawings

(a) Drawing environment.

(b) Create objects with model space.

(c) Create annotations and dimension in paper space.

(d) Plot drawing.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. Use real life examples of components to illustrate the techniques contained in the Module.

2. Visit a Mechanical Engineering Drawing Office to familiarise students with the different conventional representation on drawings and the use and importance of drawing standards.

3. Have students research and deliver presentations on topics contained in the Module.

RESOURCES

Jackson, E.	*Advanced Level Technical Drawing, Revised Metric Edition*. London: Longman Group Limited, 1975.
Jensen C., Helsel, J., and, Short, D.	*Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

2A: MECHANICAL ENGINEERING DRAWING AND DESIGN
MODULE 2: ENGINEERING MATERIALS AND PROCESSES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the structure, properties and manufacturing processes of engineering components; and,*

2. *develop a safe working knowledge of the uses, application and care of various types of engineering components.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *select appropriate materials for the manufacturing of engineering components;*

2. *explain the appropriate manufacturing processes for various types of engineering components;*

3. *solve problems requiring knowledge of the application of bearings and bushings; and,*

4. *solve problems requiring knowledge of the application of seals and lubricants.*

CONTENT

1. Materials

(a) Metals:

(i) ferrous (for example, wrought iron, cast iron, carbon steel, stainless steel); and,

(ii) non-ferrous (for example, copper, aluminium, brass and other alloys).

(b) Plastics:

(i) thermoplastic – polyvinyl chloride (PVC), polytetrafluroethylene (fluorocarbons), polyethylene, polystyrene, polypropylene, polyamides (Nylon), polymethylmethacrylate (Perspex); and,

(ii) thermosetting – epoxy-resin (bakelite, melamine), laminates (tufnol, formica).

(c) Rubber:

(i) characteristics (organic, silicone, synthetic); and,

(ii) uses and applications.

2. Manufacturing Engineering Components

(a) Machining Tool Operations – turning, shaping, drilling, milling, cutting and grinding.

(b) Casting – sand, die, investment.

(c) Fabrication:

(i) welding – Shielded Metal Arc Welding (SMAW), Oxyfuel Gas Welding (OFW), Gas Tungsten-Arc Welding (GTAW or TIG), Gas Metal Arc Welding (GMAW or MIG), Laser Beam Welding (LBW), Resistance Spot Welding (RSW);

(ii) welding symbols and their application;

(iii) riveting – cold, hot, pop; and,

(iv) sheet metal work – grooved seam, rolling and bending.

(d) Safety in Manufacturing:

(i) safety equipment and material;

(ii) safety procedures and processes in manufacturing; and,

(iii) designing for safety in manufacturing.

3. Bearings and Bushings

(a) Types of bearings and their functions:

(i) ball – radial, thrust, angular contact, self-aligning, single/double row;

(ii) roller – cylindrical (radial, thrust), tapered, spherical, needle; and,

(iii) journal – pillow block, self-lubricating.

(b) *Application of bearings in:*

- *(i) rotational and linear movements;*
- *(ii) handling stresses;* and,
- *(iii) reduction of friction.*

(c) *Application of bushings:*

- *(i) bush – drill, sleeve (tolerances);*
- *(ii) reduction of friction;*
- *(iii) reduction of wear;* and,
- *(iv) mounting.*

4. Seals and Lubricants

(a) Types of seals and uses:

- (i) static – gasket, o-ring; and,
- (ii) dynamic – labyrinth, split ring, 'U', garter spring, o-ring.

(b) Types of lubricants:

- (i) liquid;
- (ii) solid; and,
- (iii) gas.

(c) Methods of applications of lubricants:

- (i) liquid – splash, pressurised;
- (ii) solid; and,
- (iii) gas (mist, air).

2A: MECHANICAL ENGINEERING DRAWING AND DESIGN
MODULE 2: ENGINEERING MATERIALS AND PROCESSES (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. Use real life examples of components made from the manufacturing processes and materials in Module. Have students select from the examples and prepare presentations that will showcase the processes involved from the drawing stage to the actual production of the component.

2. Have students visit machine and mechanical engineering workshops to familiarise themselves with the various machine-tools, equipment and sub-assembly components being repaired.

3. Have students visit engineering plants/factories to observe the manufacture of components/products using the various processes and materials in the Module.

4. Have students research and make presentations on topics contained in the Module.

5. *Have students build actual models and produce CAD stimulations.*

RESOURCE

Jensen C., Helsel, J., and, Short, D. *Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

2A: MECHANICAL ENGINEERING DRAWING AND DESIGN
MODULE 3: ENGINEERING DESIGN ELEMENTS

GENERAL OBJECTIVES

On completion of this Module, students should*:*

1. *develop the ability to synthesise and modify designs using technical information and scientific principles; and,*

2. demonstrate the ability to prepare freehand sketches and drawings of machine components suitable for different manufacturing processes.

SPECIFIC OBJECTIVES

Students should be able to:

1. solve problems requiring knowledge of various elements of power transmission;

2. prepare freehand sketches and drawings of machine components;

3. discuss the stages in the design process;

4. explain the principles of design;

5. *modify* designs of machine parts and components; *and,*

6. use CAD software to produce engineering drawings.

CONTENT

1. Power Transmission

(a) Couplings:

(i) rigid;

(ii) flange;

(iii) fluid;

(iv) oldham;

(v) universal joint;

(vi) cross and bearing.

(b) Clutches:

(i) single plate;

(ii) multi-plate;

(iii) centrifugal.

(c) Gears:

(i) spur;

(ii) helical;

(iii) bevel;

(iv) worm.

(d) Belt drives:

(i) vee;

(ii) flat and toothed (tensioning of belts, fixed and movable shafts).

(e) Brakes:

(i) single shoe;

(ii) double shoe;

(iii) internal drum disc.

(f) *Chain drives:*

(i) *roller;*

(ii) *inverted tooth/silent;*

(iii) *tensioning of chain.*

2. **Freehand Sketches of machine Components**

   (a) *Fasteners.*

   (b) *Locking devices.*

   (c) *Keys, keyways, splines.*

   (d) *Shaft coupling.*

   (e) *Bearings.*

   (f) *Pistons, connecting rods and crankshafts.*

   (g) *Hole preparations – countersink, counter bore.*

3. ***Stages in the* Design Process**

   (a) Recognition of need.

   (b) Definition of problem.

   (c) Synthesis.

   (d) Analysis and optimisation.

   (e) Evaluation.

   (f) Presentation.

4. **The Principles of Design**

   (a) Elements:

      (i) materials specification;

      (ii) manufacturing processes;

      (iii) size and shape.

   (b) Aesthetics.

   (c) Ergonomics

      - *human machine relationships, for example, control loops, mouse.*

(d) Cost.

5. Design Details

Design for:

(a) Casting.

(b) Machining.

(c) Fabrication.

6. *Using CAD Software to produce engineering components*.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. Use articles from current periodical on relevant Mechanical Engineering topics to assist students in adequately covering the content in the Module.

2. Have students complete a number of working and assembly drawings of various engineering components.

3. Place emphasis on the importance of freehand sketching to enable students to become familiar with the differences in the theory and construction of various devices.

4. Have students visit a Mechanical Engineering Drawing Office to familiarise them with the different conventional representation on drawings and the use and importance of drawing standards.

5. *Arrange for experts to present on trends in the field that have influenced changes in the way the industry operates. Have student's journal the three most important lessons learnt.*

6. *Have students build actual models and produce CAD stimulations.*

RESOURCE

Jensen C., Helsel, J., and, Short, D. *Engineering Drawing and Design.* New York: McGraw Hill Science, 2007.

2B: BUILDING DRAWING AND DESIGN
MODULE 1: STRUCTURAL DRAWINGS

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the principles underlying the design and preparation of different types of structural drawings using conventional and CAD methods; and,*

2. *develop the ability to design structural drawing plans and layouts of various types of timber, concrete and steel structures in accordance with structural building codes.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *determine forces in structures using graphical methods;*

2. *construct shear force and bending moment diagrams in beams;*

3. *create detailed free hand sketches of structural drawings; and,*

4. *produce a complete set of structural drawings using suitable scales.*

CONTENT

1. Graphical Methods

(a) *Triangle, parallelogram and polygon of forces to find:*

  (i) resultant equilibrium;

  (ii) resolution of forces in members of simple framework.

(b) *Space and polar diagrams and funicular (link) polygons to find the position of resultant or equilibrium.*

2. Beams

(a) *Types of beams:*

  (i) simply supported;

(ii) *cantilever;*

(iii) *overhanging;*

(iv) *continuous.*

(b) *Beam sign conventions.*

(c) *Shear force diagram (SFD) and bending moment (BMD) of beams.*

3. Detailed sketches:

(a) *Auger Pile plan with grid lines:*

(i) *auger pile plan layout;*

(ii) *detail section through pile foundation.*

(b) *Column plan with grid lines:*

(i) *column plan layout with grid lines;*

(ii) *column detail;*

(iii) *section through column.*

4. Structural Drawings

(a) *Beam and column plan:*

(i) *structural beam framing plan layout;*

(ii) *Structural details of each beam.*

(b) *Reinforced concrete plan:*

(i) *first floor slab plan;*

(ii) *sectional drawing through reinforced concrete first floor slab.*

(c) *Roof Plan:*

- (i) *gable;*
- (ii) *hip;*
- (iii) *bow string;*
- (iv) *reinforced concrete roof slab.*

(d) *Structural connection details:*

- (i) *corner wall stiffeners detail;*
- (ii) *corner junctions (L and T) wall stiffener details;*
- (iii) *details of ground, lintel and ring beams;*
- (iv) *box drain and slipper drain.*

(e) *Septic tank and soak-a-way pit details:*

- (i) *plan of septic tank and soak-a-way pit;*
- (ii) *sectional elevation through septic tank and soak away pit.*

(f) *Staircase Layout:*

- (i) *straight flight:*
  - *with landing*
- (ii) *'U' Shape;*
- (iii) *L flight;*
- (iv) *spiral.*

(g) *Wooden structures*

Structures:

- (i) *floors;*
- (ii) *ceiling;*
- (iii) *walls.*

2B: BUILDING DRAWING AND DESIGN
MODULE 1: STRUCTURAL DRAWINGS (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. *Use articles from current periodical on relevant architectural drawing topics to assist students in adequately covering the content in the Module.*

2. *Have students complete a number of working and assembly drawings of various structural components.*

3. *Place emphasis on the importance of sketching to enable students to become familiar with the differences in the theory and construction of building structures.*

RESOURCES

Chudley, R. and Green, R.	*Construction Technology, 4th edition*. Essex: Pearson Prentice Hall, 2005.
Krishna, N.	*Structural Design and Drawing: Reinforced Concrete and Steel*. University Press, 2005
Kubba, D.	*Blue Print Reading: Construction Drawing for the Building Trade*. McGraw Hill, 2008
Marshall, D. et al	*Understanding Housing Defects, 2nd edition.* 2013
Newton, P.	*Structural Detailing: for Architecture, Building and Civil Engineering 2nd edition*. Macmillan Publisher, 1991.

2B: BUILDING DRAWING AND DESIGN
MODULE 2: BUILDING MATERIALS AND PROCESSES

GENERAL OBJECTIVES

On completion of this module, students should:

1. *understand the uses, production and characteristics of construction materials to satisfy specifications of construction processes in building designs;*

2. *develop an awareness of the processes and equipment used in the application of building materials; and,*

3. *understand the fundamental principles of construction management.*

SPECIFIC OBJECTIVES

The students should be able to:

1. *discuss the use of various types of construction materials;*

2. *discuss common properties associated with building construction materials;*

3. *analyse the properties of different types of building construction materials;*

4. *outline the processes involved in the production of common building construction materials;*

5. *select suitable materials and their symbols for use in the design of different building structures; and,*

6. *use common construction equipment and hand tools;*

CONTENT

1. Construction Materials

(a) *Sand.*

(b) *Bricks.*

(i) common;

(ii) facing;

(iii) engineering.

(c) Blocks:

(i) concrete;

(ii) stone;

(iii) clay.

(d) Timber.

(e) Paint:

(i) solvent;

(ii) primer;

(iii) undercoat;

(iv) finishing;

(v) rubberised;

(vi) rust proofing.

(f) Plastics:

(i) thermoplastics, for example, conduits, drain, waste, vents, sidings;

(ii) thermosets, for example, laminates, electrical fixtures.

(g) Glass.

(h) Cement:

(i) ordinary Portland cement (OPC);

(ii) relative humidity Portland cement (RHPC);

(iii) sulfate resistant Portland cement (SRPC);

(iv) coloured Portland cement.

(i) Aggregates.

(j) Concrete.

(k) Plaster.

(l) Steel.

(m) Tiles.

(n) Rubber.

2. Common Properties of Construction Materials

Definitions and characteristics:

(a) thermal expansion;

(b) thermal conductivity;

(c) heat movement and heat flow:

(d) insulation (High and low U factors);

(e) thermal resistance;

(f) strength and stress;

(g) deformation;

(h) strain;

(i) creep;

(j) elasticity and plasticity.

3. Analysing Construction Materials

Types and testing procedures and findings of:

(a) concrete (stressed and pre-stressed);

(b) cement;

(c) *sand;*

(d) *concrete blocks;*

(e) *steel.*

4. Construction Processes

(a) *Preparing and applying concrete.*

(b) *Rendering/plastering.*

(c) *Plumbing.*

(d) *Electrical wiring.*

(e) *Landscaping.*

5. Materials for Building Structures

(a) *Footing walls.*

(b) *Floors.*

(c) *Ceilings.*

(d) *External walls.*

(e) *Partition/internal walls.*

(f) *Roofs.*

6. Construction Equipment and Hand Tools

Processes:

(a) *preparing and applying concrete;*

(b) *rendering/plastering;*

(c) *screeding.*

2B: BUILDING DRAWING AND DESIGN
MODULE 2: BUILDING MATERIALS AND PROCESSES (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. *Use real life examples of components made from the manufacturing processes and materials in Module. Have students select from the examples and prepare presentations that will showcase the processes involved from the drawing stage to the actual production of the component.*

2. *Have students visit a manufacturing plant and/or hardware store to familiarise them with the various tools, equipment and processes.*

3. *Have students research and make presentations on topics contained in the Module.*

4. *Invite experts to engage students in demonstrations and discussions on new technologies in the industry. Have students make presentations on the three most interesting lessons they learnt from the session.*

RESOURCES

Chudley, R. and Green, R.	*Construction Technology, 4th edition*. Essex: Pearson Prentice Hall, 2005.
Allen, E., and, Joseph I.	*Fundamentals of Building Construction: Materials and Methods*, 6th edition. Hoboken, NJ: John Wiley & Sons, 2013.
Marotta, T., et al.	*Basic Construction materials, Methods and Testing*. Essex: Prentice Hall, 2010.

2B: BUILDING DRAWING AND DESIGN
MODULE 3: MANAGEMENT AND DESIGN

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *develop the ability to synthesise and modify designs using creativity, technical information and scientific principles; and,*

2. *demonstrate the ability to prepare sketches and drawings of building designs using CAD.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *discuss the basic principles of construction management;*

2. *discuss the stages in the design process;*

3. *explain the principles of design;*

4. *prepare sketches of external and internal design features of buildings;* and,

5. *use CAD to produce designs of buildings.*

CONTENT

1. *Construction Management*

(a) *Management techniques relating to:*

- *(i) production planning;*
- *(ii) cost control of projects;*
- *(iii) principles of planning repetitive and non-repetitive construction work.*

(b) *Planning techniques:*

- *(i) bar charts;*
- *(ii) network analysis;*
- *(iii) line of balance;*

(iv) work study.

(c) *Plant decision making:*

(i) plant selection;

(ii) plant acquisition (buying, leasing, indirect or direct ownership);

(iii) developing and classifying objectives;

(iv) establishing alternatives choices;

(v) evaluating the outcome of each alternative;

(vi) choosing the best alternative.

2. The Design Process

(a) Recognition of need.

(b) Definition of problem.

(c) Synthesis.

(d) Analysis and optimisation.

(e) Evaluation.

(f) Presentation.

3. The Principles of Design

(a) Elements:

(i) materials specification;

(ii) manufacturing processes;

(iii) size and shape.

(b) Aesthetics.

(c) Ergonomics.

(d) Cost.

4. Design Features of Buildings

(a) External wall finishes:

(i) trowel plastering;

(ii) tile (ceramic, marble, clay, coral);

(iii) cladding (metal);

(iv) paint.

(b) Internal wall finishes:

(i) paint;

(ii) cladding;

(iii) tiles (ceramic, marble, porcelain).

(c) Floor finishes:

(i) tiles (ceramic, marble, clay, porcelain, vinyl);

(ii) hard wood (teak, mahogany, green heart);

(iii) terrazzo.

(d) Doors and windows (internal and external):

(i) wooden (teak, mahogany, green heart);

(ii) glass;

(iii) metal (steel, zinc, aluminium).

(e) Cupboard:

(i) wooden, for example, teak, mahogany, green heart, plywood, Medium Density Fibre Board (MDF), pine;

(ii) concrete (block work).

Fixtures and fittings:

(i) bathroom, for example, face basin, water closet, shower enclosure, shower taps, faucet;

(ii) kitchen (kitchen sinks, faucet).

(a) Electrical Fittings:

(i) lighting fixtures;

(ii) electrical panel and power outlets;

(iii) switches;

(iv) auxiliary outlets, for example, television and networking cable.

(b) Counter top finishes:

(i) ceramics;

(ii) porcelain;

(iii) hard wood;

(iv) synthetic surfaces;

(v) granite.

(c) Landscaping:

(i) lawn, flower bed;

(ii) driveway;

(iii) walkway;

(iv) rock garden.

(d) Sick Building Syndrome (SBS).

5. Using CAD software

(a) Full set of working drawings for two-storey building.

(b) Rendering and finishes.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives in this Module, teachers are advised to engage students in the following teaching and learning activities.

1. *Organise teams to study design features in the school and community and to solve design problems.*

2. *Have students visit construction sites to observe the utilisation of components/products.*

3. *Have students research and make presentations on topics contained in the Module.*

RESOURCE

Chudley, R. and Green, R. — *Construction Technology, 4th edition. Essex: Pearson Prentice Hall, 2005.*

♦ OUTLINE OF ASSESSMENT

Each Unit of the syllabus will be independently assessed and graded separately. Candidates have the option of submitting their responses to Paper 02 using either the traditional drawing method (drawing board and tee square) or Computer-Aided Drafting (CAD) software.

EXTERNAL ASSESSMENT ***(70%)***

Written Papers

Paper 01 *(1 hour 30 Minutes)*	***Unit 1*** *This paper will consist of 45 multiple-choice items, 15 items based on each of the three Modules in the Unit. All items are compulsory. To accommodate the Option of either Module 3A or 3B, there will be two papers. Both papers will consist of 15 items from Modules 1 and 2 each and 15 items from either Module 3A or 3B.*	*30%*
(1 hour 30 Minutes)	***Unit 2*** *Option A and Option B* *The paper tests options A and B separately and consists of 45 multiple choice items, 15 items based on each of the three Modules in the Unit.*	
Paper 02 *(2 hours 30 Minutes)*	*Unit 1* *Eight extended response questions arranged in four Sections A, B, C and D.* *Sections A, B, C and D each comprise two questions. Section A tests Module 1; Section B tests Module 2; Section C tests Option A in Module 3; and Section D tests Option B in Module 3* *Candidates will be required to answer All questions from Sections A and B and ALL questions from either Section C* ***or*** *Section D.* ***Unit 2*** *Option A and Option B.* *For each Option: Six extended response questions arranged in three Sections: A, B and C.* *In both Options, Sections A, B and C each comprises two questions. Section A tests Module 1; Section B tests Module 2; and Section C tests Module 3.* *Candidates will be required to answer ALL questions from each Section.*	*40%*

SCHOOL-BASED ASSESSMENT ***(30%)***

Paper 03

The SBA for Unit 1 is derived from the composite marks of the entries in the School-Based Assessment portfolio and which may include related CVQ Units of Competency aligned to the content in the syllabus. Where applicable the candidates who successfully complete selected Units in the CVQ Regional Occupational Standards will be awarded a Statement of Competence.

The SBA for Unit 2 is derived from the composite marks of the entries in the School-Based Assessment portfolio and which may include related CVQ Units of Competency aligned to the content in the syllabus. Where applicable the candidates who successfully complete selected Units in the CVQ Regional Occupational Standards will be awarded a Statement of Competence.

ASSESSMENT DETAILS

Each Unit will be assessed as follows:

External Assessment by Written Papers – (70 per cent of Total Assessment)

<u>Paper 01 (1 1/2 hours – 30 per cent of Total Assessment)</u>

1. Composition of the Paper

<u>Unit 1</u>

This paper consists of 45 multiple-choice items on all Modules as follows:

To accommodate the option between 3A and 3B, there will be two papers. Each paper will have 15 similar items each from Module 1 and Module 2 and 15 items from either Module 3A (Engineering Drawing) or 3B (Building Drawing). All questions are compulsory.

<u>Unit 2</u>

This paper consists of 45 multiple-choice items on all Modules as follows:

Option A (Mechanical Engineering) and Option B (Building Drawing) will each consist of 45 multiple-choice items; 15 items from each Module. All questions are compulsory.

2. Mark Allocation

This paper is worth 45 marks and contributes 30 per cent towards the final assessment. Each Module is worth 15 marks and contributes 10 per cent towards the final assessment.

3. Use of Calculators

Candidates may use silent, non-programmable calculators.

<u>Paper 02 (2 1/2 hours – 40 per cent of Total Assessment)</u>

1. ***Composition of Paper***

<u>Unit 1</u>

This paper consists of eight questions in four sections, A, B, C and D. Each section contains two questions.

- *Section A tests Module 1;*
- *Section B tests Module 2;*
- *Section C tests Module 3 Option A; and,*
- *Section D tests Module 3 Option B.*

The candidate is required to answer ALL questions from Section A, Module 1 and Section B Module 2 and ALL questions from ***either*** *section C, Module 3A* ***or*** *Section D, Module 3B.*

<u>Unit 2</u>

For each option in the Unit, Paper 02 is divided into three sections, A, B and C, each representing one of the three Modules. Each section contains two questions. The candidate is required to answer ALL questions from each of the three sections.

All questions are equally weighted and may require knowledge of more than one topic in the Module from which they are taken.

2. ***Mark Allocation***

This paper is worth 120 marks and contributes 40 per cent towards the final assessment. Each Module is worth 40 marks and contributes approximately 13.3 per cent towards the final assessment. Each question is worth 20 marks.

3. ***Award of Marks***

Full marks will be awarded for correct answers supported by relevant working or demonstration of the process.

No marks will be awarded to a correct answer which is unsupported by any details of the method used (for example, calculations, construction or line-work). Candidates are therefore advised to show ***<u>all</u>*** *their working.*

4. ***Use of Calculators***

Candidates may use silent, non-programmable calculators.

SCHOOL-BASED ASSESSMENT (30 per cent of Total Assessment)

School-Based Assessment is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The activities for the School-Based Assessment are linked to the syllabus *and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.*

During the course of study for the subject, students obtain marks for the competence they develop and demonstrate in undertaking their School-Based Assessment assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of School-Based Assessment. The guidelines provided for the assessment of the assignments are intended to assist teachers in awarding marks that are reliable estimates of the achievement of students in the School-Based Assessment component of the course. In order to ensure that the scores awarded by teachers are in line with the Caribbean Examinations Council's standards, the Council undertakes the moderation of a sample of the School-Based Assessment assignments marked by each teacher.

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the student at various stages of the experience. This helps to build the self-confidence of students as they proceed with their studies. Schools-Based Assessment also facilitates the development of the critical skills and abilities emphasised by this CAPE subject and enhances the validity of the examination on which candidate performance is reported. Internal Assessment, therefore, makes a significant and unique contribution to both the development of relevant skills and the testing and rewarding of students for the development of those skills.

The Caribbean Examinations Council seeks to ensure that the School-Based Assessment scores are valid and reliable estimates of accomplishment. The guidelines provided in this syllabus are intended to assist in doing so.

The School-Based Assessment will consist of a Portfolio for each Unit consisting of assignments taken from the Module(s) outlined in the syllabus.

UNIT 1

<u>Paper 03 - Drawing Portfolio (30 per cent of the Total Assessment)</u>

Composition

The Drawing Portfolio must consist of six assignments. Two assignments must be set on each Module. ***At least one assignment from each Module must be CAD-based.*** *A complete record of freehand sketches and final drawing solutions must be submitted in the Drawing Portfolio. The assignments in each Portfolio will be assessed by the teacher and a sample of the Portfolios will be reassessed by a moderator appointed by CXC.*

Mark Allocation

The mark recorded for each Module will be the average of the TWO Module assignments. ***The Internal Assessment for each Module is compulsory and failure to submit all assignments will normally result in no marks being awarded for Internal Assessment.*** *Each assignment is worth 20 marks and is set and assessed by the teacher, using the School-Based Assessment Assignments, Criteria and Mark Schemes provided on pages 52–55 of the syllabus.*

UNIT 1

Assignments

Each candidate is required to produce a Drawing Portfolio consisting of six original drawings. Examples of appropriate sources and topics on which these assignments may be based are given below.

*For **EACH** assignment the student will submit a completed drawing or set of drawings on A2 (420 x 594 mm) paper by itself with border lines and title block.*

Candidates pursuing Option 3A (Engineering Drawing) will complete the following SBA Assignments:

<u>Assignment 1</u>

Candidates will be expected to produce drawings based on Specific Objectives 1 and 2 of Module 1.

<u>Assignment 2</u>

Candidates will be expected to produce ONE drawing based on Specific Objectives 3 and 4 of Module 1.

<u>Assignment 3</u>

Candidates will be expected to produce ONE drawing based on Specific Objectives 2 to 5 of Module 2.

<u>Assignment 4</u>

Candidates will be expected to produce ONE drawing using CAD software and based on Specific Objective 6 of Module 2.

<u>Assignment 5</u>

Candidates will be expected to produce drawings based on Specific Objectives 1, 2 and 3 of Module 3A.

<u>Assignment 6</u>

Candidates will be expected to produce ONE drawing based on Specific Objectives 4, 5 and 6 of Module 3A.

Candidates pursuing Option 3B (Building Drawing) will complete the following SBA Assignments:

<u>Assignment 1</u>

Candidates will be expected to produce drawings based on Specific Objectives 1 and 2 of Module 1.

<u>Assignment 2</u>

Candidates will be expected to produce ONE drawing based on Specific Objectives 3 and 4 of Module 1.

Assignment 3

Candidates will be expected to produce ONE drawing based on Specific Objectives 2 to 5 of Module 2.

Assignment 4

Candidates will be expected to produce ONE drawing using CAD software and based on Specific Objective 6 of Module 2.

Assignment 5

Candidates will be expected to produce drawings based on Specific Objectives 1 of Module 3B.

Assignment 6

Candidates will be expected to produce ONE drawing based on Specific Objectives 2, 3 and 4 of Module 3B.

Mark Scheme for Assignments 1, 2, 3, 5 and 6

Teachers should allocate marks as shown in the table below.

CRITERIA	***MARKS***	***TOTAL MARKS***
1. Construction of lines and curves to form components (showing construction line where appropriate). *- More than 90% accurate* *- More than 80% accurate* *- More than 70% accurate* *- More than 60% accurate*	 *4* *3* *2* *1*	***4***
2. Use of line types, centre lines dimensions as needed (Balloon referencing and parts listing, hatching lines). *- More than 95% accurate* *- More than 90% accurate* *- More than 85% accurate* *- More than 80% accurate* *- More than 70% accurate* *- More than 60% accurate*	 *6* *5* *4* *3* *2* *1*	***6***
3. Accuracy of components drawn from given objects, sketches or drawings. *- More than 95% accurate* *- More than 90% accurate* *- More than 85% accurate* *- More than 80% accurate* *- More than 70% accurate* *- More than 60% accurate*	 *6* *5* *4* *3* *2* *1*	***6***
4. Linework *- Neat* *- Clean*	 *1* *1*	***2***
5. Completion of drawings *- Title blocks completed* *- Border lines completed*	 *1* *1*	***2***
TOTAL		**20**

Mark Scheme for Assignment 4

The student will submit:

1. *a list of the commands used for a given set of tasks on a separate sheet;*

2. *a complete drawing on A4 (210 x 297 mm) paper from a given sketch or drawing; and,*

3. *a labelled diskette with the completed drawing and commands.*

Teachers will allocate marks as shown in the table below.

CRITERIA	MARKS	TOTAL MARKS
1. Use of commands		***4***
- More than 90% accurate	*4*	
- More than 80% accurate	*3*	
- More than 70% accurate	*2*	
- More than 60% accurate	*1*	
2. Production of drawing using CAD software		***16***
- drawing (point on node)		
- line size		
*- line **types***		
- scales		
- dimensions		
- notations		
For each of the features in the list above award marks as follows to a maximum of 2 marks for each feature:		
- more than 90% accurate		
- 70 – 89% accurate	*2*	
	1	
- drawing		
- more than 90% completed	*2*	
- 70 – 89% completed	*1*	
- title block	*1*	
- border lines	*1*	
TOTAL		**20**

General

1. *Teachers should inform candidates of the assessment criteria.*

2. *Teachers should guide the candidates in choosing appropriate assignments that relate to the candidates' interest and specific objectives identified.*

3. *Teachers and candidates should agree to a schedule of the dates for submitting assignments.*

4. *The teacher should offer guidance in the process and the preparation of the portfolio.*

Management of Drawing Portfolio

Teachers should encourage students to start the first assignment during the first term and to complete an assignment once every five weeks.

UNIT 2

Paper 03 – Design Portfolio

Composition

The Design Portfolio must consist of three phases leading to the final design solution, namely:

(i) *Phase 1 – Conceptualisation of the project;*
(ii) *Phase 2 – Design of project;*
(iii) *Phase 3 – Work programme (methodology, resources, schedule).*

Students will be assessed on completed assignments at each phase. ***The Design Portfolio must be CAD-based, with evidence of the acquisition of knowledge and skills gained at each phase****. A* complete record of the proposal, pictorial and working drawings, freehand sketches, specifications, *calculations and final design solution should be kept in the Design Portfolio. The Design Portfolio will be assessed by the teacher and a sample of the documents will be reassessed by a moderator appointed by CXC.*

Each student must prepare a technical report on the project and make a presentation of his/her final design solution in class. Teachers are encouraged to use experts in the fields of mechanical engineering and architectural design to provide feedback on candidates' work.

Mark Allocation

There is one assignment in the Design Portfolio which is worth 60 marks. These marks will be awarded based on the criteria listed below (see pages 58–62 for detailed breakdown of Assessment Criteria).

Assessment Criteria			*Marks*
(i)	*Development of Project*		*22*
	• *Phase 1 – Conceptualisation of the Project*	*(06)*	
	• *Phase 2 - Design of Project*	*(10)*	
	• *Phase 3 – Work programme (methodology, resources schedule)*	*(06)*	
(ii)	**Use of CAD*		*06*
(iii)	*The Project Report*		*16*

(iv)	*Contents of Portfolio*	*08*
(v)	*The Interactive Presentation*	*08*

(*Commands used and electronic copy of final drawings must be submitted)

SCHOOL-BASED ASSESSMENT CRITERIA AND MARK SCHEMES

<u>Project, Design Portfolio and Interactive Presentation</u>

Candidates will be awarded a total of six marks for communicating information in a logical way using correct grammar.

The assessment of the Design Portfolio must be done by the teacher. The Assessment Criteria provided below are intended to assist teachers in awarding marks that are reliable assessments of the achievement of students on the design project they select. These assessments should be submitted to CXC.

	Assessment Criteria	*Range of Marks*	*Total Marks*

1	***Development of Project***
	
	Phase 1 – Conceptualisation of Project
	
	In this phase, students are expected to seek the guidance of their teachers and engage in research that will inform the conceptualisation of the Project.
	
	- ***Good***
	  - *Demonstrated a comprehensive understanding and good insight of concept(s)*
	  - *Demonstrated keen interest for the task*
	  - *Gathered relevant information (90%) from appropriate sources*
	  - *Required minimal supervision to complete complex and routine tasks*
	- ***Satisfactory***
	  - *Demonstrated a satisfactory understanding of the concept(s)*
	  - *Demonstrated interest in the task*
	  - *Gathered relevant information (70%) from appropriate sources*
	  - *Required some supervision to complete complex tasks but not the routine tasks*
	- ***Limited***
	  - *Demonstrated a limited understanding of the concept(s)*
	  - *Demonstrated limited interest in the task*
	  - *Gathered irrelevant information (>50%)*
	  - *Main source of information inappropriate*
	  - *Unable to complete routine tasks without supervision*
		
		(6)
		
		5 – 6
		
		3 – 4
		
		1 – 2
			22

Assessment Criteria	*Range of Marks*	*Total Marks*
Phase 2 – Design of Project *In this practical phase, students are expected to work closely with their teachers to complete a) to e) for their Projects.* *The design must include:* *(a) sketches of preliminary and final design solutions* *(b) detailed working drawings* *(c) assembly drawings* *(d) application of theories explored in Phase 1* *(e) the specifications of the component(s) in the Project*	***(10)***	
- ***Good:*** *Sketches and drawings for more than THREE different design solutions presented. Strong link between the theories explored in Phase 1 and details in sketches and drawings of the chosen design. Good rationale for the chosen specifications.*	*7 – 10*	
- ***Satisfactory:*** *Sketches and drawings for THREE different design solutions presented. Satisfactory link between the theories explored in Phase 1 and details in the sketches and drawings of the chosen design. Satisfactory rationale for the chosen specifications.*	*4 – 6*	
- ***Limited:*** *Sketches and drawings for less than THREE different design solutions presented. A moderate link between the theories explored in Phase 1 and details in the sketches and drawings of the chosen design. Fair rationale for the chosen specifications.*	*0 – 3*	

	Assessment Criteria	Range of Marks	Total Marks
	Phase 3 – Work Programme	***(06)***	
	This report must include: *a) statement of approach or methodology* *b) resources, including software, equipment and literature used* *c) scheduling of tasks for each Phase*		
	• ***Good:*** *Used appropriate methodology and resources. Most tasks completed and schedule indicates an efficient use of time.*	*5 – 6*	
	• ***Satisfactory:*** *Used appropriate methodology. Many tasks (60%) completed and suitable resources were used. Schedule indicates a satisfactory use of time.*	*3 – 4*	
	• ***Fair:*** *Inappropriate use of methodology and/or most resources. There were many incomplete tasks and/or the schedule was loosely organised.*	*0 – 2*	
2	***Use of CAD Software***		***06***
	• ***Good:*** *ALL (>90%) drawings completed with accurate representations of the components and correct use of commands.*	*5 – 6*	
	• ***Satisfactory****: MANY (>75%) drawings completed with accurate representations of MANY of the components with minor errors in the use of commands.*	*3 – 4*	
	• ***Limited****: FEW (>60%) drawings completed with major inaccuracies in the representations of the components and use of commands.*	*1 – 2*	

	Assessment Criteria	Range of Marks	Total Marks
3	***The Project Report***		***16***
	(a) Project proposal (statement of purpose or definition of problem).	***(03)***	
	- Concise, aligned with the design problem	*3*	
	- Loose or ambiguous alignment with the design problem	*1 – 2*	
	(b) Statement of project scope and specifications	***(02)***	
	- Statement is relevant to project theme/title, specifications unambiguous	*2*	
	- Statement is generally relevant to project theme/title some ambiguity in specifications	*1*	
	(c) Constraints and limitations	***(02)***	
	- Satisfactory insight in the identification of problem-solving strategies	*2*	
	- Limited insight in the identification of problem-solving strategies	*1*	
	(d) Final design of project (freehand sketches, detailed working drawing, assembly drawing, specifications)	***(04)***	
	- Satisfactory match of products with specifications outlined in the project scope	*3 – 4*	
	- Limited match of products with specifications outlined in the project scope	*1 – 2*	
	(e) Communication of information in a logical way	***(05)***	
	• communicates information in a logical way using correct grammar and appropriate terminology of the field MOST of the time	*4 – 5*	
	• communicates information in a logical way using correct grammar and appropriate terminology of the field SOME of the time	*2 – 3*	
	• communicates information in a logical way RARELY using correct grammar and appropriate terminology of the field.	*0 – 1*	
4	***Contents of Portfolio***		***08***
	*• **Good**: Contents were neatly organised, containing relevant materials for the task.*	*6 – 8*	
	*• **Satisfactory**: Contents were generally neat and organised and/or most of the materials were relevant for the task.*	*3 – 5*	
	*• **Limited:** Contents were loosely organised and/or contained many irrelevant materials for the task.*	*0 – 2*	

	Assessment Criteria	Range of Marks	Total Marks
5	***The Interactive Presentation***		**08**
	• *Quality of presentation*	***(05)***	
	- *Logical sequence of ideas in presentation; student demonstrates full knowledge of the topic by answering questions with explanations and elaboration*	*4 – 5*	
	- *Explanation needed to follow the sequence of ideas in presentation; student demonstrates knowledge of most aspects of the topic and answered the rudimentary questions.*	*2 – 3*	
	- *Sequence of ideas erratic and difficult to follow; student was unable to answer many of the questions related to the topic*	*0 – 1*	
	• *Use of computer-aided material*	***(02)***	
	- *Generally relevant to concepts*	*2*	
	- *Moderately relevant to concepts*	*1*	
	• *Communication of Information(vocabulary, grammar)*	***(01)***	
	- *Presented ideas using appropriate terminology and generally correct grammar*	*1*	
Total			***60***

♦ REGULATIONS FOR PRIVATE CANDIDATES

Candidates who are registered privately will be required to sit Paper 01, Paper 02 and Paper 03. Detailed information on Papers 01, 02 and 03 is given on pages 48–50.

♦ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Papers 01 and 02 and Paper 03 of the examination for the year for which they re-register. Resit candidates may elect not to repeat the School-Based Assessment component, provided they rewrite the examination no later than two years following their first attempt.

A candidate who rewrites the examination in the same Unit within two years may opt to complete a School-Based Assessment for each Unit written or may opt to reuse the moderated SBA score earned in the previous sitting within the preceding two years. Candidates reusing SBA scores in this way must register as “Resit candidates” and provide the previous candidate number. Candidates are no longer required to earn a moderated score that is at least 50 per cent of the maximum possible score; any moderated score may be reused.

Resit candidates must be entered through a school, a recognised educational institution, or the Local Registrar’s Office.

♦ ASSESSMENT GRID

The Assessment Grid for each Unit contains marks assigned to each paper and to each Module and the percentage contribution of each paper to total scores.

PAPERS	*MODULES*			*TOTAL (WEIGHTED)*	*(%)*
	Module 1	*Module 2*	*Module 3*		
External Assessment Paper 01	*15 (30)*	*15 (30)*	*15 (30)*	*45 (90)*	*(30)*
Paper 02	*40*	*40*	*40*	*120*	*(40)*
Unit 1 School-based Assessment Paper 03/1	*40 (30)*	*40 (30)*	*40 (30)*	*120 (90)*	*(30)*
Unit 2 School-based Assessment Paper 03/1	*20 (30)*	*20 (30)*	*20 (30)*	*60 (90)*	
Total	*100*	*100*	*100*	*300*	*(100)*

♦ RESOURCES

British Standards Institutions, *Engineering Drawing Practice for Schools and Colleges*, London: British Standards Institution, 1986.

BS 4500A, *Selected ISO Fits – Hole Basis.*
BS 4500B, *Selected ISO Fits – Shaft Basis.*

Brown, W. C.	*Drafting for Industry*. Illinois: Goodhart Wilcox, 1994.
House, R	*Using AutoCAD 2000.* Indianapolis: The Macmillian Press, 2000.
McLain, K.J	*Designers AutoCAD 2000 Tutorial.* Ohio: Thompson Learning Company 2001.
Simmons, C. and Maguire, D.	*A Manual of Engineering Drawing.* London: Hodder and Stoughton, 1995.
Yarwood, A.	*Introduction to AutoCAD 2000.* London: Longmans, 1999.

♦ GLOSSARY OF TERMS

WORD/TERM	DEFINITION/MEANING
account for	Present reason for action or event
annotate	add a brief note to a label
apply	use knowledge of principles to solve problems
assess	present reasons for the importance of particular structures, relationships or process
calculate	arrive at the solution to a numerical problem
classify	divide into groups according to observable characteristics
comment	state opinion or view with supporting reasons
compare	state similarities and differences
construct	use a specific format to make and draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model), draw scale diagram
deduce	make a logical connection between two or more pieces of information; use data to arrive at a conclusion
define	state concisely the meaning of a word or term
demonstrate	show; direct attention to...
describe	provide detailed factual information of the appearance or arrangement of a specific structure or a sequence of a specific process
determine	find the value of a physical quantity
design	plan and present with appropriate practical detail
develop	expand or elaborate an idea or argument with supporting reasons
diagram	simplified representation showing the relationship between components.
differentiate	state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories.
discuss	present reasoned argument; consider points both for and against; explain the relative merits of a case
draw	make a line representation from specimens or apparatus which shows an accurate relation between the parts
estimate	make an approximate quantitative judgement

WORD/TERM	DEFINITION/MEANING
evaluate	weigh evidence and make judgements based on given criteria
explain	give reasons based on recall; account for
find	locate a feature or obtain as from a graph
formulate	devise a hypothesis
identify	name or point out specific components or features
illustrate	show clearly by using appropriate examples or diagrams, sketches
investigate	use simple systematic procedures to observe, record data and draw logical conclusions
label	add names to identify structures or parts indicated by pointers
list	itemise without detail
measure	take accurate quantitative readings using appropriate instruments
name	give only the name of
note	write down observations
observe	pay attention to details which characterise a specimen, reaction or change taking place; to examine and note scientifically
outline	Give basic steps only
plan	prepare to conduct an investigation
predict	use information provided to arrive at a likely conclusion or suggest a possible outcome
record	write an accurate description of the full range of observations made during a given procedure
relate	show connections between; explain how one set of facts or data depend on others or are determined by them
sketch	make a simple freehand diagram showing relevant proportions and any important details
state	provide factual information in concise terms outlining explanations
suggest	offer an explanation deduced from information provided or previous knowledge. (... a hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.)
test	to find out, following set procedures

♦ C MINIMUM EQUIPMENT LIST

(For Every 15 Students)

EQUIPMENT/MATERIAL	DESCRIPTION/SPECIFICATION	QUANTITY
Drawing Room	With proper lighting	1
Drafting Table	With proper lighting	15
Stool		15
Computer	Microsoft Windows XP SP2 Operating System Intel® Pentium® 4 Processor or AMD Anthlon®, 2.2 GHz or Greater Intel AMD Dual Core Processor, 1.6 GHz or Greater 1 GB RAM 750 MB free Hard Disc space for Installation Microsoft Internet Explorer 6.0 (SPI or Higher	5
Monitor	15 or 17 inches (1024 x 768 VGA with true colour)	5
Software	AutoCAD 2009 or later version Chief Architect 10 or Later Version Revit 3D Home or 3D Architect SKETCHUP	1 copy
ISO Standard/BS 3888	Technical Drawing	1
ISO Standard/PP 7307	Graphical symbols for use in schools and colleges	1
ISO Standard/PP 7308	Engineering Drawing Practice for schools and colleges	1
ISO Standard TC-S9	Buildings and civil engineering works	1
ISO Standard ICS - 91	Construction Material and Building	1
CUBiC (code)	Caribbean Uniform Building Codes Electrical code Plumbing code Structural code Wind code Earthquake code	1
Local Code		1

Students are expected to provide the following:

(i) drawing paper;
(ii) tee square;
(iii) set squares (30° and 45°);
(iv) drafting set;
(v) metric scale;

(vi) eraser;
(vii) pencils;
(viii) masking tape
(ix) external storage device (thumb drive).

Western Zone Office
8 April 2015

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination®

BUILDING AND MECHANICAL ENGINEERING DRAWING

Specimen Papers and Mark Schemes/Keys

Specimen Papers:	-	Unit 1, Paper 01 Option A (Engineering Drawing) Unit 1, Paper 01 Option B (Building Drawing) Unit 1, Paper 02 (Building and Mechanical Engineering Drawing) Unit 2, Paper 01 Option A (Mechanical Engineering Drawing and Design) Unit 2, Paper 01 Option B (Building Drawing and Design) Unit 2, Paper 02 Option A (Mechanical Engineering Drawing and Design) Unit 2, Paper 02 Option B (Building Drawing and Design)
Mark Schemes and Keys:	-	Unit 1, Paper 01 Option A (Engineering Drawing) Unit 1, Paper 01 Option B (Building Drawing) Unit 1, Paper 02 (Building and Mechanical Engineering Drawing) Unit 2, Paper 01 Option A (Mechanical Engineering Drawing and Design) Unit 2, Paper 01 Option B (Building Drawing and Design) Unit 2, Paper 02 Option A (Mechanical Engineering Drawing and Design) Unit 2, Paper 02 Option B (Building Drawing and Design)

TEST CODE **02168010**

SPEC 2015/02168010

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

OPTION A – ENGINEERING DRAWING

SPECIMEN PAPER

Unit 1 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.

2. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.

3. Look at the sample item below.

   Sample Item

   In drawings, thin, short dashes represent

   (A) hidden details
   (B) adjacent parts
   (C) movable parts
   (D) irregular details

   Sample Answer

   ● Ⓑ Ⓒ Ⓓ

   The best answer to this item is "hidden details", so (A) has been shaded.

4. If you want to change your answer, erase it completely before you fill in your new choice.

5. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.

6. You may do any rough work in this booklet.

7. Figures are not necessarily drawn to scale.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

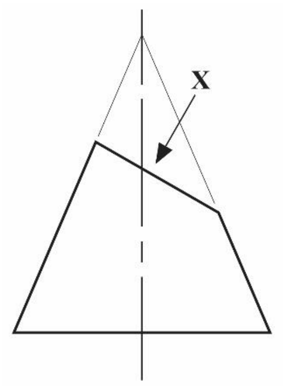
1. Which of the following geometric shapes is obtained by cutting a right cone at an angle to its base?

(A) Circle
(B) Ellipse
(C) Parabola
(D) Hyperbola

2. Which of the following engineering curves may be defined as the locus of a point which moves away from another fixed point at uniform linear velocity and uniform angular velocity?

(A) Involute
(B) Cycloid
(C) Epicycloid
(D) Archimedean Spiral

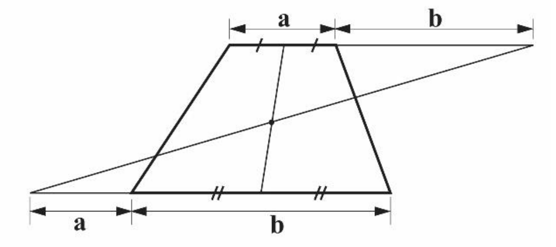
<u>Item **3**</u> refers to the following diagram of a truncated cone.



3. The view taken from the position of the arrow 'X' is an

(A) oblique view
(B) isometric view
(C) auxillary view
(D) orthographic view

<u>Item **4**</u> refers to the following diagram.



4. The diagram shows how to

(A) find the area of a quadrilateral
(B) determine the perimeter of a trapezium
(C) find the centre of gravity of a trapezium
(D) divide a trapezium into four parts of equal area

5. Which of the following curves is generated if a piece of string is wound around a cylinder?

(A) Cycloid
(B) Helix
(C) Involute
(D) Trochoid

6. Which of the following BEST describes the locus of a point which moves so that its distance from a focus bears a constant ratio of one to its perpendicular distance from the directrix?

(A) Ellipse
(B) Parabola
(C) Hyperbola
(D) Hypocycloid

7. The centroid coincides with the center of mass or the centre of gravity only if the material of the body is

(A) solid
(B) irregular
(C) symmetrical
(D) homogenous

8. If an area possesses two lines of symmetry, its centroid lies at

(A) the end of each symmetry line
(B) their intersection of the symmetry
(C) 1/3 from point of intersection
(D) 1/2 from point of intersection

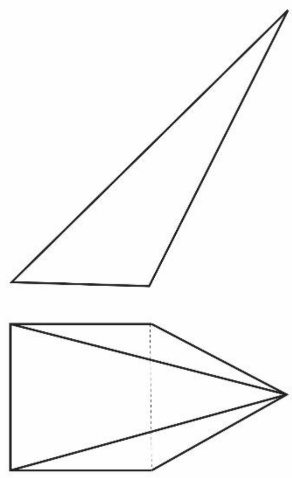
9. The first step in determining the centroid of a composite shape is

(A) determining a first moment
(B) identifying common shapes
(C) identifying individual centroids for each shape
(D) calculating the complete area of the composite shape

10. A curve that is generated by a point that revolves uniformly around, up and down the surface of a cylinder is a

(A) helix
(B) cycloid
(C) spring
(D) parabola

<u>Item **11**</u> refers to the following views of an oblique square pyramid.



11. Which of the following is the MOST suitable method to use to construct the development of the oblique square pyramid?

(A) Polar method
(B) Method of arcs
(C) Measuring sides
(D) Method of triangulation

12. In reference to orthographic projection, when a line passes through a plane, the point of intersection is

(A) a trace
(B) first-angle projection
(C) third-angle projection
(D) oblique projection

Item **13** refers to the following types of lines used in drawings.

I. Angular lines
II. Perpendicular lines
III. Curves

13. Which of the lines can be drawn using polar coordinates in CAD?

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

14. Which of the following is NOT in the modify tool bar?

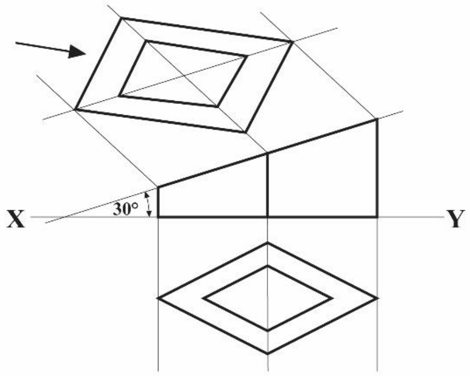
(A) Erase
(B) Array
(C) Draw
(D) Offset

15. Which of the following statements are TRUE of first angle projection?

I. The base represents the horizontal plane on to which is projected the plan.
II. The three sides represent the three vertical planes on to which the front elevation
and the two end elevations are projected.
III. The plan is in the vertical plane to the end elevation.

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

Item **16** refers to the following diagram.



16. Which view is indicated by the arrow?

(A) Plan view
(B) Front view
(C) Auxiliary plan
(D) Setional view

17. Which of the following describes a curve generated by a point on the circumference of a circle, which rolls without slipping along the outside of another circle?

(A) Hypocycloid
(B) Epicycloid
(C) Cycloid
(D) Trochoid

18. The primary reason for using an auxiliary view is to

(A) locate centre marks
(B) eliminate hidden lines
(C) show cylinders as ellipses and spheres
(D) create a true projection plane from an incline plane

19. Which of the following definitions BEST describes an ellipse?

(A) Locus of a curve that moves around a cylindrical object
(B) Locus of a point on the periphery of a circle which rolls on a straight path
(C) Locus of a point moving such that the ratio of the distances from a fixed point and a fixed line remain constant
(D) Locus of a point moving such that a curve is generated on the periphery of a circle which s along the foci

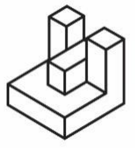
20. A bicycle tyre picks up a thumb tack as the cyclist rode an up curving ramp. Which of the following curves is produced if the locus of the tack is plotted?

(A) Cycloid
(B) Trochoid
(C) Epicycloid
(D) Hypocycloid

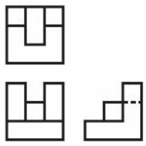
21. Which of the following curves is produced when the locus of a point on the periphery of a circle which rolls on a curved path is drawn?

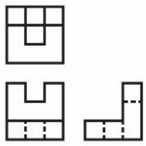
(A) Epicycloid
(B) Trochoid
(C) Cycloid
(D) Involute

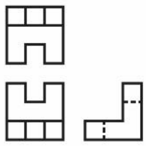
Item 22 refers to the following diagram of a figure drawn in isometric.

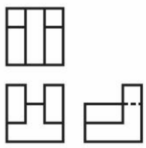


22. Which of the following orthographic views corresponds with the isometric figure?

(A)


(B)


(C)


(D)


23. Which orthographic view is needed to produce an auxiliary elevation?

(A) End
(B) Plan
(C) Section
(D) Elevation

24. Which of the following pairs of drawings is necessary when drawing the development of a cylinder with an oblique top?

(A) Plan and section
(B) Plan and elevation
(C) Elevation and section
(D) Elevation and end elevation

25. A hexagonal pyramid that does NOT have its apex directly above the centre of its base is described as

(A) a regular pyramid
(B) a truncated pyramid
(C) an oblique pyramid
(D) a frustum pyramid

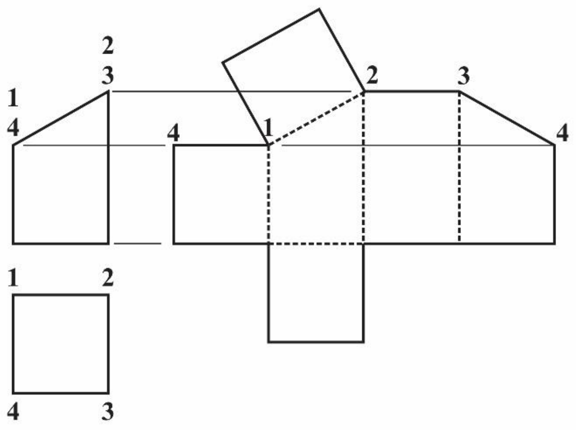
26. In isometric projection, the four center method is used to construct

(A) an ellipse
(B) a square
(C) a triangle
(D) a rectangle

27. Which of the following conditions must be met in order to classify a pictorial drawing as an isometric projection?

(A) The isometric axes must be 30° apart
(B) The isometric axes must be 45° apart
(C) The isometric axes must be 60° apart
(D) The isometric axis must be 120° apart

<u>Items **28–29**</u> refer to the following diagram.



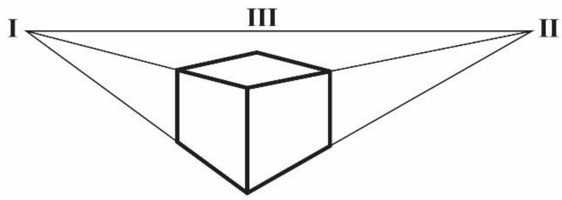
28. The development in the diagram shows a

(A) square prism with square top
(B) pyramid with rectangular top
(C) square prism with an oblique top
(D) hexagonal prism with a square top

29. What do the dotted lines in the development represent?

(A) Width
(B) Corners
(C) Drawing line
(D) Cutting line

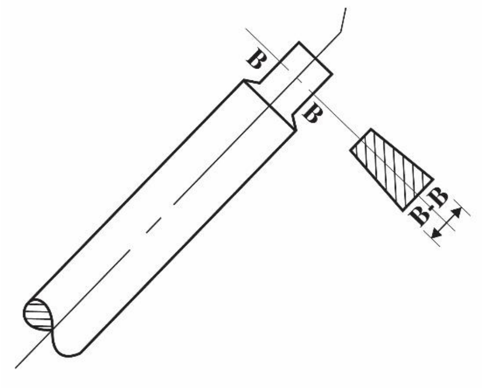
<u>Item **30**</u> refers to the following pictorial diagram of a box.



30. What type of projection was used to draw the box?

(A) Oblique
(B) Isometric
(C) Perspective
(D) Planometric

Item **31** refers to the following diagram.



31. What type of sectioning is shown in the diagram?

(A) Aligned section
(B) Half section
(C) Revolved section
(D) Removed section

32. The distance that a follower moves in one revolution while in contact with the cam is called

(A) fall
(B) rise
(C) dwell
(D) displacement

33. Hatching lines are used for

(A) identifying machine parts
(B) displaying saw-tooth lines
(C) showing cut-off sections
(D) displaying internal components

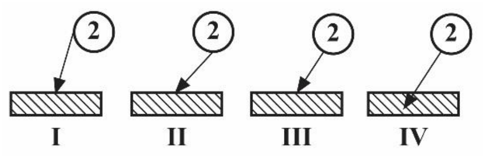
34. The standard thickness of hatching lines is

(A) 0.1 mm
(B) 0.3 mm
(C) 0.5 mm
(D) 0.7 mm

35. Which of the following items is NOT sectioned?

(A) Keys
(B) Shafts
(C) Pulleys
(D) Nuts and bolts

Item **36** refers to the following balloon referencing (item listing) arrow terminations.



36. Which of the balloon references is correct?

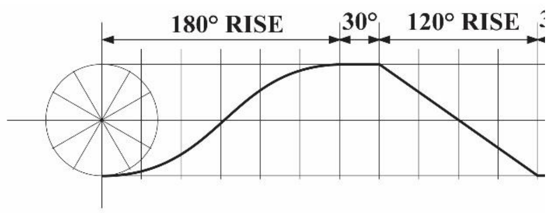
(A) I
(B) II
(C) III
(D) IV

37. Which of the following is NOT part of an items (parts) listing?

(A) MATL.
(B) No. OFF
(C) REMARKS
(D) TOLERANCE

<u>Items **38 – 40**</u> refers to the following diagram of a performance curve for a cam profile.

38. What type of motion will be imparted to the follower during its rise?



(A) Dwell
(B) Uniform velocity
(C) Simple harmonic motion
(D) Uniform acceleration and retardation

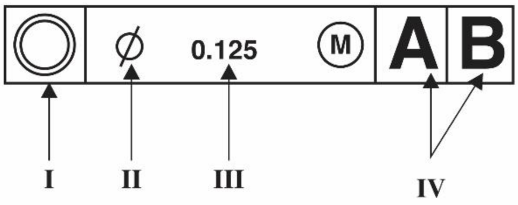
39. For what angle of rotation is the cam follower neither rising nor falling?

(A) 30°
(B) 60°
(C) 90°
(D) 120°

40. The cam will fall with

(A) 120° uniform retardation
(B) 150° uniform retardation
(C) 120° uniform velocity
(D) 150° uniform velocity

<u>Items **41–43**</u> refer to the following diagram showing dimension elements.



41. Which element is denoted by the arrow labelled 'III'?

(A) Tolerance value
(B) Geometric condition
(C) Optional diameter
(D) Material condition of tolerance

42. Which element is denoted by the arrow labelled 'IV'?

(A) Datum
(B) Optional diameter
(C) Geometric condition
(D) Tolerance value

43. Which element represents concentric circles?

(A) I
(B) II
(C) III
(D) IV

44. Which of the following is a disadvantage of the knife-edge follower?

(A) It wears faster.
(B) It slows down the cam.
(C) It is difficult to construct.
(D) It has the ability to move around the cam easily.

45. Which of the following valves is MOST suitable for allowing flow in one direction, uses pressure and velocity to flow, and cannot be controlled from an external source?

(A) Globe
(B) Gate
(C) Ball
(D) Check

END OF TEST

TEST CODE **02169010**

SPEC 2015/02169010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

OPTION B – BUILDING DRAWING

SPECIMEN PAPER

Unit 1 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.

2. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.

3. Look at the sample item below.

   Sample Item

   In drawings, thin, short dashes represent

   (A) hidden details
   (B) adjacent parts
   (C) movable parts
   (D) irregular details

   Sample Answer

   ● (B) (C) (D)

   The best answer to this item is "hidden details", so A has been shaded.

4. If you want to change your answer, erase it completely before you fill in your new choice.

5. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.

6. You may do any rough work in this booklet.

7. Figures are not necessarily drawn to scale.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

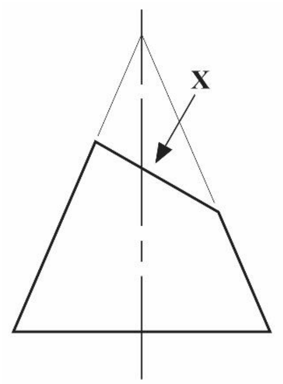
1. Which of the following geometric shapes is obtained by cutting a right cone at an angle to its base?

(A) Circle
(B) Ellipse
(C) Parabola
(D) Hyperbola

2. Which of the following engineering curves may be defined as the locus of a point which moves away from another fixed point at uniform linear velocity and uniform angular velocity?

(A) Involute
(B) Cycloid
(C) Epicycloid
(D) Archimedean spiral

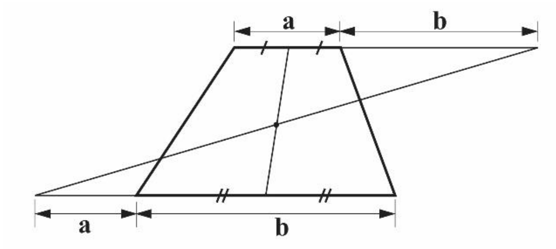
Item **3** refers to the following diagram of a truncated cone.



3. The view taken from the position of the arrow 'X' is an

(A) oblique view
(B) isometric view
(C) auxillary view
(D) orthographic view

Item **4** refers to the following diagram.



4. The diagram shows how to

(A) find the area of a quadrilateral
(B) determine the perimeter of a trapezium
(C) find the centre of gravity of a trapezium
(D) divide a trapezium into four parts of equal area

5. Which of the following curves is generated if a piece of string is wound around a cylinder?

(A) Cycloid
(B) Helix
(C) Involute
(D) Trochoid

6. Which of the following BEST describes the locus of a point which moves so that its distance from a focus bears a constant ratio of one to its perpendicular distance from the directrix?

(A) Ellipse
(B) Parabola
(C) Hyperbola
(D) Hypocycloid

7. The centroid coincides with the centre of mass or the centre of gravity only if the material of the body is

(A) solid
(B) irregular
(C) symmetrical
(D) homogenous

8. If an area possesses two lines of symmetry, its centroid lies at

(A) the end of each symmetry line
(B) their intersection of the symmetry
(C) 1/3 from point of intersection
(D) 1/2 from point of intersection

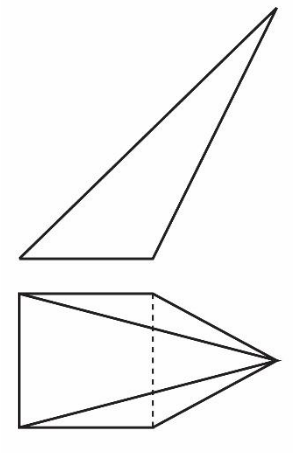
9. The first step in determining the centroid of a composite shape is

(A) determining a first moment
(B) identifying common shapes
(C) identifying individual centroids for each shape
(D) calculating the complete area of the composite shape

10. A curve that is generated by a point that revolves uniformly around, up and down the surface of a cylinder is a

(A) helix
(B) cycloid
(C) spring
(D) parabola

<u>Item **11**</u> refers to the following views of an oblique square pyramid.



11. Which of the following is the MOST suitable method to use to construct the development of the oblique square pyramid?

(A) Polar method
(B) Method of arcs
(C) Measuring sides
(D) Method of triangulation

12. In reference to orthographic projection, when a line passes through a plane, the point of intersection is

(A) a trace
(B) first-angle projection
(C) third-angle projection
(D) oblique projection

Item **13** refers to the following types of lines used in drawings.

I. Angular lines
II. Perpendicular lines
III. Curves

13. Which of the lines can be drawn using polar coordinates in CAD?

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

14. Which of the following is NOT in the modify tool bar?

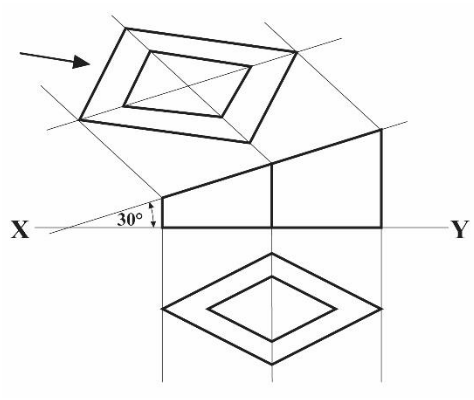
(A) Erase
(B) Array
(C) Draw
(D) Offset

15. Which of the following statements are TRUE of first angle projection?

I. The base represents the horizontal plane on to which is projected the plan.
II. The three sides represent the three vertical planes on to which the front elevation and the two end elevations are projected.
III. The plan is in the vertical plane to the end elevation.

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

Item **16** refers to the following diagram.



16. Which view is indicated by the arrow?

(A) Plan view
(B) Front view
(C) Auxiliary plan
(D) Sectional view

17. Which of the following describes a curve generated by a point on the circumference of a circle, which rolls without slipping along the outside of another circle?

(A) Hypocycloid
(B) Epicycloid
(C) Cycloid
(D) Trochoid

18. The primary reason for using an auxiliary view is to

(A) locate centre marks
(B) eliminate hidden lines
(C) show cylinders as ellipses and spheres
(D) create a true projection plane from an incline plane

19. Which of the following definitions BEST describes an ellipse?

(A) Locus of a curve that moves around a cylindrical object
(B) Locus of a point on the periphery of a circle which rolls on a straight path
(C) Locus of a point moving such that the ratio of the distances from a fixed point and a fixed line remain constant
(D) Locus of a point moving such that a curve is generated on the periphery of a circle which rolls along the foci

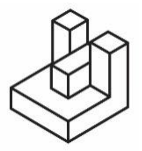
20. A bicycle tyre picks up a thumb tack as the cyclist rode an up curving ramp. Which of the following curves is produced if the locus of the tack is plotted?

(A) Cycloid
(B) Trochoid
(C) Epicycloid
(D) Hypocycloid

21. Which of the following curves is produced when the locus of a point on the periphery of a circle which rolls on a curved path is drawn?

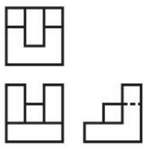
(A) Epicycloid
(B) Trochoid
(C) Cycloid
(D) Involute

<u>Item **22**</u> refers to the following diagram of a figure drawn in isometric.

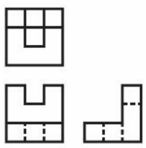


22. Which of the following orthographic views corresponds with the isometric figure?

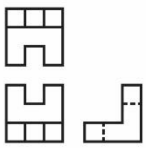
(A)



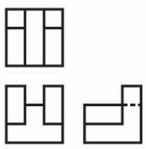
(B)



(C)



(D)



23. Which orthographic view is needed to produce an auxiliary elevation?

(A) End
(B) Plan
(C) Section
(D) Elevation

24. Which of the following pair of drawings is necessary when drawing the development of a cylinder with an oblique top?

(A) Plan and section
(B) Plan and elevation
(C) Elevation and section
(D) Elevation and end elevation

25. A hexagonal pyramid that does NOT have its apex directly above the centre of its base is described as

(A) a regular pyramid
(B) a truncated pyramid
(C) an oblique pyramid
(D) a frustum pyramid

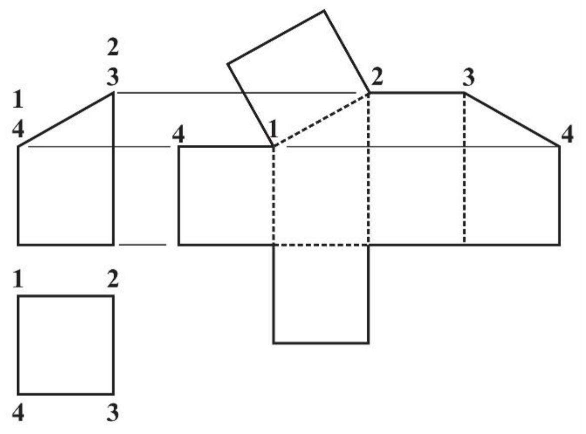
26. In isometric projection, the four center method is used to construct

(A) an ellipse
(B) a square
(C) a triangle
(D) a rectangle

27. Which of the following conditions must be met in order to classify a pictorial drawing as an isometric projection?

(A) The isometric axes must be 30° apart.
(B) The isometric axes must be 45° apart.
(C) The isometric axes must be 60° apart.
(D) The isometric axis must be 120° apart.

<u>Items **28–29**</u> refer to the following diagram.



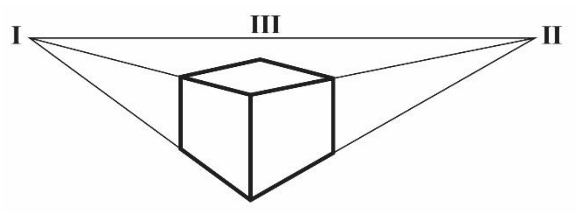
28. The development in the diagram shows a

(A) square prism with square top
(B) pyramid with rectangular top
(C) square prism with an oblique top
(D) hexagonal prism with a square top

29. What do the dotted lines in the development represent?

(A) Width
(B) Corners
(C) Drawing line
(D) Cutting line

<u>Item **30**</u> refers to the following pictorial diagram of a box.



30. What type of projection was used to draw the box?

(A) Oblique
(B) Isometric
(C) Perspective
(D) Planometric

31. The unit of modulus of elasticity is the same as that of

(A) stress, strain and pressure
(B) strain, pressure and force
(C) stress, force and modulus of rigidity
(D) stress, pressure and modulus of rigidity

32. Which of the following is NOT a component of building structures?

(A) Roofs
(B) Beams
(C) Columns
(D) Rendering

33. The most commonly used type of foundation is the

(A) pile
(B) strip
(C) pad
(D) step

34. If each common rafter (including tail) of a gable roof is 14′ long, how many 16′ pieces of lumber constructed 24″ on centres, will be needed to provide common rafters for a 30′ long building with no overhang?

(A) 28
(B) 30
(C) 32
(D) 42

35. Which of the following identifies the horizontal timber piece at the apex of a roof truss that supports the common rafters?

(A) Ridge board
(B) Hip rafter
(C) Eave board
(D) Valley rafter

36. Which of the following in architectural drawing is used to illustrate detail structural components?

(A) Pictorial drawings
(B) Perspective drawings
(C) Sectional drawings
(D) Oblique drawings

37. What is the MOST appropriate way of improving the bearing capacity of a water logged soil?

(A) Compacting the soil
(B) Draining the soil
(C) Increasing the soil depth
(D) Adding more soil

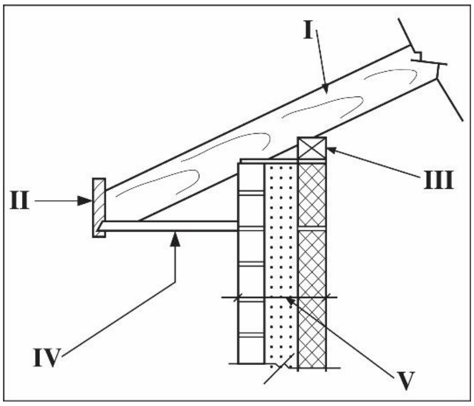
38. An overview of boundaries, proposed buildings, natural features and entrance is shown on a

(A) site plan
(B) floor plan
(C) pictorial drawing
(D) front elevation

39. If a sewer line is blocked, which of the following would give clear access for checking?

(A) Manhole
(B) Septic tank
(C) Soakaway
(D) Main drain

Items **40–41** refer to the following diagram with several components labelled.



40. The diagram shows

(A) a roof plan
(B) eaves detail
(C) roof detail
(D) column detail

41. The component labelled II indicates the

(A) eave
(B) rafter
(C) wall plate
(D) fascia board

42. Which of the following is not a function of a foundation?

(A) Aesthetics
(B) Load distribution
(C) Anchoring the building
(D) Transferring loads to the subsoil

43. The main purpose of a legend on an electrical plan is to

(A) locate the site
(B) locate pot head
(C) explain fixtures
(D) explain contours

44. A stair which extends from one level to another without turns or winders may be classified as a

(A) straight run
(B) quarter turn
(C) half turn
(D) spiral

45. A quarter turn stairway will make a turn of

(A) 45°
(B) 60^0
(C) 90^0
(D) 180^0

END OF TEST

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

Unit 1 – Paper 02

2 hours 30 minutes

SPECIMEN PAPER

GENERAL INFORMATION

1. This paper consists of EIGHT questions.

2. Answer ALL questions from Sections A and B and ALL questions from either Section C or D.

3. EACH question is worth 20 marks. You are advised to spend approximately 25 minutes on each question.

4. Silent, non-programmable calculators may be used for this examination.

5. For this examination, each candidate should have:

Two sheets of drawing paper (both sides may be used)
Two sheets of graph paper
Drawing board and T-square
Two sheets of tracing paper
Drawing instruments
Data sheet B.S.4500 (both hole and shaft basis), provided as an insert

INSTRUCTIONS TO CANDIDATES

1. All dimensions given are in millimetres unless otherwise stated.

2. Where scales are not stated the full size should be applied.

3. All geometrical construction lines MUST be visible on all drawings.

4. When first-angle or third-angle is not specified, the choice of projection is left to the candidate's discretion, in which case the type of projection used MUST be clearly stated.

5. The candidate should use his/her own judgement to supply any dimensions or other details not directly shown on the drawings.

6. The number of EACH question MUST be written next to the solution.

7. Each candidate MUST enter his/her school code and registration number in the appropriate space at the bottom of the drawing paper.

SECTION A

MODULE 1

GEOMETRY 1

Answer ALL questions from this section.

1. Figure 1 shows the framework for a parabola.

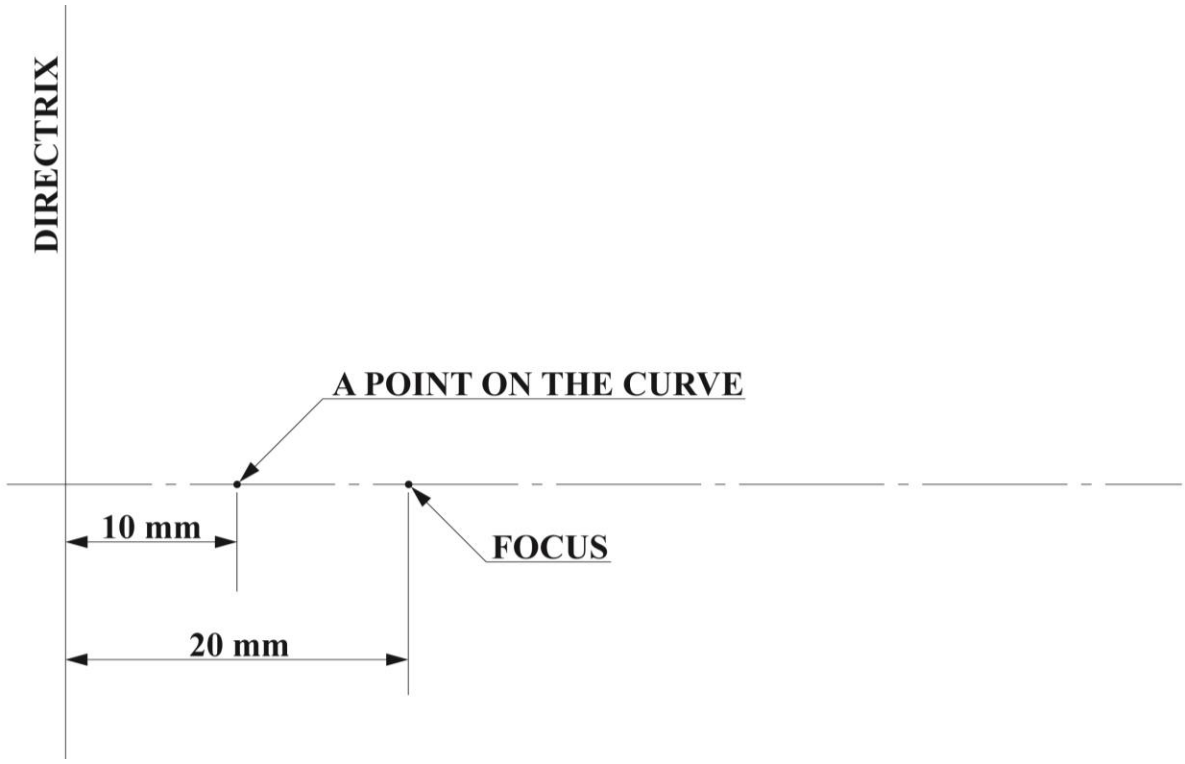


Figure 1. Framework for parabola

(a) Draw a parabola given the relative positions of the focus and the directrix as shown in Figure 1. **[5 marks]**

(b) (i) Draw an Archimedean spiral of one convolution with the shortest and longest radii of lengths 10 mm and 50 mm respectively.

(ii) Draw the normal and tangent at a point on the curve, 25 mm from the pole. **[11 marks]**

(c) Sketch an ellipse showing the following features. Label these features.

Vertices

Foci

Directrix

Axes **[4 marks]**

Total 20 marks

2. Figure 2 shows a plate cam with its camshaft clearly identified.

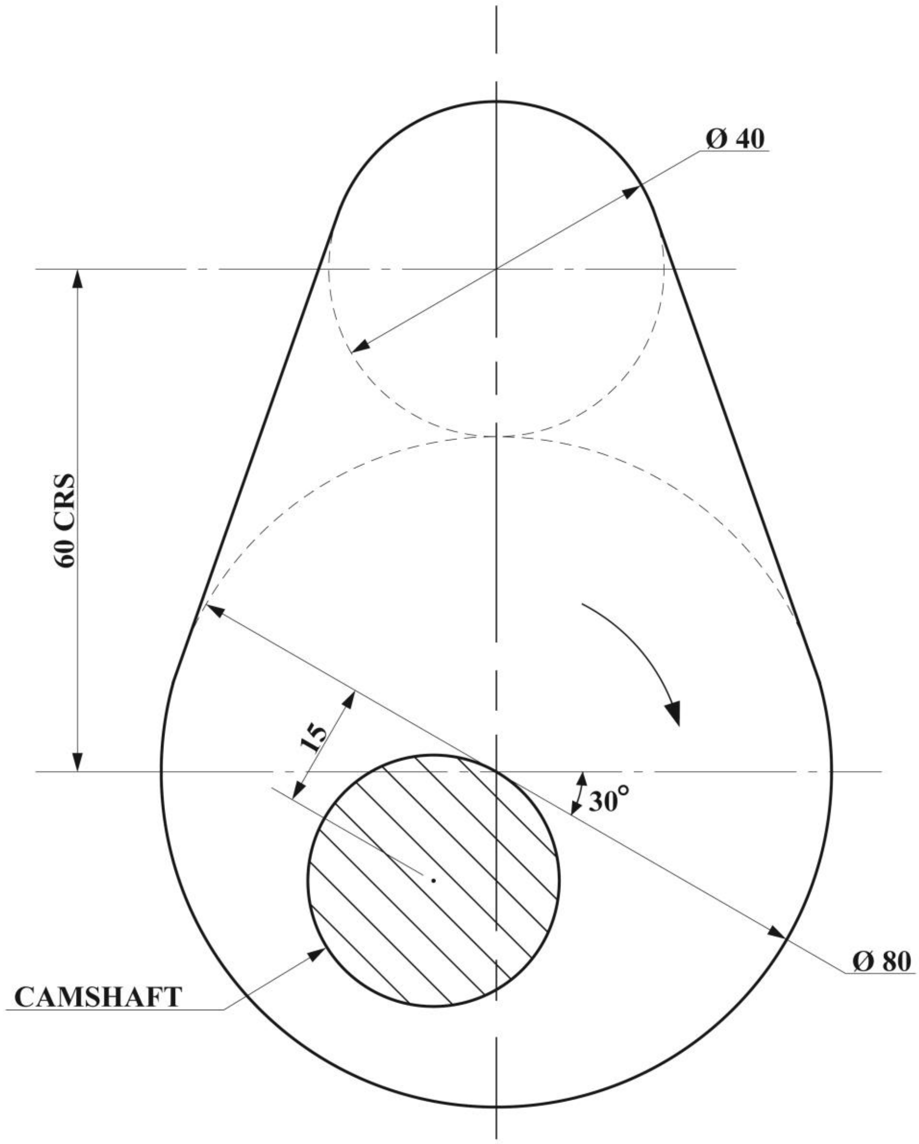


Figure 2. Plate cam

(a) Reproduce the cam shown in Figure 2. **[4 marks]**

(b) Project the complete performance diagram for a knife edge follower. **[9 marks]**

(c) Fully label the drawing. **[2 marks]**

(d) Identify the dwell period on your performance diagram. **[3 marks]**

(e) Explain why the performance curve is NOT symmetrical. **[2 marks]**

Total 20 marks

SECTION B

MODULE 2

GEOMETRY 2

Answer ALL questions from this section.

3. Construct two turns of a right hand, single start square thread of 75 mm outside diameter and 25 mm lead. Do NOT show hidden details. **Total 20 marks**

4. Figure 4 shows a cylinder intersecting a right cone at an angle of 60° to the horizontal.

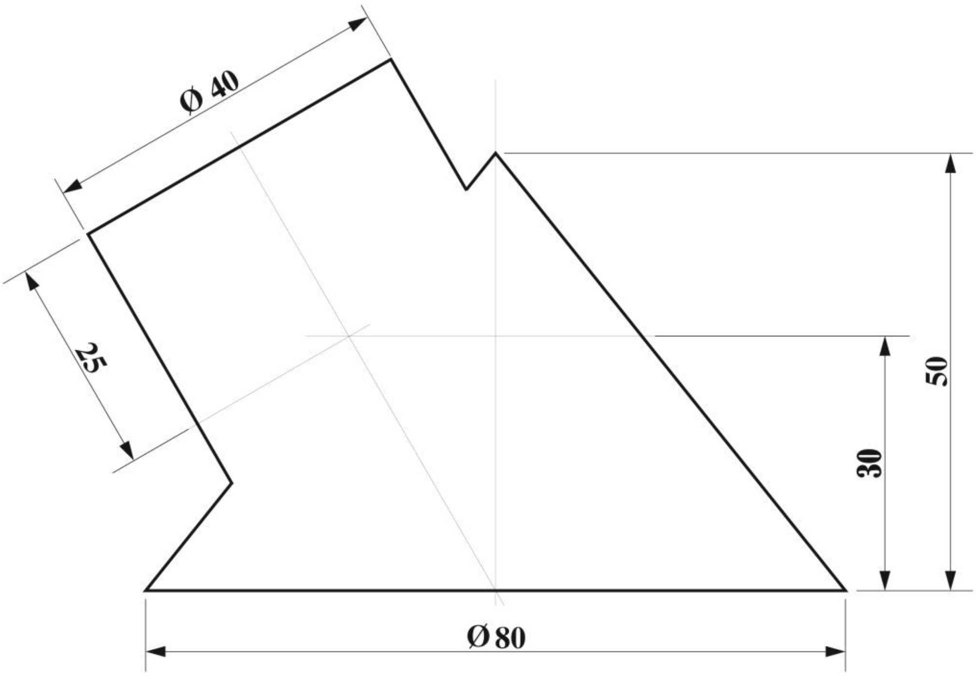


Figure 3. Cylinder intersecting right cone

Draw the plan and elevation. Project the end of the inclined cylinder to the horizontal plane to obtain the ellipse (auxiliary plan). Hence, draw the curve of interpenetration in both elevation and plan.

Total 20 marks

SECTION C

MODULE 3A

ENGINEERING DRAWING

Answer ALL questions from this section.

5. A draftsman is given a rigid stool to use and finds that he is uncomfortable because he is unable to swivel the stool.

(a) Define the design problem.

(b) Suggest THREE possible solutions (using freehand sketches).

(c) Give details of ONE possible solution and explain its special features.

(d) Select a material for the construction of your design and evaluate your choice of material.

Total 20 marks

6. Figures 4 and 5 show drawings of an assembled centrifugal pump and motor.

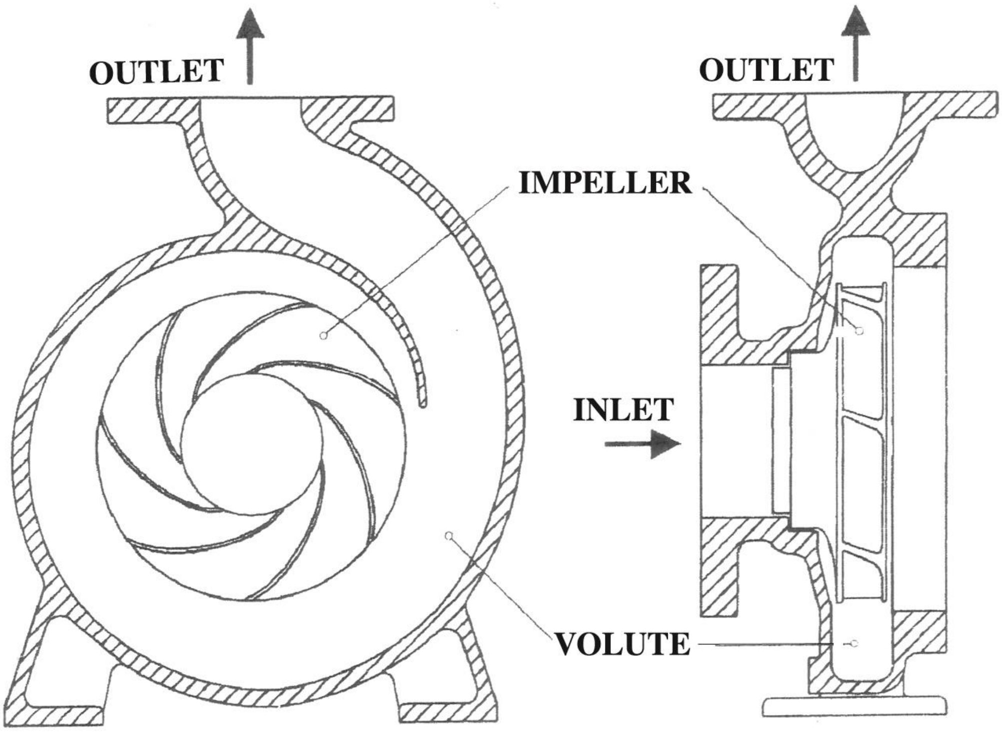


Figure 4. Centrifugal pump

AC Motor

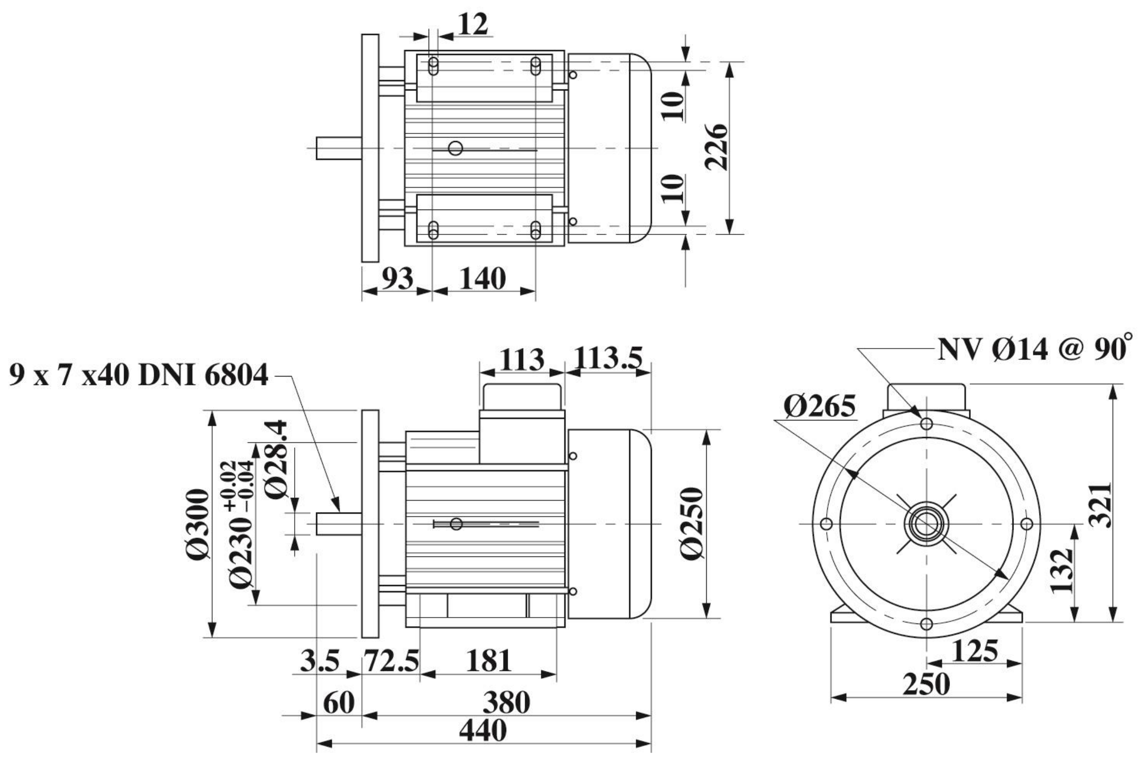


Figure 5. AC motor

(a) Sketch freehand and in good proportion a cutaway view of the pump and motor, and show how they are directly coupled. (**Show the external components of the pump**.)

(b) Label the components of the assembly.

(c) Give an application of a centrifugal pump.

Total 20 marks

SECTION D

MODULE 3B

BUILDING DRAWING

Answer ALL questions from this section.

7. Figure 6 on the attached sheet outlines sketches of a plan and elevation for a straight flight timber staircase from the upper floor of a suspended wooden decking floor to the concrete ground floor of the main building. The decking spans the width of the building and the staircase is located in the centre of the span as shown in the outline. In addition, the finished decking floor in 2.4750 mm above the finished concrete ground floor. And continued using teak lumber.

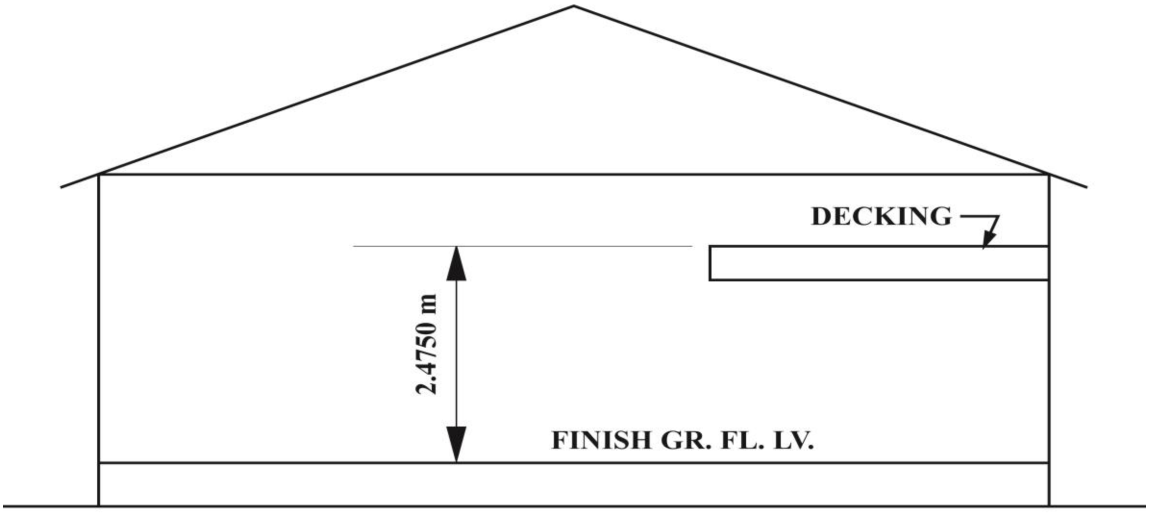
Using the specification below draw the following:

(a) Longitudinal section through A.A of the staircase room the top of the decking to ground floor. Scale 1:10. **(16 marks)**

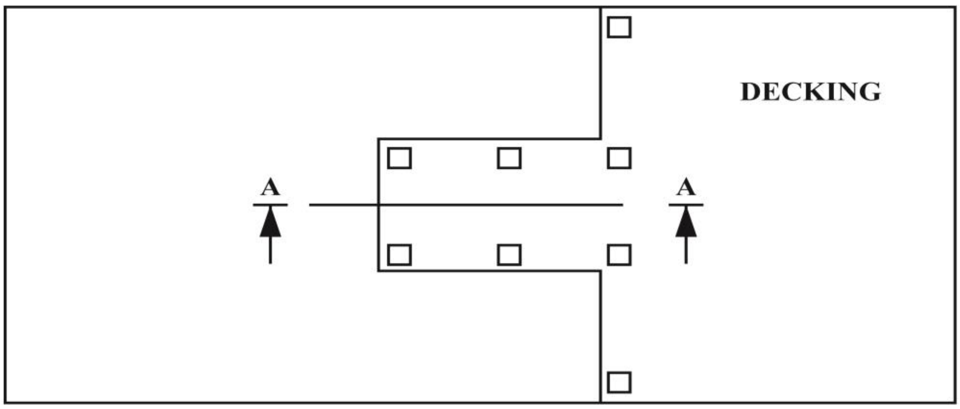
(b) A removed section showing a construction joint used at the threads and risers. Scale approximately 1:5. **(4 marks)**

Specifications:

Newel post — 100 mm × 100 mm
Staircase width — 900 mm
Threaders — 38 mm × 275 mm
Risers — 38 mm × 175 mm
Trimmer joint — 50 mm × 150 mm
Outer String — 25 mm × 300 mm
Tongue & groove Flooring Board — 21 mm × 150 mm



FRONT ELEVATION



PLAN

Figure 1. Outlined plan and elevation

Total 20 marks

8. Figure 7 shows the upper floor plan of a beach house and a main sewer line.

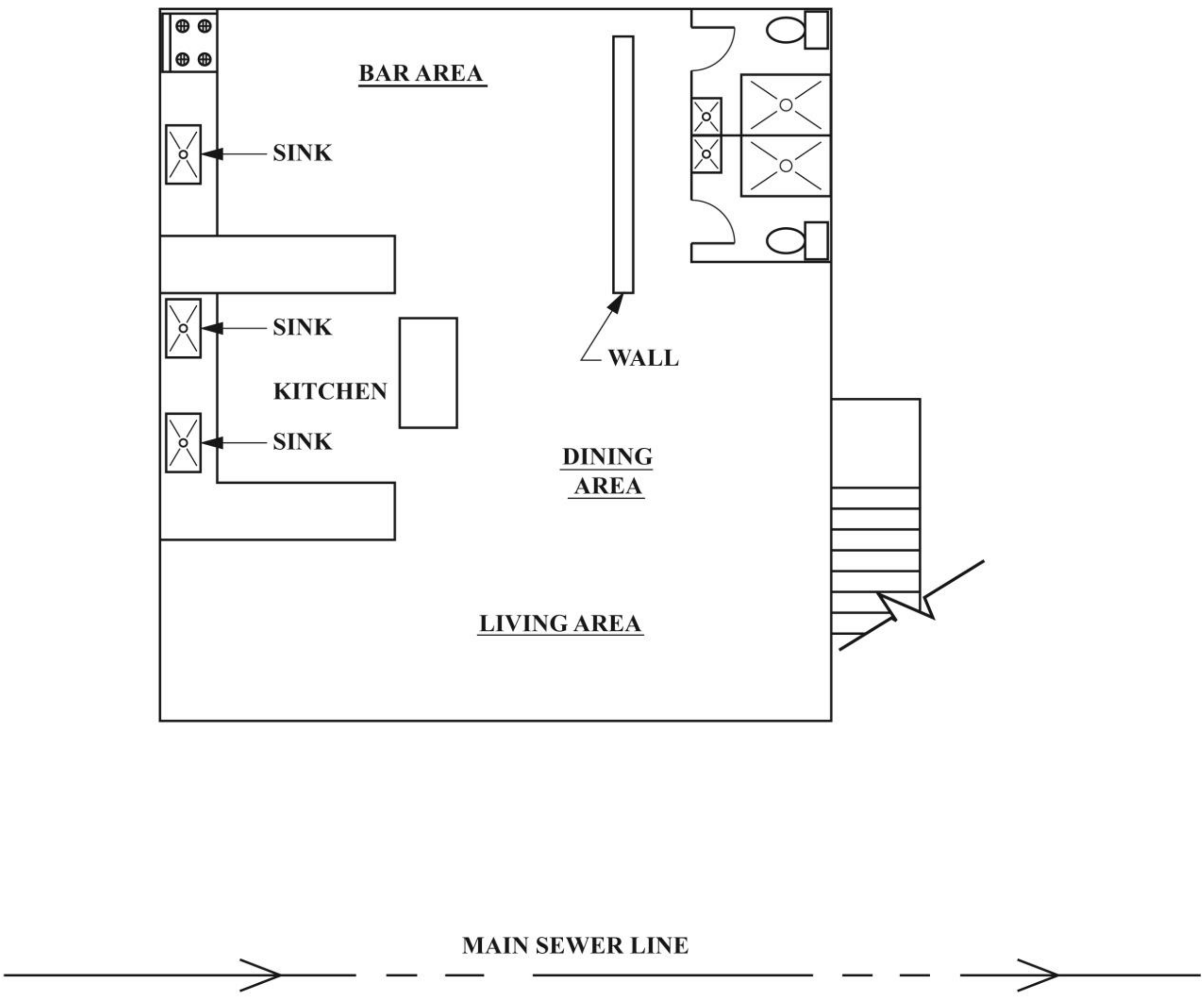


Figure 7. Upper floor plan

Redraw the layout of the beach house in proportion to the given figure showing

(a) the existing plumbing fixtures and main sewer line

(b) the flow of the waste water and solids from the fixtures to the main sewer line. Label all necessary structures and fittings as required by building codes locally to assist with the flow for the sewer system.

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

TEST CODE **02268010**

SPEC 2015/02268010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

OPTION A – MECHANICAL ENGINEERING DRAWING AND DESIGN

SPECIMEN PAPER

Unit 2 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.

2. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.

3. Look at the sample item below.

   Sample Item

   In drawings, thin, short dashes represent

   (A) hidden details
   (B) adjacent parts
   (C) movable parts
   (D) irregular details

   Sample Answer

   ● (B) (C) (D)

   The best answer to this item is "hidden details", so A has been shaded.

4. If you want to change your answer, erase it completely before you fill in your new choice.

5. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.

6. You may do any rough work in this booklet.

7. Figures are not necessarily drawn to scale.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

1. Which of the following is the CORRECT formula for calculating the circular pitch (C.P.) for an involute spur gear?

(A) $C.P. = \frac{\text{PCD x } \pi}{\text{T}}$

(B) $C.P. = \frac{\text{T x } \pi}{PCD}$

(C) $\text{C.P.} = \frac{\text{m x } \pi}{PCD}$

(D) $C.P. = \frac{\text{PCD}}{\text{T x M}}$

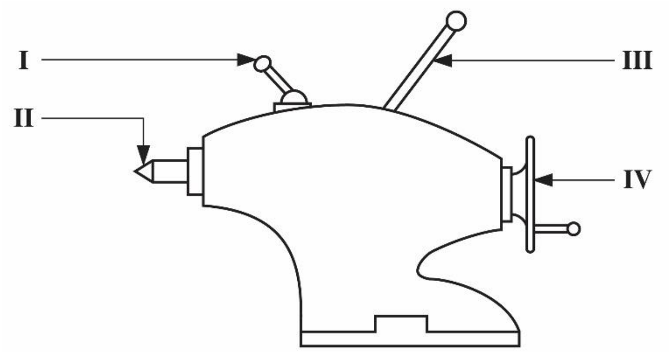
2. What is the pitch circle diameter of an involute spur gear, given that the metric module (m) = 10 and the number of teeth (T) = 25?

(A) 50 mm
(B) 125 mm
(C) 250 mm
(D) 350 mm

3. Which of the following mechanisms is used on a typical drill press machine to transmit power from the electric motor to the spindle?

(A) Gear system
(B) Lever system
(C) Chain drive system
(D) Pulley belt drive system

<u>Items **4–6**</u> refer to the following diagram showing a component of a lathe with several parts labelled.



4. What is the name of the component illustrated in the diagram?

(A) Headstock
(B) Tailstock
(C) Toolpost
(D) Compound Slide

5. Which of the labelled features is used for supporting a work piece between centres?

(A) I
(B) II
(C) III
(D) IV

6. Which of the labelled features is responsible for the advancing and retracting of the sleeve?

(A) I
(B) II
(C) III
(D) IV

<u>Items **7–8**</u> refer to the following properties of materials.

I Toughness
II Ductility
III Malleability
IV Hardness

7. Which property gives a material the ability to resist scratches?

(A) I
(B) II
(C) III
(D) IV

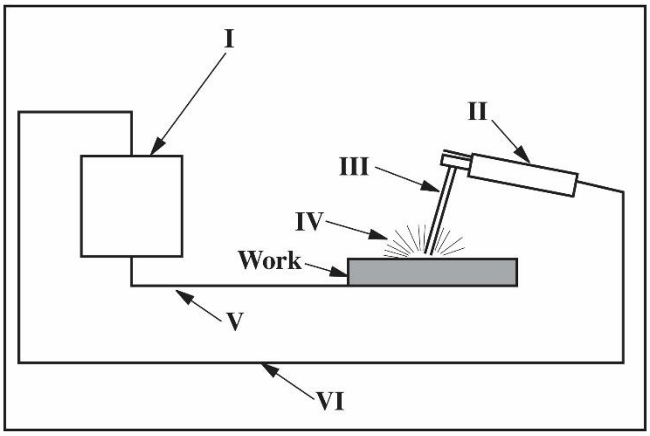
8. Which property is essential for materials that are to be used to make wires?

(A) I
(B) II
(C) III
(D) IV

9. Which method of casting would be most efficient in the mass production of plastic soup bowls?

(A) Net casting
(B) Die casting
(C) Sand casting
(D) Investment casting

Items **10–12** refer to the following line diagram of an arc welding setup with components labelled.



10. Which of the labelled arrows denotes the electrode holder?

(A) I
(B) II
(C) III
(D) IV

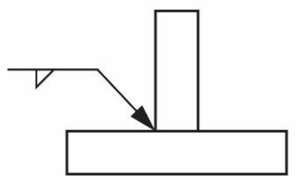
11. Which feature of the setup does arrow VI represent?

(A) Arc wire
(B) Electrode arc
(C) Electrode cable
(D) Worktable cable

12. Which of the labelled arrows identifies the electrode?

(A) I
(B) II
(C) III
(D) IV

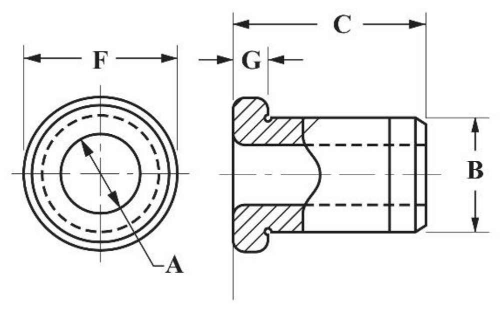
<u>Item **13**</u> refers to the following diagram.



13. What information is being communicated by the welding symbol on the diagram?

(A) Fillet weld, arrow side
(B) Fillet weld, other side
(C) Groove weld, both sides
(D) Groove weld, underside

<u>Items **14–15**</u> refer to the following diagram which shows a typical drill bushing.



14. Which of the following is the BEST fit to use for the outside dimension of the bush?

(A) H9/e9
(B) H7/h6
(C) H7/k6
(D) H7/p6

15. Which of the following is the BEST fit for the inside dimension of the bush?

(A) H9/e9
(B) H7/h6
(C) H7/k6
(D) H7/p6

16. Which of the following is NOT a stage of the design process?

(A) Synthesis
(B) Evaluation
(C) Presentation
(D) Coordination

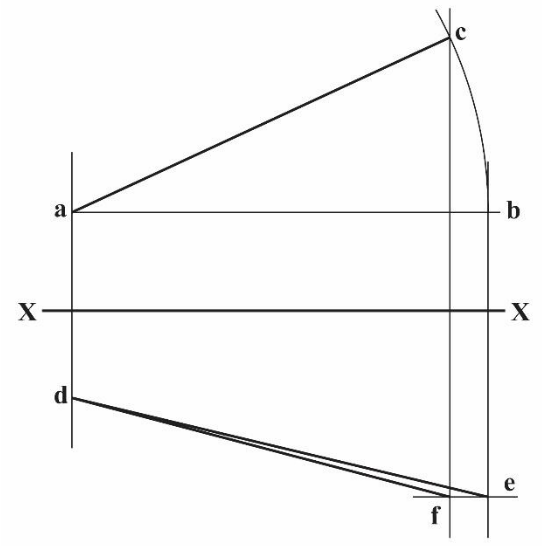
17. In the design process, recognition of need means

(A) having persons in need of help
(B) realizing that a design is complete
(C) establishing that a component is to be designed
(D) recognizing that needy people always have to be fed

18. In the design process, optimization is

(A) ensuring all the design parts fit
(B) testing a design for best results
(C) revealing all the features of the design
(D) creating all the ideas needed to complete the design

Items **19–21** refer to the following diagram which shows an orthographic view of a skew line.



19. Which of these lines are projections of the original line in space?

(A) a–c, d–f
(B) a–b, d–e
(C) a–c, a–b
(D) d–f, d–e

20. Which line is the true length?

(A) a–b
(B) a–c
(C) d–e
(D) d–f

21. In which plane is figure abc located?

(A) Vertical
(B) Auxiliary
(C) Horizontal
(D) True length

Item **22** refers to the following diagram of a plastic chair.

22. Which of the following is the BEST manufacturing process for mass producing the chair?

(A) Welding
(B) Fabrication
(C) Sand casting
(D) Injection moulding

23. Which of the following nonmetallic materials is capable of being formed or molded with the aid of heat, pressure, chemical reactions, or a combination of these?

(A) Glass
(B) Metal
(C) Plastic
(D) Rubber

24. Which of the following types of plastic can be reheated, reformed or reused?

(A) Silicone
(B) Bakelite
(C) Thermoplastic
(D) Thermosetting plastic

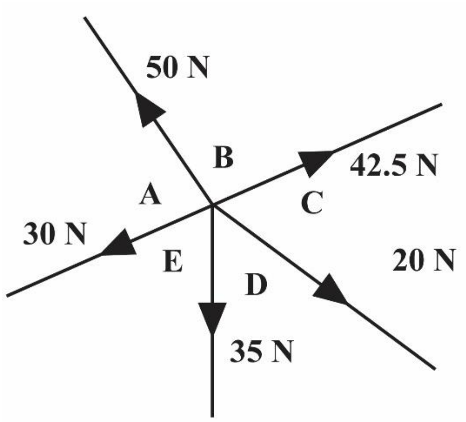
25. A conveyer belt to transport bags in the airport customs area is to be installed. What type of bearings would be MOST suitable to operate the conveyer belt?

(A) Ball
(B) Roller
(C) Thrust
(D) Tapered

26. A continuous, flexible device that transmits motion from one wheel or pulley to another is a

(A) gear
(B) belt drive
(C) chain drive
(D) rack and pinion

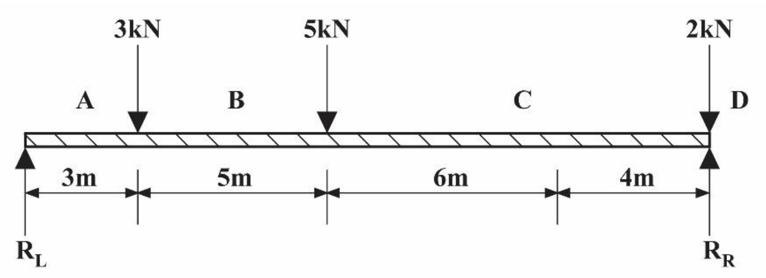
<u>Item **27**</u> refers to the following diagram of a system of forces.



27. From a visual inspection of the diagram, which of the following statements is TRUE?

(A) The system is in equilibrium.
(B) The resultant of the system is 177.5 N.
(C) Force 'AB' has no vertical component.
(D) Force 'ED' has no horizontal component.

<u>Items **28–29**</u> refer to the following diagram of forces acting on a beam.



28. Which of the following is the resultant of R_L?

(A) 3.93 kN
(B) 6.07 kN
(C) 7.0 kN
(D) 8.0 kN

29. Which of the following is the resultant of R_R?

(A) 3.93 kN
(B) 6.07 kN
(C) 7.0 kN
(D) 8.0 kN

30. Which of the following gears is MOST suitable for transmitting power between two shafts that are at right angles to each other?

(A) Spur
(B) Bevel
(C) Worm
(D) Rack and pinion

31. Lubricants are used in bearings to

I. Reduce friction between rubbing surfaces
II. Act as coolant to carry off heat
III. Reduce leakage

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

32. In using the design concept, what term is used to describe the functional aspect of the design?

(A) Ergonomics
(B) Aesthetics
(C) Economics
(D) Anthropometrics

33. In using the design concept, what term is used to describe the appearance/beautification of the design?

(A) Ergonomics
(B) Aesthetics
(C) Economics
(D) Anthropometrics

34. In the design concept, prototyping is used by the designer to

I. see the product in three dimensions
II. sell the product to clients
III. check the engineering concept

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

35. Which of the following is used to reduce the friction between an axle and a wheel and increase the efficiency of the turning force?

(A) Bushings
(B) O-rings
(C) Bearings
(D) Sprockets

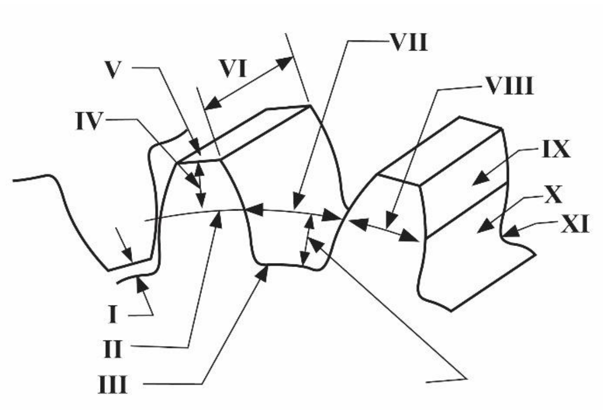
36. Which of the following couplings provides an angular misalignment of up to 45°?

(A) Split
(B) Friction
(C) Flange
(D) Universal joints

37. Which of the following is used in a front wheel drive motor vehicle to transmit power from the transmission to the wheels, allowing angular misalignment between the driving shaft and the wheel?

(A) Flanged coupling
(B) Universal joint
(C) Friction coupling
(D) Constant velocity joint

Items **38–40** refer to the following diagram which shows part of an involute spur gear.



38. Which label identifies the dedendum?

(A) II
(B) III
(C) IV
(D) XII

39. Which label identifies the addendum?

(A) II
(B) III
(C) IV
(D) XII

40. Which of the following does the label I identify?

(A) Flank
(B) Clearance
(C) Space width
(D) Pitch circle

41. Which of the following angles are commonly used as the pressure angle when drawing a spur gear?

I. 14.5^0
II. 20^0
III. 30^0

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

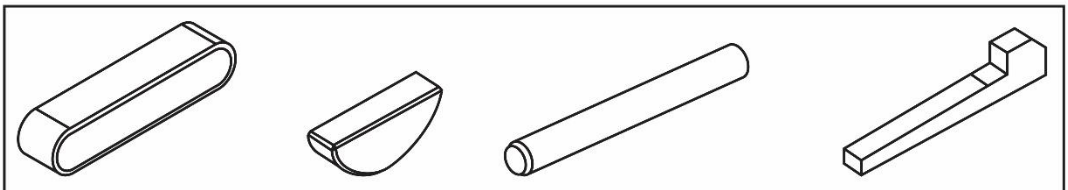
42. Which force member refers to a single truss segment that is neither in tension nor compression?

(A) Concurrent
(B) Coplanar
(C) True
(D) Zero

43. Which of the following formulas is used to determine the maximum bending moment for a simply supported, uniformly distributed load?

(A) $wl^2/8$
(B) $wl/4$
(C) $wl^2/2$
(D) wl^2

<u>Items **44–45**</u> refer to the following diagram which shows a set of keys.



I II III IV

44. Which of the keys is a feather key?

(A) I
(B) II
(C) III
(D) IV

45. Which of the following identifies the dowel?

(A) I
(B) II
(C) III
(D) IV

END OF TEST

TEST CODE **02269010**

SPEC 2015/02269010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

OPTION B – BUILDING DRAWING AND DESIGN

SPECIMEN PAPER

Unit 2 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 minutes to answer them.

2. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.

3. Look at the sample item below.

   <u>Sample Item</u>

   In drawings, thin, short dashes represent

   (A) hidden details
   (B) adjacent parts
   (C) movable parts
   (D) irregular details

   <u>Sample Answer</u>

   ● (B) (C) (D)

   The best answer to this item is "hidden details", so A has been shaded.

4. If you want to change your answer, erase it completely before you fill in your new choice.

5. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.

6. You may do any rough work in this booklet.

7. Figures are not necessarily drawn to scale.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

1. Ramming a stiff dry cement mortar mix into the space between new underpinning work and an existing structure is known as

(A) Pynford pinning
(B) final pinning
(C) pretest pinning
(D) wall underpinning

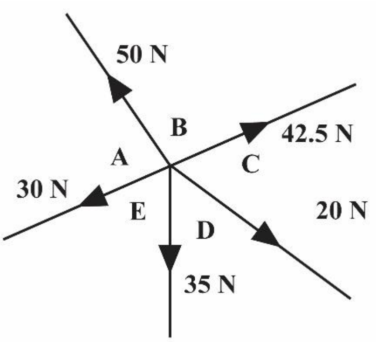
2. The method of underpinning that uses pairs of jacks or bored piles in conjunction with a reinforced beam is

(A) the Pynford stooling method
(B) wall underpinning
(C) traditional underpinning
(D) needle and piles

3. A load of wet concrete is considered to be approximately

(A) 1,400 Kg/m^3
(B) 2,400 Kg/m^3
(C) 3,400 Kg/m^3
(D) 4,400 Kg/m^3

Item **4** refers to the following diagram of a system of forces.



4. From a visual inspection of the diagram, which of the following statements is TRUE?

(A) The system is in equilibrium.
(B) The resultant of the system is 177.5 N.
(C) Force 'AB' has no vertical component.
(D) Force 'ED' has no horizontal component.

5. A concrete column 400 mm × 400 mm in cross sectional area is subjected to an axial thrust of 800 kN. What is the stress in the concrete?

(A) 2 N/mm^2
(B) 5 N/mm^2
(C) 8 N/mm^2
(D) 10 N/mm^2

6. Which one of the following statements BEST defines a project estimate?

(A) An approximation of project time and cost targets, refined throughout the project life cycle.
(B) A prediction of a future condition or event based on information or knowledge available now.
(C) The value of useful work done at any given point in a project to give a measure of progress.
(D) A situation that affects or influences the outcome of the project expressed in time or cost terms.

7. The accuracy of a project estimate should

(A) stay constant throughout the project life cycle
(B) decrease as a project progresses through its life cycle
(C) increase as a project progresses through its life cycle
(D) vary independently of where the project is in its life cycle

8. A key aspect of managing a project involves

(A) identifying routine tasks
(B) planning to achieve defined objectives
(C) ensuring ongoing operations are maintained
(D) defining which operational systems to put in place

9. Project scheduling can BEST be defined as the process used to determine

(A) overall project duration
(B) project cost estimating
(C) the project management plan
(D) the subcontractor’s responsibilities

10. During project planning, execution involves taking actions to

(A) establish a good plan
(B) close out the project
(C) provide feedback to key vendors
(D) ensure that activities in the project plan are completed

11. Which of the following statements is TRUE about couples?

(A) Consist of two unequal forces acting in line with each other.
(B) The moment of a couple is 2 × force × perpendicular distance between the forces.
(C) Consist of two equal unlike parallel forces acting out of line.
(D) Couples can be balanced by a single force of the same moment as the couple.

12. Which force member can carry loads in the event that variations are introduced in the normal external loading configuration?

(A) Concurrent
(B) Coplanar
(C) True
(D) Zero

13. Which of the following formulae is used to determine the maximum bending moment for a simply supported, uniformly distributed load?

(A) $\mathrm{wl}^2/8$
(B) $\mathrm{wl}/4$
(C) $\mathrm{wl}^2/2$
(D) wl^2

14. Which of the following is the final stage in the designing process?

(A) Synthesis
(B) Evaluation
(C) Presentation
(D) Analysis and optimization

15. Which of the following illustrates the correct sequence for distributing electrical power in a domestic dwelling?

(A) Fuse , switch, load
(B) Load, fuse, switch
(C) Fuse, load, switch
(D) Switch, load, fuse

16. The purpose of the preconstruction conference is to

(A) negotiate cost and sign the contract
(B) assign work to equipment operators
(C) agree on the project's requirements
(D) look at the equipment to be used

17. Which of the following describes the time-dependent phenomenon in which concrete is held under sustained stress?

(A) Creep
(B) Shrinkage
(C) Contraction
(D) Temperature expansion

18. Which of the following is the number of days concrete takes to reach its compressive strength?

(A) 3
(B) 7
(C) 28
(D) 32

19. The recommended slump for mass concrete is

(A) 25 mm to 50 mm
(B) 50 mm to 100 mm
(C) 100 mm to 125 mm
(D) 125 mm to 150 mm

20. Which of the following describe the design principles of a blueprint?

I. Aesthetics
II. Accessibility
III. Cost efficiency
IV. Energy conservation

(A) I and II only
(B) I and III only
(C) I, II and III only
(D) I, II, III and IV

21. The MOST important element affecting the strength of concrete is the

(A) method of mixing
(B) water-to-cement ratio
(C) volume of the mixture
(D) weather condition during curing

22. Which of the following is the MOST suitable to apply as a first coat to an external grill to seal the surface and protect it from damp air?

(A) Priming paint
(B) Finishing paint
(C) Undercoating paint
(D) Water-based paint

23. Which of the following ingredients of paint provides body, colour and durability?

(A) Linseed oil
(B) Pigment
(C) Synthetic resin
(D) White lead

24. Which of the following types of cement has the BEST resistance to natural sulphates found in some subsoils?

(A) OPC
(B) CPC
(C) RHPC
(D) SRPC

25. Thermal insulation is defined as the

(A) measure of a material's ability to resist heat
(B) measure of a material's ability to transmit heat
(C) ability for the natural flow of heat to a higher temperature source
(D) barrier to the natural flow of heat from an area of high temperature to an area of low temperature

26. Which of the following concrete mixes gives the strongest reinforced concrete for a flight of steps?

(A) 1:2:4
(B) 1:3:6
(C) 1:2:8
(D) 1:5:10

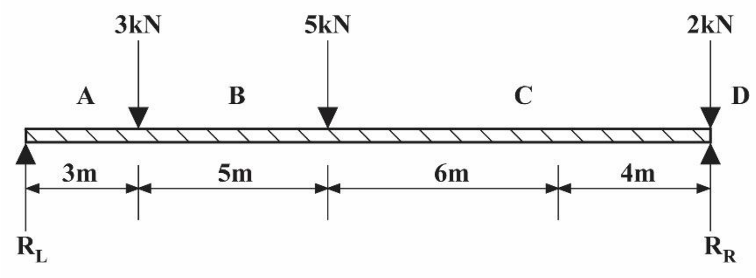
27. Which of the following tests is conducted on concrete when it is in a solid state?

(A) Silt
(B) Creep
(C) Slump
(D) Compression

28. Which of the following is the correct order for the stages of project management?

(A) Scoping , planning, launching, monitoring and closing
(B) Planning, scoping, launching, closing and monitoring
(C) Launching, planning, scoping, monitoring and closing
(D) Scoping, planning, monitoring, launching and closing

<u>Items **29 – 30**</u> refers to the following diagram of forces acting on a beam.



29. Which of the following is the resultant of R_L?

(A) 3.93 kN
(B) 6.07 kN
(C) 7.0 kN
(D) 8.0 kN

30. Which of the following is the resultant of R_R?

(A) 3.93 kN
(B) 6.07 kN
(C) 7.0 kN
(D) 8.0 kN

31. Which of the following is TRUE of thermoplastic?

I. It can be reformed
II. It cannot be reheated
III. It can reused

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

32. If a 70 g sample of timber weighs 40 g after seasoning, what is the current moisture content of the sample?

(A) 30 g
(B) 110 g
(C) 70%
(D) 75%

33. Which of the following is NOT an appropriate internal wall finish?

A. Tile
B. Paint
C. Cladding
D. Concrete block

34. Which of the following is the term used to indicate the total rise of a staircase?

(A) Lift
(B) Going
(C) Travel
(D) Riser

35. In an effort to minimize twisting and general movement of joists, members are placed between them. Which of the following is NOT a method of placing members between joists?

(A) In-line
(B) Noggins
(C) Staggered
(D) Herringbone

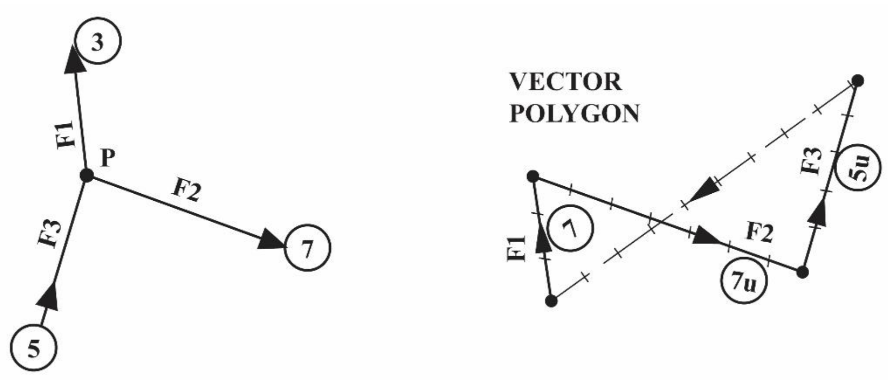
36. An extended tread found between two consecutive flights of stairs is known as a

(A) riser
(B) landing
(C) handrail
(D) newel post

37. The MAIN disadvantage of a spiral staircase is that it has

(A) tapered treads
(B) a helical handrail
(C) no landing
(D) no strings

Item **38** refers to the following diagrams showing three forces acting at a point and a vector polygon resolving the forces.



Three forces acting at a point Vector Polygon

38. What is the magnitude of the force that will bring stability to the system of forces?

(A) 7.3µ
(B) 8.3µ
(C) 9.3µ
(D) 10.3µ

39. For which of the following is a hollow-core wood door BEST suited?

(A) A residential exterior door
(B) An interior residential door
(C) A door in a private office
(D) A twenty-minute smoke barrier door

40. A building's primary electric service system is usually sized on the basis of the

(A) connected load
(B) number of lights used
(C) transformer rating
(D) number of rooms to be lighted

41. An overview of boundaries, proposed buildings, natural features and entrance is shown on a

(A) site plan
(B) floor plan
(C) pictorial drawing
(D) front elevation

42. Which of the following is NOT a stage of the design process?

(A) Synthesis
(B) Evaluation
(C) Presentation
(D) Coordination

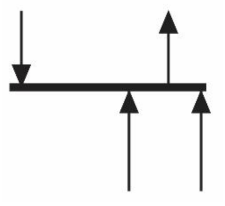
43. In the design process, recognition of need means

(A) having persons in need of help
(B) realizing that a design is complete
(C) establishing that a component is to be designed
(D) recognising that needy people always have to be fed

44. In the design process, optimization is

(A) ensuring all the design parts fit
(B) testing a design for best results
(C) revealing all the features of the design
(D) creating all the ideas needed to complete the design

Item **45** refers to the following diagram of a force system.



45. Which type of force system is represented?

(A) Parallel
(B) Coplanar
(C) Structured
(D) Concurrent

END OF TEST

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

MECHANICAL ENGINEERING DRAWING AND DESIGN

Unit 2 – Paper 02

2 hours 30 minutes

SPECIMEN PAPER

GENERAL INFORMATION

1. **This paper consists of SIX questions.**

2. **Answer ALL questions from EACH section.**

3. **EACH question is worth 20 marks. You are advised to spend approximately 25 minutes on each question.**

4. **Silent, non-programmable calculators may be used for this examination.**

5. **For this examination, each candidate should have:**

   Two sheets of drawing paper (both sides may be used)
   Two sheets of graph paper
   Drawing board and T-square
   Two sheets of tracing paper
   Drawing instruments
   Data sheet B.S.4500 (both hole and shaft basis), provided as an insert

INSTRUCTIONS TO CANDIDATES

1. **All dimensions given are in millimetres unless otherwise stated.**

2. **Where scales are not stated the full size should be applied.**

3. **All geometrical construction lines MUST be visible on all drawings.**

4. **When first-angle or third-angle is not specified, the choice of projection is left to the candidate's discretion, in which case the type of projection used MUST be clearly stated.**

5. **The candidate should use his/her own judgement to supply any dimensions or other details not directly shown on the drawings.**

6. **The number of EACH question MUST be written next to the solution.**

7. **Each candidate MUST enter his/her school code and registration number in the appropriate space at the bottom of the drawing paper.**

SECTION A

MODULE 1

MECHANICS OF MACHINES

Answer ALL questions from this section.

1. Figure 1 shows a simply supported beam with two concentrated loads of 20 kN and 10 kN.

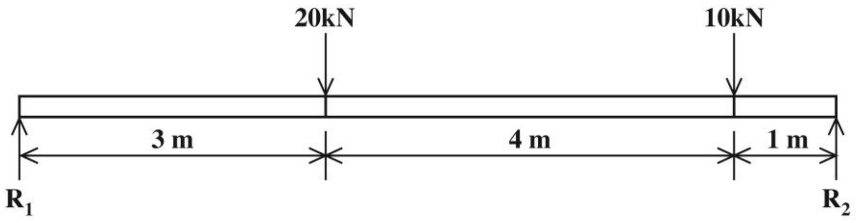


Figure 1. Supported beam

(a) Find graphically the magnitude of the reactions R_1 and R_2. **[15 marks]**

(b) Verify analytically the magnitude of the reactions R_1 and R_2. **[5 marks]**

Total 20 marks

2. (a) Figure 2 shows the parts of a spur gear.

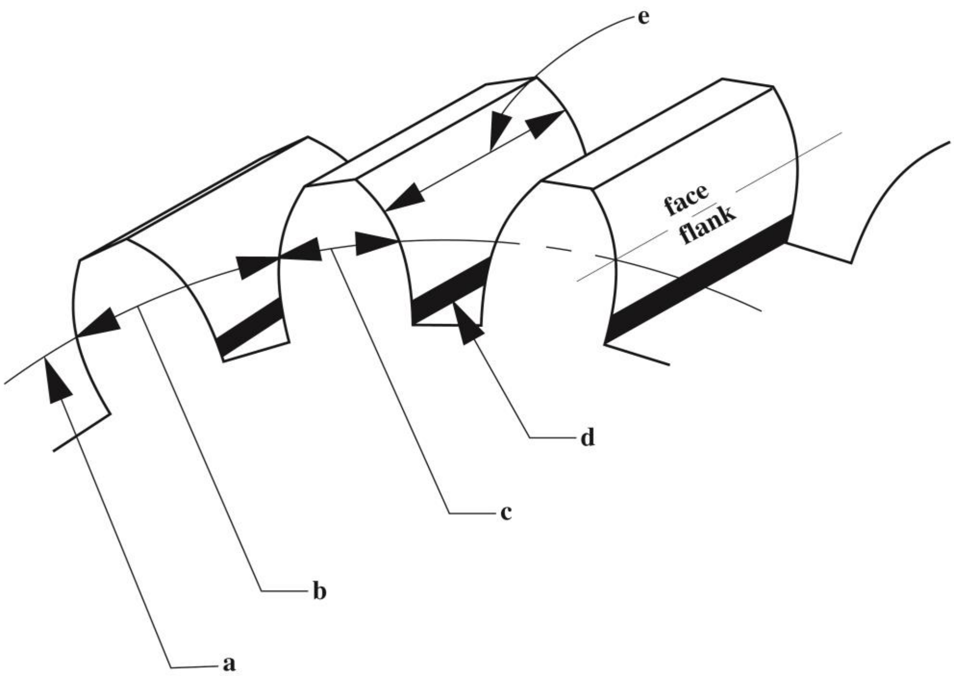


Figure 2. Parts of a spur gear

(i) Sketch freehand the THREE consecutive teeth of the spur gear. **[3 marks]**

(ii) Name and label the terms associated with a, b, c, d and e. **[7 marks]**

(b) The letter “A” (**not shown**) casts shadows on the horizontal plane and vertical plane as shown in figure 3.

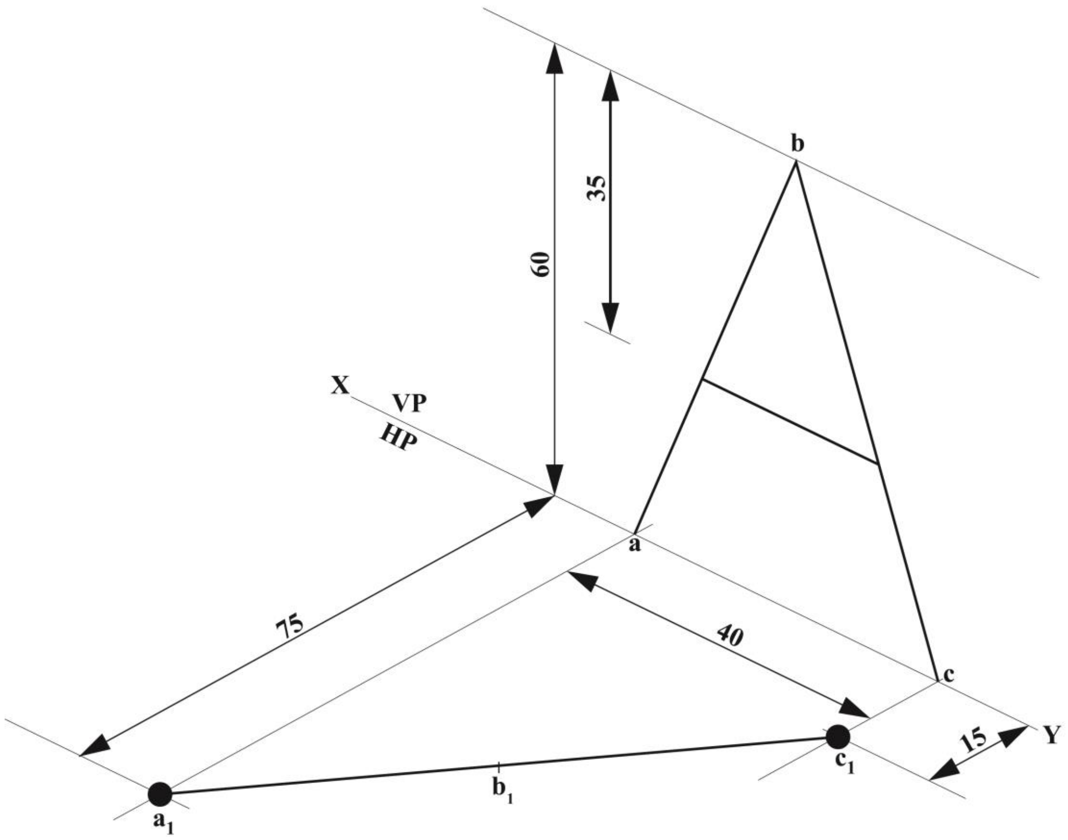


Figure 3. Shadow of letter “A”

(i) Construct the true shape of the letter “A”. **[5 marks]**

(ii) Determine the size of angle abc of the letter. **[5 marks]**

Total 20 marks

SECTION B

MODULE 2

ENGINEERING MATERIALS AND PROCESSES

Answer ALL questions from this section.

3. Figure 4 shows a cylinder head.

Figure 4

(a) Sketch the seal that would be used when mounting the head.

(b) Name the seal.

(c) Of what material would the seal be made?

(d) List TWO steps that would be taken when properly installing seals.

Total 20 marks

4. (a) Describe EACH of the following:

(i) Ferrous metals

(ii) Grey cast iron

(iii) Carbon steel

(b) Give the carbon content, principal properties and the common uses of the following types of steel:

(i) Low carbon

(ii) High carbon

(c) Give the principal property and ONE common use of TWO of the following types of alloy steel:

(i) Molybdenum

(ii) Chromium

(iii) Chromium-vanadium

(d) Describe the following plastics and give ONE example of EACH:

(i) Thermoplastics

(ii) Thermosetting plastics

Total 20 marks

SECTION C

MODULE 3

MANAGEMENT AND DESIGN

Answer ALL questions from this section.

5. Figure 5 shows two sections of an automotive brake system, Section A and Section B. Section A is showing the portion of the brake that is inside the automotive and Section B is showing the portion where the wheel is situated.

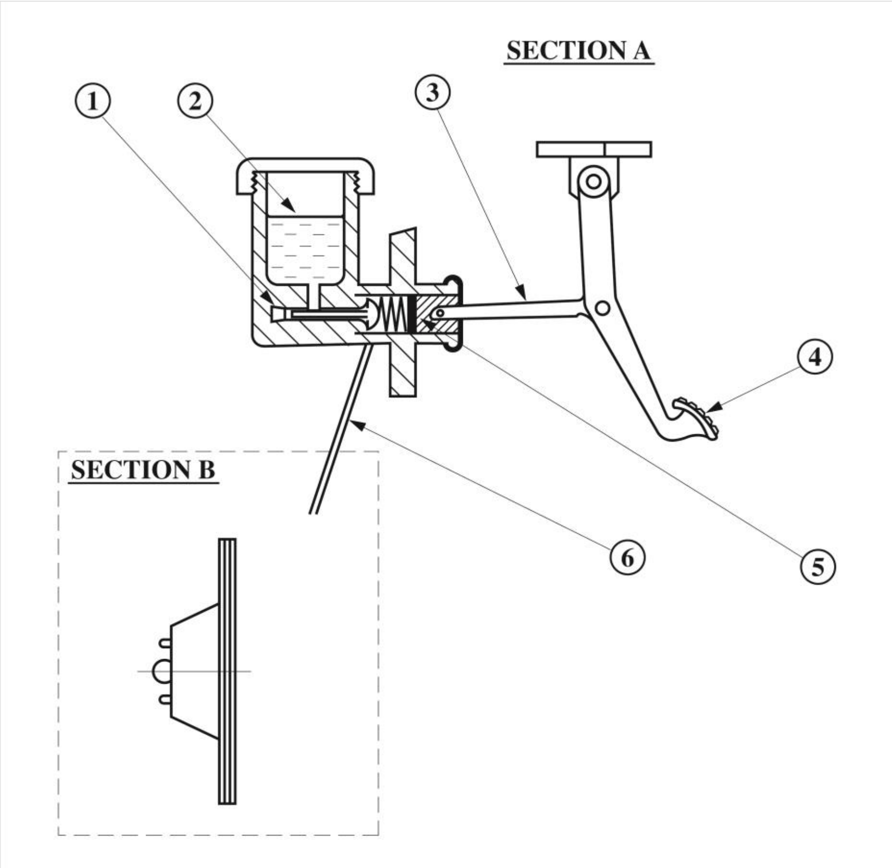


Figure 5

(a) Write the numbers 1, 2, 3, 4, 5 and 6, and next to EACH number write the name of the corresponding part.

(b) Complete the drawing in Section B showing the cross-sectional view of a disc brake. Fully label the drawing.

(c) Explain how the disc brake works.

Total 20 marks

6. (a) With the aid of a neat, labelled pictorial sketch, show the construction of a flanged coupling. **[12 marks]**

(b) State THREE reasons why the coupling mentioned in (a) can be used to connect a motor and generator. **[6 marks]**

(c) Explain TWO different ways in which flaws or defects in the flanged coupling system can be identified. **[2 marks]**

Total 20 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

SPEC 2015/02269010

TEST CODE **02269020**

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

BUILDING AND MECHANICAL ENGINEERING DRAWING
OPTION B - BUILDING DRAWING AND DESIGN

UNIT 2 – Paper 02

2 hours 30 minutes

SPECIMEN PAPER

GENERAL INFORMATION

1. **This paper consists of SIX questions.**

2. **Answer ALL questions from EACH section.**

3. **EACH question is worth 20 marks. You are advised to spend approximately 25 minutes on each question.**

4. **Silent, non-programmable calculators may be used for this examination.**

5. **For this examination, each candidate should have:**
   Two sheets of drawing paper (both sides may be used)
   Drawing board and T-square
   Drawing instruments
   Data sheet B.S.4500 (both hole and shaft basis), provided as an insert

INSTRUCTIONS TO CANDIDATES

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5. **The candidate should use his/her own judgement to supply any dimensions or other details not directly shown on the drawings.**

6. **The number of EACH question MUST be written next to the solution.**

7. **Each candidate MUST enter his/her school code and registration number in the appropriate space at the bottom of the drawing paper.**

SECTION A

MODULE 1

STRUCTURAL DRAWINGS

Answer ALL questions from this section.

1. Figure 1 shows a simply supported beam with two concentrated loads of 20 kN and 10 kN.

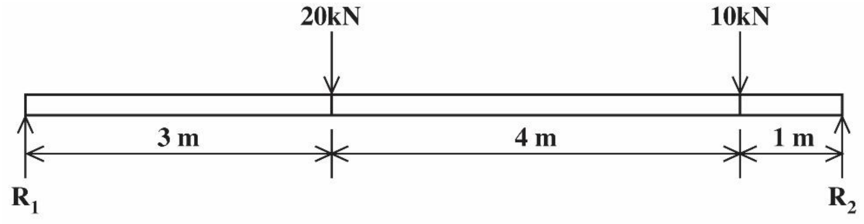


Figure 1. Supported beam

(a) Find graphically the magnitude of the reactions R_1 and R_2. **[15 marks]**

(b) Verify analytically the magnitude of the reactions R_1 and R_2. **[5 marks]**

Total 20 marks

2. Figure 2 shows a plan of a round column and the footing that supports the column.

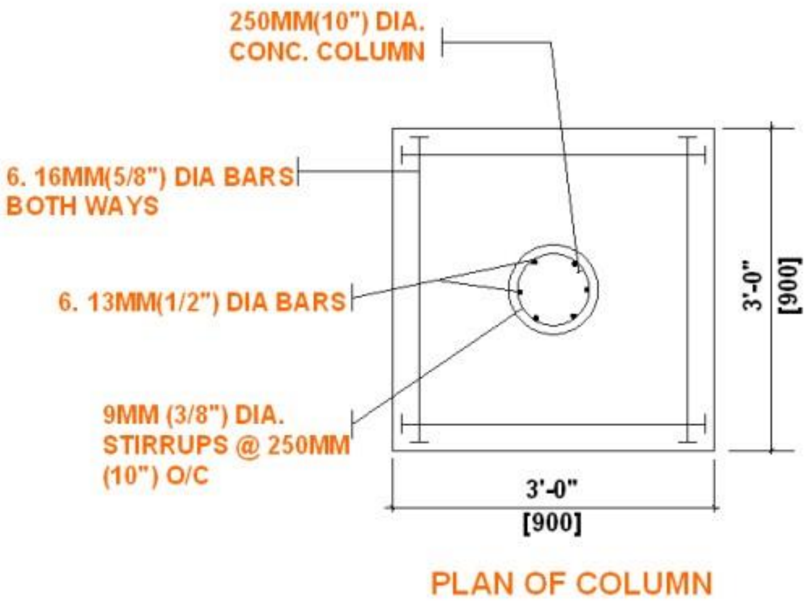


Figure 2. Plan of column

(a) Produce a well-proportioned sketch showing a section through the column and footing. All dimensions and specifications should be included. **[15 marks]**

(b) Sketch the plan view of EACH of the following.

(i) An 'L' corner stiffener detail

(ii) A 'T' corner stiffener detail **[5 marks]**

Total 20 marks

SECTION B

MODULE 2

BUILDING MATERIALS AND PROCESSES

Answer ALL questions from this section.

3. Concrete is the most widely used construction material, careful preparation of concrete mixes is essential to the structural integrity of concrete structures.

.

(a) Explain the importance of batching/proportioning when preparing a concrete mix. **(4 marks)**

(b) Define the term water-cement (w/c) ratio. **(1 mark)**

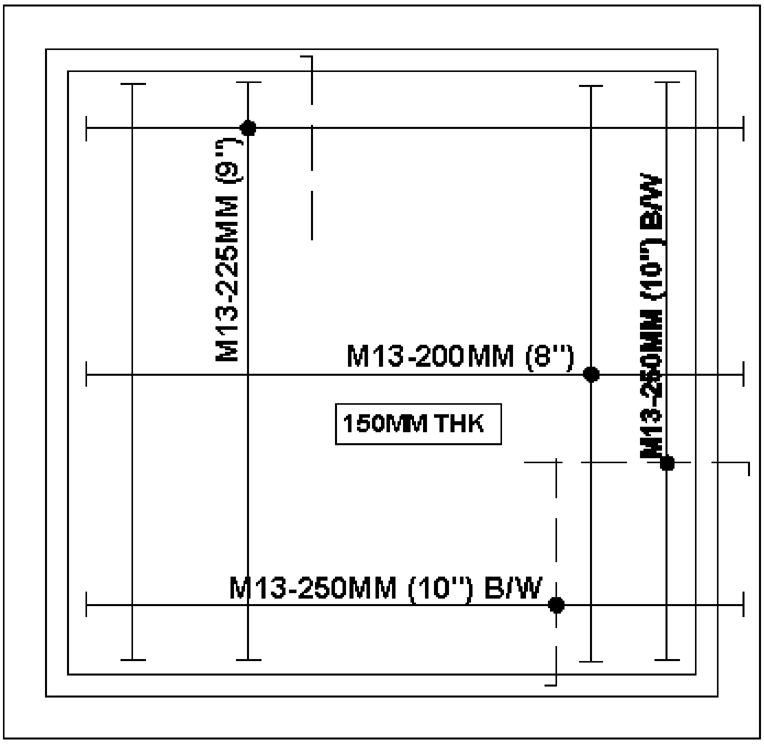
(c) Explain how the water-cement (w/c) ratio affect the concrete mix**.** **(3 marks)**

(d) Explain the term hydration as it relates to concrete. **(2 marks)**

(e) Sketch two methods of connecting treads and risers on a timber staircase. Hatching is required **(10 marks)**

Total 20 marks

4. Figure 3 shows a reinforced concrete slab that covers a room 4.5 meters wide and 4.8 meters long. The slab has a 300 mm cantilever.



Using a scale of 1:20, draw a cross-section through the concrete slab.

ALL dimensions and specifications should be included. **(20 marks)**

SECTION C

MODULE 3

MANAGEMENT AND DESIGN

Answer ALL questions from this section.

5. Table 1 shows the activities, their estimated duration and predecessors for a construction project.

TABLE 1: ACTIVITES FOR A CONSTRUCTION PROJECT

Activity		**Duration**	**Predecessors**
A	Drill well	3	--
B	Power line	5	A
C	Excavate	7	A
D	Order & deliver materials	3	B, C
E	Pump house	5	B
F	Install pipe	4	D
G	Foundation	2	C
H	Assemble tank	5	E, F, G

(a) Construct the project activity network using AOA methodology. Label EACH node and arrow appropriately. **(8 marks)**

(b) Determine the duration of the project. **(4 marks)**

(c) Calculate the early start, early finish, latest start, latest finish and slack time for EACH activity. **(8 marks)**

Total 20 marks

6. (a) Using the six stages of the design process, explain how the design of a two storey apartment building is conceptualized.

[18 marks]

(b) Explain how the design principle of aesthetics would Impact on the apartment building in (a) above. . **[2 marks]**

Total 20 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

Unit 1 – Paper 01 Option A – Engineering Drawing

No.	Syllabus Ref.	Module	Key
1.	1:1:1 b	1	B
2.	1:1:1 b	1	D
3.	1:2:3	2	C
4.	1:1:2	1	C
5.	1:2:5	2	B
6.	1:1:b	1	B
7.	1:1:2	1	D
8.	1:1:2	1	B
9.	1:1:2	1	B
10.	2:5:a	2	A
11.	2:4:a	2	D
12.	1:1:3	1	A
13.	1:1:4: a	1	A
14.	1:1:4:C	1	A
15.	1:1:3:b	1	B
16.	1:2:2:c	2	C
17.	1:1:1(iv)	1	B
18.	1:2:2	2	D
19.	1:1:b (i)	1	C
20.	1:1:1	1	D
21.	1:1:1	1	A
22.	1:1:3	1	A
23.	1:2:2	2	B
24.	1:2:4	2	B
25.	1:2;4	2	C
26.	1:2:1 a	2	A
27.	1:2:1	2	D
28.	1:2:5	2	C
29.	1:2:5	2	B
30	1:2:1 a	2	C
31.	1:3A: 3	3A	D
32.	1:3A:7 a	3A	D
33.	1:3A:3	3A	D
34.	1:3A:3	3A	B
35.	1:3A:3	3A	C
36.	1:3A:5 d	3A	C
37.	1:3A:5 d	3A	D
38.	1:3A:7 c	3A	C
39.	1:3A:7 c	3A	B
40.	1:3A:7 c	3A	C
41.	1:3A:5	3A	A
42.	1:3A:5	3A	A
43.	1:3A:5	3A	A
44.	1:3A:7 b	3A	A
45.	1:3A:6 f	3A	D

Unit 1 – Paper 01 Option B Building Drawing

No.	Syllabus Ref.	Module	Key
1.	1:1:1 b	1	B
2.	1:1:1 b	1	D
3.	1:2:3	2	C
4.	1:1:2	1	C
5.	1:2:5	2	B
6.	1:1:b	1	B
7.	1:1:2	1	D
8.	1:1:2	1	B
9.	1:1:2	1	B
10.	2:5:a	2	A
11.	2:4:a	2	D
12.	1:1:3	1	A
13.	1:1:4: a	1	A
14.	1:1:4:C	1	A
15.	1:1:3:b	1	B
16.	1:2:2:c	2	C
17.	1:1:1(iv)	1	B
18.	1:2:2	2	D
19.	1:1:b (i)	1	C
20.	1:1:1	1	D
21.	1:1:1	1	A
22.	1:1:3	1	A
23.	1:2:2	2	B
24.	1:2:4	2	B
25.	1:2;4	2	C
26.	1:2:1 a	2	A
27.	1:2:1	2	D
28.	1:2:5	2	C
29.	1:2:5	2	B
30	1:2:1 a	2	C
31.		3B	D
32.	1:3B:3	3B	D
33.	1:3B:3	3B	C
34.	1:3B:3 b	3B	C
35.	1:3B:3 b	3B	A
36.	1:3B:2	3B	C
37.	1:3B:3	3B	B
38.	1:3B:3 e	3B	A
39.	1:3B:3 e	3B	A
40.	1:3A:2 b	3B	B
41.	1:3A:2 a	3B	D
42.	1:3B:4 g	3B	A
43.	1:3B:1	3B	C
44.	1:3B:3	3B	A
45.	1:3B:3	3B	C

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BUILDING AND MECHANICAL ENGINEERING DRAWING

UNIT 1 — PAPER 02

MARK SCHEME

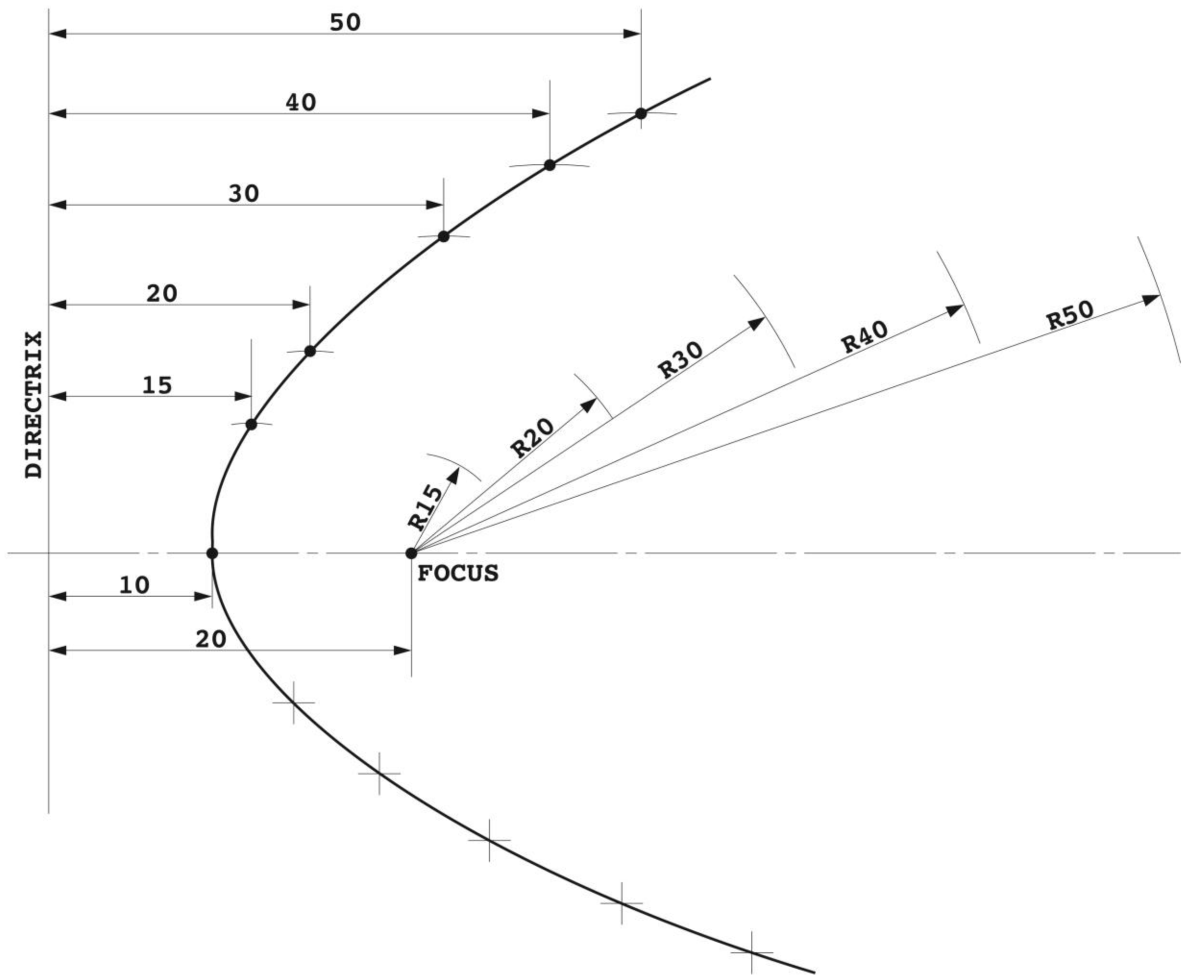
MAY/JUNE 2015

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

SECTION A

Question **1**

Criteria	**K**	**A**	**DS**
• Identified and drew the relatice positions of the focus and directrix		1	1
• Got the intersection points of Radii with lines drawn parallel	1	1	
• Drew a neat curve passing through the intersection points.			1
	1	**2**	**2**

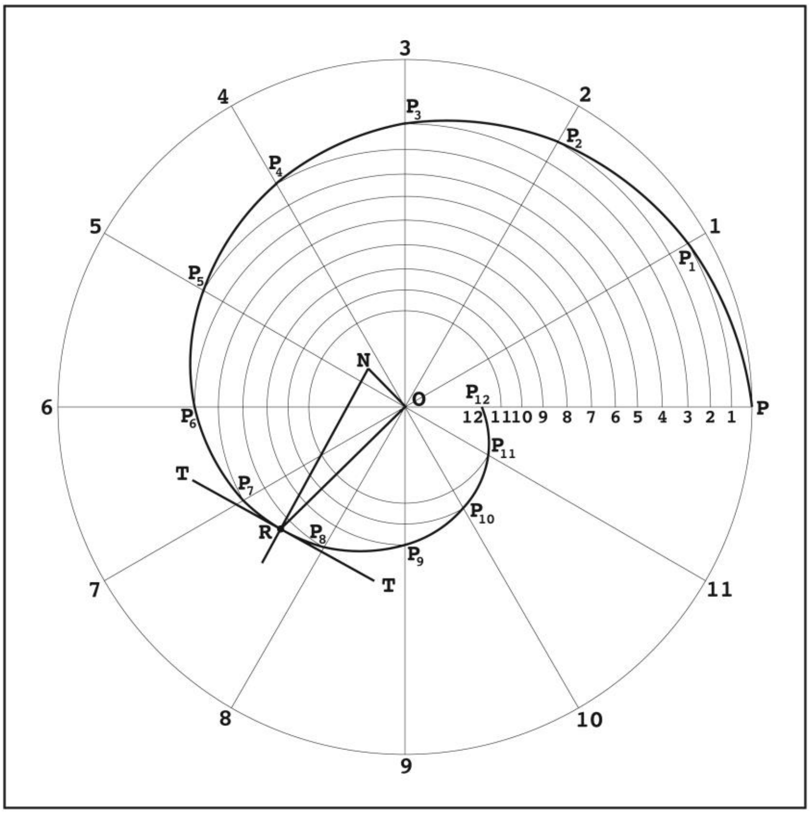


Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **1** cont'd

	Criteria	**K**	**A**	**DS**
(b)(i)	• Drew OP = 50 mm (length) and located the shortest length", 10 mm with '0' as centre.	1	1	1
	• Divided the angular movement of one revolution and corresponding linear distance travelled into 12 equal Darts (say)		2	2
	• Plotted a smooth Archimedean curve passing through the points		1	1
(ii)	• Drew a normal and tangent			
	• Located the given point of 25 mm from the pole on the curve.	1		1
		2	**4**	**5**

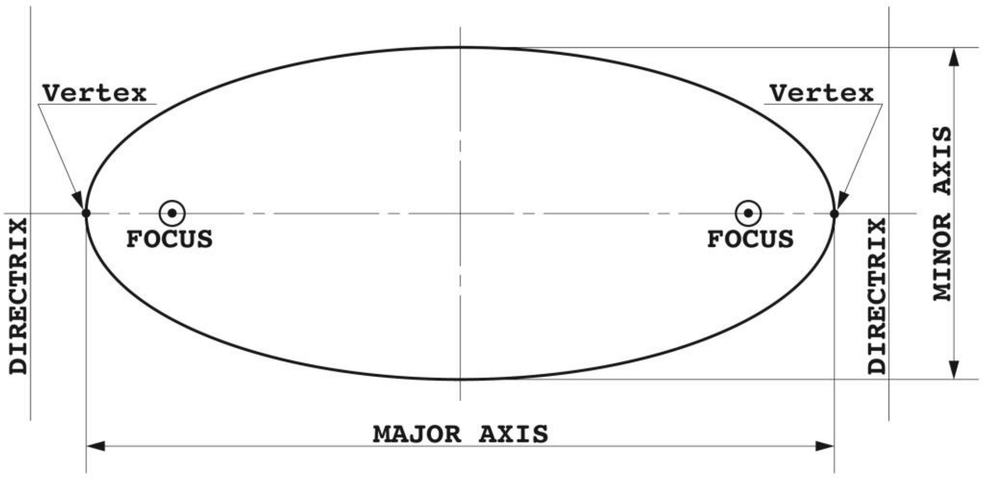
SECTION A



Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **1** cont'd

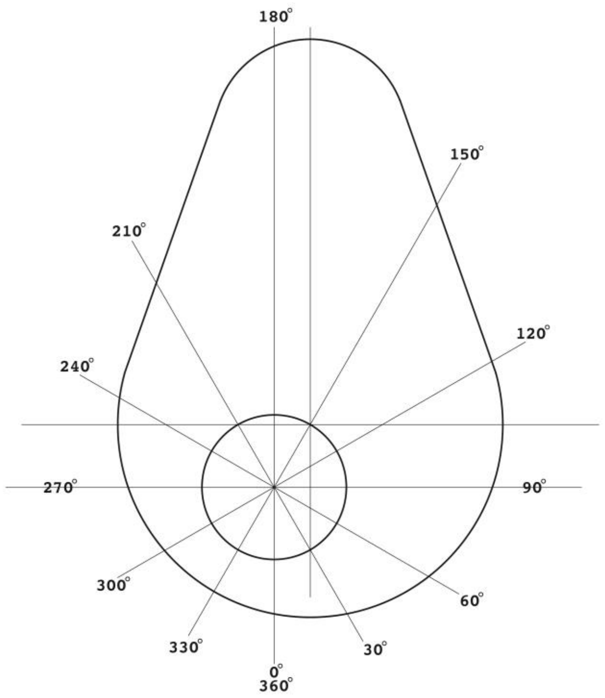
Criteria	K	A	DS
(c) • Draw a freehand sketch	1	1	1
• Labelled the required features		1	
	1	**2**	**1**

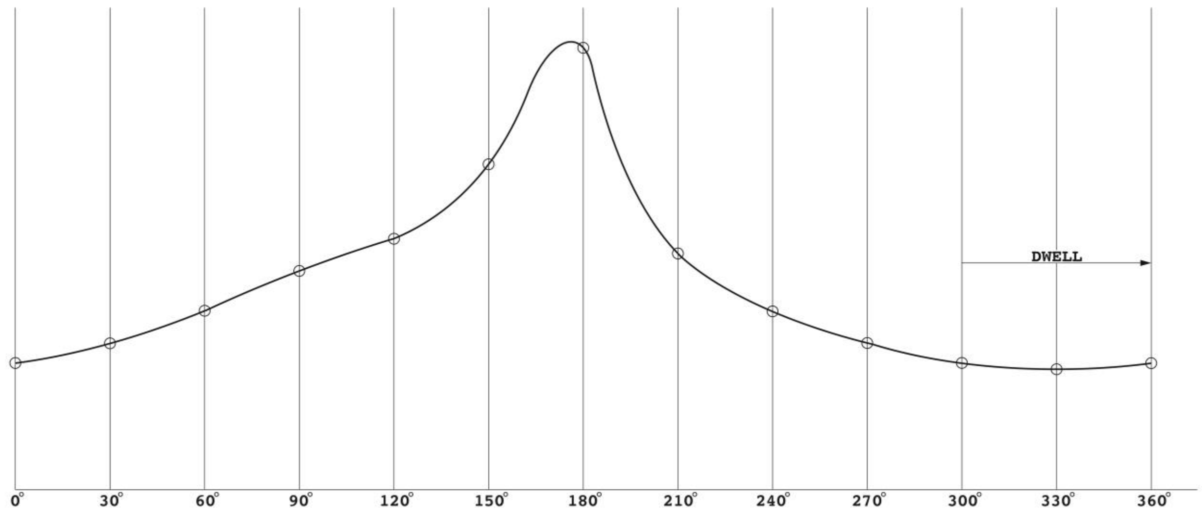


Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **2**

	Criteria	**K**	**A**	**DS**
(a)	Reproduced cam	1	1	2
(b)	Drew performance diagram	1	2	1
	Transferred performance Drew curve	1	2	2
(c)	Fully label the drawing		1	1
(d)	Identified dwell	2	1	
(e)	Non-symmetrical curve (explanation)	1	1	
	TOTAL	**6**	**8**	**6**





PERFORMANCE DIAGRAM

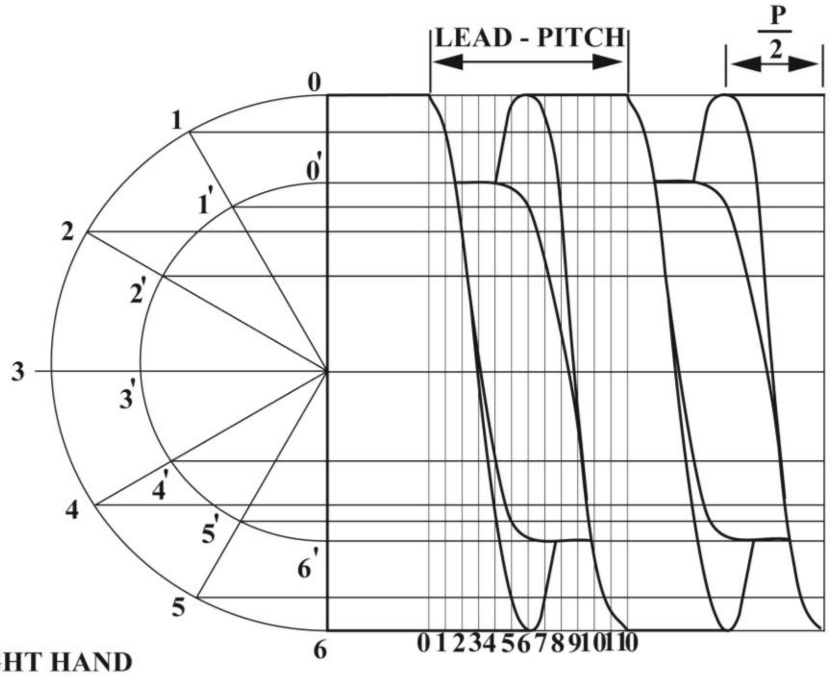
(c) The dwell period is between 300°

(d) Curve is not symmetrical because camshaft is off centre

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **3**

SOLUTION



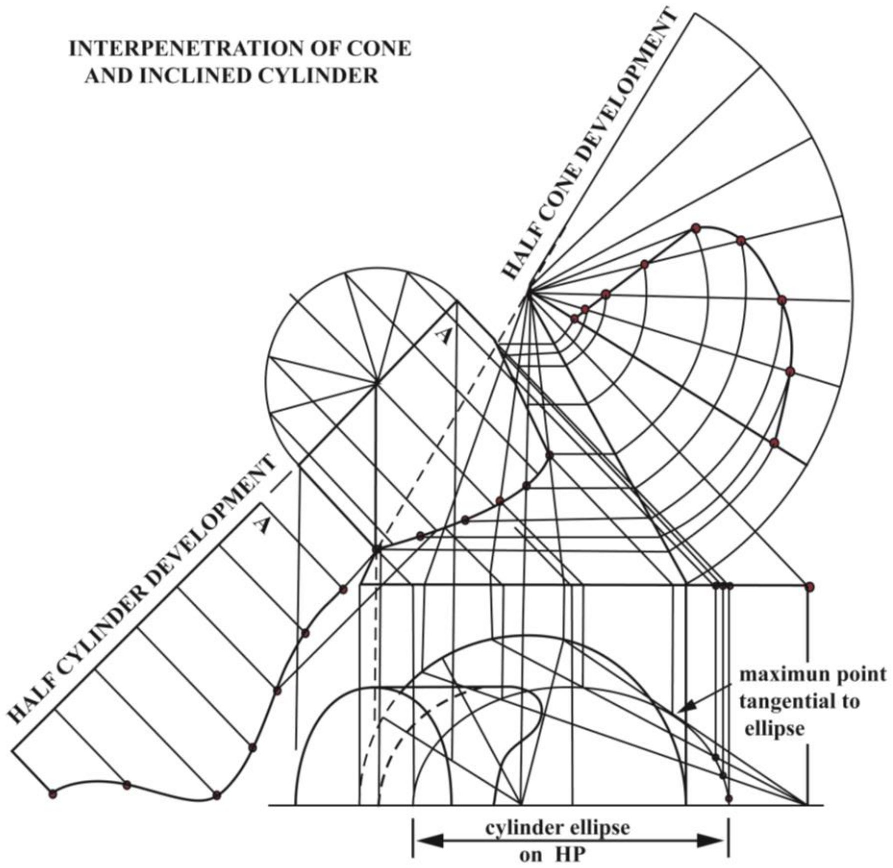
RIGHT HAND
SQUARE THREAD
SINGLE START

MODULE 2

	CRITERIA	**K**	**A**	**DS**
	Draw base line and vertical and mark off two diameters.			2
	Draw semi-circles for the two diameters, divide and project horizontally.	1	1	1
	Mark off leads (pitches), divide and project vertically	1	1	1
	(i) Plot points and join with smooth curve. (ii) Plot points and join with smooth curve. (iii) Plot points and join with smooth curve. (iv) Plot points and join with smooth curve.	3	6	3
		5	**8**	7

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **4**



	CRITERIA	K	A	DS
	Reproduce figure			1
	Draw Plan	1	2	1
	Draw elevation	2	1	2
	Draw auxiliary plan	2	2	2
	Draw curve of interpenetration.	1	1	2
		6	**6**	**8**

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question **5**

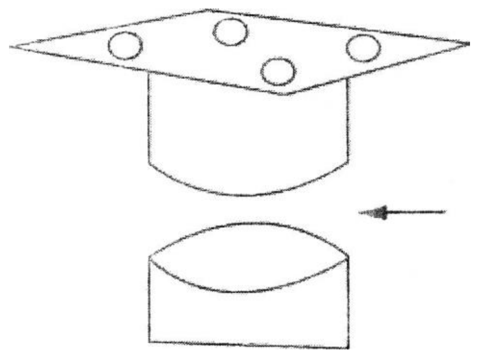
Solution

Definitions

(a) Design a mechanism which allows the rigid stool to swivel

(b) Any rrHREE ideas

(c) Any good design:



(d) Material steel: Strong, machinable, needs coating, may rust.

	CRITERIA	**K**	**A**	**DS**
	Defined the problem	1	2	
	Suggested solution (THREE)	2	3	3
	Detailed Design	1	2	3
	Chose material and evaluate	1	2	
		5	**9**	**6**

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Unit 1 Paper 02
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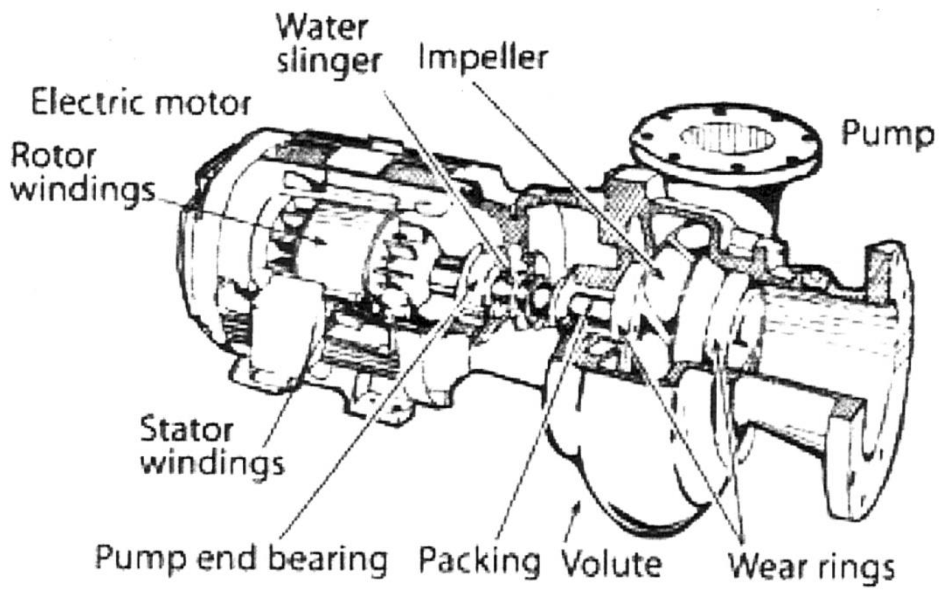
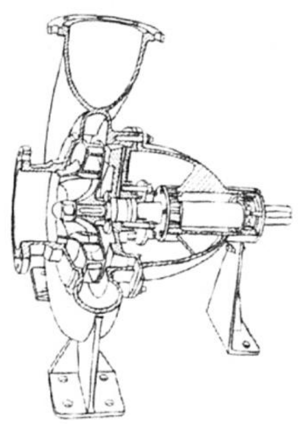
Question **6**

SOLUTION





(a) } [See drawings]
(b)

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

(c) Move water or air for irrigation or ventilation

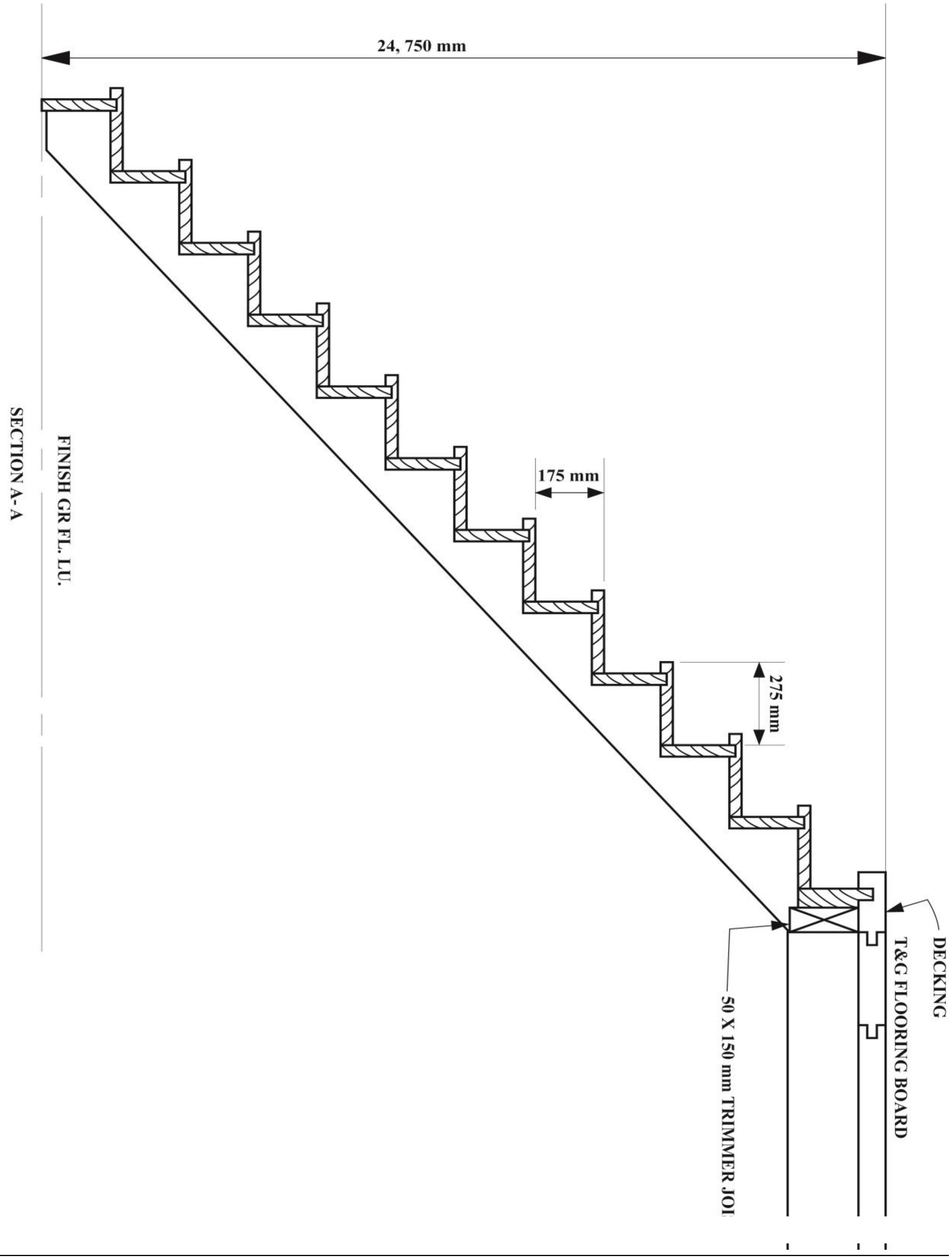
QUESTION 6 (cont'd)

MARK SCHEME

CRITERIA		K	A	DS
(a)	Sketch pump correctly	1	2	1
	Cut-away view		1	1
	Sketch motor correctly	1	2	1
	Show method of coupling	1		
	Free hand construction		1	2
	Good proportion			2
(b)	Label components	1	2	
(c)	Give application		1	
		4	**9**	**7**

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question 7



SOLUTION A

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
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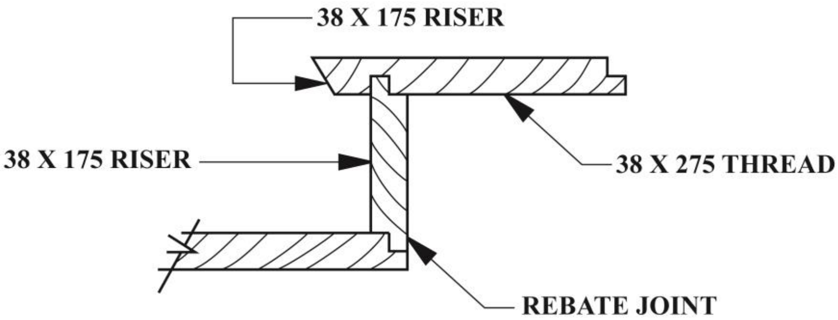
May/June 2015

Question 7 (cont'd)

SOLUTION B

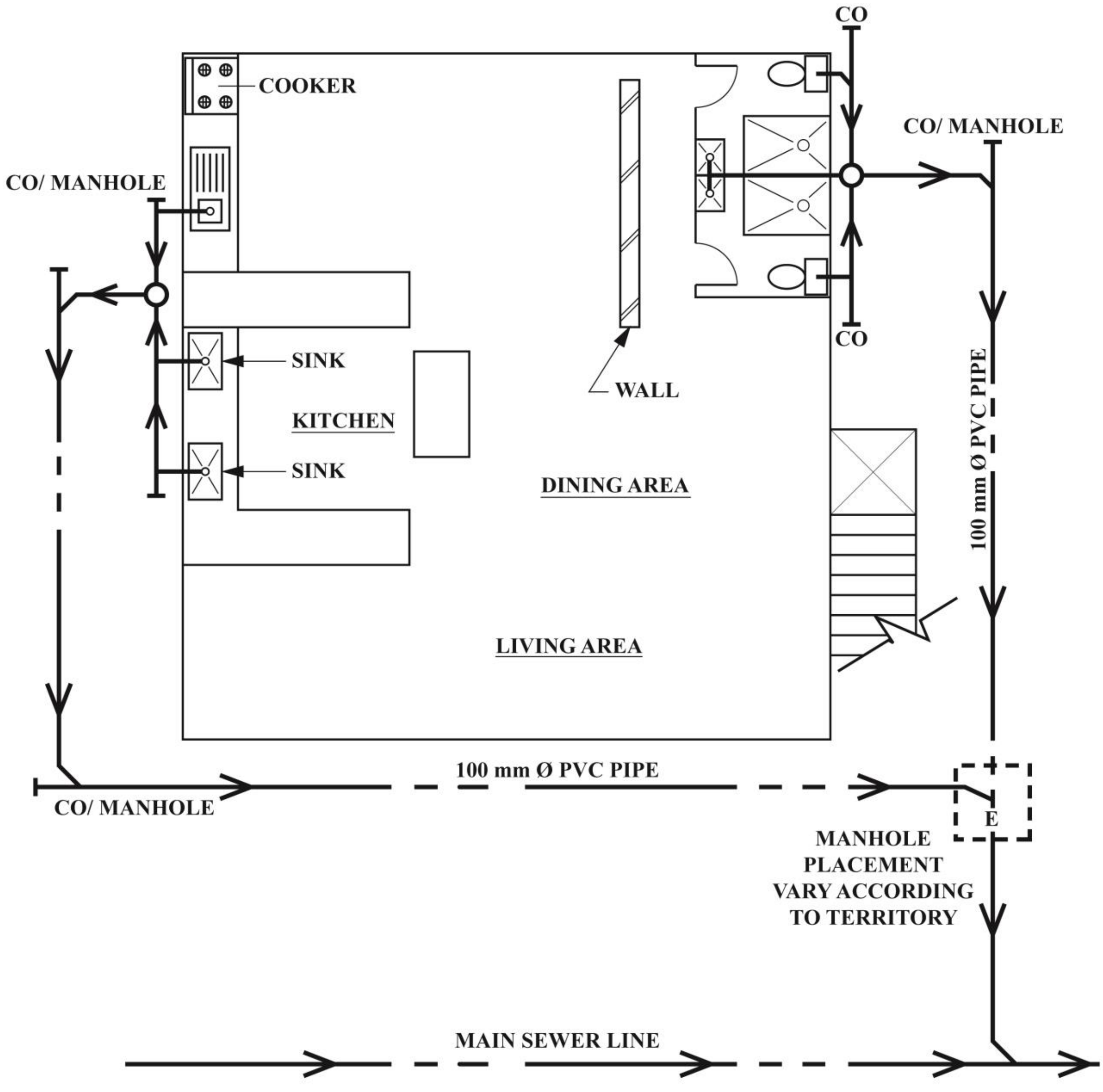


Criteria	**K**	**A**	**DS**	**Total**
(a) - Outline of decking and ground floor	1		1	
- Equal division of risers to suit height	1	1	1	
- Sectional view of threads and risers with trimmer joint		2	4	
- Hatching lines		2		
- Labeling of members		2		
(b) Construction Joint				
- Sectional view of joint at junction	1	1	2	
- Labeling of members		1		
	3	**9**	**8**	**20**

Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question 8

SOLUTION



Building and Mechanical Engineering Drawing
Unit 1 Paper 02
Mark Scheme
May/June 2015

Question 8 (cont’d)

Criteria	**K**	**A**	**DS**	**Total**
Layout of existing upper floor plan in proportion	1	2	2	
Plumbing fixtures on layout		1	2	
Main sewer line		1	1	
Identification of flow from fixtures to main stack	1	2	2	
Connection of property pipe to main sewer line	1	1	1	
Labeling of structures and fitting		2		
	3	**9**	**8**	**20**

BMED MDS Unit2 Option A - Mechanical Engineering Drawing and Design

No.	Syllabus Ref.	Module	Key
1.	2A:1:3	1	A
2.	2A:1:3	1	C
3.	2A:2:2	2	D
4.	2A:2:2	2	B
5.	2A:2:2	2	B
6.	2A:2:2	2	D
7.	2A:2:2	2	D
8.	2A:2:2	2	B
9.	2A:2:1 b	2	B
10.	2A:2:2	2	B
11.	2A:2:2	2	C
12.	2A:2:2	2	C
13.	2A:2:2 c	2	A
14.	2A:2:3 c	2	D
15.	2A:2:3 c	2	A
16.	2A:3:3	3	D
17.	2A:3:3	3	C
18.	2A:3:3	3	B
19.	2A:1:2	1	A
20.	2A:1:2	1	C
21.	2A:1:2	1	C
22.	2A:3:4 a	3	D
23.	2A:1:1 b	1	C
24.	2A:2:1 b	2	C
25.	2A:2:3 a	2	B
26.	2A:3:1	3	B
27.	2A:1:1 a	1	D
28.	2A:1:1 a	1	B
29.	2A:1:1 a	1	A
30	2A:2:1 c	2	D
31.	2A:2:4 b	2	A
32.	2A:3:4 b	3	A
33.	2A:3:4 b	3	B
34.	2A:3:4 b	3	B
35.	2A:2:3	2	C
36.	2A:3:1	3	A
37.	2A:3:1	3	A
38.	2A:1:3	1	D
39.	2A:1:3	1	C
40.	2A:1:3	1	B
41.	2A:1:3	1	A
42.	2A:1:1	1	D
43.	2A:1:2	1	A
44.	2A:3:2	3	A
45.	2A:3:2	3	C

Unit 2 – Paper 01 Option B Building Drawing and Design

No.	Syllabus Ref.	Module	Key
1.	2B:2:1 j	2	B
2.	2B:2:1 j	2	D
3.	2B:2:1 j	2	C
4.	2B:1:1	1	D
5.	2B:1:2	1	B
6.	2B:3:1 a	3	A
7.	2B:3:1 a	3	C
8.	2B:3:1 a	3	B
9.	2B:3:1 a	3	A
10.	2B:3:1 b	3	D
11.	2B:1:1	1	B
12.	2B:1:1	1	D
13.	2B:1:2	1	A
14.	2B:3:2	3	C
15.	2B:3:2	3	A
16.	2B:3:1	3	C
17.	2B:2:2	2	A
18.	2B:2:2	2	C
19.	2B:2:3	2	A
20.	2B:3:3:	3	D
21.	2B:2:1	2	B
22.	2B:2:1 e	2	A
23.	2B:2:1 e	2	B
24.	2B:2:1 h	2	D
25.	2B:2:2 d	2	D
26.	2B:2:3 b	2	A
27.	2B:2:3 a	2	D
28.	2B:2:7 a	2	A
29.	2B:1:1 a	1	B
30	2B:1:1 a	1	A
31.	2B:2:1 f	2	B
32.	2B:3:1	3	D
33.	2B: 3: 4	3	D
34.	2B:1:4 f	1	A
35.	2B:1:4	1	B
36.	2B:1:4 f	1	B
37.	2B:1:4 f	1	A
38.	2B:1:1	1	C
39.	2B:3:4	3	B
40.	2B:2:4 d	2	A
41.	2B:1:1	2	A
42.	2B:3:2	3	D
43.	2B:3:2	3	C
44.	2B:3:2	3	B
45.	2B:1:1	1	A

02268020/SPEC/2015

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MECHANICAL ENGINEERING DRAWING AND DESIGN

SPECIMEN PAPER

UNIT 2 - PAPER 02

SOLUTIONS AND MARK SCHEME

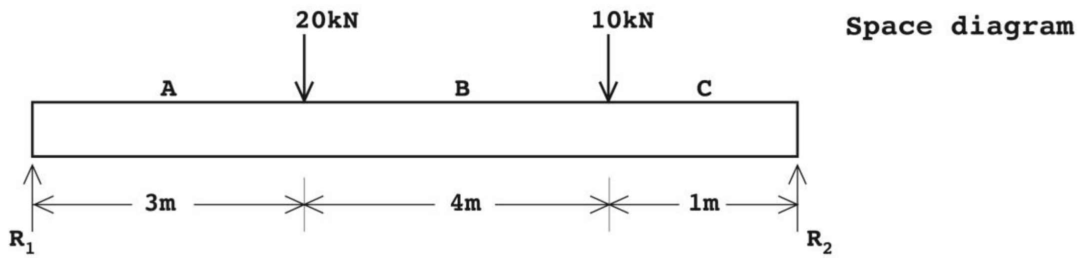
MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

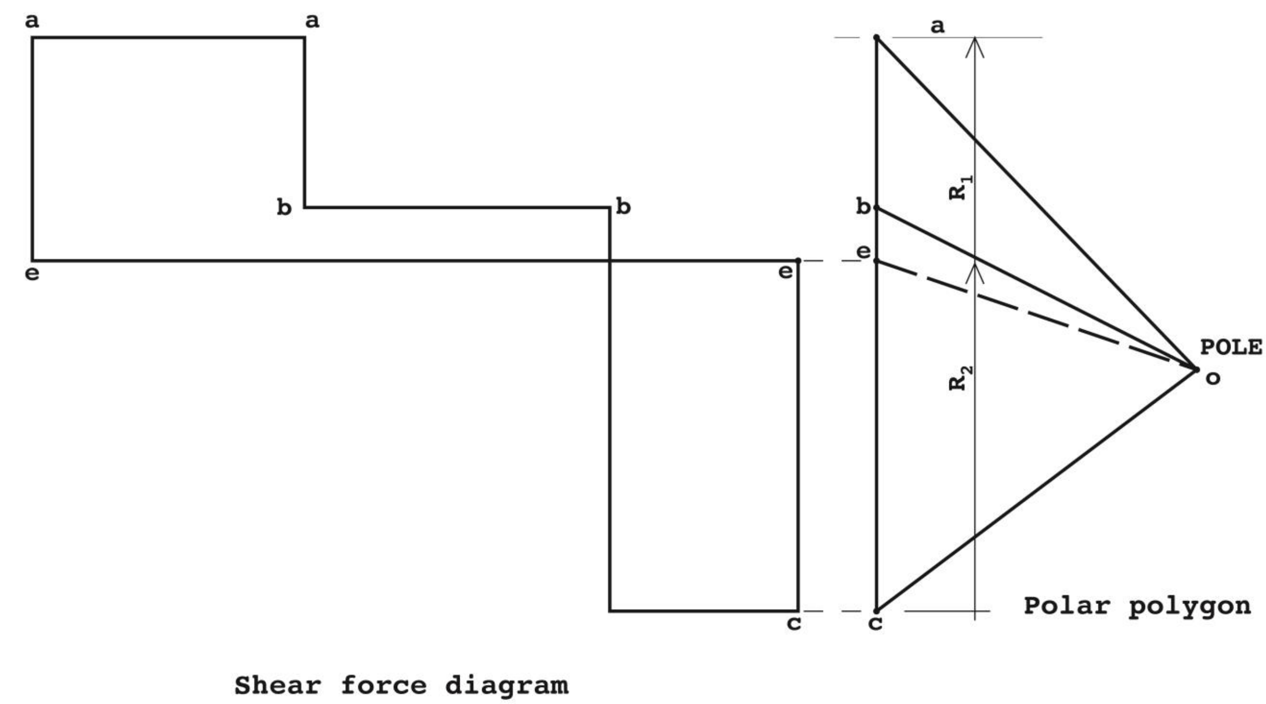
Question 1

	CRITERIA	K	A	DS
(a)	Drew the beam and loads to a convenient scale			1
	Drew the polar polygon	2	3	2
	Found the reactions	2	2	3
(b)	Compute the reactions analytically	1	4	
	TOTAL	**5**	**9**	**6**

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 1 Cont'd



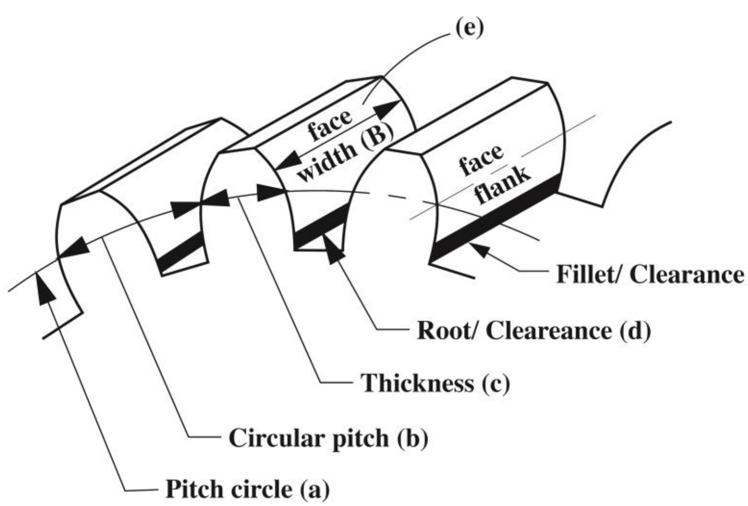


MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 2

(a)

	CRITERIA	K	A	DS
(i)	Produced freehand sketch of the three consecutive teeth			3
(ii)	• Identified the terms a-e	5		
	• Labelled the identified terms		1	1
	TOTAL	**5**	**1**	**4**



MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 2 Cont'd

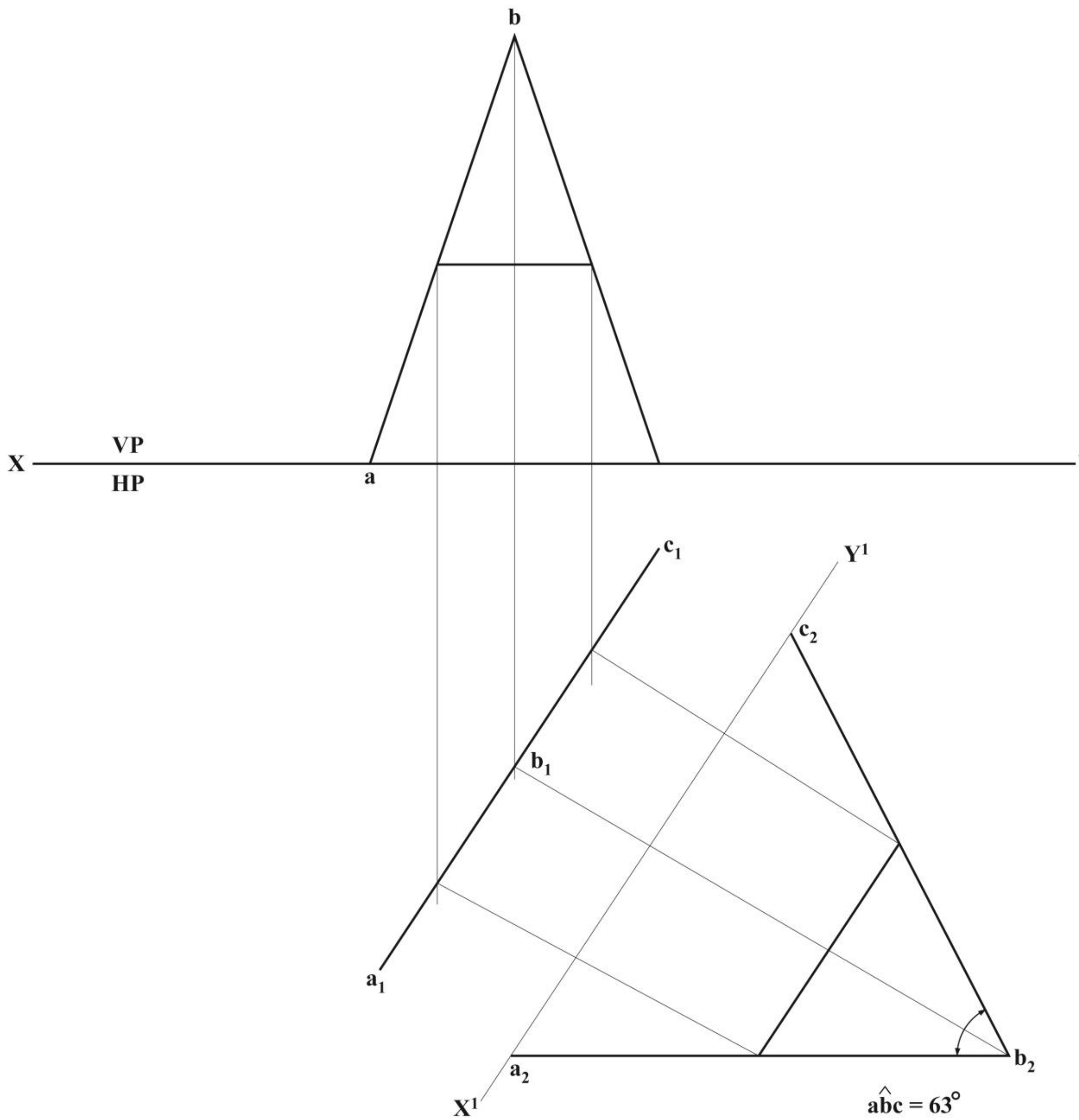
(b)

	CRITERIA	K	A	DS
(i)	Orthographic view	1	1	2
	Auxiliary view		2	2
(ii)	State angle	2		
		3	3	4

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 2 cont'd

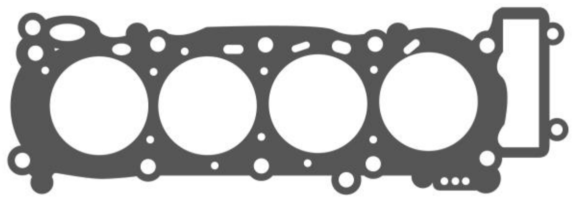
(c) and (d)



MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Module 2

Question 3



(a)

(b) Gasket

(c) Metal, copper, aluminium, asbestos (obl), cork, rubber

(d)
1. Ensure seal is flat
2. Use sealant
3. Do not over/under tighten
4. Use correct tightening sequence
5. Install clean

	CRITERIA	K	A	DS
	Sketch	2	2	2
	Name gasket – type of gasket	1	1	
	Select material	2	2	
	Installation	4	4	
	TOTAL	**9**	**9**	**2**

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 4.

SOLUTION

(a) (i) Ferrous metals are metals that contain iron

(ii) Gray cast iron is a super saturated solution of carbon in an iron matrix. The excess carbon precipitates out in the form of graphite flakes

(iii) Carbon steel is essentially an iron – carbon alloy with small amounts of other elements

(b)

Types of carbon steel	Principal properties	Common uses
Low carbon steel (0.06 to 0.20% carbon)	Toughness and less strength	Chains, rivets, shafts and pressed steel products
Higher carbon steel (over 0.50% carbon)	Less toughness and greater hardness	Saws, drills, knives razors, finishing tools and music wire

(c)

Types of steel	Principal properties	Common uses
Molybdenum steel	High strength	Axels, forgings, gears cams, mechanical parts
Chromium steel (stainless steel)	Hardness, great strength and toughness	Gears, shaft, bearings, springs, connecting rods
Chromium – vanadium steel	Hardness and strength	Punches and dies, piston rods, gears, axels

(d) Thermoplastics – soften or liquify and flow when heat is applied. Removal of heat causes these material to set or solidify. They may be reheated and reformed or reused. Eg. Acrylics, cellulosics, nylons (polyamides), polyethylene, polystyrene, polyfluoro carbons, vinyls.

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 4. (cont'd)

Thermosetting plastics – undergo a irreversible chemical change when heat is applied or when a catalyst or reactant is added. They become hard, insoluble and infusible, and they do not soften upon reapplication of heat. Eg. phenolics, amino plastic (melamine and urea) cold molded polyesters, epoxies, silicones, alkyds, allylics, casein.

MARK SCHEME

CRITERIA				K	A	DS
(a)	(i)	Ferrous metals		**1**	**1**	
	(ii)	Gray cast iron		**1**	**1**	
	(iii)	Carbon steel		**1**	**1**	
(b)	(i)	Low carbon steel		**2**	**1**	
	(iii)	High carbon steel		**2**	**1**	
(c)	(i)	Molybdenum steel		**1**	**1**	
	(ii)	Chromium steel	Any TWO steels.	**1**	**1**	
	(iii)	Chromium-vanadium steel		**1**	**1**	
(d)	(i)	Thermoplastics		**1**	**1**	
	(ii)	Thermosetting plastics		**1**	**1**	
				11	**9**	

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Module 3

Question 5.

SOLUTION

(a) 1 Relief Valve

2 Reservoir

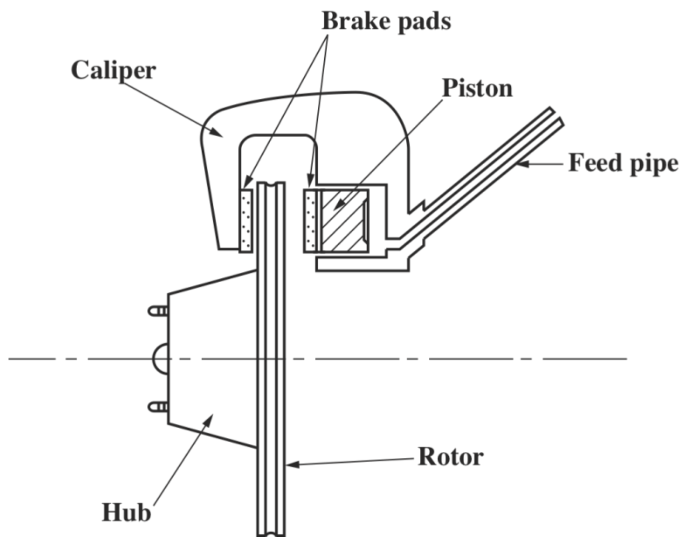
3 Push Rod

4 Pedal

5 Piston

6 Feed Pipe

(b)



(c) Pressurized fluid (hydraulics) comes from the feed line when the pedal is depressed, this pressurized fluid pushes the piston as it fills the chamber. This pushing causes the brake pads to squeeze onto the rotor causing the disc to slow down and eventually stop.

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 5. (cont'd)

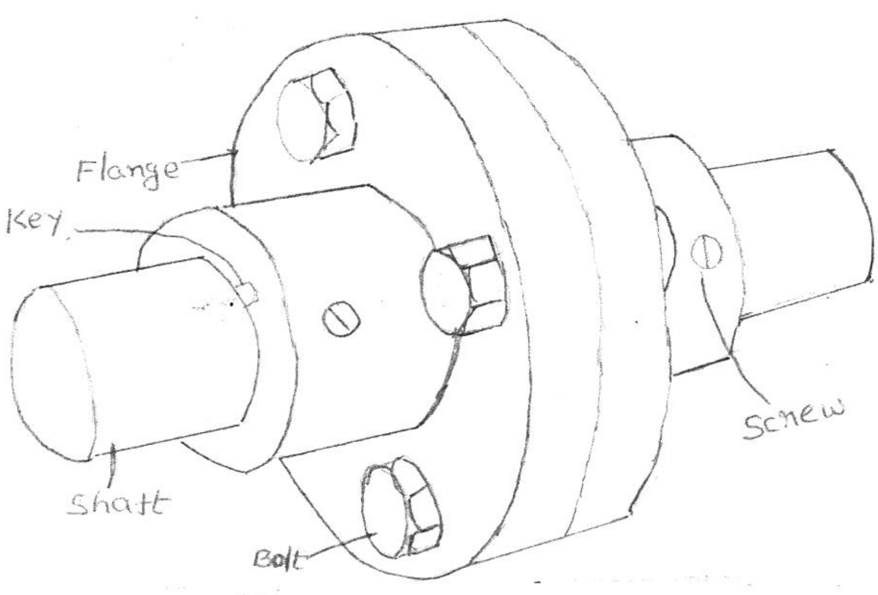
MARK SCHEME

CRITERIA	K	A	DS
(a) Label the points	**3**	**3**	
(b) Complete Section B;			
(i) Draw caliper	**1**		**1**
(ii) Draw Piston	**1**		**1**
(iii) Draw Brake Pads	**1**		**1**
(iv) Reproduce Rotor and Hub			**1**
(v) Label all points	**2**	**2**	
(c) Explain how the disc brake works	**1**	**2**	
	9	**7**	**4**

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 6.

	Criteria	**K**	**A**	**DS**
(a)	(i) Draw a freehand sketch	3	3	3
	(ii) Labelling	3		
(b)	Reasons for its application		6	
(c)	Identifying flaws	2		
		8	**9**	**3**



Flange coupling-pictorial representation

MECHANICAL ENGINEERING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

(b) Reasons why the coupling can be used to connect a motor and generator:

- Provide a connection for shafts of the two units
- Provide for misalignment of the shafts or introduce mechanical flexibility
- Reduce the transmission of shock loads from one shaft to another
- Alter the vibration characteristics of the motor and generator shafts
  Introduce protection against overloads. **(Any THREE - 2 marks each)**

(c) Flaws or defects in the flanged coupling can be identified by:

- Performing visual inspection
- Checking for signs of wear or fatigue
- Cleaning the coupling regularly **(One mark each - any TWO)**

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C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

BUILDING DRAWING AND DESIGN

SPECIMEN PAPER

UNIT 2 - PAPER 02

SOLUTIONS AND MARK SCHEME

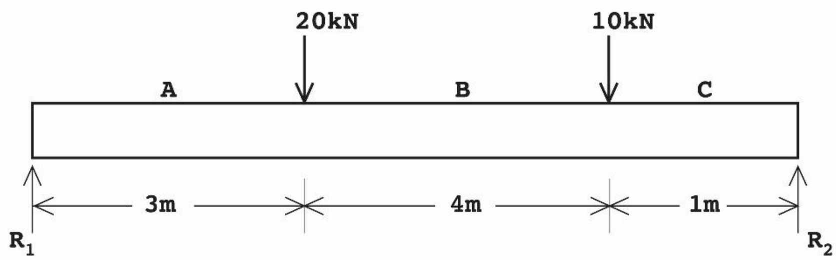
BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME
Module 1

Question 1

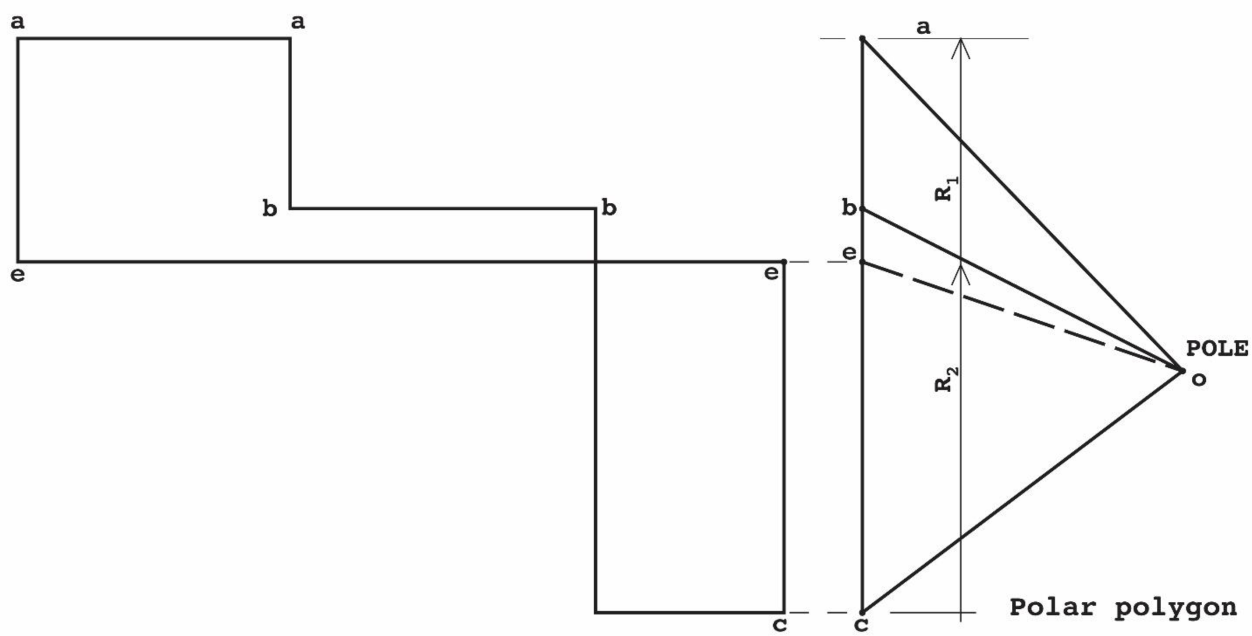
	CRITERIA	K	A	DS
(a)	Drew the beam and loads to a convenient scale			1
	Drew the polar polygon	2	3	2
	Found the reactions	2	2	3
(b)	Compute the reactions analytically	1	4	
	TOTAL	**5**	**9**	**6**

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 1 Cont’d



Space diagram



Polar polygon

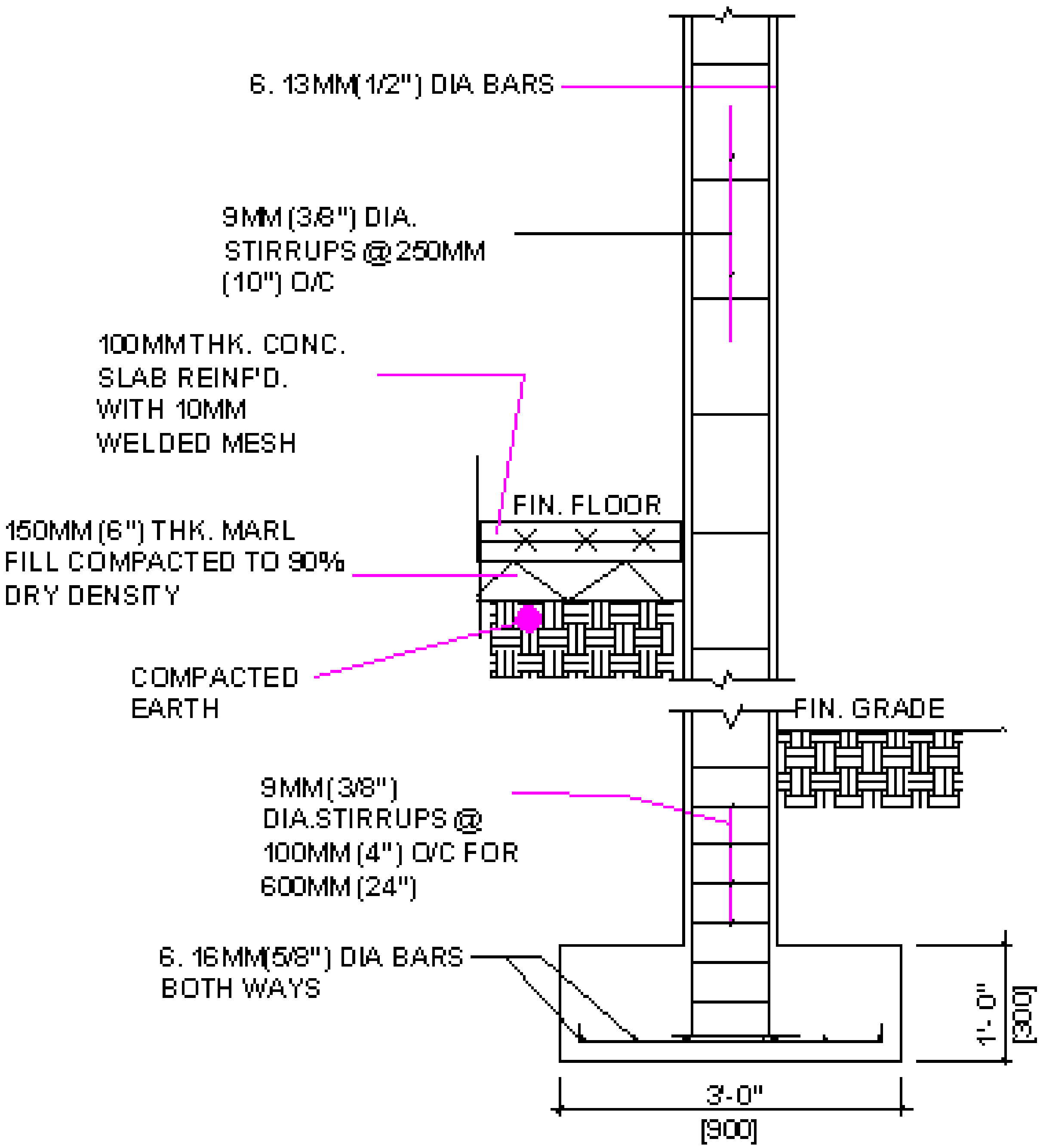
Shear force diagram

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 2

	CRITERIA	K	A	DS
(a)	Sketch of column and footing	2	2	3
	Placement of reinforcement	1	1	3
	Labelling of components	3		
(b)	• L- corner stiffener detail	1		2
	• T- corner stiffener detail	1		1
	TOTAL	**8**	**3**	**9**

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

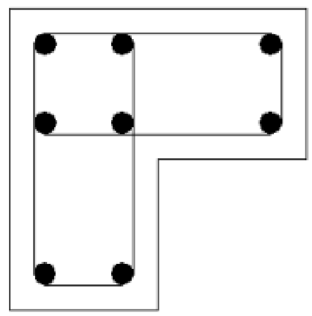


SECTION "THRU" COLUMN

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

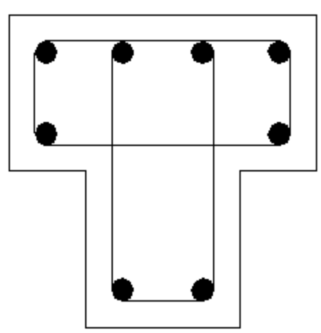
Question 2 cont'd

(b) (i)



L STIFFENER

(b) (ii)



T STIFFENER

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME
Module 2

Question 3

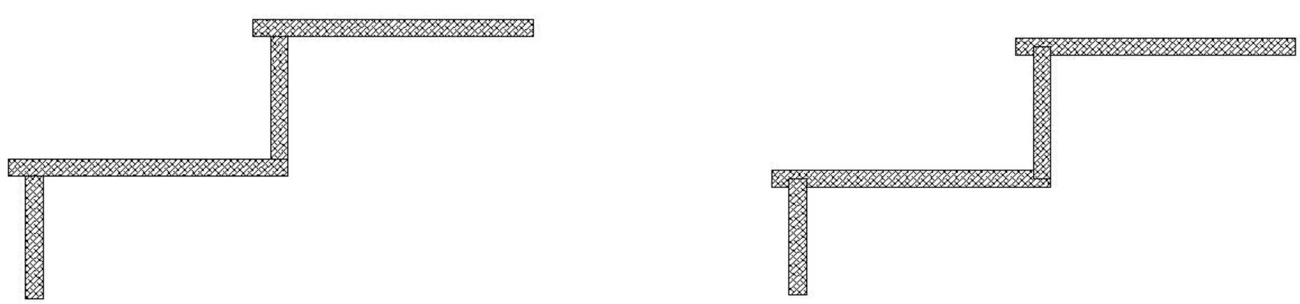
(a) In preparing the concrete mix the inclusion of the correct quantity of each ingredient is critical as this ensures that the mix is economical, strong and workable. If too little of any ingredient is added it compromises the strength and workability of the mix while if too much ingredient is added it will invariably affect the cost of preparing the mix.

(b) The amount of water used in relation to cement when preparing concrete mixes.

(c) It affects the strength and workability of the concrete. High w/c ratio means less strength. Low w/c ratio means less workability.

(d) The chemical reaction between cement and water in which new compounds with strength producing properties are formed over a 28 day period.

Two methods of connecting threads and risers on a timber staircase



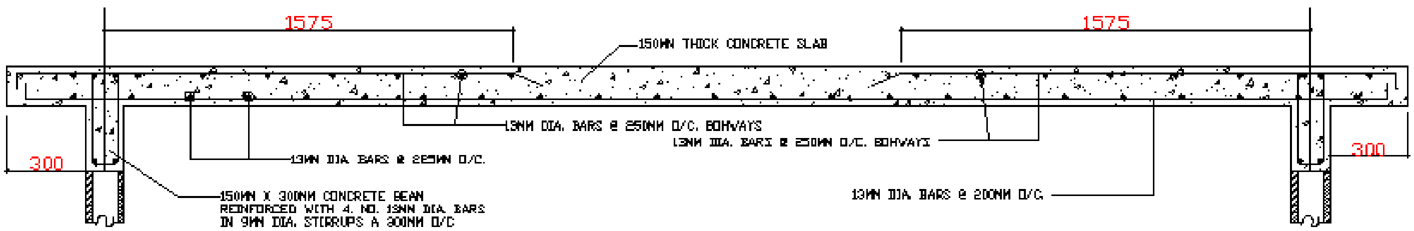
BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 3 cont'd

	CRITERIA	K	A	DS
(a)	Importance of batching concrete	2	2	
(b)	Define water/cement ratio	1		
(c)	Explain how water/cement ration affects concrete	1	2	
(d)	Explain hydration as it affects concrete	1	1	
(e)	Sketch two methods of connecting treads and risers		5	5
	TOTAL	**5**	**10**	**5**

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

<u>Question 4</u>



SECTION THROUGH CONCRETE SLAB
SCALE 1:20

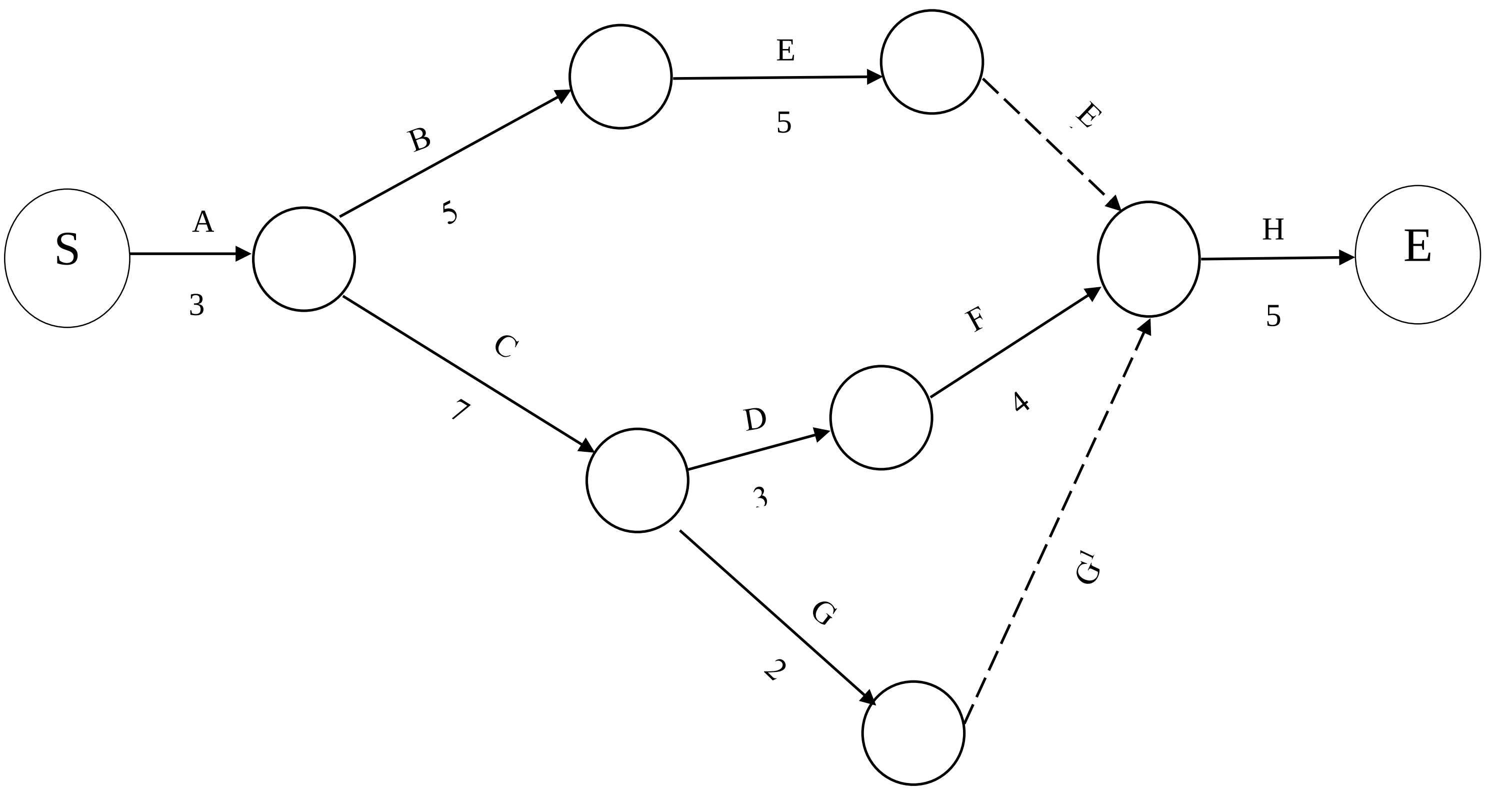
	CRITERIA	K	A	DS
	Sketch section of floor slab	1	2	4
	Reinforcement detail	1	2	3
	Cantelever		2	1
	Details of section shown		2	
	Labelling	2		
	TOTAL	**4**	**8**	**8**

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME
Module 3

Question 5

(a)

Project Activity Network



(b) Duration of project

A B E E^1 H = 3+5+5+0+5 = 18
A C D F H = 3+7+3+4+5 = 22
A C G G^1 H = 3+7+2+0+5 = 17

A C D F H is the critical path (22 days)

Duration of the project is 22 days

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 5 cont'd

(c)

Activity	Duration	ES	EF	LS	LF	Slack
A	3	0	3	0	3	-
B	5	3	8	5	10	2
C	7	3	10	3	10	-
D	3	10	13	10	13	-
E	5	8	13	13	17	4
F	4	13	17	13	17	-
G	2	10	12	15	17	5

	CRITERIA	K	A	DS
(a)	Construct project activity network using AOA methodology	2	4	2
(b)	Determnine duration of the project	2	2	
(c)	Calculate early start and finish, latest start and finish and slack time	2	6	
	TOTAL	**6**	**12**	**2**

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Module 3

Question 6.

(a) **Stages of the design process.**

Recognition of need – the specific needs for such a building are identified, e.g. the two storey structure with two apartments. The designer would have to identify additional needs such as whether an apartment would be on each level or whether each apartment would utilize both levels.

Definition of problem – a clear definition of the problem is required to be certain that all needs are taken care of during the design phase. Issues such as accessibility, use and number of occupants per apartment would have to be clarified.

Synthesis – Several solutions are identified through brainstorming. Where necessary these are sketched or drawn and checked for conformity to solving the problem. At this stage, investigations are carried out to identify possible customers' likes and dislikes. The goal is to identify as many solutions as possible.

Analysis and optimization – various analytical techniques are employed to identify the best solution. For example, consistency testing, economic analysis, engineering analysis are employed to optimize the best results.

Evaluation – the solutions are evaluated to determine the best useable solution. This can be achieved using scale models, diagrams etc. Other factors evaluated can include but are not limited to reliability of structural members, strength, environmental impact and safety.

Presentation – at this stage, solutions are presented to clients to gauge reactions and to determine meeting of needs. All data and designs generated are communicated to the clients for their input and for selection of the final solution.

(b) In the design of the apartment building, the principle of aesthetics is key to ensuring the building has a particular look that appeals to the senses of those using or observing the building. Attributes such as colour, texture, shape, pattern, balance and repetition are critical to achieving the aesthetic appeal of the building. The product designer needs a knowledge of these attributes to successfully design the building.

BUILDING DRAWING AND DESIGN
UNIT 2 – PAPER 02
SOLUTIONS AND MARK SCHEME

Question 5. (cont’d)

MARK SCHEME

	CRITERIA		K	A	DS
(a)	Identification of each stage of the design process	(1 mark each)	6		
	Explanation of each design stage	(2 marks each)	6	6	
(b)	Explanation of the design principle of aesthetics			2	
			12	8	

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2004

GEOMETRICAL MECHANICAL ENGINEERING DRAWING

GEOMETRICAL MECHANICAL ENGINEERING DRAWING

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2004

GENERAL COMMENTS

Generally there was a decline in the candidates' performance in 2004 from past years. Based on some of their responses, it would appear that candidates were not exposed to a wide variety of examples. This variety is critical, in helping candidates understand the concepts and procedures for solving different problems. There was some evidence that candidates had experiences with different engineering components, tools, equipment and engineering applications, but there must be increased opportunities for this type of interaction. There were instances where some centres had no candidates attempting particular questions, which indicated that those candidates had no knowledge of those topics. There was also a case where candidates from a centre attempted Paper 01 but failed to attempt Paper 02. This practice should not be encouraged.

The overall performance of candidates in this examination declined when compared with the performance of those who wrote the examination in 2003. In 2004, 80 per cent of the candidates achieved Grades I – V, compared with 92 per cent in 2003. This decline in performance was consistent across Modules 2 and 3, Solid Geometry and Mechanical Engineering Drawing respectively, and on Papers 01 and 02.

Candidates continued to show good drawing skills but failed to demonstrate the required level of knowledge and application of concepts particularly on Module 3 – Mechanical Engineering Drawing. Greater attention should be given to Orthographic and Auxiliary Projections in Module 2 – Solid Geometry. There was also a wide gap between candidates' performance on the Internal Assessment and their performance on the external papers.

DETAILED COMMENTS

PAPER 01

Question 1

This question assessed candidates' understanding of an archimedian spiral and their ability to perform the related construction.

It was attempted by approximately 66 per cent of the candidates and approximately 46 per cent of them gave satisfactory responses.

Part (a) of the question was generally very poorly done. Candidates emphasised the actual construction of the spiral rather than explaining the concept and definition.

In part (b), many candidates used the internal diameter as radius. Some candidates started plotting the points from the center of the circles and not from a point on the circumference of the 10mm diameter circle. It appeared that generally candidates were taught to start the spiral from the center and not from an internal circle.

Some candidates added the 100mm to the 58mm for the outside circle while some demonstrated no knowledge of an archimedian spiral.

Question 2

This question assessed candidates' ability to determine the centraid of a lamina. It was attempted by 73 per cent of the candidates. Most were able to divide the figure into three rectangles. Among those who did the question incorrectly, most could not find the ratio of the areas of the three rectangles. They had difficulty in dividing the sum of the first two areas by the third area to find the ratio.

Question 3

This question assessed candidates' knowledge of cam displacement diagrams. This question was attempted by 88 per cent of the candidates with 65 per cent earning satisfactory marks.

Part (a) was attempted by many candidates who performed satifactorily. A few candidates did this part incorrectly and drew the uniform velocity as a horizontal line.

In part (b), performance on the simple harmonic motion was the best a of the three parts for those who attempted the question.

Part (c) of the question was attempted by many candidates. Approximately 33 per cent of those who attempted the question did not understand how the vertical displacement was to be divided to obtain the uniform acceleration and retardation. Most of those who did it incorrectly applied the semi-circle to obtain the division of the vertical displacement. The drawing skills of the candidates varied greatly from weak to very good.

Question 4

This question tested candidates' ability to plot points and draw the curve of interpenetration.

The question was attempted by 80 per cent of the candidates with 65 per cent of those attempting the question receiving satisfactory marks. Approximately 40 per cent of the candidates did not understand the concept of the curve of interpenetration and how to project the points between different views. Most candidates demonstrated an understanding of orthographic projection. Some candidates were only exposed to the intersecting prisms with aligned centres, and not the areas with their centres were off set.

Question 5

This question assessed candidates' ability to draw an auxiliary view in order to obtain the tive shape of a surface, cut by an inclined plane. This question was attempted by 77 per cent of the candidates with 64 per cent receiving satisfactory marks.

Most candidates did not understand that to obtain the tive shape they had to project lines perpendicular to the surface. Most candidates also had problems plotting points in the auxiliary view and locating points from the plan to transfer to the auxiliary view.

Question 6

This question assessed candidates' ability to draw the development of the truncated right cone.

This question was attempted by 72 per cent of the candidates with 66 per cent of them receiving satisfactory marks. This question was attempted by many candidates. Few candidates did not draw the semi-circle to divide the base of the cone into 12 equal parts to join lines to the apex of the cove. Where these lines met the 15° line, some candidates did not draw lines horizontal to the side of the cone to obtain the tive length. Some candidates drew the lines from the leave base vertically to intersect the 15° line rather than joining them to the apex of the cone.

Question 7

This question assessed candidates' knowledge of the application of welding and machining symbols. Only 35 per cent of the candidates attempted this question. Thirty-four per cent of those candidates attempting the question received satisfactory marks.

Most of the candidates showed no knowledge of the meaning of the symbols. In some responses there was the indication that the machining symbol related to the surface lent, but generally candidates did not know how to demonstrate this using an illustration.

Question 8

This question tested candidates' ability to extrapolate dimensions from a drawing and their ability to accurately measure a drawing. This question was attempted by 78 per cent of the candidates with 78 per cent receiving satisfactory marks.

Many of the candidates demonstrated an understanding of the concept of 'dimensioning' and the ability to accurately measure the drawing. However, most did not know how to 'dimension' curves and circles. Candidates displayed very weak drawing skills in this question.

Question 9

This question tested candidates' knowledge of the tail stack of a center lathe and the wood turning lathe and also their sketching ability.

Only 27 per cent of the candidates attempted this question. Of those attempting the question 50 per cent received satisfactory marks.

Candidates' sketching ability varied from a highly artistic approach to a simple orthographic view. Most of the sketches were labelled. Some candidates gave a sectional view which demonstrated that they had knowledge of the tail stack and of working drawings.

PAPER 02

Question 1

This question assessed candidates' ability to plot the locus of a point. This question was attempted by 61 per cent of the candidates with 50 per cent of them receiving satisfactory marks. A number of candidates did not number the diagram. A misinterpretation of the diagram by some candidates was that they allowed the line AX to pass through the point X thereby arriving with a different locus.

Question 2

This question assessed candidates' ability to graphically find the second moment of area of a lamina about an axis along the base. This question was attempted by 33 per cent of the candidates with 24 per cent receiving satisfactory marks. One reason for the poor performance was that quite a number of candidates placed the axis and hence the pole in the wrong position. There is a worked example similar to the figure used in the examination, in the recommended text for this subject. The difference between the two diagrams is the location of the axis. Candidates assumed the question was identical and placed the axis in the incorrect position.

Question 3

This question assessed candidates' ability to construct the profile of a plate cam in order to impart different types of motion to an in-line roller follower. This question was attempted by 56 per cent of the candidates with satisfactory responses being received from 77 per cent of them. All candidates understood the importance of the direction of rotation of the cam as it related to the construction of the cam profile. Most candidates did not understand the concept of minimum radius. The simple harmonic motion and the dwell were well done. The uniform acceleration and retardation was not well done as most candidates had problems dividing the vertical axis correctly. The uniform velocity was also well done.

Question 4

This question assessed candidates' ability to draw the curve of intersection and development of two intersecting cylinders and also of the construction of the auxiliary view to obtain true shape. This question was attempted by 64 per cent of the candidates with 39 per cent giving a satisfactory performance. There was an error in one of the dimensions on the figure. Some candidates realized the dimension was wrong and made the correction. Some centres did extremely well while others performed poorly even though a compensation for the error was made during the marking process.

Question 5

This question assessed candidates' ability to construct a single start square thread applying the concept of a helix. This question was attempted by 24 per cent of the candidates with 93 per cent of them receiving satisfactory marks. A small number of candidates attempted this question and of those who attempted it, all but two did extremely well. There were some centres from which no candidate attempted the question.

Question 6

This question assessed candidates' ability to produce drawings in orthographic projection from isometric drawings. This question was attempted by 37 per cent of the candidates with only two per cent receiving satisfactory marks. The great majority of candidates performed poorly on this question.

Question 7

This question assessed candidates' ability to produce an assembly drawing from a detailed drawing. This question was attempted by 49 per cent of the candidates with 34 per cent receiving satisfactory marks. The identification of views (front end) was poorly done. The projection from view was also poorly done. Few candidates understood where a split pin is to be located and how it is installed. Few understood the construction of a nut. Some candidates had problems with the tangency aspect of the hook (blending of curves). Only one candidate turned the bracket upside down. The assembly of the crane hook was well done. The pulley was drawn satisfactorily. Most completed the first and third views, the second view was only partially completed.

Question 8

This question assessed candidates' knowledge of limits and fits, their ability to use the B.S. Data Sheet 4500A and their knowledge of components that require different types of fit. This question was attempted by three per cent of the candidates and all candidates scored zero. Candidates seemed unprepared for a question which focussed on basic concepts and procedures. It also appeared that the spreadsheet with the selected ISO fits – Hole Basis was not familiar to candidates.

Question 9

This question assessed candidates' knowledge of mechanisms and their sketching ability. This question was attempted by 24 per cent of the candidates with 57 per cent receiving satisfactory marks. Of the candidates who attempted this question most gave a satisfactory performance. A few candidates produced sketches of very good quality.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2005

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2005

General Comments

Generally there was a decline in the performance of candidates in 2005 when compared to past years. From the presentations it would appear that many candidates were not exposed to a wide variety of examples of engineering tools and components. The exposure to a wide variety of examples and different methods of solving a particular problem is critical in helping candidates understand the concepts and procedures used to solve different problems. There was some evidence that a few candidates had experiences with a range of engineering components, tools and applications, but there must be increased opportunities for this type of interaction by all candidates. There were instances, in some centres, where no candidates attempted questions from one of the modules, and in some instances the few who attempted the questions gave an unsatisfactory performance. This indicated that those candidates had minimal knowledge of those topics. There were five cases where candidates from four centres attempted Paper 02 but did not attempt Paper 01. This is an increase from last year and this practice should be discouraged.

Overall, candidates displayed poor drawing skills (line work). The drawings were not very neat. A few candidates were not familiar with projecting the plan. Candidates must be encouraged to read the questions carefully so that they can provide answers for what is asked. The correct labelling of diagrams should be stressed and candidates should be encouraged to aim for accuracy in their drawings.

DETAILED COMMENTS

PAPER 01

<u>Question 1</u>

This question tested candidates' ability to construct an ellipse using a rectangle and radiating lines method. A large percentage of the candidates attempted this question and responded well. The weaker candidates who had problems completing the elliptical curve were unable to perform the following:

- divide only the sides of the rectangle
- divide the major axis into the same number of equal parts as the sides
- draw radiation lines from the minor axis and not drawing them through

- the major axis
- locate points to plot for the curve
- draw a smooth curve.

Question 2

This question tested candidates' ability to find the centroid of an L-shaped figure using the graphical method. A large percentage of candidates attempted this question. Few were able to complete the construction. The main weaknesses of candidates were their ability to divide the L-shape into two rectangles; drawing the diagonals; join the diagonals centres; calculate the ratio; divide the line geometrically.

Question 3

This question tested candidates' understanding of cams and cam profiles. Approximately 50 per cent of candidates were unable to list some of the advantages and disadvantages of the types of cams. The question is clear in its requirements. However, it is also clear that those who did not attempt the question simply did not know the answer.

Question 4

This question tested candidates' ability to draw true shapes of sections. Most of the candidates who attempted this question showed great skill in being able to produce a plan that corresponded to the given elevation. The division on the plan for the shape interpreted was fairly well done. However, the shape to represent the cut surface in the plan was not well done. Many candidates failed to use the correct angle to produce the true shape of a cut surface. Twenty per cent of the candidates showed good technique and drawing skills to produce the true shape of the cut surface.

Note: All candidates using the CAD software were required to show all construction procedures in solving the problem.

Question 5

This question was designed to test candidates' ability to draw lines of intersection between solids. Candidates showed great skill in reproducing the given views and dividing the cylinder in the plan and front elevation into the same amount of equal parts. Candidates were unable to trace the points from the division in the plan and elevation to correspond in the front elevation to get the curve of intersection. Candidates who completed this question showed good drawing skills and technique in solving the problem.

Question 6

This question tested candidates' ability to construct a helix on a conical form. Most candidates failed to grasp the concept of the lead and proceeded to construct the helix over the entire circle. A few did not know they should converge the lines from the base to the apex. Drawing skills were generally poor, but those candidates who answered correctly understood that they needed to show a part of the curve in hidden details.

Question 7

This question tested candidates' understanding of geometrical tolerances. Some candidates showed an understanding of Limits and Fits but NONE understood geometrical tolerances.

Question 8

This question was designed to test candidates' ability to sketch fasteners. Very few candidates showed anything that resembled a slotted nut. Less that 20 per cent produced a double ended stud. Less than 30 per cent produced a gile-head key. Less than 30 per cent produced a wood ruff key. Approximately two candidates showed/ sketched an internal circlip.

Question 9

This question tested candidates' ability to make neat freehand sketches of pipe fittings. The vast majority of candidates who attempted this question answered using orthographic projection. Few candidates identified the concept of a flange. This question was attempted by the majority of candidates and most candidates performed well. However, the sketching was generally poor.

PAPER 02

Question 1

This question was designed to test candidates' understanding of loci. Few candidates responded correctly. Most candidates had problems understanding that point "D" is a pivot (most made it into a slide); in locating point "C" (candidates were able to complete the problem except for a few who kept point "B" as a stationary pivot); highlighting the "given" original figure; labeling the diagram.

Question 2

This question tested candidates' understanding of procedure in finding centroid using graphical method. Of the candidates who attempted this question, many tried to use the simple method of finding centroid which ignored the fact that the question asked for the use of graphical method.

Question 3

This question was designed to test candidates' ability to construct cam profiles and displacement diagrams. Some candidates lacked the ability to interpret the data and draw the initial diagram to start the cam. They also neglected to show the knife edge follower offset at 8mm to the left of the cam center. The majority of the candidates showed the minimum cam diameter, but only a few showed the line of action for the follower. The majority of candidates showed very good knowledge and understanding in interpreting the data and drawing the displacement diagram, showing uniform velocity, dwell, simple harmonic matron and uniform acceleration and deceleration. Very few candidates were able to show the correct way of drawing tangential lines to the 8mm radius circle.

Note: All candidates using a CAD software were required to show all construction procedures in solving the problem.

Question 4

This question tested candidates' ability to draw lines of intersection between solids, and to develop surfaces. Most candidates reproduced the figure and divided the cylinder but did not know how to transfer the points and construct the circles in the plan. Most candidates were comfortable with the development in spite of having the intersection curve incorrect. Line work was poorly done. Candidates who obtained the correct curve of intersection went on to draw the correct development for the cylinder. However, a number of candidates developed the right cone instead of the cylinder and the question specifically asked for the development of the cylinder.

Question 5

This question tested candidates' understanding of screw threads and springs. Not many candidates attempted this question. The main weakness of candidates centred around their inability to draw the front view of a cylindrical construction; divide the lead for the one and a half times; draw the root circle; draw the square by using half the pitch; draw half full size; draw smooth curves.

Question 6

This question was designed to test candidates' understanding of first-angle orthographic projection. The majority of the candidates attempted this question with most being able to complete the solution. There were areas that candidates did not show, for example:

- the point of tangency in the front elevation
- the correct projection (1st angle)
- the correct dimension
- the fillet in the plan
- the centre lines
- the naming of the views.

<u>Question 7</u>

This question tested candidates' ability to make freehand sketches of a selected machine part. The majority of candidates did not attempt this question and of the few who attempted, only a few did well. Most candidates did not know what was a tool maker's clamp.

<u>Question 8</u>

This question tested candidates' understanding of assembly drawings. More than half of the candidates did not scale the drawing and most did not assemble the parts totally. The drawings were not very neat and a few candidates were not familiar with projecting the plan.

<u>Question 9</u>

This question tested candidates' ability to prepare drawings with sectional views. Orthographic projection seemed to be understood by the majority of candidates. Sectional views were not properly understood, for example, screw threads and hidden details. The concept in hatching has to be taught, for example, contrast of lines, cutting open spaces, crossing solid lines.

RECOMMENDATIONS TO TEACHERS

Teachers are reminded to make full use of the suggested teaching and learning activities outlined in the syllabus. The activities are intended to facilitate the enhancement of capabilities and skills consistent with the aim of the syllabus.

Teachers should provide opportunities that will allow students to:

(i) solve problems pertaining to the content of the syllabus in the recommended texts

(ii) use real life examples to promote class discussion and illustrate the use and purpose of the various aspects of Geometry and Mechanical Engineering

(iii) use CAD software to produce drawings

(iv) visit Mechanical Engineering Drawing Offices and Mechanical Engineering Workshops to familiarize themselves with standards and good practice

(v) use articles from relevant periodicals on Mechanical Engineering topics to assist in adequate coverage of content in the modules

(vi) benefit from lectures by experienced engineers in order to enhance understanding and appreciation of the content in the modules.

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GENERAL COMMENTS

The revised syllabus was offered for the first time this year. Candidates wrote examinations in both Unit 1 and Unit 2. Candidates continue to display poor drawing skills and a lack of knowledge with regards to ISO standards. It is recommended that tours of engineering establishments be done and have candidates write reports after each tour. Actual engineering components should be used for demonstration purposes. Candidates should be required to practice ISO conventions whenever they are drawing.

DETAILED COMMENTS

UNIT 1

PAPER 1

Question 1

This question tested candidates' knowledge of an involute and their ability to construct an involute. Approximately half of the candidates were able to define the involute while others confused the involute with the cycloid, hypocycloid or epi-cycloid.

In the second part of the question, candidates were asked to construct an involute. Some candidates drew radial lines on the divided circle and marked off the distances on this line rather than on the tangents to the divided circle at the division points. Approximately 80 per cent of the candidates were able to construct the involute. The response to this question was good.

Question 2

This question tested candidates' knowledge of the centroid of an area and their ability to find the centroid graphically. This question was very popular and was attempted by more than 95 per cent of the candidates. Most candidates only drew up to the given figure. There were many varieties of the solution and they were marked accordingly. The candidates who used the graphical integration to find the first derived figure did not find the centroid.

Question 3

This question tested candidates' knowledge of cams and their ability to make graphical representation of the cam. Candidates showed a general lack of understanding or knowledge of cams. They confused the cam profile with the cam follower. Very few candidates knew what a face cam looked like and did not know what a pictorial shape is. The candidates had difficulty representing the cylindrical cam. General drawing skills were very poor most candidates knew. What was required but application and graphical representation were weak.

Question 4

This question tested candidates’ knowledge of isometric view and their sketching skills. A number of responses showed weakness in circular details. Candidates did not know how to construct isometric circles and arcs.

Question 5

This question tested candidates’ ability to draw the development of truncated figures. While, candidates were familiar with the topic of development. Some candidates were only able to draw the given view. The dimensions on the view were ignored. Some candidates did not project lines perpendicular to the axis but rather they used horizontal lines. Projection lines were taken horizontally instead of vertically.

Question 6

This question tested candidates’ ability to draw auxiliary view. A large number of candidates produced incomplete responses, resulting in a low score. Candidates failed to recognize the key or projection symbol shown and produced a view that did not conform to any projection known.

The auxiliary view requested from the direction of arrow B proved to be a bit difficult for some candidates, suggesting that not much time was spent on practice in this area. Candidates displayed poor sketching ability. The requested end view from the direction of arrow A was misinterpreted by many candidates. Several gave x three separate views situated on the right side of the plan.

Question 7

This question tested candidates’ knowledge and drawing skills in producing a sectioned view of a component. Generally candidates who attempted this question demonstrated good knowledge of the principles of orthographic projection. However, some candidates lacked the ability to complete a half-sectioned view. The basic line convention for hatching was ignored. Some candidates displayed reasonable skills in sketching in proportion, while some opted to use a straight edge to produce the drawing when the question clearly stated freehand. Some candidates did not understand the difference between an orthographic view and a pictorial view.

Question 8

This question tested candidates’ knowledge of limits and fits. The majority of candidates did understand tolerances. A number of candidates spoke of the amount of pressure a component can take. Teachers need to encourage candidates to read and research mechanical engineering practices.

Question 9

This question tested candidates’ knowledge of seals. The response to this question was fairly low with about 15 per cent of candidates attempting the question. Responses generally indicated that candidates had little or no knowledge of seals. The definitions were poor. A number of candidates interpreted static to mean electricity. The application and drawing skills demonstrated in the responses emphasized the lack of knowledge. A number of candidates highlighted bottle caps as seals while it was difficult to comprehend the sketches. Of those who attempted the question only a few candidates were able to score eight out of 10.

It is recommended that more attention be paid to seals and their applications and those candidates be provided with practical experience with regard to these applications.

UNIT 1

PAPER 2

Question 1

This question tested candidates' ability to plot the locus of a point on a link mechanism. This question was attempted by most candidates. The responses were well done.

Question 2

This question tested candidates' ability to find the centroid of a figure. The question was not very popular. Some candidates only drew the given figure. Those who were able to integrate the first and second moments did not calculate the distance of the centroid and the second moments of area. The formula and the symbols for the various points were not identified. The construction lines for the first and second derived figures were too close and were not shown clearly. The few candidates who were able to find the solution showed that they understood the topic very well. Some used the construction of centroid by moments and a few used the link (funicular) method which was not asked for.

Question 3

This question tested candidates' ability to design and draw the profile of an edge cam. Most candidates failed to mark off angular divisions in the correct direction. A number of responses did not indicate the dwell on the cam profile. Some candidates showed difficulty in being able to distinguish among the different motions. Some candidates gave UARM for UV. However, most of the responses showed the candidates being able to draw the displacement diagram for SHM. Some candidates scaled the drawings but did not show the scales. Some candidates failed to transfer points correctly to plot cam profile.

Question 4

This question tested candidates' ability to construct auxiliary view and sectional plan. Generally, candidates who attempted this question demonstrated poor knowledge of required steps to obtain the sectional plan. Most candidates were unable to use the horizontal cutting plane in the given elevation to produce the curve in the sectional plan. Some candidates demonstrated limited skills and knowledge in projecting lines perpendicular to the cutting plane 'x-x' to obtain the auxiliary view.

Question 5

This question tested candidates' ability to draw the curve of intersection and the development of intersecting cylinders. Some candidates who attempted this question did quite well. A few candidates did not project lines from the elevation to plot the plan. In some cases the end view was not attempted and the development was completely ignored. Quite a few candidates did not project lines perpendicular to the axis of the cylinder, for which the development was required. Generally, it was clear that candidates were familiar with the topic of development, but did not apply it properly to the problem given.

Question 6

This question tested candidates' ability to construct a helical spring with a round cross-section. A large number of candidates interpreted the 10mm diameter as 10mm radius. Some candidates had the pitch values greater than was given. Many candidates divided the circle in more than 12 equal parts. Some candidates did not divide the circle and pitch into the same number of equal parts while some candidates did not plot and draw circles which defined the spring.

Question 7

This question tested candidates' ability to assemble a bearing and draw a sectional front elevation and plan. Most candidates were able to assemble the components to form the required view. However, a few candidates experienced difficulty visualizing the sectional elevation and where section lines should be used. A large number of candidates omitted the bush. Approximately 75 per cent of the candidates experienced difficulty with the construction of nut and stud and the hexagonal nut and bolt.

Question 8

This question tested candidates' ability to assemble a component and apply the ISO convention as it relates to machining symbols. The majority of candidates responded to this question and demonstrated knowledge of assembly. A few, however, were unable to apply the nut and bolt assembly. Candidates also demonstrated knowledge of sectioning, some were unclear with regard sectioning more than one component. No measurements were given for the drawing, so candidates were required to transfer dimensions for the question paper. Most of them showed some knowledge of this but they were not consistent with the dimensions. A number of candidates fell down in the area of drawing skills. Only a few demonstrated knowledge of the application of a parts list and the machining symbol. They also showed limited knowledge of materials and material selection.

Question 9

This question tested candidates' knowledge of machine tool and sketching ability. Very few candidates exhibited knowledge of a shaping machine. A few candidates were able to list a few of the parts but none could produce a sketch remotely resembling the shaper. It is recommended that greater attention be paid to the aspects of the syllabus dealing with machines and machine operations so that candidates can develop a better understanding of the area. If the resources are not available in the institution for practical demonstrations, organized tours as well as mechanical engineering text can be used.

UNIT 2

PAPER 1

Question 1

This question tested candidates' knowledge of forces and their ability to use the graphic method to find the resultant of a system of forces. Candidates had problems in defining coplanar and concurrent forces. Many candidates omitted direction arrows in the force diagram. Bow's notation was not properly expressed and utilized. Many candidates completed the problem without stating the measured magnitude and direction. Some candidates gave the equilibrant when what was asked for was the resultant.

Question 2

This question tested candidates' knowledge of finding where a line cuts a plane. Most candidates failed to answer this question and only drew the given figure. Few were able to identify the point where the line cuts the plane. No one was able to draw the hidden line. Some candidates interpreted this question to be an auxiliary and hence tried to find the true length. No line was drawn downwards from where the line cuts the plane to find the point.

Question 3

This question tested candidates’ knowledge of spur gear tooth terminology. Candidates referred to the pitch circle as the circular pitch. Many responses failed to describe the gear terminology as distances but as points. Consequently, some responses indicated the addendum and dedendum as points. Most candidates were able to clearly describe and sketch to illustrate the tooth thickness.

Question 4

This question tested candidates’ knowledge of the advantages of forging as compared to machining a bolt head. Most of the candidates who responded to the question were able to identify that the strength of the material would be greater with forging and that there would be more material wastage with machining. Most candidates did not use sketches to illustrate the advantages and disadvantages. Very few candidates were able to describe the correct forging operation for producing the bolt head. Drawing skills were poor.

Question 5

This question tested candidates’ knowledge of plain bearings. This question presented a challenge to many candidates at this level; only about 2 per cent of candidates were able to achieve marks above 80 per cent. Many candidates illustrated roller bearings instead of plain bearings.

Question 6

This question tested candidates’ knowledge of the method of lubricating a plain bearing. Approximately 70 per cent of the candidates were able to design an appropriate method of lubricating the bearing. However, the ability of candidates to produce clear detailed drawing was a problem. The basic principles of sketching was not used.

Question 7

This question tested candidates’ knowledge of design consideration when designing for forging and welding. The majority of candidates performed poorly.

Question 8

This question tested candidates’ knowledge of gears. Candidates related the concept of gears to actual mechanical devices and directly to spur gears. Drawing skills were poor and very few drew the correct representation of the gears. Most candidates who did the question understood what was required graphically for the straight spur gear but had difficulty with the definition. About 85 per cent of the candidates who attempted the question did not know what a helical spur gear was.

Question 9

This question tested candidates’ knowledge of the stages in the design process. Candidates who attempted this question demonstrated good knowledge in describing the stages in the design process.

UNIT 2

PAPER 2

Question 1

This question tested candidates’ knowledge and ability to draw shear force and bending moment diagram. Candidates generally performed well on this question, most of them earned the full mark. A few candidates had problems stating the appropriate scale and also stating the values of the reactions. In a few cases, candidate did not produce a shear force diagram, and others did not label the bending moment diagram.

Question 2

This question tested candidates’ ability to find the shortest distance between two skew lines. This question was attempted by the majority of candidates. However, most candidates only reproduced the given views. Few candidates got the solution to the problem. Some candidates used the conical method to get the true length. The construction for the auxiliary was very well done by those who attempted the question. Some did not construct the perpendicular, but drew the line.

Question 3

This question tested candidates’ knowledge of spur gear teeth parameters and their ability to draw the gear tooth profile. The question was poorly attempted.

Question 5

This question tested candidates’ knowledge of sand-casting. Of those who attempted there was an indication of a general knowledge of the advantages, however they were vague in their explanation of the disadvantages. Candidates also demonstrated limited knowledge of the sand-casting method. The steps listed were generally not in keeping with sand-casting methods. Candidates also failed to give good illustrationx for the production steps. It is recommended that more time be given in class to the metalworking processes.

Question 6

This question tested candidate’s knowledge of lubrication and seals. The question was generally ignored. Teachers are encouraged to guide candidates according to the syllabus.

Question 7

This question tested candidates’ knowledge of couplings. The question was poorly done. Candidates demonstrated poor knowledge of coupling.

Question 8

This question tested candidates’ knowledge of the design process. Approximately 90 per cent of the candidates who attempted this question demonstrated a good knowledge of the design process. The linkages and examples given were well presented for each stage of the design process.

Question 9

This question tested candidates’ knowledge of ergonomics. The question was generally ignored. Teachers are encouraged to guide candidates according to the syllabus requirements.

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GENERAL COMMENTS

There has been significant improvement in candidates' performance in Unit 2 this year. However, candidates continue to display poor drawing skills and limited knowledge of ISO standards and conventions. Site visits to engineering establishments and regular practice using ISO standards should help candidates preparing for the examination.

UNIT 1

PAPER 01

Question 1

This question tested candidates' ability to plot points of an auxiliary view from a truncated cone. The weaker candidates reproduced the given figure, a few were able to do the projection, but failed to get the correct curve in the auxiliary view. Most did not do a plan view to show the cut area. Overall approximately 70 percent to 80 percent performed fairly well.

Question 2

This question tested candidates' ability to draw and differentiate between the performance graphs for different cam motions. The question was generally well done, with some candidates scoring full marks. A few candidates were unable to draw the performance graphs, particularly with respect to the uniform acceleration. In some cases candidates incorrectly identified the performance graphs (UV for SHM, UA for SHM,). Weaker candidates confused the three graphs.

Question 3

This question tested candidates' ability to graphically determine the centroid of a quadrilateral. Approximately 70 percent of the candidates who attempted the question scored 75 percent and over. Several candidates tried unorthodox means of finding the centroid of the given figure and ended up having difficulties.

Question 4

This question tested candidates' ability to construct the curve of intersection of a cylinder and a right cone. Most candidates who attempted the question did not demonstrate the correct method(s) for producing the curve of intersection. Approximately 50 percent of the candidates who attempted the question reproduced the given figure. About 40 percent of the candidates who reproduced the figure knew how the curve of intersection would actually look.

Question 5

This question tested candidates' ability to construct an auxiliary view to show the true shape of the cut surface of the cylinder. Most candidates' responses were weak. Some candidates only reproduced the given figure. Most of the candidates who attempted the question were able to produce the correct response. More practice is needed with cylindrical solids (truncated).

Question 6

This question tested candidates' knowledge of double start helix. Candidates who attempted this question exhibited a good grasp of the concept of the helix thread and the construction process necessary. Approximately 30 percent of all candidates that attempted the question went beyond the parameter of the question by constructing spring and triple start helix. Generally the response to this question was very good with approximately 98 percent of the candidates obtaining approximately 70 percent of the marks allocated.

Question 7

This question tested candidates' knowledge of welding and machining symbols. Candidates incorrectly identified the weld on opposite side as indicated by the arrow. Some candidates reproduced the given symbols instead of the pictorial sketches that were required. Some candidates seem to lack the knowledge of welding symbols. A number of responses were given as sections. Very few candidates scored above 50 percent and no candidate scored full marks. Most responses showed candidates only being aware of fillet weld symbol. Very few responses indicated the correct meaning of the machining symbols.

Question 8

This question tested candidates' knowledge of oblique projection and freehand sketching. Several candidates were unable to differentiate isometric and oblique projection and were unable to draw neat proportional sketches. A large number of candidates copied the given isometric drawing from the question paper. Approximately 30 percent of the candidates scored 50 percent to 100 percent.

Question 9

This question tested candidates' ability to assemble different engineering components to produce a single drawing. It also tested their knowledge of simple locking devices. The most challenging aspect of the question was the application of the locking devices. 207 candidates attempted this question. Most of the candidates demonstrated a good understanding of how to assemble the components to produce the final drawing.

PAPER 02

Question 1

This question tested candidates' knowledge of the locus of a point on a crank and link mechanism. Candidates who attempted this question generally completed the locus of point "P". Quite a number of candidates either did not use construction lines or erased them. Some candidates used incorrect measurements when drawing the given arrangement. A few candidates did the loci question from examples they remembered ignoring the arrangement given. Approximately 70 percent of the candidates failed to outline the given arrangement or outline at least one position of the mechanism. 65 percent to 70 percent of the candidates were unable to show the path for the roller's center. Candidates were able to demonstrate good knowledge and understanding of the movement of the mechanism. There is need to improve the line work and lettering fundamental skills which seem to be lacking at this advanced stage of drawing. Teachers are asked to encourage their students to read loci problems and check all the measurements, before attempting them.

Question 2

This question tested candidates' ability to design a cam profile of a radial plate cam to impart the following motions:-

(1) Simple Harmonic Motion;
(2) Dwell;
(3) uniform acceleration and retardation.

Over 80 percent of the candidates attempted this question. Construction of the cam profile was generally well done. A few candidates experienced difficulties with display roller position and drawing tangents to the required rollers.

The majority of the candidates who attempted this question performed well. Some candidates exhibited weakness in the following areas:

(1) not aligning cam profile with cam construction;
(2) inability to determine the direction of cam movement;
(3) poor construction method to find the acceleration and retardation curve;
(4) inability to place the roller in the different positions on the cam profile.

Question 3

This question tested candidates' knowledge of the centroid and second moment of area. This was a very popular question. Generally, candidates were able to reproduce the given figure and demonstrate good knowledge and understanding and drawing skills in dividing the figure and finding the first and second derived figures graphically. Candidates showed a poor level of understanding in integrating the areas using the first and second derived curves to find the centroid and the second moment of area. Some candidates were able to state the formula but were not able to apply it. Most candidates using graph paper to determine Areas A, A1, A2 did not determine it correctly, the resulting areas were exactly twice as much or greater.

Question 4

This question tested candidates' knowledge of the curve of intersection and development. It was attempted by less than half of the candidates and the responses were poor. Many candidates were unable to correctly construct the curve of intersection and proceeded to draw the curve freehand. Candidates also displayed an inability to draw the development of the right cone. Most candidates were only able to score an average of 15 percent of the marks allocated.

Question 5

This question tested candidates' knowledge of an auxiliary view. It was attempted by about 30 percent of the candidates. A number of candidates had difficulty in projecting the auxiliary curves. Candidates did not demonstrate this understanding that the lines are pulled perpendicularly to the surface and that the curves are to be divided in the given orthographic view, then transferred to the auxiliary view. Generally, candidates were able to reproduce the given orthographic views and project lines to get their auxiliary view but had difficulty with auxiliary views with curves and other engineering features.

Question 6

This question tested candidates' ability to convert an orthographic drawing to an isometric projection. It was attempted by over 75 percent of the candidates. A large majority gave a satisfactory response. There were good performances on the construction of the lower semi-circle. The construction of the upper semi-circle was the weaker area. A large number of candidates were able to handle satisfactorily the isometric axis. However, about 12 percent of the candidates interpreted isometric to mean either oblique or axonometric projection. It would be an advantage for candidates to practice isometric drawings that have non-isometric lines, circles and arcs.

Areas of difficulty were identified as follows:-

(1) making ‘X’ the lowest point;
(2) using the correct angles for isometric projection;
(3) accuracy of measurement;
(4) interpretation from orthographic to isometric;
(5) construction of isometric circles.

Question 7

This question tested the candidates’ knowledge of limits and fits. This was not a popular question. The overall performance was poor. For parts (a) and (b) only 10 percent of respondents correctly used the table and completed the required calculations.

For part (c), candidates were able to produce a drawing of the bush; however, the majority misunderstood the phrase ‘working drawing’ and also failed to dimension the component correctly indicating its limits and fits.

None of the candidates was able to correctly suggest a suitable bushing for the component. Candidates, who scored in the region of 70 percent for this question, stated the formula and used the table. They were also able to correctly interpret part (c). It is recommended that greater attention be paid to this topic in the classroom. Students should be encouraged to use the applications for limits and fits when producing drawings as a norm.

Question 8

This question tested candidates’ knowledge of assembly drawing. This question proved to be the most popular in this section with over 60 percent of candidates providing a response. The majority of respondents demonstrated knowledge of assembly, as well as, a knowledge of sectioning. Only 10 percent of candidates were able to correctly assemble and section the component.

Of those attempting this question, 20 percent showed a clear knowledge and application of balloon referencing. The majority demonstrated a knowledge of the parts lists. Candidates generally were unable to produce the end view. Candidates who scored in the region of 80 percent on this question, set out and assembled the drawing correctly and showed clearly the differences in components to be sectioned. They also applied the principles of balloon references well.

Candidates, who scored poorly, produced ambiguous drawings and they were unable to apply the general principles. In the classroom it is, therefore, necessary to enforce higher drawing standards to allow students the opportunity to constantly practice line types, layout, drawing techniques, projection symbol and types of projection assembly and sectioning.

Question 9

This question tested candidates’ knowledge of centrifugal and reciprocating pumps, seals and fastening devices. Approximately 50 percent of the candidates attempted this question. Sketching was poorly done but the labeling of the pumps was done satisfactorily. Most candidates lacked the knowledge to explain the difference between the two types of pumps. Some candidates explained very well how static seals are used. Part (c) of the question was almost invariably answered correctly for those who attempted it. For part (d) all candidates who attempted the question were able to show the nut and bolt, however, they had difficulty showing the correct shape for the pan head rivet.

UNIT 2

PAPER 01

<u>Question 1</u>

This question tested candidates' ability to draw the true shape of the surface of a prism and find the true angle of slope between two planes. Approximately 40 percent of the candidates who attempted this question completed only the given views. About 90 percent of the candidates who attempted part (a) of the question completed the true length successfully. Some candidates used a construction method to find the true length of BC even though this was given. A number of candidates drew the triangles only, when the question asked for the given view.

<u>Question 2</u>

This question tested candidates' ability to use graphic methods to determine the reactions of a loaded beam. This was a very popular question, and several candidates made a perfect score. The range of marks was from eight to 10. In a few cases, marks were deducted for not stating the magnitudes and not stating the appropriate scale used. A small number of candidates, about five percent or smaller, scored zero to two for drawing the loaded beam to scale, and extending lines of actions of load and scored no further points since the rest of the problem was solved mathematically instead of graphically.

<u>Question 3</u>

This question tested candidates' knowledge of gear teeth and terminology. The quality of sketches produced by the candidates showed a wide range of abilities, from the well defined three dimensional view to two scrappy lines. Candidates need to understand the importance of producing neat clearly annotated sketches/drawing. Over 90 percent of the candidates had no idea what the blank circle diameter was. Some were suggesting that this was a trick question. Candidates were not familiar with terms and practices used.

<u>Question 4</u>

This question tested candidates' knowledge of the properties of materials. It was not handled well by the candidates. Many of the terms were incorrectly identified, except for malleability. Many candidates did not give correct examples for plasticity. Examples for toughness and hardness were generally correct.

<u>Question 5</u>

This question tested candidates' knowledge of the difference between radial and thrust load and their ability to produce neat labeled sectional sketches of ball bearing to take these loads. This question was generally well handled. Candidates had some knowledge of bearings. Some problems that were noted are as follows:

(1) candidates showed confusion in identifying the correct bearing;
(2) the definition was long;
(3) suitable diagrams were not drawn.

<u>Question 6</u>

This question tested candidates' knowledge and ability to identify welding processes abbreviation and symbols. About 60 percent of the candidates attempted the question. Very few candidates were able to identify the abbreviations and about 50 percent of those who attempted the question were able to accurately identify the welding symbols.

Question 7

This question tested candidates' knowledge of power transmission mechanisms. Many candidates who attempted this question displayed a fair understanding of spur gears but neglected the distance apart of the shafts a feature which made spur gear not a suitable choice. 20 percent were able to produce sketches of a suitable mechanism. Candidates are advised to spend more time in this area and to visit machine shops and factories focusing on solutions to simple problems.

Question 8

This question tested candidates' knowledge of couplings. Many candidates were able to produce sketches of couplings but were unable to give proper names to the sketches. Candidates should be encouraged to compile charts of different types of power transmission devices and their uses. A portfolio approach with field trips should be of help in understanding power transmission devices.

Question 9

This question tested candidates' knowledge of the engineering design principles and process. Candidates were able to express themselves sufficiently clear to indicate that they understood what engineering design meant, however, some candidates could not explain Synthesis and Optimization.

PAPER 02

Question 1

This question tested candidates' knowledge of forces acting in the members of a simple framework. Approximately 98 percent of the candidates attempted this question. Most candidates had difficulty identifying the tie and strut. Some candidates were unable to distinguish between a framework and a simple beam.

Question 2

This question tested candidates' knowledge and ability to find the shortest distance between two lines in space and to find the angle of slope between the shortest distance and the horizontal plane. Approximately 70 percent of the candidates attempted this question with approximately 25 percent of them scoring between 15 and 25 marks, while about 60 percent scored between zero and eight marks of the total score of 25 marks. A large percentage of the candidates experienced difficulty in finding the second true length of the two lines in space. Most candidates could not project the shortest distance back to the front elevation and plan.

Question 3

This question tested candidates' knowledge and ability to calculate gear teeth parameters and to construct three consecutive gear teeth. Approximately 60 percent of the candidates responded to this question. Most responses scored well, approximately 20 out of 25 marks, with some candidates scoring full marks. Few responses scored less than 10. The question asked candidates to draw twice full size, however, some candidates drew the gear at full, half full size and four times full size. Most candidates were able to perform the calculations to obtain the base, pitch, root and outside circles. Some candidates had difficulty distinguishing between pitch circle and pitch circle diameter. Likewise, a number of candidates indicated the addendum and dedendum as points on the root and outer circles, rather than as distances between these circles and the pitch circle. Many candidates failed to indicate the gear data.

Question 4

This question tested candidates' knowledge and ability to identify the three main components of a precision vice, and to select suitable materials and explain how each part can be manufactured. In addition, they were asked to design a suitable handle, list ergonomic and aesthetic qualities of the design and explain how the vice works. This was a popular question and most candidates performed well. The weak candidates had difficulties in understanding the terms mentioned.

Question 5

This question tested candidates' knowledge of antifriction and journal bearings. In addition, they were to sketch a taper roller bearing, explain its use and give an application. This question was a very popular question with approximately 70 percent of the candidates attempting it. Approximately 80 percent of those who did the question scored over 15 out of a maximum of 25 marks. Most candidates were able to

(1) identify the bearings;
(2) explain the difference between antifriction and journal/sleeve bearings;
(3) give an example of an application for the taper roller bearing;
(4) sketch a taper roller bearing.

Question 6

This question tested candidates' knowledge of properties and uses of thermosetting plastics and thermoplastics. Candidates were also asked to list properties of rubber that is suitable for seals, and applications of rubber. Most candidates, who responded to this question, were able to easily distinguish between thermosetting plastic and thermoplastic. Some candidates confused properties of rubber with its application. Most candidates were able to give uses of plastics.

Question 7

This question tested candidates' knowledge of the design stages and their ability to redesign a component to be fabricated by welding. Few candidates attempted this question. Their scores ranged from two to 18 marks. This wide range shows a great disparity in the abilities of those candidates who attempted it. Most candidates seemed to have misunderstood the phrase "indicate simple forms". This part of the question carried a significant portion of the marks, resulting in many of the low scores. The choice of appropriate materials was a major challenge to most candidates.

Question 8

This question tested candidates' knowledge and ability to select suitable materials based on the specifications given of an engineering component. This question was very popular. The terms used were not fully understood by the weaker candidates.

Question 9

This question tested candidates' knowledge and ability to design a wall mounted television stand to satisfy some specified conditions. It also tested their knowledge of materials and manufacturing processes. This question was well done by the majority of the candidates who attempted it. Several candidates scored over 12. Few candidates scored below 10. Some of the candidates experienced difficulty with sketching and choosing appropriate materials.

INTERNAL ASSESSMENT

UNIT 1

Assignment 1

This assignment was fairly well done. Attempts at problem solving were reasonably informed.

Assignment 2

Well done by most candidates. Candidates showed good knowledge of this area of Engineering. However, in terms of housekeeping, (ensuring that Cam Data, Cam centres, Cam rotation arrow are listed or visible), much work is needed.

Assignment 3

In this area of the syllabus, many intersections were incorrectly done.

Assignment 4

Software incompatibility was evident. Some candidates copied the assignment solutions both on soft and hard copy and submitted them as their own. Some standardization is also necessary for the list of commands requested.

Assignment 5

Design was not handled very well. The design process needs to be followed and marks awarded according to the marking scheme.

Assignment 6

This assignment was handled very well in terms of the quality of the assignment and the level of the drawing skills.

UNIT 2

Design

Most centers did a fairly good job in addressing the aspects of the design process. However, emphasis must be placed on mechanical design in terms of pumps, gears, etc. as opposed to the aesthetics of the design. Candidates must be encouraged to follow the six-stage design process.

LIMITATIONS

- CAD Software incompatibility.

RECOMMENDATIONS

(1) Greater attention should be paid to the problem solving steps. This would allow candidates to be better equipped when solving a design problem.

(2) The design process should form part of the curriculum even in the lower school.

(3) The choice of projects should be addressed so that candidates are encouraged to explore topics within each of the modules.

(4) Greater attention is given to the range of communication skills necessary to produce quality project reports.

(5) Teachers should utilize the resources of the school/community and do team teaching in relevant topics.

(6) Where centers lack teaching aids such as are readily available in the mechanical workshops, students should be taken on tours to observe the related technologies in action.

SEE APPENDIX - SOLUTIONS TO SELECTED QUESTIONS

APPENDIX

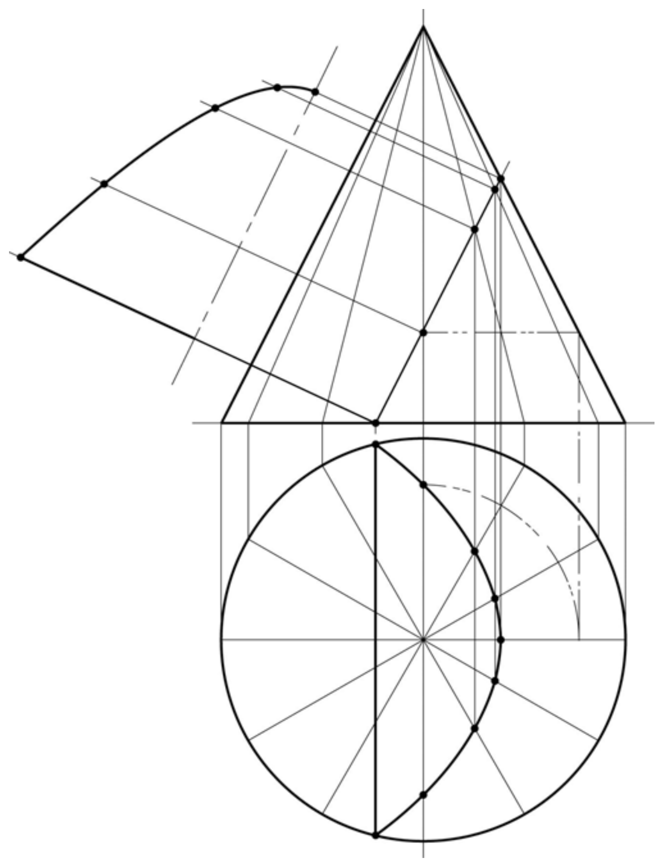
SOLUTIONS TO SELECTED QUESTIONS

UNT 1

PAPER 01

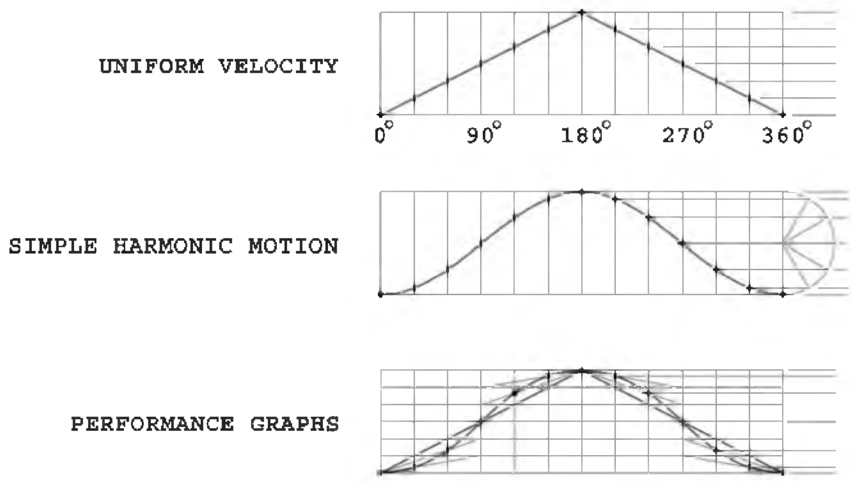
Question 1

SOLUTION



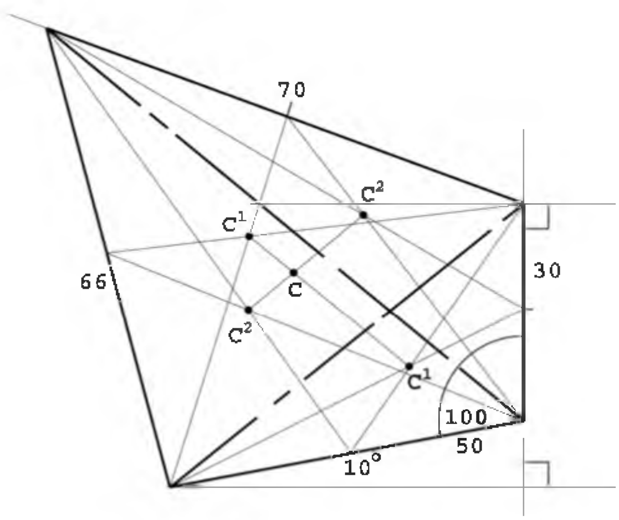
Question 2

SOLUTION



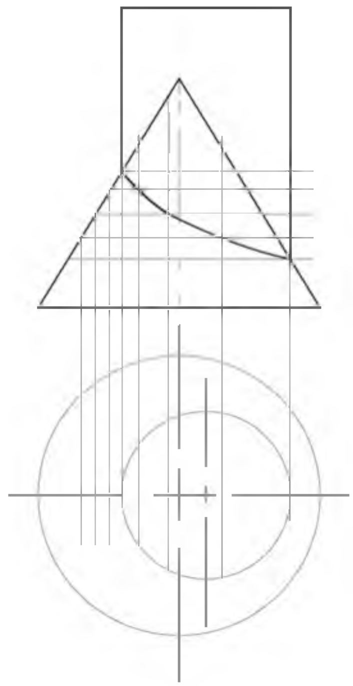
Question 3

SOLUTION



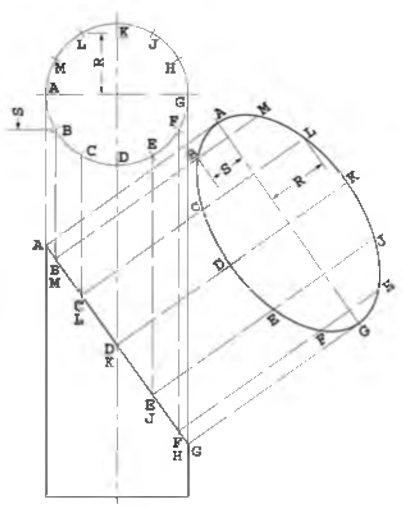
Question 4

SOLUTION



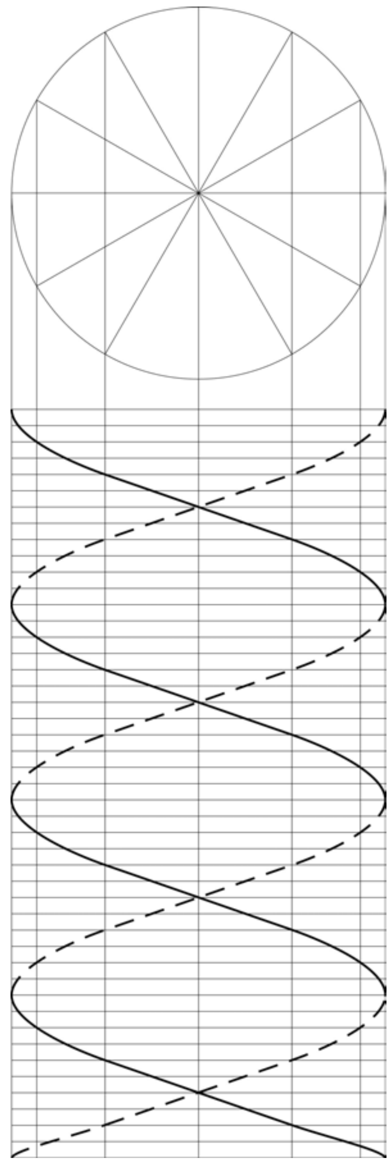
Question 5

SOLUTION



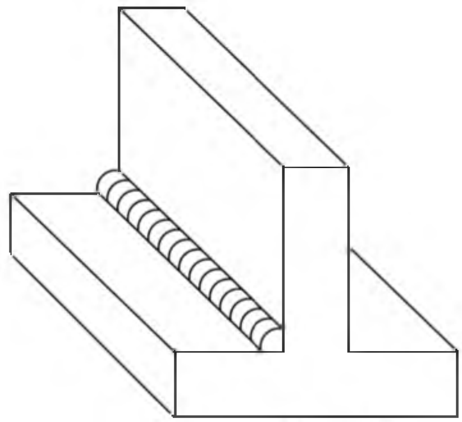
Question 6

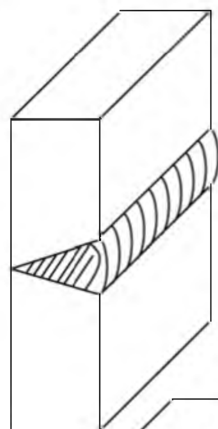
SOLUTION

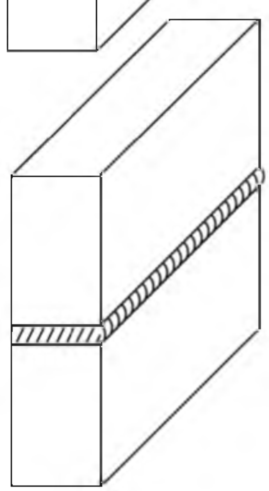


Question 7

SOLUTION

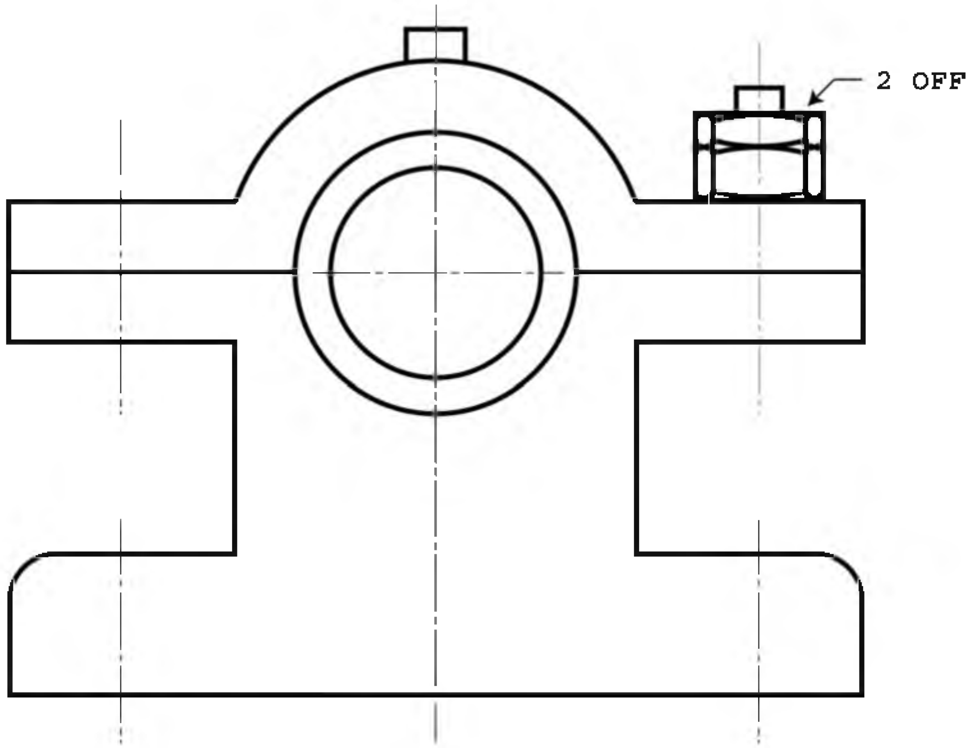
(i)  Fillet weld on arrow side.

(ii)  Single vee butt weld on arrow side.

(iii) 

Question 9

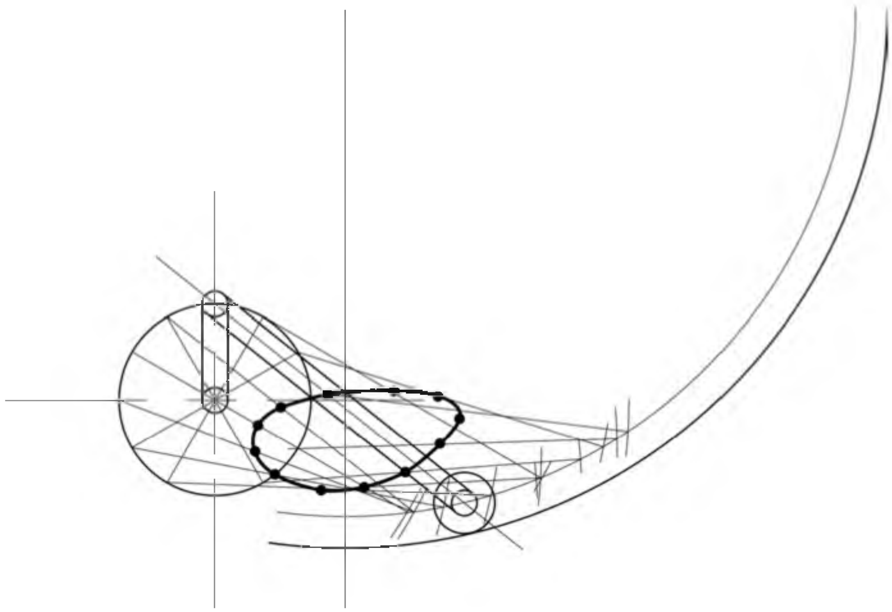
SOLUTION



PAPER 02

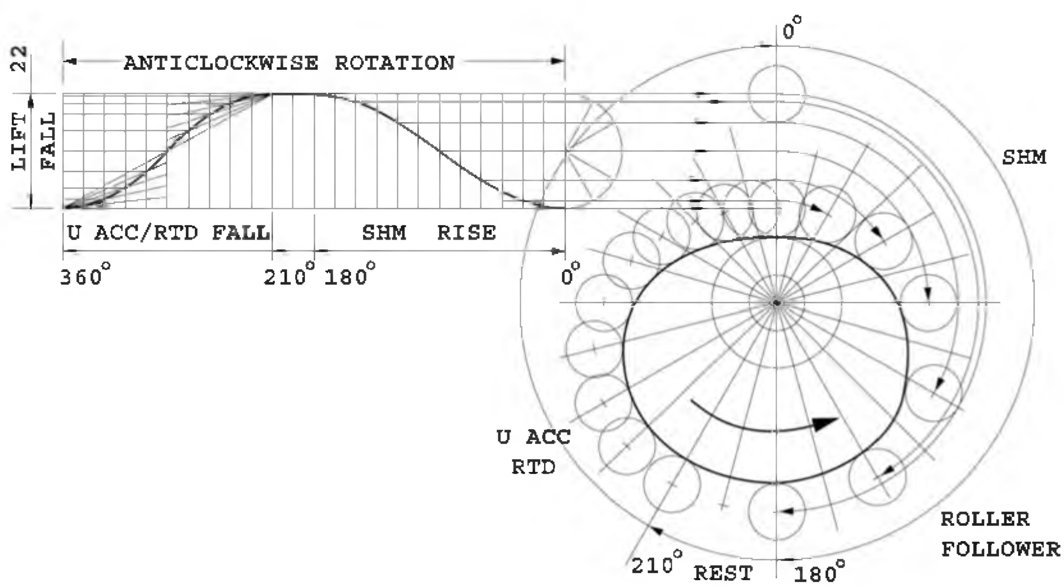
Question 1

SOLUTION



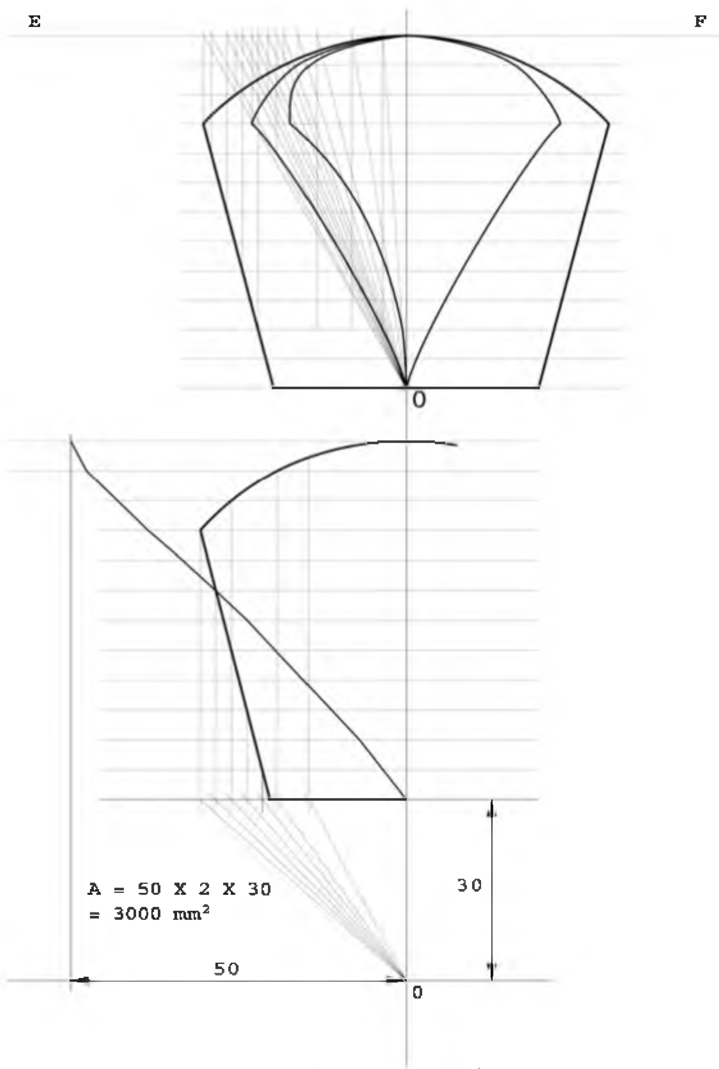
Question 2

SOLUTION



Question 3

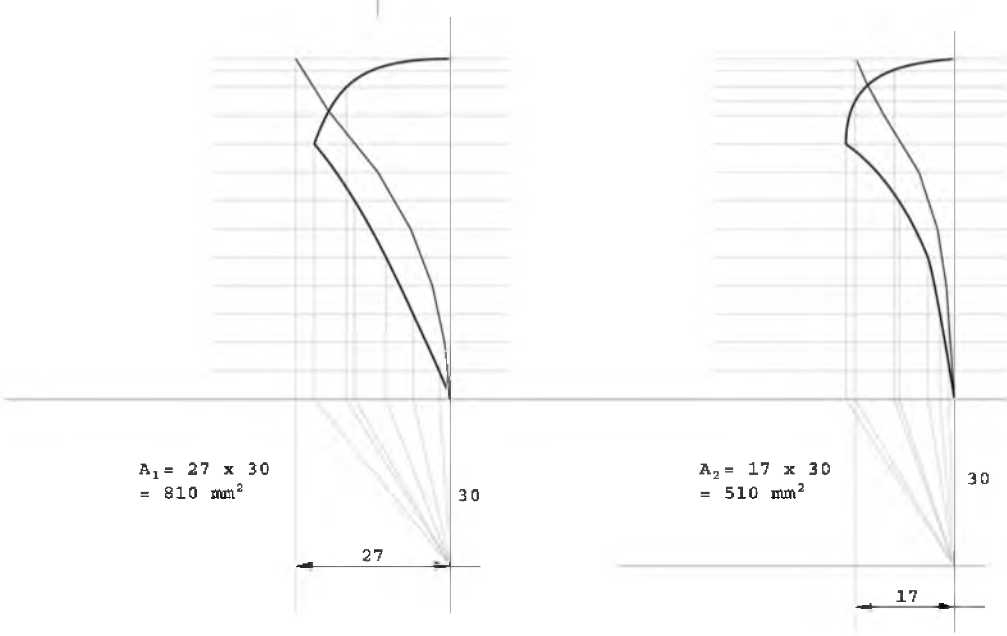
SOLUTION



$A = 50 \times 2 \times 30 = 3000\ mm^2$
$A_1 = 27 \times 30 = 810\ mm^2$
$A_2 = 17 \times 30 = 510\ mm^2$
$d = 60$

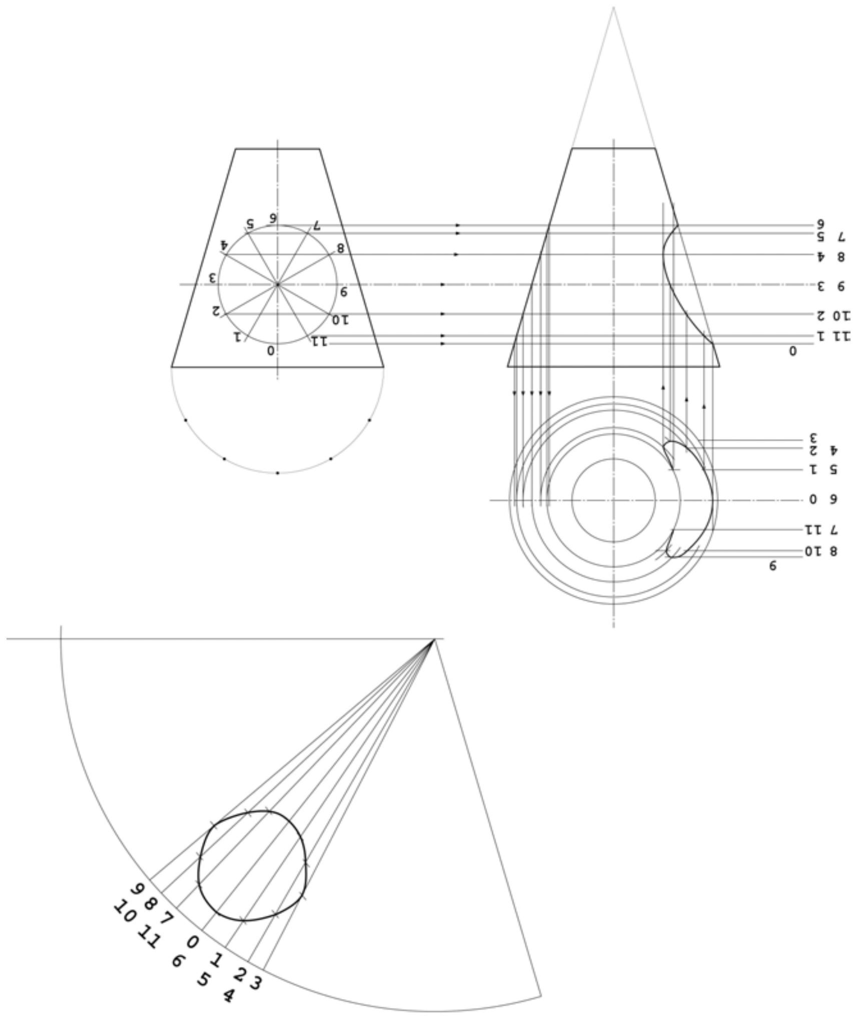
$$\bar{y} = \frac{Aid}{A} = \frac{810 \times 60}{3000}$$
$= 16.2$ mm

2^{nd} Moment of Area =
$= 510\ mm^2 \times 60 \times 60$
$= 1836000\ mm^4$
$= 1.836 \times 10^6\ mm^2$



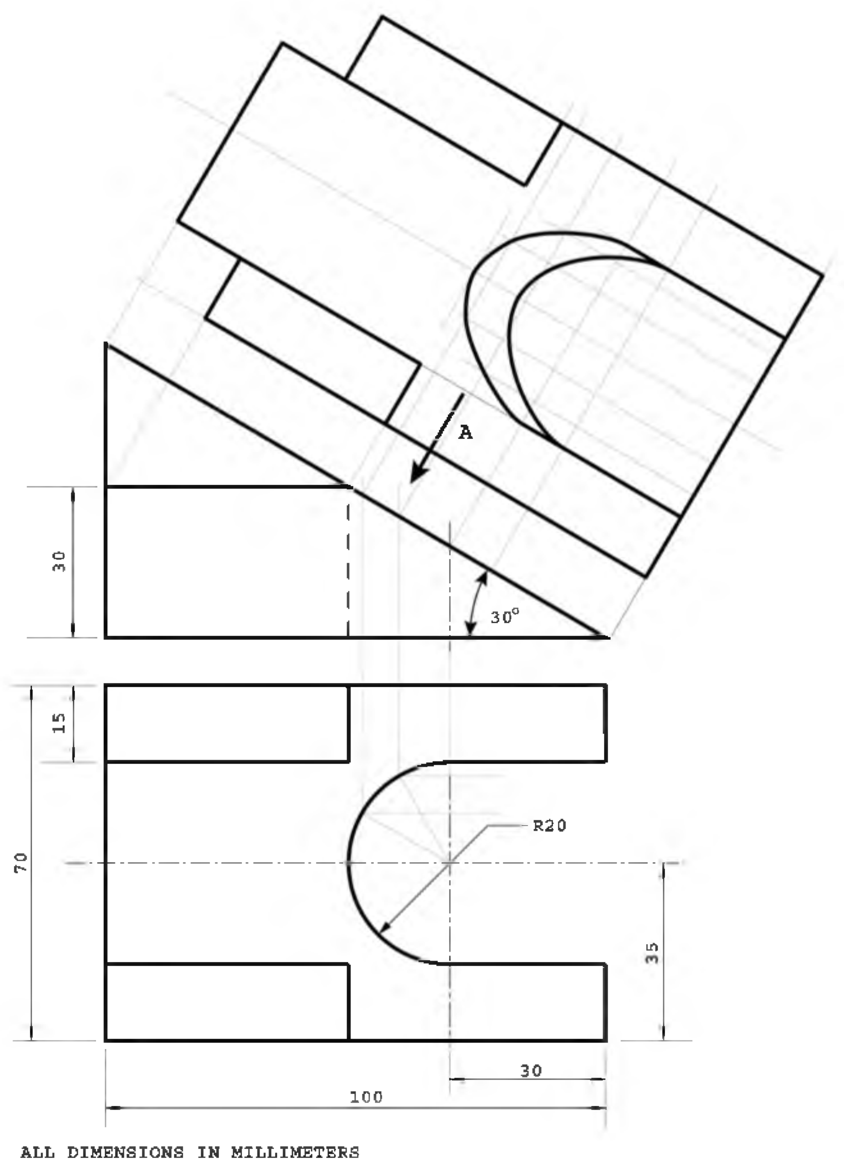
Question 4

SOLUTION



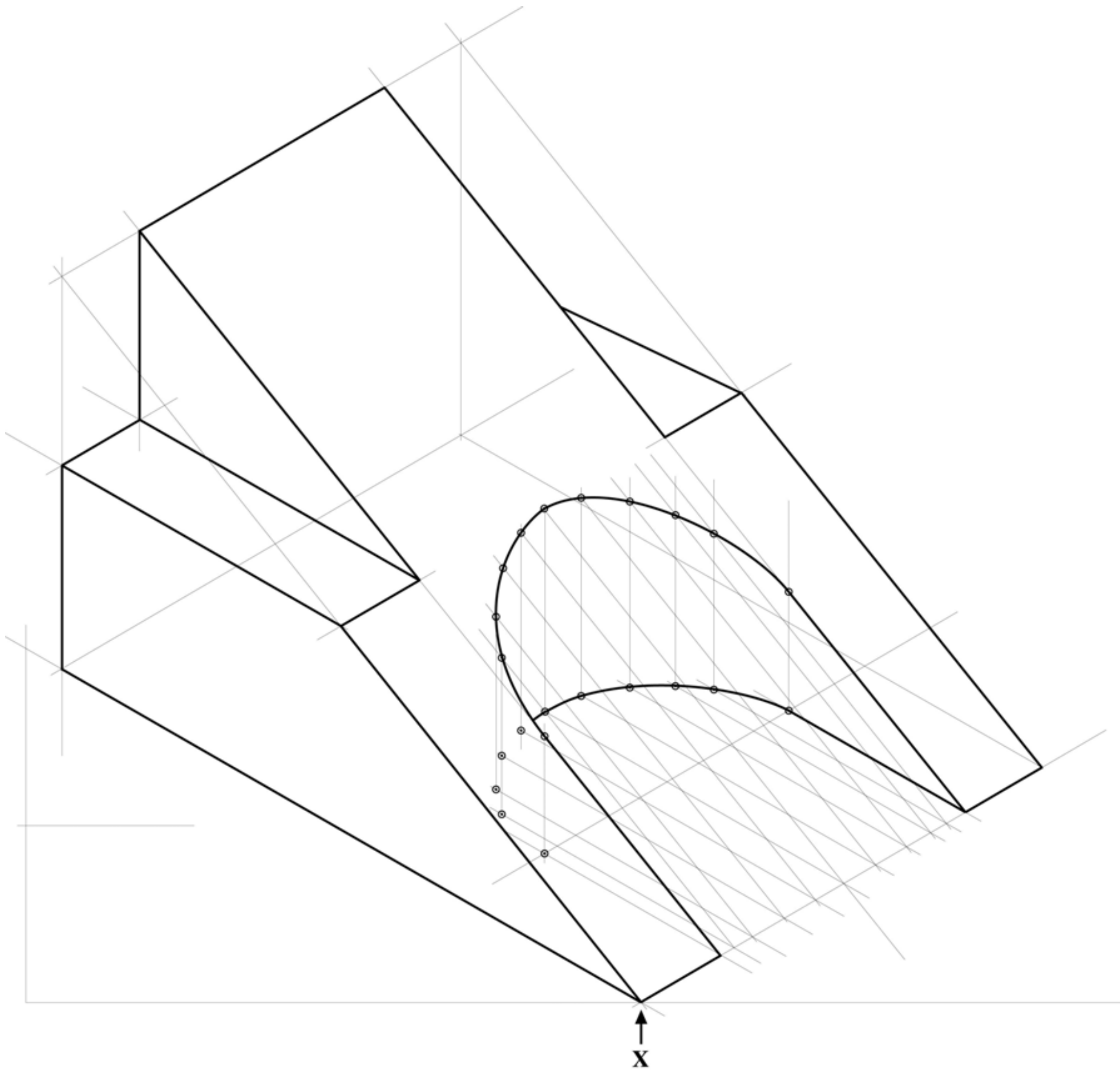
Question 5

SOLUTION



Question 6

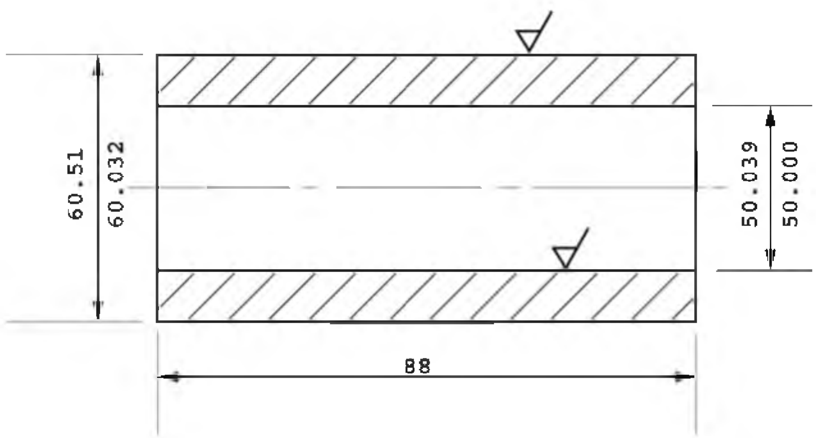
SOLUTION



Question 7

SOLUTION

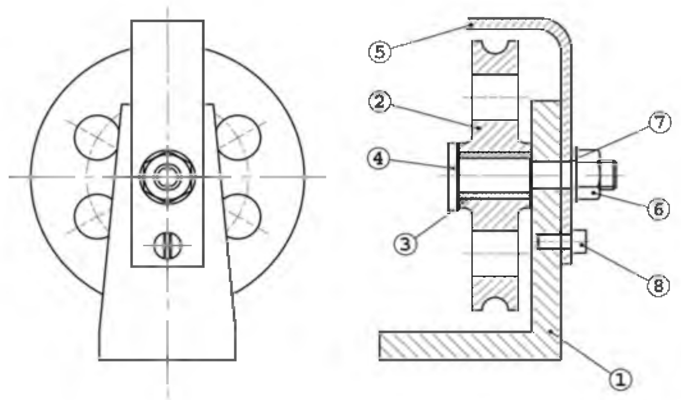
50	H8 / f7	H8 -	+39 0	f7 -	-25 -50	Clearance
		50.039 50.000		49.975 49.950		0.025 0.089
60	H7 / p6	H7 -	+30 0	p6 -	+51 +32	Interference
		60.030 60.000		60.051 60.032		0.032 0.081



ALL DIMENSIONS IN MILLIMETERS

Question 8

SOLUTION

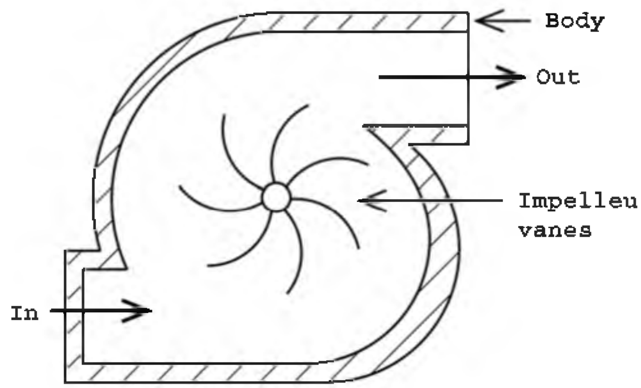


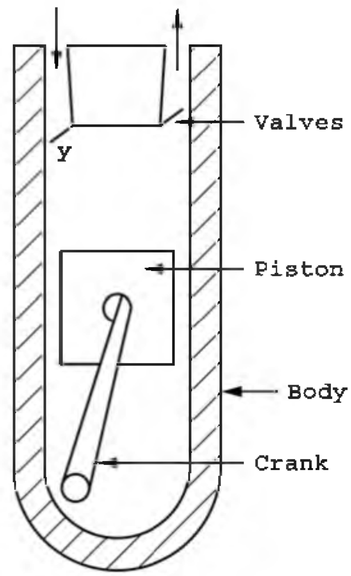
9	M6 CAP SCREW	4
8	M6 SCREW	
7	M12 WASHER	
6	M12 NUT	
5	RETAINING BRACKET	
4	SPINDLE	
3	BUSHING	
2	PULLEY	
1	GUIDE BRACKET	
PART NO.	PART	NO. REQ,D

Question 9

SOLUTION

(a)



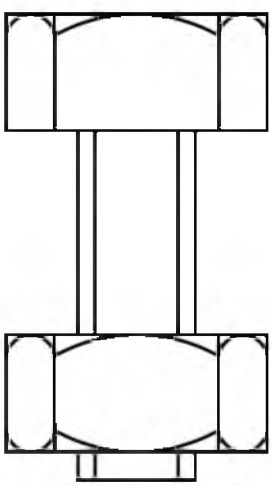


(b) Continuous rotating action vs reciprocating cyclic action.

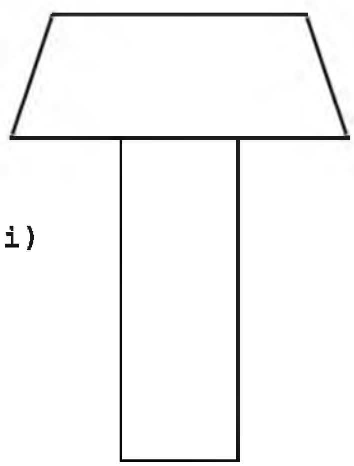
(c) One side of the body is grooved and the ‘O’ ring fitted inside the groove. Parts will be sealed when clamped together.

(d)

(i)



(ii)

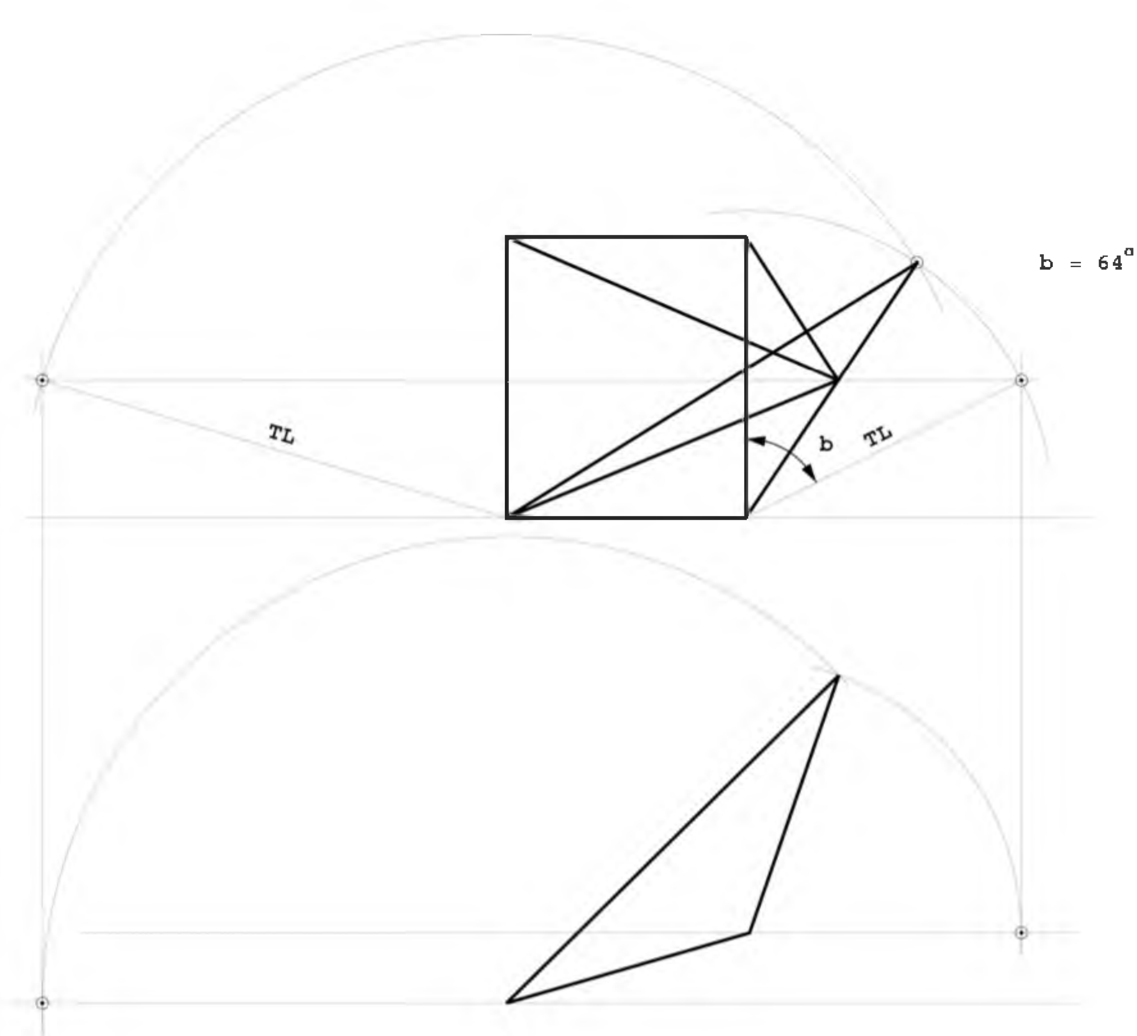


UNIT 2

PAPER 01

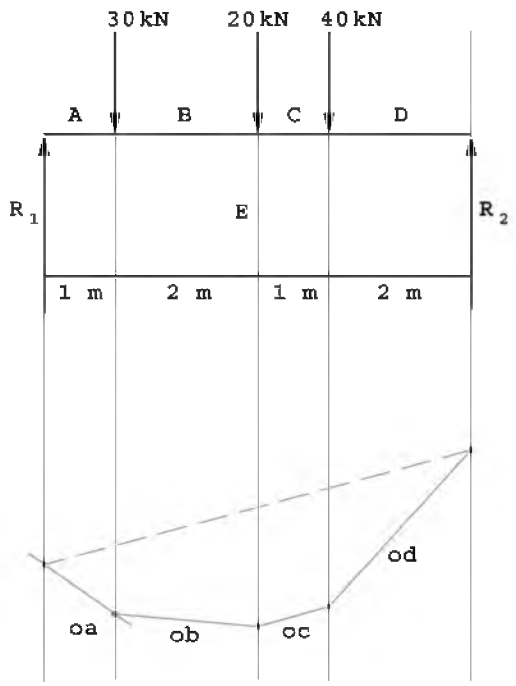
Question 1

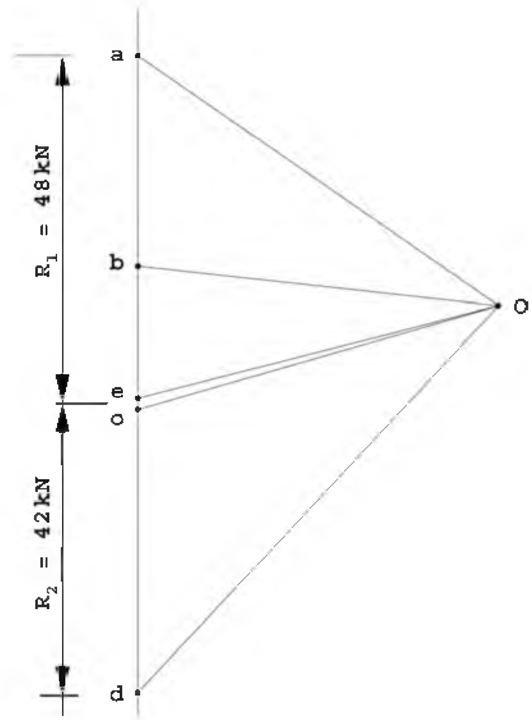
SOLUTION



Question 2

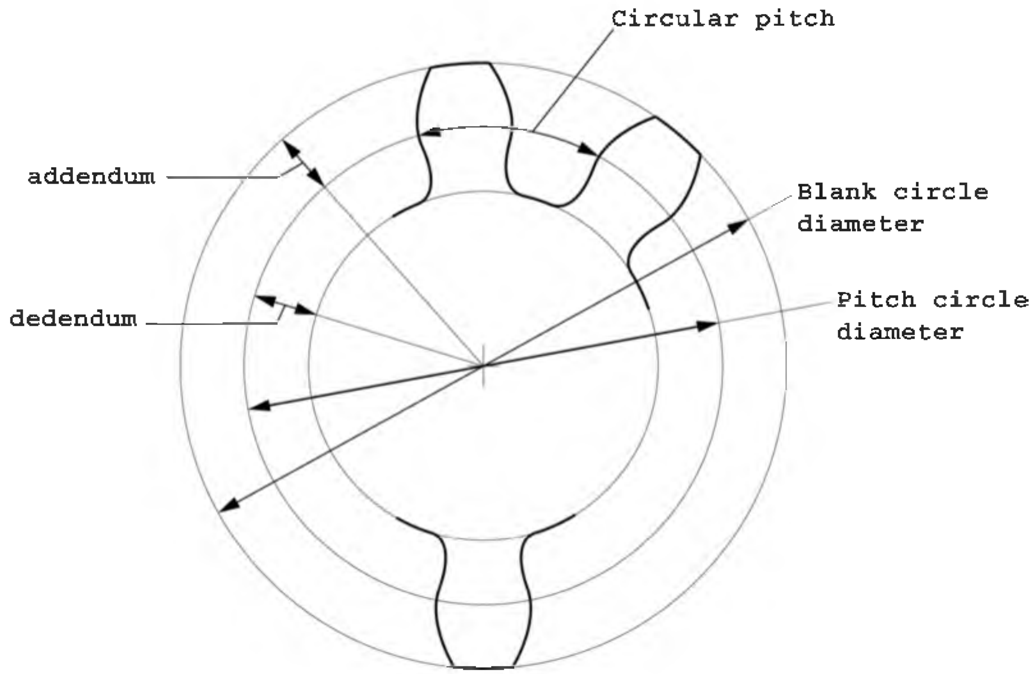
SOLUTION





Question 3

SOLUTION



(a) Pitch circle diameter:- Diameter of the solid of revolution (i.e. cylinder) which will transmit the correct relative motion.

(b) Blank circle diameter (outside):- Diameter of the blank from which the gear will be cut and is measured across the tips of opposite teeth.

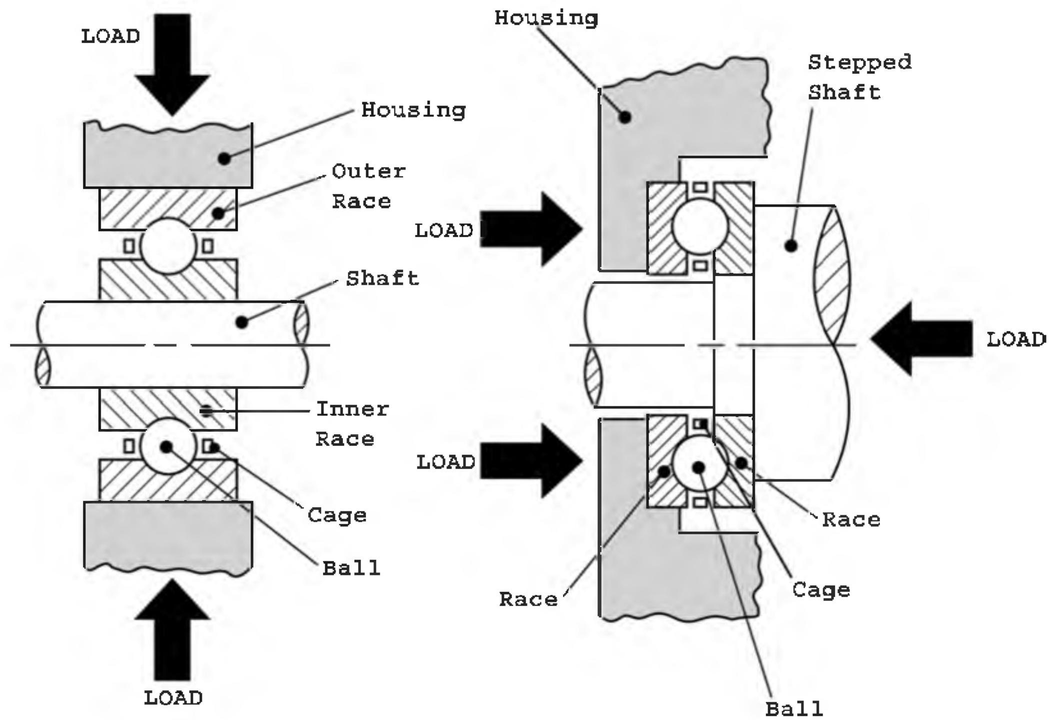
(c) Addendum:- Height of tooth from pitch circle to top of tooth.

(d) Dedendum:- Depth of tooth from pitch circle to root of tooth.

(e) Circular pitch:- The length of arc of pitch circle between similar faces of successive teeth.

Question 5

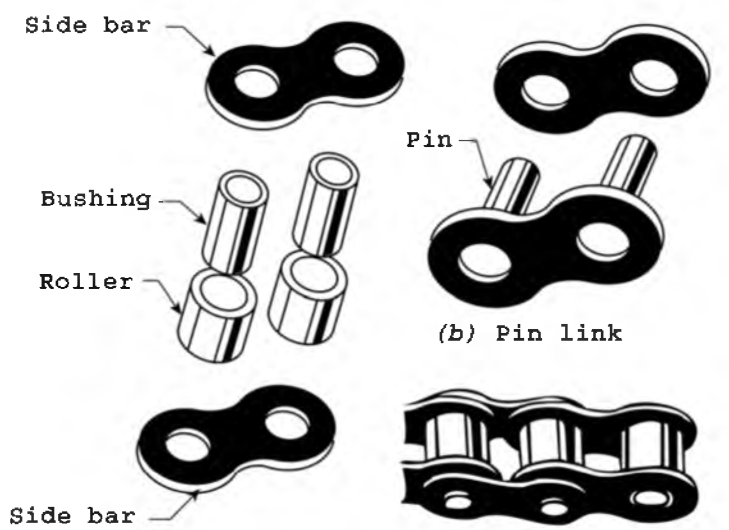
SOLUTION



(b) RADIAL (c) THRUST

Question 7

SOLUTION



(a) Roller link (c) Links assembled

Question 8

SOLUTION

Question 9

SOLUTION

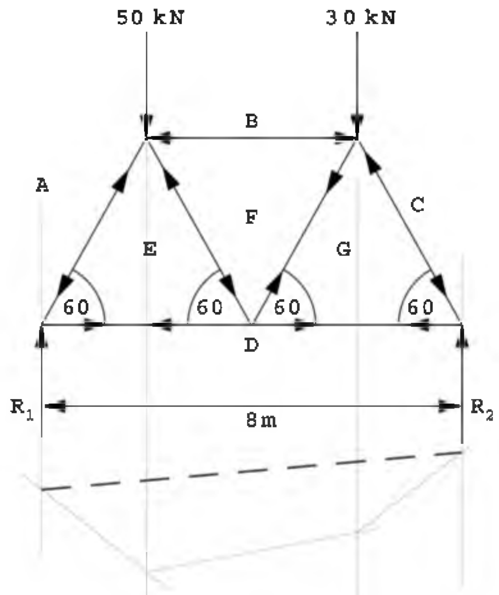
(a) (i) Synthesis: generate ideas.
(ii) Optimization: seek best solution.
(iii) Presentation: show optimized solution.
(iv) Prototype: build first test model.

(b) Ergonomic control loop: getting feedback from a machine to a human and showing a response towards corrective action to the feedback.

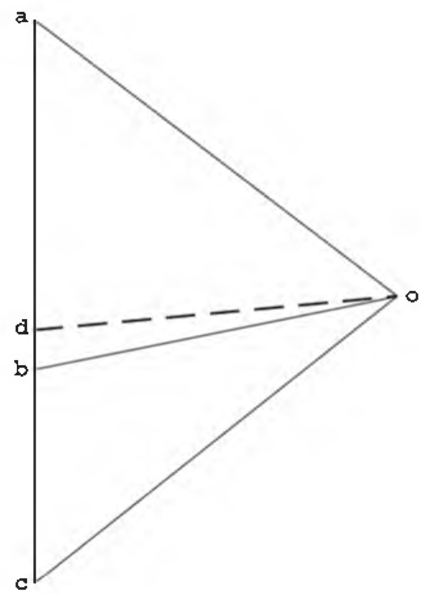
PAPER 02

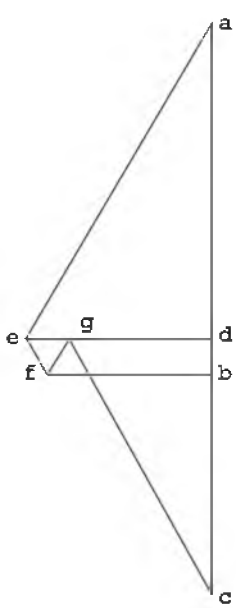
Question 1

SOLUTION



R_1 = 45 kN
R_2 = 35 kN

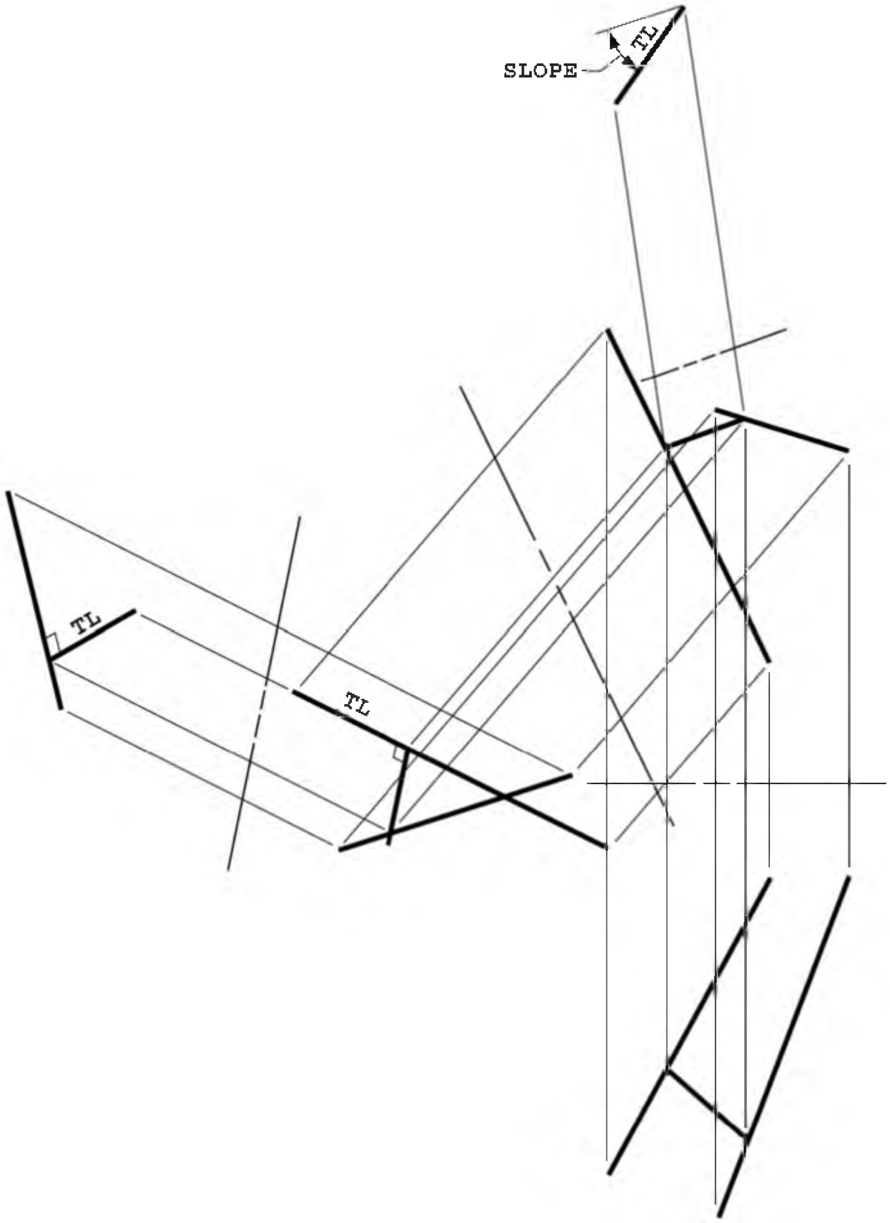




Member	Magnitude	Type
AE	53 kN	Compressive
BF	23 kN	Compressive
CG	40 kN	Compressive
DG	20 kN	Tensile
DE	26 kN	Tensile
EF	6 kN	Compressive

Question 2

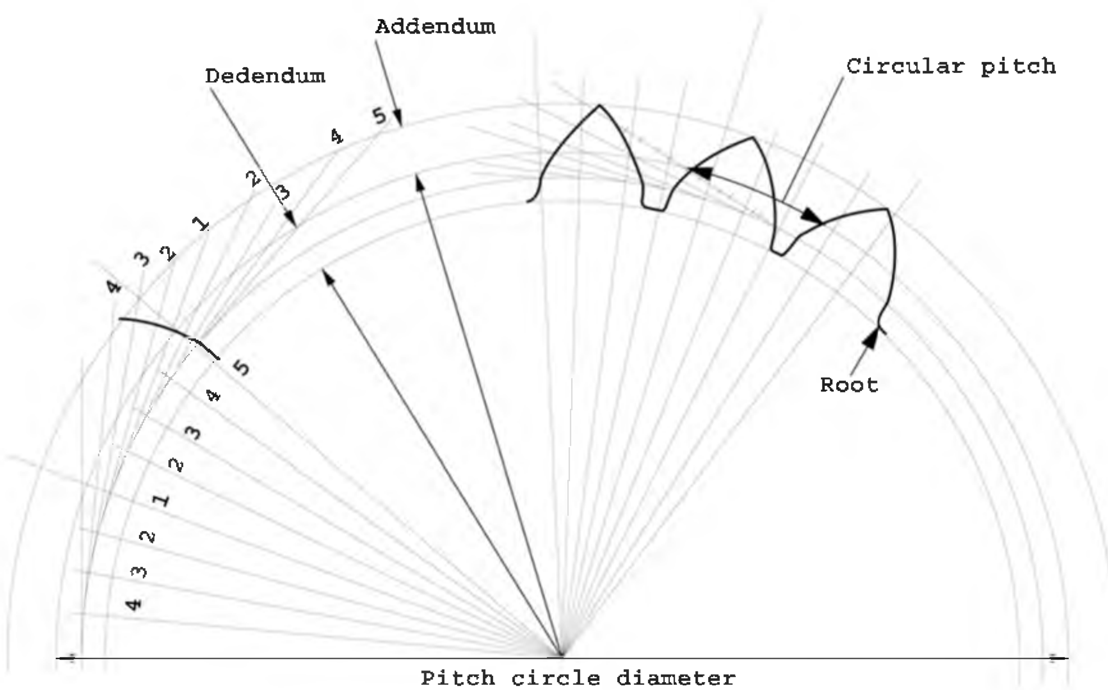
SOLUTION



Question 3

SOLUTION

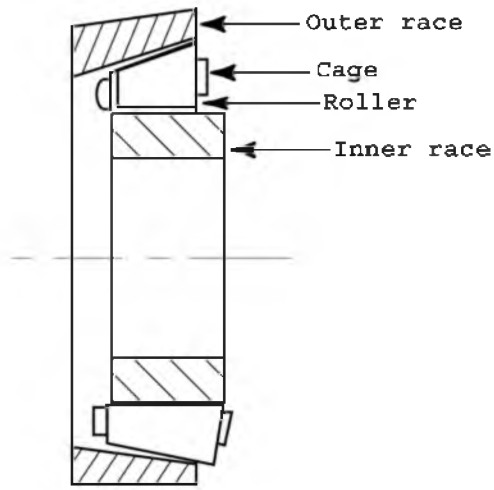
P.S.D = 6×24 = 144 mm	Outside diameter = $144 + (2 \times 6)$ = 156 mm
Addendum = m = 6 mm Dedendum = 1.25 m = 7.5 mm	Root diameter = $144 - (2 \times 7.5)$ = 129 mm
Circular pitch = $\frac{\pi \times 144}{24}$ = 18.9 mm	Base Circle = $144 \cos 20°$ = 135.3 mm
Tooth thickness = $\frac{18.8}{2}$ = 9.5 mm	



Question 5

SOLUTION

(b) (i)



(ii) Used for rotating elements (shafts) that have axial (longitudinal side) loads.
Example: car front axel, electric motor shaft.

Question 7

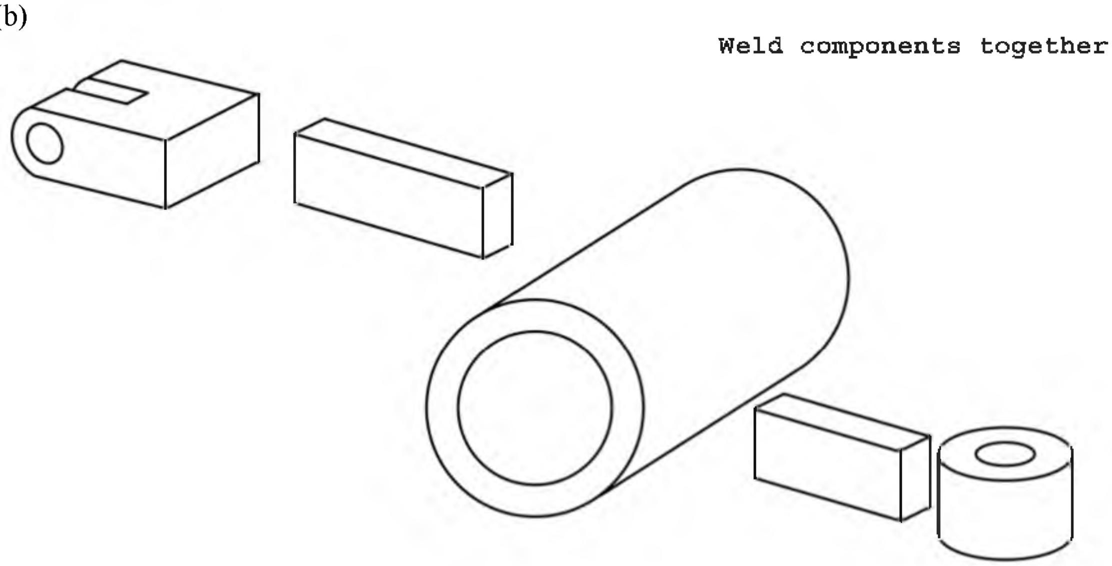
SOLUTION

(a) (i) Evaluation: check to see if design meets specification.

(ii) Synthesis: generate ideas.

(iii) Definition of Problem: prepare specification of problem to meet requirements.

(b)



(c) Choose mild steel because it is easier to machine and weld yet strong and cheap.

Material	**Reason**
Mild Steel	Easy to weld, cheap, strong.
Aluminum	Hard to weld but non corrosive.
Brass/Bronze	Braze (not weld) expensive but non corrosive.
Cast Iron	Poor choice – cheap, brittle, difficult to weld.
Other Metals	Poor choice.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING (TRINIDAD AND TOBAGO)

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING
(TRINIDAD AND TOBAGO)

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

UNIT 1

PAPER 01

Question 1

This question tested candidates' ability to define and draw a 'hypocycloid' for a 60 mm diameter rolling circle and a 180 mm base circle. The requirement of this question was to plot the path trace of a point on the circumference of the rolling circle as it rolls without slipping on the inside of the base circle.

Of the sample chosen, about 60 per cent of the candidates attempted this question. Of that 60 per cent only 5 per cent was able to complete this correctly.

The error that candidates committed were as follows:-

- The definition given was that of an epicycloid
- Most candidates reproduced an epicycloid instead of the hypocycloid
- 1 per cent of the candidates reproduced a cycloid instead of the hypocycloid

Question 2

This question tested candidates' knowledge and application of the construction steps for the Archimedean spiral. This question was attempted by approximately 90 per cent of the candidates of which 70 per cent produced satisfactory responses.

For Part (a) of the question, most candidates demonstrated knowledge of the spiral; however, the average and weak candidates were unclear of the definition. Ninety per cent of the respondents demonstrated the ability to construct the spiral with 75 – 80 per cent providing clear accurate constructions. A few candidates had problems establishing the position of the longest and shortest radii and drawing of a neat curve of the spiral. The weaker candidates failed to mark off the limit of the movement for the spiral in the correct direction and this caused problems with plotting the points. More than half of the candidates also showed the spiral moving in an anti-clockwise direction.

It is recommended that greater attention be paid to the definition of spiral curve as these terms will generally inform construction methods.

Question 3

This question was not clearly stated and needed some clarification. It tested the candidates' ability to find the centroid of a plane figure.

This question was attempted by almost all of the candidates with more than 50 per cent giving an incomplete or inaccurate solution. Candidates showed knowledge of both force diagram and finding the ratio method, but definitely lacked the practice of completing the solution accurately.

Candidates should practice a complete solution showing all calculations and construction.

Question 4

This question was clearly stated and was attempted by almost all of the candidates. The solution was generally well done. This question tested the candidates' ability to convert pictorial views to orthographic projection.

Question 5

This question tested candidates' ability to draw one complete revolution of a conical right hand helix single start.

Most candidates who attempted this question displayed a good grasp of the knowledge and principles for constructing a conical right hand helix. The majority of candidates, however, appeared to have problems in obtaining the corresponding point on the elevation. Generally, this question was well done.

Question 6

This question was clearly stated and fairly simple. The candidates were required to copy the orthographic projection and complete the plan view through the use of the cutting plane/sections.

Copying the orthographic projection which was attempted by almost all of the candidates was well done. Some candidates however, had problems in completing the plan through the use of sections. Approximately 50 per cent of the candidates either had the solution incomplete or inaccurate.

It is recommended that the candidates practice the completion of views projected from irregular-shaped cutting planes.

Question 7

This question tested candidates' understanding of functions of valves as it relates to the topic 'Transmission Motion and Power'.

It was attempted by less than 30 per cent (less than 11 per cent of all candidates), of candidates at this exam (with the question being compulsory), with about 35 per cent, of those giving satisfactory responses. Candidates also displayed an inability to sketch responses in good proportion using plane figures.

Teachers and candidates should be reminded that this topic, 'Power and Transmission', does form part of the syllabus and as such should spend some time studing its aspects.

Question 8

This question was clearly stated and required candidates to copy the given figure and apply the knowledge of machining symbols, tolerances, finishes, limits and fits.

Approximately 60 per cent of the candidates did better than average.

The first part of the question was very well done as the diagram was very simple to copy. More than 80 per cent of the candidates attempted this question. The second part of the question was not well done as the candidates showed little knowledge in terms of outlining, dimensioning accurately, applying machining symbols and tolerance.

Most candidates displayed proficiency in reproducing the circles to the correct radii and distance between centers. The principles for locating the centers of the arcs and the points of tangency appeared to have been a challenge for some candidates.

Question 9

This question tested candidates' knowledge and application of welding symbols. It was attempted by over two-third of the candidates with over 50 per cent providing satisfactory responses.

This question was divided into two parts: 9 (a) and 9 (b)

Part (a) required that candidates show the appropriate welding symbol. Candidates generally demonstrated knowledge of the symbols. The weaker candidates, however, failed to clearly show the application of the appropriate symbol.

Part (b) required that candidates apply welding symbols to a working drawing to specify the type of welding to be used. Candidates were able to show some of the symbols correctly applied. Most candidates, however, did not show that the weld should be done all around.

It is recommended that greater attention be paid to identifying types of welds and their symbolic representations.

PAPER 02

Question 1

This question tested knowledge and ability to draw the displacement diagram and cam profile from a given specification. The displacement diagram posed little problem for the majority of candidates, however, most candidates did not draw tangents to the points on the radial lines before drawing the cam profile. A significant number of candidates appeared confused by the expression "mm diameter flat follower" and drew very small tangents (The size of the follower was inadvertently omitted from question paper). A few candidates numbered the same direction as rotation but got the same result because the cam was symmetrical.

Question 2

This question tested candidates' ability to reproduce the given drawing, producing the correct elevation and producing an auxiliary view of the cut surface showing the true shape. This question was a popular question as it was attempted by most of the candidates. Candidates' performance was good, with only a few candidates unable to do or complete the auxiliary view.

Question 3

This question tested candidates' knowledge and ability to construct an ellipse and also to construct the first and second moment of area. Candidates were required to construct an ellipse having a major axis of 120 mm and a minor axis of 120 mm. This caused for a couple candidates who changed the minor diameter to 60 mm. It is significant that only five of about 43 responses were correct. The other candidates, who attempted this question, simply drew the semi-circle with their compasses. Candidates were able to construct the derived curves. A few proceeded to calculate the centroid and second moment of area I_{xx}.

Question 4

This question tested candidates' ability to produce the development of a transition piece. It was attempted by less than 50 per cent of the candidates, many of whom did not complete the question. It could be said that some candidates did not recognize the object to be a transition piece of a square base to a circular top and as such treated it as a basic cone. This meant that candidates did not resolve to obtain the true length; therefore, this made the lengths incorrect for the development.

Question 5

This question tested candidates' ability to draw an isometric projection of a wedge bracket and construct an auxiliary view of the wedge bracket. Fifty-eight per cent of the candidates who sat the examination responded to this question.

Part (a) of the question was done satisfactorily by candidates. Most candidates knew how to outline the bracket but failed to construct and outline the curves accordingly. Of the two curves, the one situated on the back slant surface posed most of the difficulty to the candidates.

Part (b) of the question posed a great deal of difficulty. Only about 40 per cent of the candidates who attempted this question responded to this part. However, the majority of these candidates did fairly well in constructing the auxiliary view of the wedge bracket. The construction of the curves was well done by most of these candidates, who pretty much knew how to transfer distances from the given view to the auxiliary view.

Question 6

Candidates' ability to produce an auxiliary view of a block as viewed from a specified direction, given two views, was tested. Overall, candidates' response to this question was not favourable in that not many candidates responded to this question. The few candidates who attempted the question presented responses that were weak. Candidates were able to do up to stage 3 or 4 of the profile in marking, comfortably. Some struggled to gain marks after stage 4 but did poorly. Practicing this topic using simple shapes would help candidates.

Question 7

This question tested candidates' knowledge of joining methods, fasteners and power transmission. The question was attempted by approximately 25 per cent of the candidates, with only a few giving satisfactory responses. No candidate completed the question. Very few of the responses showed candidates being able to design more than two methods of joining the two plates. In some instances the sketches were poor. Similarly in Part (b), many of the responses showed candidates only able to identify and sketch no more than two of the four methods of locking a nut. Very few of the candidates that responded to this question were able to complete Part (c). No candidate was able to correctly sketch the gear pump to show the internal components.

Question 8

This question tested candidates' ability to produce orthographic views of an isometric drawing of a component, inserting title block and using ISO convention. It was widely done and most candidates completed it. The main area for concern was: most candidates did not make a separate drawing of the bearing. Many candidates did not place the quality of dimensions required and many more tended to place most of the dimension in the front view and none in their end view. Little attention was placed on radii and diameters.

Question 9

This question tested candidates' ability to correctly draw an assembled front elevation and plan of a wheel puller assembly, given the working drawing. It was not generally well done, with just about one third of the candidates attempting the question. In some instances candidates only drew one of the two required views. Most responses showed no dimensions as was required. Very few of the candidates that responded to this question were able to draw the correct assembly and in some of these responses, candidates were not able to draw the head of the bolt correctly.

REPORT ON INTERNAL ASSESSMENT

Approximately 70 per cent of the Unit One Internal Assessment was completed with a high level of accuracy. Candidates displayed good understanding of what the Internal Assessment required in regards to the objectives to be tested in each module.

There was an alarming deficiency on the part of the teachers where 30 per cent of the internal assessments were submitted without the list of questions, list of commands for question four and the three sketches for the design solution (#5). Twenty one out of the fifty four schools (37 per cent) continue to submit the six assignments using traditional method of drawing, ignoring the fact that at least one question from each module MUST be CAD based.

According to the syllabus (page 30), each candidate is required to produce SIX ORIGINAL DRAWINGS. Failure to do this, all assignments will normally result in NO MARKS being awarded for the internal assessment (page 29). The trend found this year was that, candidates completed five drawings and marks were allotted for six assignments. One of the drawings is marked for two assignments. This was evident with question four (Auto CAD) and question six (Assembly drawing) being submitted as one assignment.

As usual the drawings were relatively clean and displayed the relevant information required in terms of candidates' number, centre number and the number of drawings submitted.

RECOMMENDATIONS

- Schools should print their work on CD's instead of 3½ floppy.
- Schools should indicate the CAD used for their projects.
- Revise the Gemd 1 – 3 and the Gmed 2 – 3 forms to indicate the marks allocated for each criterion.

UNIT 2

PAPER 01

Question 1

This question tested candidates' knowledge of concurrent forces and coplanar forces. It also tested their ability to find graphically the resultant of a system of concurrent, coplanar forces. Approximately 97 per cent of the candidates attempted this question with 61 per cent of them receiving a score of 80 per cent or more. Only 21 per cent of the candidates received a score of below 50 per cent. This question was reasonably well done with the main deficiency being in the area of the application of BOW's notation and the labeling of the vector diagram. Candidates displayed good understanding of the definitions of concurrent and coplanar forces, with only 18 per cent of them getting it incorrect. One candidate completed this question by graphically resolving the forces into vertical and horizontal components, summing them up using vector addition and hence obtaining the resultant.

Question 2

This question tested candidates' knowledge of the definition of spur gear teeth terminology and their ability to sketch and label a gear wheel. Seventeen per cent of the candidates who attempted this question scored over 80 per cent and 51 per cent of the candidates scored below 50 per cent. Generally, candidates had knowledge of the gear terminology but lost marks for the labeling of the sketch of the gear.

Candidates should be made to practice more on labeling their diagrams; this would also help them in understanding how to further construct the gear teeth profile.

Question 3

This question tested candidates’ knowledge of skew lines and their ability to apply it in finding the true length of a line. Eighty per cent of the candidates responded to this question. Of those candidates just about 25 per cent received maximum marks, 75 per cent received 6 out of 10 marks or higher. This question was satisfactorily done. In responding to the question few candidates attempted to complete the front elevation first, and incorrectly mark off the true length “ab” of this view. In all the responses, candidates were able to correctly construct the X-X planes. The majority of responses showed candidates correctly projecting the partial plan and front elevation. In those responses which showed the front elevation incorrectly drawn, candidates failed to ensure that the perpendicular distance from the X-X planes to the top of the triangle (a) on the front elevation and auxiliary view were the same.

Question 4

This question was designed to test candidates understanding of engineering materials. Approximately 90 per cent of candidates attempted this question.

Part (a) required candidates to differentiate between ferrous and non-ferrous metals. Few of the candidates were able to correctly differentiate between the two metals in terms of iron content in the metals. Most other candidates attempted to describe the structures of ferrous and non-ferrous metals in differentiating between the two.

Part (b) required candidates to describe engineering materials and give examples of use. In most of the responses, candidates were able to give, at least, a partial description and give one use of each.

In (b) (ii) and (iii) candidates were expected to select only one of the three steels and one of the two plastics, however some candidates described all three steels and the two plastics. The question was very clear with the OR capitalized. Some candidates gave one example of the plastic rather than one use of the plastic.

Question 5

This question tested candidates’ knowledge of plain bearings and anti-friction bearings. It also tested candidates’ ability to select a suitable roller bearing for a particular loading condition and produce a labeled sketch of the bearing indicating the loads.

Seven per cent of the candidates scored above 80 per cent, while 70 per cent, of the candidates scored below 50 per cent. Candidates’ attempt at this question was weak. Most candidates failed to identify the bearing as a tapered roller bearing and produced a labeled sketch with arrows indicating the radial and thrust loads. Most candidates failed to give clear definitions of a plain bearing and an anti-friction bearing. It is recommended that candidates be shown samples of real bearings as a teaching aid and compare it with the diagrams being used to teach.

Question 6

This question tested candidates’ knowledge of a stuffing box and gland assembly as well as their knowledge of different types of seals and their sketching ability. Fifty-six per cent of the candidates attempted this question with only 30 per cent of them scoring over 50 per cent. This question highlighted deficiencies in sketching, identifying gaskets and “U” seals. Candidates demonstrated limited knowledge of the appropriate screws to be utilized on the stuffing box on the rotating shaft.

Question 7

This question tested candidates' knowledge of belt, chain and gear drives. It also tested their ability to produce a sketch showing the application of an idler pulley in tensioning a belt drive. Of the candidates who responded to this question, 12 per cent scored 80 per cent and above while 61 per cent scored 50 per cent and below. 17 per cent of the candidates did not respond. This was due to candidates failing to produce the correct sketch and proper labeling. Also they showed weakness in giving clear description of the different drives. Candidates need to be given more practice at describing the drives as well as given more exercises on application of the different drives.

Question 8

This question tested candidates' knowledge of the manufacturing processes and their ability to apply a process to manufacture a particular component. Candidates demonstrated relatively good understanding of this question. Approximately 36 per cent of the candidates scored 80 per cent or more, while only 29 per cent scored 50 per cent or less. Out of a total of 41 candidates, 3 candidates did not attempt this question. There was a high level of knowledge displayed in the naming of the processes (97 per cent) however, there were deficiencies in giving three reasons for the process they chose. This would indicate that they are having problems with the application of the manufacturing processes.

Question 9

This question tested candidates' knowledge and understanding of the stages in the design process and their ability to apply them in a particular situation. It was well attempted with about 75 per cent of the candidates responding to it. Most of the candidates showed that they were able to explain "analysis", however only a few were able to explain "optimization" in terms of "….repeating the process to seek the best final product".

Part (b) was satisfactorily done, with the majority of the responses revealing that candidates were able to suggest three ways of analyzing or optimizing the metallic T-square.

PAPER 02

Question 1

This question tested candidates' knowledge and ability to determine graphically the reaction and resultant of a loaded beam and to draw the shear force and bending moment diagram. This was a popular question and was well attempted with a high degree of accuracy. Approximately 64 per cent of the candidates who attempted this question received a score of 80 per cent and above. Only 14 per cent of the candidates received a score below 50 per cent. Of the 41 candidates, only 2 candidates did not attempt the question. Candidates displayed good knowledge of the link polygon, shear force diagram and identifying the resultant. There were minor deficiencies in labeling the link polygon.

Question 2

This question tested candidates' ability to use auxiliary projection to determine the point where a line pierces a plane and also to construct the true shape of a figure. Fifty-one per cent of the candidates attempted this question with 76 per cent scoring below 50 per cent, and 14 per cent scoring above 80 per cent. The question had a two part response and candidates showed weakness in locating the point "P" where the line pierced the plane. Candidates were able to do some amount of auxiliary projections but failed to correctly produce the true lengths for constructing the true shape of the triangle. A more indepth revision and practice on this topic would increase the performance of the candidates.

Question 3

This question tested candidates' knowledge of calculating the parameters of an involute spur gear and their ability to construct the gear tooth profile. Approximately 50 per cent of the candidates attempted it, with just over 10 per cent obtaining full marks. Eight candidates received between 1 – 10 marks, five received between 11 – 17 marks, and 9 obtained 18 – 25 marks.

Most of the candidates were able to correctly apply the formula for computing the gear parameters, and draw the necessary pitch, root and outside circles. Additionally, those responses showed candidates were able to correctly mark off the pressure angle. However, in few of the responses candidates were not able to construct the involute and failed to accurately construct the gear profile.

Question 4

This question tested knowledge of the sand casting process and the ability of candidates to sketch and describe the step by step procedures in casting a hollow cylindrical component. Seventy per cent of the candidates displayed a fair amount of knowledge in describing the sand casting process. However, in part "B" of the question, candidates lacked the ability to sketch the process in the correct order. Approximately 55 per cent – 60 per cent of the candidates displaced poor sketching ability and produced sketches with bad proportions. In addition, 70 per cent – 80 per cent of the candidates showed lack of ability to use the correct terminologies for the various stages in the sand casting process. It is recommended that candidates be made aware of the difference between a solid and a hollow cylindrical component.

Question 5

This question tested candidates' knowledge of different lubricants and lubrication methods and their ability to use sketches to illustrate how the external reservoir lubricating system can be used to lubricate gears. Approximately 72 per cent of the candidates attempted this question. Of those who did so 80 per cent displayed very good knowledge in explaining, with the aid of sketches, the difference between bath, splash and pressurized lubrication methods. Approximately 60 per cent displayed a fair amount of sketching skills in representing the external reservoir and how it is used to lubricate gears. Eighty per cent showed good knowledge and understanding of two main functions of lubricants in bearings. Overall candidates demonstrated good knowledge of lubricants; however most candidates (approx. 90 per cent) had problems in selecting suitable materials for use as a solid lubricant

Question 6

This question tested candidates' knowledge of limits and fits as it applies to shaft and bush. It also tested candidates' ability to calculate the maximum and minimum clearance or interference of a particular fit. Their knowledge of materials and the purpose and use of a bush were also tested. Approximately 50 per cent of the candidates who sat the exam attempted this question.

Part (a) of the question was well done with the majority of candidates identifying the bushing and shaft correctly.

Part (b) was fairly well done, however, some candidates did not know how to calculate the maximum and minimum clearance and interference.

n Part (d) posed a bit of a problem as the majority of candidates who responded had difficulty dimensioning the drawing appropriately.

Part (e), (f) and (g) were also poorly done.

Fourteen per cent of the candidates scored between 0 – 8 marks, 67 per cent scored between 9 – 17 marks and 19 per cent scored between 18 – 25 marks.

Question 7

This question tested candidates' knowledge of the ergonomic and aesthetic factors in a design. It also tested candidates' ability in applying their knowledge of engineering materials and manufacturing processes to the design of a specific component and also factors that would affect the cost of the component.

This was a very popular question. Seventy-nine per cent of the candidates who sat the exam responded to the question. Part (a) of the question was well done. The majority of the candidates scored maximum marks. Parts (b) and (c) were also well done. Part (d) of the question posed a bit of a problem. Fifty per cent of the candidates responded to this part and scored poorly. Twelve per cent of the candidates who responded scored between 0 – 8 marks, 63 per cent scored between 9 – 17 marks while 25 per cent scored between 18 – 25 marks. While speaking to a few teachers they commented on the fact that they did not have a text with the ergonomic control loop and so they did not know what it was and was not able to teach the candidates about it.

Question 8

This question tested candidates' knowledge of the design process, manufacturing processes and engineering materials and their ability to apply these in the design of a stool for a drawing table. Part (a) of the question was fairly well done; however, most of these candidates did not synthesize the three sketches and only did one final design. Part (b), (c) and (d) of the question was well done. The majority of the candidates knew the design stages, the advantages and the alternative materials that could be used 9 per cent of the candidates who responded to this question scored between 0 – 8 marks, 58 per cent scored between 9 – 17 marks while 33 per cent scored between 18 -25 marks.

Question 9

This question tested candidates' knowledge of different types of couplings and their ability to sketch and describe them. This was not a popular question with 29 per cent of the candidates responding to it. However, the question was fairly well done. The majority of candidates who responded to it could sketch and describe the couplings. However, approximately 50 per cent of these candidates had difficulty sketching the Hooke's coupling. Their drawing skills were below standard. Thirty-three per cent of those who responded to this question scored between 0 – 8 marks. Thirty-three per cent scored between 9 – 17 marks and 33 per cent scored between 18 – 25 marks.

REPORT ON INTERNAL ASSESSMENT

Generally, the design portfolios submitted displayed a good level of understanding by the candidates about the design process. Approximately 80 per cent of the samples received a passing grade. However, there is lots of room for improvement, especially where the design phases are concerned.

Many design aspects were unaccounted for such as:

- The three (3) alternative preliminary design sketches
- Justification
- A Technical report comprising of a work schedule
- Limits and constraints
- Proper organisation of the contents of the portfolio
- Final drawings with proper dimensions

There was a general lack of consideration for Health and Safety in the designs submitted. Teachers need to put more emphasis on this aspect when guiding the candidates in the preliminary stages of the design.

Candidates demonstrated competently how their design would work showing satisfactory technical and verbal skills. However, about 25 – 30 per cent submitted designs with obvious structural design flaws that should have been corrected by their teachers during the design process.

The design assignment was to be CAD based but about 30 per cent showed no CAD in their portfolios and of those that did submit CAD based designs, only 20 per cent submitted all that was required. The vast majority of candidates did not submit list of commands, electronic copies of CAD work nor CAD drawings on the correct paper size with border, block and all relevant information.

About 40 – 45 per cent of candidates displayed exceptional CAD skills, producing exploded views, solid modeling (3D), and other higher level techniques. However, they fell down when it came to the written aspect of the design portfolio, producing poor design sketches, poor Project Reports and poor or no Technical Report.

Technical Report writing must be revisited. Even though marks were awarded for the work programme provided by the candidate, in most cases it was not a Technical Report. A Gantt chart does not constitute a Technical Report and candidates at this level must demonstrate satisfactory Technical Report skills.

Centres must supply CXC headquarters with knowledge of the version of CAD they are using in their school. Many disks received could not be viewed because of in compatibility of software.

In terms of the marking of the internal assessment, there was a need to see a breakdown of the scores supplied, especially when it comes to the Interactive Presentation.

RECOMMENDATIONS

- Schools should print their work on CD’s instead of 3½ floppy.
- Schools should indicate the CAD used for their projects.
- Revise the Gemd 1 – 3 and the Gmed 2 – 3 forms to indicate the marks allocated for each criterion.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING (REGION EXCLUDING TRINIDAD AND TOBAGO)

GEOMETRICAL AND MACHANICAL ENGINEERING DRAWING

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

UNIT 1

PAPER 01

Question 1

This question was clearly stated and generally tested the candidates' ability to reproduce drawings as well as finding the centroid. The question had more than one approach to finding the solution.

Over 90 per cent of the candidates attempted this question with 55 per cent giving satisfactory performances. A majority of the candidates were able to identify the individual steps of the solution but had difficulty moving beyond the half-way point and finding the centroid. Many of the solutions were incomplete. A major hindrance in the completion was the step linking the ratio to finding of the centroid.

The candidates who used the computer had problems in producing the correct size print and sometimes there was a solution without the steps towards this solution.

It is suggested that candidates should be exposed to the different methods of finding the solution.

Question 2

This question was divided into two parts: 2 (a) and 2 (b). These two parts were similar and tested the candidates' ability to recall and sketch. The question was clearly stated with over 90 per cent of the candidates attempting this question. However, it was generally not well handled; the candidates had the ability to sketch and they had the knowledge of the general topic but showed a lack in the area of specific knowledge and the question was specific.

The candidates should be exposed to all aspects of cam design so that they can differentiate between them. A large percentage of candidates did not attempt the written aspect of the question as they attempted to answer with a sketch.

The practice of writing descriptions should be introduced.

Question 3

This question tested the ability to construct an ellipse and a parabola as a template. Approximately 80 per cent of the candidates constructed the ellipse correctly; however only about 30 per cent of candidates constructed the parabola by applying the correct technique. This question was done generally good with well outlines and construction lines.

Additionally, some candidates drew the shape without any construction lives which produces a low quality drawing. This should be discouraged. The correct drawing practices should be encouraged.

Question 4

This question tested candidates' understanding of the Oblique Cabinet Projection and the ability to draw a circle on the Oblique plane.

It was attempted by over 75 per cent of the candidates, of which only 50 per cent approximately were able to draw in the projection required.

This question was clearly stated and presented no language problems. Marks were fairly allocated.

However, most candidates were unable to draw in the plane and to produce the circle required.

The response shoed that candidates who performed poorly displayed an inability to

a) Recognize the oblique plane.
b) Reproduce a circle on this plane.
c) Draw in the oblique projection.
d) Recognize the difference between the cabinet and the cavalier projection which was not being tested.

Question 5

This question tested the candidates' ability to draw a front elevation and plan of a pyramid with an auxiliary view of a surface on the pyramid, truncated at 45 degrees. From a sample of the scripts, 60 per cent of the candidates attempted this question.

Most of the candidates were able to project lines at 45 degrees from the auxiliary view and from the elevation vertically downward for the plan. However in many cases, the candidates either oriented the plan incorrectly or when the plan was oriented correctly, the length of the sides was incorrect.

At the end of the question, the word 'pyramid' influenced how the candidates interpreted the question in about two per cent of the cases and resulted in incorrect evaluation and plan reproduced.

Question 6

This question was generally well done. From the sample of scripts, about 90 per cent of the candidates attempted it; of this sample, 80 per cent of the candidates achieved scores ranging from 9 – 10 marks out of __ marks.

The errors that candidates made were as follows

a) Projecting from the elevation at an angle other than vertical. Example, diagonally at some angle
b) Projecting along a circular path
c) Development from a seam other than the "A" resulting in a different shape

Question 7

This question presented candidates with an enclosed sheet showing details of the parts that make up an English Type Lathe Tool Post. The question was designed to test candidates' proficiency and skills in orthographic drawing, assembly drawing and candidates' ability to produce neat freehand sketches.

Most candidates that attempted this question lacked the ability to produce well proportioned neat freehand sketches of the component. Candidates were able to assemble the components that make the lathe assembly and produce the required views.

It is recommended that teachers spend more time developing the fundamentals of sketching; since this is a very important topic in the language of graphic communication and a very important skill.

Question 8

This question required candidates to apply symbolic representations in dimensioning a fabricated component. Candidates were therefore required to demonstrate knowledge of machined, knurled, threaded and welded components. They were also required to produce a neat sketch.

Over 80 per cent of candidates attempted this question. Respondents were generally able to produce a fair sketch. However, only 20 per cent of those who attempted it were able to produce satisfactory responses.

This question was divided into four parts: (a), (b), (c) and (d).

In Part (a), candidates demonstrated qualifying this knowledge of machining. However, the majority were unable to accurately represent machining symbols.

In Part (b), the majority of candidates demonstrated no knowledge of knurling and therefore were unable to apply the representation.

In Part (c), candidates demonstrated qualifying this knowledge and application of a threaded component, but the weaker candidates failed to show the dimensioning standard (ms x 1).

In Part (d), the representation of the welded joint was inconsistent. The majority of candidates either did not attempt this part or were unable to accurately represent the weld.

Candidates MUST be made aware of conventional methods of dimensioning and be able to apply these methods.

<u>Question 9</u>

This question required candidates to sketch and explain four methods of locking a nut. It was attempted by 65 per cent of the candidates with 14 per cent producing satisfactory responses.

The majority of candidates demonstrated qualifying this knowledge of locking devices; however the weaker candidates were unable to show clear applications of the devices.

Neat freehand sketches were required; however, a number of respondents represented the component in CAD using templates. This shows a misunderstanding of the requirements of the question. Ten per cent of the candidates produced sketches of spanners etc. which also indicated a misunderstanding or lack of knowledge.

The majority of candidates also failed to use written explanations with their sketches. Their explanations would assist in cases where the sketches are unclear.

Candidates MUST be exposed to the application of locking devices and must be engaged in discussion on the selection of application of devices.

PAPER 02

<u>Question 1</u>

This question tested candidates’ ability to:

a) Reproduce the given figure.
b) Construct the first and second derived curves.
c) Determine the area of these curves graphically.
d) Compute the height of the centroid of the figure above x – x and the second moment of area.

All candidates attempting Question 1 completed task (a) successfully. A few did not complete task (b) successfully. Some candidates used the correct method to determine the area of the curves but forgot to multiply by 2 when half the figure was used. Some candidates attempted to determine three areas on a single diagram, making it difficult to trace their work. Most candidates who attempted task (d) did so successfully; however, a few either used the incorrect formulae of brought forward incorrect data. Some candidates answered without stating formulae, and entering the correct data before they produced the final results.

Question 2

This question tested candidates' knowledge of the function of a cam and their ability to produce the performance graph of a specific cam in relation to the direction of rotation. Candidates' response to this question was about 60 per cent to 70 per cent. A fair number of candidates would get about 50 per cent of the mark or above.

The problem candidates faced were to divide the cam into equal angular dimensions from the rotating center 'o'. Some candidates divisions were from the center of the larger circle which was wrong and caused them to lose a significant amount of marks. Perhaps candidates observing a cam in operation in relation to its performance curve may help them to minimize this error.

Question 3

This question tested candidates' knowledge of engineering curves (ellipse) and their ability to plot the locus of a point on a link mechanism.

Of all the candidates who attempted this question, some gave incomplete responses; many others only drew the ellipse and the link mechanism but did not complete the locus of the point 'B' as required.

Part (a) of the question was generally well done, with only very few responses showing candidates inability to correctly construct an ellipse.

Part (b) was generally well done by the candidates who performed well in Part (a). The weaker candidates showed an inability to correctly mark off the focal points F_1 and F_2.

Part (c) posed a great difficulty. Few candidates were able to plot the locus of point B correctly. Some responses showed candidates obtaining a second ellipse for the locus of 'B'.

In cases where this question was done using CAD, most of the responses showed dimensions that did not compare to those given in the question. Some candidates even drew the ellipse twice full size.

Question 4

This question tested candidates' knowledge and ability to construct the curve of intersection between a right cone and a cylinder. The question proved to be fairly popular among the candidates, however many did not successfully complete the question. In many instances candidates failed to divide the base of the cone and to connect the points from the base to the apex of the cone. As a result many were unable to complete the plan or the end elevation. Not many of the few candidates who completed the question gained full marks.

Question 5

This question tested candidates' knowledge of orthographic projection and their ability to project an auxiliary view to obtain the true shape of a sloping surface. Most of the candidates who attempted this question were able to correctly identify the front view of the bracket to produce the required elevation. However, there were difficulties in candidates being able to obtain the radiused corners. Some candidates failed to indicate the correct line types (center, hidden etc.) in the required views.

Part (a) of this question showed few candidates incorrectly drawing the slant face A as the front of the bracket. The majority of the responses showed the hole (m 20 x 2.0) going all the way through the bracket.

In Part (b), many responses highlighted candidates' inability to project lines to obtain the true shape. Many responses also showed either no radii for the fillet or incorrect ones.

Question 6

This question tested candidates' knowledge and ability to draw an isometric view of a component described in orthographic projection. This included the construction of multiple circles and curves and non-isometric lines. Most candidates attempted this question, approximately 90 per cent. Difficulty was experienced by candidates with respect to the correct layout of the solution. Particularly challenging was the constructing of non-isometric lines and reproduction of similar curves and circles. Less than 10 per cent of candidates completed this question. The quality of line-types was below what could reasonably be expected at this level.

Some challenge was noted with respect to the orientation of the drawing, i.e. recognition of lowest point. About 10 per cent of candidates had this challenge. There was difficulty in recognizing the correct plane (vertical or horizontal) of the drawing and a few candidates placed the component on its side. This question was moderately done and was attempted by nearly all of the candidates.

Question 7

This question tested candidates' knowledge of assembly and working drawing and their ability to assemble and produce orthographic views of mechanical components. Seventy-five per cent of the candidates attempted it. However, most of these candidates failed to complete all three views. Twenty per cent of the candidates who attempted this question scored between 18 – 25 marks, while 30 per cent scored between 10 – 17 marks. The question was worth __ marks.

The majority of the candidates knew how to assemble the components. However, most of them lacked knowledge of the components to be sectioned, thus hatching lines were not well placed. Most candidates went on to hatch the roller (Part 2) without cutting it.

Question 8

This question tested candidates' ability to produce working drawings. The question was not very popular with the majority of candidates, but still received reasonable attention. Very few of the candidates that attempted it did it well. Many of them made the following errors:

a) Many produced a sectioned drawing of the jack
b) Quite a few of them simply reproduced the drawing as shown in the booklet,
c) The omission of dimensions
d) The omission of engineering symbols

It would appear based on the responses, that candidates were not adequately prepared in the production of working drawings.

Question 9

This question tested candidates' knowledge of a household flashlight and the materials the parts were made of and their ability to design a flashlight. It was a very popular question, seeing approximately 90 per cent of the candidates responding to it. It was obviously clear that candidates (95 per cent) knew where each component should be placed.

Part (a) of the question required candidates to assemble the various components of the flashlight. Instead of producing a sectional assembled view, the majority of the candidates drew an exploded view of the components. Some candidates assembled the flashlight without showing the internal components.

Part (b) of the question required candidates to suggest appropriate materials for each of the components. The majority of candidates (90 per cent) had knowledge of the type of materials that should be used.

REPORT ON INTERNAL ASSESSMENT

Approximately 70 per cent of the Unit 1 Internal Assessment was completed with a high level of accuracy. Candidates displayed good understanding of what the Internal Assessment requires in regards to the objectives to be tested in each module.

There was an alarming deficiency on the part of the teachers where 30 per cent of the internal assessments were submitted without the list of questions, list of commands for question four and the three sketches for the design solution (#5). Twenty-one out of the fifty-four schools (37 per cent) continue to submit the six assignments using traditional methods of drawing, ignoring the fact that at least one question from each module MUST be CAD based.

According to the syllabus (page 30), each candidate is required to produce SIX ORGINAL DRAWINGS. Failure to do this, all assignments will normally result in NO MARKS being awarded for the internal assessment (page 29). The trend found this year was that, candidates are completing five drawings and marks are allotted to six assignments. One of the drawings in marked for two assignments. This was evident with question four (Auto CAD) and question six (Assembly drawing) being submitted as one assignment.

As usual, the drawings were relatively clean and displayed the relevant information required in terms of candidates' number, centre number and the number of drawing submitted.

RECOMMENDATIONS

- Schools should print their work on CD's instead of 3½ floppy.
- Schools should indicate the CAD used for their projects.
- Revise the gmed 1-3 and the gmed 2-3 forms to indicate the marks allocated for each criterion.

UNIT 2

PAPER 01

<u>Question 1</u>

This question tested candidates' knowledge and ability to determine graphically the reactions and the resultant of a loaded beam. A number of candidates used inappropriate scales such as 2.75: 1, 2.5: 1 etc rather than a whole number. Too many candidates were unable to correctly apply Bow's notation and opted to draw the load line without paying too much attention to lettering. This created a problem for them since they drew the link polygon lines in the incorrect spaces. Candidates need to be aware of the relationship between the force (load) diagram and the space diagram.

Question 2

This question tested candidates’ knowledge of gear teeth terminologies and their ability to insert them on a sketch of the gear teeth. Although this question was compulsory a few candidates did not score well. This is due to poor labeling of diagram and failure to give clear definitions. A few candidates whose definitions were not clear, showed an understanding in the labeling. More practice in sketching and labeling of the actual gear or diagram would help candidates relate more in defining parts of the gear.

Question 3

This question tested candidates’ knowledge and ability in finding the true length of a skewed line. Most candidates were able to meet the first requirement. In meeting the second requirement a fair amount were not able to do so. Requirement three was natural for most candidates to produce. However, a fair attempt was made at this question but more practice is needed in a wide area for using this method for a solution.

Question 4

This question tested candidates’ knowledge and understanding of manufacturing processes. Most candidates attempted it. In most of the cases, candidates were only able to indicate the welding process correctly. Very few responses indicated candidates’ knowledge of press as a manufacturing process. While many candidates were aware of casting and forging as manufacturing processes, they incorrectly indicated these two processes for the five products that were given.

Question 5

This question tested candidates’ knowledge of shaft seals and the application of a splash lubrication system. This was a popular question. The majority of the candidates (approx. 90 per cent) who sat the exam responded to it; however this question was poorly done.

Part (a) of the question was generally well done. Most of the candidates knew the purpose of a shaft seal.

Part (b) posed a bit of a problem. Approximately 30 per cent of the candidates scored seven marks and above. Forty-five per cent scored three to four marks.

Part (c) posed great difficulty. Only 10 per cent of the candidates who responded to this question attempted this section. This meant that the majority of the candidates did not know what a splash lubrication system was.

Question 6

This question tested candidates’ knowledge of a drill bush and twist drill and their sketching ability. Approximately 95 per cent of the candidates attempted it. Most responses gave an orthographic presentation. Challenges were noted in correctly sectioning the bush by about 20 per cent of the candidates and about 20 per cent had difficulty in representing a twist drill. A few candidates reproduced the exact figure and a few candidates inserted a power drill in the figure. This question revealed some challenges in recognizing drills and drill bushes.

Question 7

This question tested candidates' knowledge of the use of an idler gear in a gear system and an idler pulley in a belt drive system. Also tested was candidates' knowledge of a coupling that was capable of accepting angular misalignment. A large number of candidates attempted this question; however, the responses were not generally of a high level. Few of the candidates were able to successfully complete all three aspects of the question. Candidates' lack of knowledge of the use of an idler in a transmission system was quite evident. Even more evident was the candidates' lack of knowledge of a coupling that should be used when there is an angular misalignment.

Question 8

This question tested candidates' knowledge of hand tools and their ability to produce good quality free hand sketches of them. Most of the candidates who responded showed an ability to produce good free hand sketches in good proportion. A few were unable to produce sketches of any of the tools listed. Some responses were void of ergonomic considerations, while a few responses confused ergonomic and aesthetic considerations. A few candidates included mechanical considerations in their responses.

This question was compulsory and was attempted by most (approx. 95 per cent) of the candidates. It was fairly well done by the candidates although the deficiency in recognizing ergonomic factors by a few candidates is of some concern.

Question 9

This question tested candidates' knowledge of engineering materials, manufacturing processes (fabrication) as well as ergonomic and aesthetic factors.

Some candidates suggested cast iron for the frame and consequently casting as a means of forming the shape of the frame. The majority suggested some type of steel or aluminum for the frame. A significant number of candidates confused ergonomic considerations with aesthetic considerations.

PAPER 02

Question 1

This question was clearly stated and tested the candidates' ability to calculate the parameters necessary for the construction of gear tooth profile and using parameters to construct the gear tooth profile.

This question was attempted by approximately 70 per cent of the candidates but was inadequately handled by more than half of them.

The calculation of the parameters which represented the first part of the question was adequately done but some candidates had problems in calculating all of the parameters.

The actual construction of the shape of the gear posed some problems to the candidates as many of the solutions were incomplete.

A major recommendation is that there should be more practice of this topic from calculation to construction.

Question 2

This question tested candidates' ability to determine graphically (i) Reactions R1 and R2 and (ii) the magnitude and types of the force for each member for a roof framing truss.

A relatively large percentage of candidates attempted this question. The majority of them were unable to determine the reaction of R1 and R2 graphically through the use of the force diagram and link polygon.

The second part of the question posed the most difficult with the majority of the candidates being able to construct the force diagram and those that were able to complete the drawing found difficulty extracting data from it.

The majority of the candidates were unable to construct simple vector diagrams for each member and those that were able to construct vector diagrams, confused compression members with tensile members and vice versa. Some candidates also found difficulty converting the measurement of the scale drawing to the magnitude of the force.

The average score obtained by most of the candidates was seven marks.

It is recommended that teachers need to ensure that candidates understand the fundamentals necessary for the construction of the force diagram.

Question 3

This question was structured to test the knowledge and analytical skills of candidates. Of the sample of scripts that was corrected about 70 per cent of the candidates attempted this question. Sixty per cent of the candidates answered this question well attaining a score in the range 20 – 25 marks.

From the sample, 30 per cent of the candidates were able to reproduce the given skew lines in proper orientation and label it accurately; this was enough to secure a score of seven marks.

In addition, 10 per cent of the candidates were able to reproduce the drawing of the skew lines in proper orientation and to label them correctly. Furthermore, the candidates were also able to draw the first auxiliary axis and label the resulting projections correctly. This was enough to attain a sore of 13 marks.

The problem was treated as one in which the objective was to find the true length of the lines, rather than find the true length of the shortest distance between them.

Question 4

This question tested candidates' knowledge and application of casting and moulding processes. They were required to describe processes and identify similarities and differences. Candidates were also required to justify the use of the drop forging process for the manufacture of a component.

It proved unpopular as it was attempted only by one-third of the candidates. Less than half of this number gave satisfactory responses.

The stronger candidates were able to clearly explain the casting and moulding techniques. However, most respondents failed to identify or differentiate between the use of metal and plastics.

Responses for Parts (b) and (c) were not clear. Most candidates failed to give clear reasons in each section.

It is suggested that greater attention be paid to exploring casting and moulding processes and the terms associated with these processes.

Question 5

This question tested candidates' knowledge and application of aspects of the transmission of the motion component of the syllabus. Candidates were required to identify components of drive system for a winch as well as to apply seals and explain a method of lubrication.

Eighty per cent of candidates responded to this question with more than half providing satisfactory responses.

The majority of candidates provided a clear sketch with parts correctly identified. The average candidate showed three of five parts correctly identified, while the very weak candidates were unable to identify any parts.

Candidates' responses to Part (b) were not done well with only 10 per cent being able to represent satisfactory application of a sealing system. Most candidates seemed to misunderstand the requirements of this section.

The majority of candidates demonstrated knowledge of lubrication. Forty per cent were able to clearly show the correct lubrication method. The weaker candidates however, failed to correctly apply the knowledge of lubrication.

It is clear that the majority of candidates were well prepared for this aspect of the syllabus. Greater attention can, however, be paid to sealing and the application of the lubricant.

Question 6

This question tested candidates' skills in freehand sketching to illustrate bearings. These were to be shown by the use of freehand orthographic or pictorial sketches. A fully dimensional drawing of a bushing was also required.

The majority of candidates who attempted the question demonstrated a good general knowledge of Angular/Thrust/Double row ball bearing.

Unfortunately, the question did not provide enough information to complete the calculations necessary for the bushing specifications.

Those candidates who attempted to draw the bushing showed a reasonably high standard of competency, interpreting the data and drawing the orthographic views of the bushing.

Question 7

This question tested candidates' understanding and application of couplings in the area of transmission motion and power.

It was attempted by less than 40 per cent of the candidates of whom 75 per cent of them gave satisfactory responses.

This question consisted of two Parts (a) and (b).

Part (a) was generally well done with the weaker candidates unable to distinguish the differences between (a) (i) and (a) (ii).

In Part (b) the weaker candidates used some knowledge of what was required to create answers/designs.

Overall candidates showed a fair knowledge of couplings.

Question 8

This question tested the candidates' understanding of the systematic design process and the ways it could be used in improving upon the given product and recall of the process.

It was clearly stated and was attempted by approximately 75 per cent of the candidates with almost all of the candidates giving a satisfactory response.

Part (a) of the question was well done. Some of the weaker candidates thought the aspects of the analysis stage were the design process.

Part (b) of the question was also generally well done, however, some of the candidates failed to expand on the ergonomic and aesthetic factors.

Part (c) of the question was concise but was not adequately handled, as much of this synthesis aspect was incomplete. It is recommended that this aspect of the exercise be practiced more often.

Question 9

Forty-two per cent (42 per cent) of the candidates attempted this question. About 50 per cent of them did not describe the sand carting process with text. However, the sketches of a sand mould were reasonably well done.

Approximately 90 per cent of the candidates who attempted this question gave the advantages of die casting compared with sand casting with only a few giving the disadvantages.

In addition, some candidates mistook aesthetics for ergonomics and gave the function of the pots compared with the beauty.

REPORT ON INTERNAL ASSESSMENT

Generally, the design portfolios submitted displayed a good level of understanding by the candidates about the design process. Approximately 80 per cent of the samples received a passing grade. However, there is lots of room for improvement, especially where the design phases are concerned.

Many design aspects were unaccounted for, such as:

- The three (3) alternate preliminary design sketches
- Justification
- A Technical report comprising of a work schedule
- Limits and constraints
- Proper organization of the contents of the portfolio
- Final drawings with proper dimensions

There was a general lack of consideration for Health and Safety in the design submitted. Teachers need to put more emphasis on this aspect when guiding the candidates in the preliminary stages of the design.

Candidates demonstrated competently how their design would work showing satisfactory technical and verbal skills. However, about 25 – 30 per cent submitted designs with obvious structural design flaws that should have been corrected by their teachers during the design process.

The design assignment was to be CAD based but about 30 per cent showed no CAD in their portfolios and of those that did submit CAD based designs, only 20 per cent submitted all that was required. The vast majority of candidates did not submit list commands, electronic copies of CAD work or CAD drawings on the correct paper size with border, block and all relevant information.

About 40 – 45 per cent of candidates displayed exceptional CAD skills, producing exploded views, solid modeling (3D), and other higher level techniques. However, they fell down when it came to the written aspects of the design portfolio producing, poor design sketches, poor Project Reports and poor or no Technical Report.

Technical Report writing must be revised. Even though marks were awarded for the work programme provided by the candidates, in most cases it was not a Technical Report. A Gantt chart does not constitute a Technical Report and candidates at this level must demonstrate satisfactory Technical Report skills.

Centres must supply CXC headquarters with knowledge of the version of CAD they are using in their school. Many disks received could not be viewed because of incompatibility of software.

In terms of the marking of the internal assessment, there was a need to see a breakdown of the scores supplied, especially when it comes to the Interactive Presentation.

RECOMMENDATIONS

- Schools should print their work on CD’s instead of 3½ floppy.
- Schools should indicate the CAD used for their projects.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2009

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

GEOMETRICAL AND MECHANICAL ENGINEERING DRAWING

CARIBBEAN ADVANCED PROFICIENCY EXAMINATIONS

MAY/JUNE 2009

UNIT 1

GENERAL COMMENTS

Three hundred and eighty-six (386) candidates were entered for the 2009 examinations in Unit 1 and two hundred and thirty-four (234) for examinations in Unit 2. In Unit 1, 72 per cent of candidates earned Grade V and above. In Unit 2, 82 per cent of the candidates earned Grade V and above.

Candidates performed poorly in Unit 1 Paper 01 and particularly in Module 3 of Unit 1. Candidates' performance in all three modules of Unit 2 was good. The performance on the Internal Assessment for both units continues to be very good. A large number of candidates continue to display poor drawing skills, limited design ability and a poor knowledge of ISO convention. Candidates need to improve their knowledge of engineering components, materials and manufacturing processes.

DETAILED COMMENTS

UNIT 1

Paper 1

Module 1

Question 1

This question tested candidates' knowledge of the principle of an archimedian. The majority of candidates that attempted the question were able to identify the curve with some candidates drawing the shape without construction. Most candidates had difficulty applying the data given to solve the problem. Generally the question was well done, with approximately 60 per cent of the candidates being able to solve the problem.

Question 2

This question tested candidates' ability to reproduce a quadrilateral and subsequently find the centroid. There was more than one method of finding the solution, and all of these methods were employed by the candidates who attempted this question.

The methods used in order of popularity were:

1. Re-entrant quadrilateral
2. Resolve into composites
3. Funicular or link polygon
4. Determination of centroid using first and second derived areas and the formula.

Over 90 per cent of the candidates attempted this question with 40 per cent giving a satisfactory performance.

Method 1

Candidates who used this method were generally able to divide the sides into 3 equal parts and from that create the re-entrant quadrilateral and finally the centroid from the mid-point of the intersecting diagonals. The only difficulty was misinterpretation of the continuous dimensions in the base of the figure which rendered the shape incorrect.

Method 2

This method was employed by 45 per cent of the candidates. Candidates were generally able to divide the quadrilateral into two triangles and find their respective centroids. However, in the determination of the areas, and finding the ratio to divide the line joining the centroids of the two now existing triangles to find the centroid of the quadrilateral, proved to be their common downfall. Most of them were awarded marks up to this point only.

Method 3

The candidates who used this method had difficulties with accuracy. Weaknesses in drawing skills were readily noted.

Method 4

Of the 2 per cent that attempted this method none of them were able to eventually find the centroid, and in a few cases no data was shown to support what was drawn. The candidates who used AUTOCAD to complete their drawings had difficulty in reproducing the drawing to the correct size, and in general did not provide any supporting evidence as to how the final results were obtained.

Question 3

This question tested candidates' knowledge and ability to construct a cam displacement diagram. The question was attempted by virtually all candidates and 60 per cent gave satisfactory responses. Most candidates constructed the simple harmonic motion curve properly, while 88 per cent failed to interpret the uniform acceleration and retardation curve.

Module 2

Question 4

This question tested candidates' ability to construct the curve of interpenetration. This question was attempted by approximately 90 per cent of the candidates. The majority of the candidates were unable to perform the necessary construction for the intersection. Most candidates used the construction for the intersecting of two pipes of different diameters.

Question 5

This question tested candidates' knowledge of oblique cabinet projection and ability to draw curves of the front face and the extension of those curves in the oblique plane. It was attempted by approximately 97 per cent of the candidates, however, only approximately 55 per cent were able to produce the correct solution required whilst approximately 25 per cent were able to produce the object in the oblique plane, but failed to show the correct outline of a tapered edge and the reduced rear (cabinet) view. The final 10 per cent reproduced the given figure and were only able to gain marks on the front face.

The 25 per cent of the candidates who were able to produce the oblique object seemed to have found difficulty in being able to construct the tapered outline. Moreover, the same candidates failed to produce the figure in cabinet view. However, construction of the oblique object was well done without the above mentioned requirements. This clearly indicates that candidates generally have a basic understanding of how to construct oblique drawings correctly, but need to have a greater understanding of how to apply a taper and cabinet view to an oblique drawing. Teachers should place more emphasis on teaching these two aspects to the students.

Question 6

This question tested candidates' analytical and graphical skills of auxiliary view. This question was compulsory and was attempted by 99 per cent of the candidates, 35 per cent gave satisfactory responses. It was well noted that most candidates constructed the two given views, but most failed to produce the true face of A.

Module 3

Question 7

This question tested candidates understanding and interpretation of the projection used and candidates' ability to produce a free hand isometric sketch in good proportion. It was compulsory and was attempted by just over 70 per cent of the candidates with the majority giving satisfactory responses.

Some candidates displayed an inability to draw in good proportion and with neat clear linework. Misinterpretation of some features of the projection shown led to the omission of simple isometric structures and form.

Question 8

This question tested candidates' knowledge of locking devices, manufacturing processes and materials. It was compulsory and was attempted by approximately 65 per cent of the candidates with about 40 per cent giving satisfactory responses. Some candidates displayed an inability to design a simple device to lock and swivel two tubes. They were unable to identify the manufacturing process necessary, and the material to be used.

Question 9

This question tested candidate's knowledge of limits and fits. It was compulsory and 97 per cent of the candidates responded. Many of the candidates demonstrated that they have knowledge of what tolerance is and were able to explain the two types of tolerancing. However, they seemed to have had difficulty in demonstrating the application through their drawing skill. Part (b) of the question was fairly well done with candidates providing reasonably good responses, demonstrating a full knowledge of the terms clearance and interference fit. Approximately 70 per cent of the candidates were able to successfully produce graphical demonstrations to further describe the two terms.

Paper 2

Module 1

Question 1

This question tested candidates' ability to construct cam displacement diagrams and cam profile to produce simple harmonic motion (SHM), dwell and uniform velocity (UV), using an in-line follower. The motion being anti-clockwise.

In this section of the paper, this question was optional but proved to be popular as it was attempted by approximately 85 per cent of the candidates. Eighty per cent (80 per cent) of these gave satisfactory responses.

Many candidates were aware of the cam displacement diagram and its function and relationship in terms of producing the cam profile. They were also aware of the importance of the follower motion. The weaker candidates confused the type of follower motion and some even ignored the type of follower as stated in the question. Most of the weaker candidates left out the roller center. Some of the candidates had difficulty in terms of plotting in an anti-clockwise direction.

In the classroom attention must be given to the accuracy and completion of different types of cam examples.

Question 2

This question tested candidates' knowledge of a simple crank mechanism and their ability to plot the locus of a point on a movable arm.

It was attempted by approximately 68 per cent of the candidates. 60 per cent of them gave an excellent response and received marks of 20 and above out of 25 marks. Approximately 25 per cent gave moderate responses and received scores ranging from12 to 19 out of a possible 25 marks. What was alarming was the number of candidates who offered poor responses to the question. About 15 per cent of the candidates scored less than 10 out of 25, with a high ratio scoring only 4 out of 25. This is an indication that some students had very little knowledge of this aspect of the syllabus. What is of even greater concern is the fact that this identical objective is covered at the CSEC level. Students at this level are expected to show mastery of this particular objective.

Question 3

This question tested candidates' ability to graphically locate the centroid of a figure. It was not very popular and was attempted by approximately 150 candidates, 35 per cent of whom scored less than 11 out of 25. About 10 per cent of the candidates scored 20 or above out of 25 and approximately 55 per cent scored between 12 and 19 out of 25.

All candidates were able to accurately reproduce the given figure. About 65 per cent of them were able to derive the first and second moment of area, however, many were not able to calculate the actual area of the given figure and the first and second derived figures. The calculation of the areas and the first and second moment using the formulae was the most poorly done part of the question. Many of the candidates did not attempt this part of the question. Lack of knowledge of the formulae proved to be the downfall of many candidates.

Module 2

Question 4

This question tested candidates' knowledge and ability to draw the development of a truncated oblique cone. Many candidates used the construction method used in the development of a regular cone. This question was attempted by just over half of the candidates and 50 per cent gave satisfactory responses.

In Part (A), the candidates were able to correctly reproduce the diagram as given.

Question 5

This question tested candidates' knowledge and ability to produce orthographic projection and isometric drawings. It was the most popular question done as almost all candidates attempted it. Generally, candidates made strong responses to the reproduction of the given views and scales were good. The general weakness was seen in their interpretation of the views given. The candidates often confused the plan for the front view. This led to an often incorrect position and projection of the end view. A further weakness was noted in the creation of the isometric view. There was a fair split in candidates providing the correct solution; a solution inverted, that is, Top down, and a solution with the top facing the right and the bottom facing the left. There also seemed to be a deficiency in their understanding of first and third angle projections.

Question 6

This question tested candidates' knowledge of auxiliary projection. The question was attempted by about 30 per cent of the candidates with about 25 per cent of them giving satisfactory answers.

Parts (a) and (b) of the question tested the candidates' knowledge of orthographic projection. This was fairly well done with some inadequacy in response to Part (b). Only few candidates gave satisfactory responses to Part (c) which indicated a lack of knowledge of **auxiliary** projection. The question asked for an auxiliary front elevation, however, some candidates attempted an auxiliary plan, while most candidates did not attempt this part of the question.

Module 3

Question 7

This question tested candidates' knowledge and ability to produce working drawings. It was very popular, with approximately 75 per cent of the candidates attempting it. The general level of performance was moderate and most candidates showed that they understood what working drawings were. The accuracy of views, when done, was good. The general area of weakness was seen in the placing of machine symbols. Less than 10 candidates placed any machine symbols at all. Candidates had some challenges in presenting well dimensioned drawings; arrow heads, leader lines and the like were below standard. Some candidates provided assembled isometric drawings.

Question 8

This question tested candidates' knowledge and ability to design a crank handle. Candidates did not fully understand the operation of the crank handle capable of driving a shaft in one direction and slipping in the other. Candidates were handicapped in producing neat labelled sketches of the components of the crankhandle and cross-sectional views.

Question 9

This question tested the candidates' knowledge of the design process and the use of engineering materials. It was attempted by just over half the candidates and about 70 per cent of them gave satisfactory answers.

Part (a) of the question was generally well done with candidates giving reasonable answers.

Part (b) of the question tested candidates' ability to explain their design. This was well done.

Part (c) of the question tested candidates' knowledge of manufacturing processes. This part of the question was misinterpreted by most candidates as they stated the design of the product without stating how the product would be manufactured.

Part (d) tested the candidates' knowledge of engineering materials. This part of the question was generally well done as they identified the relevant material for the specific application. However, some candidates used the words iron and steel interchangeably, which indicates a lack of knowledge of the difference between them. In some cases, even though the design was good in itself, it was ineffective for the application to the question.

UNIT 2

Paper 1

Module 1

Question 1

This question tested candidates' ability to determine graphically the reactions on a simply supported loaded beam. Candidates were to draw a load (force diagram) line to scale, complete the polar diagram, plot the link polygon and transfer the closing line to load diagram.

Most candidates attempted this question. A significant number performed mathematical calculations rather than the graphical approach to determine the reactions on the beam. About 30 per cent of the candidates did not apply BOW's notation and a few applied scales incorrectly.
Teachers are reminded that mathematical solutions are not allowed.

Question 2

This question tested candidates' knowledge and ability to sketch a gear wheel and label the different parameters. Approximately 95 per cent of candidates attempted it. Approximately 40 per cent of those who attempted this question showed some knowledge of the definitions, but were not too clear in their expressions. As for the sketch, about 60 per cent of the candidates who attempted the question were familiar with the diagram, but failed in proper labelling with arrow indicators.

Question 3

This question tested candidates' ability to reverse first and second auxiliary orientation. After reproducing the given drawing, they were to plot the plan and then project the front elevation of the lamina. Most candidates drew the figure as given but a few changed the general orientation. This may have affected them when it came time to plotting the plan and elevation. A significant number of candidates projected the first auxiliary (a2 b2) parallel to itself, rather than perpendicular to x1 y1 as required. Some candidates projected the plan at right angle to the right as opposed to vertically upwards as required. Obviously they are not used to reversing the auxiliary operations.

Module 2

Question 4

This question tested candidates' knowledge of engineering materials and their application. It was a two-part question which asked for recalling definitions and giving examples. It was a very popular question with approximately 98 per cent of the candidates attempting it. Candidates' responses were a little vague and for some the responses were mixed up. Overall, candidates showed a fair knowledge of the question, but failed at times to mention terms in defining an item. As for Section 2 of this question, there were overlapping responses and some candidates were a little off target in terms of materials relating to engineering. Exposing students to samples of these materials and their properties along with demonstrations would be of benefit to the student.

Question 5

This question tested candidates' knowledge of seals. It was attempted by more than 75 per cent of the candidates.

Part (a), requiring candidates to name the two basic seals, was not well done. In most of the responses, candidates could name the static seal only, with few being able to name both. In giving the examples, few of the candidates who were able to name both seals, incorrectly gave the O-ring seal as a static seal or the gasket as a dynamic seal.

Part (b), which required candidates to name the given seals that were shown, was not generally well done. Most of the responses showed candidates only able to name the split – ring and /or the gasket. In few of the responses candidates referred to the O–ring as a "ball" and the gasket as a "plate". Some candidates classified the given seals as either static or dynamic instead of giving the name. It is necessary to illustrate to students the seals in application and not just a pictorial representation.

Question 6

This question tested candidates' ability to produce freehand sketches. Approximately 90 per cent of the candidates attempted this question. Although the question stated that candidates should only sketch the rolling or sliding element, most of them went on to sketch a large portion of the entire bearing. Candidates should be instructed to read the question carefully. It is recommended that greater emphasis be placed on 3-dimensional sketches. Approximately 85 per cent of the candidates attempting this question failed to score a mark on Part (a), however, the question was fairly well done.

Module 3

Question 7

This question tested candidates' knowledge of the pulley system, and required candidates to describe how the tensioning of a belt drive could be achieved by (a) an idler pulley, and (b) a hinged mount.

This question was attempted by approximately 75 per cent of the candidates and was generally not well done. Only a few of the responses showed candidates ability to accurately sketch and describe the idler pulley and hinged mount tensioning the belt drive. Many of the responses showed candidates only had some knowledge of an idler pulley but could not clearly show or describe how the belt drive is tensioned. Many of the responses showed candidates having a weak or no knowledge of a hinged mount.

Question 8

This question tested candidates' knowledge and understanding of the stages in the design process. Approximately 90 per cent of the candidates attempted it.

Part (a) of the question required candidates to list the design stages in their correct order, while Part (b) required candidates to match each stage with its correct explanation. Although this question was fairly well done, Part (a) posed some difficulty, in that some candidates did not know the correct order. However, the candidates were more aware of the explanation for the different stages.

Question 9

This question tested candidates' knowledge and understanding of ergonomics in engineering design. Candidates were required to define the term ergonomics and describe four factors to consider in designing an instrument console. It was attempted by almost 90 per cent of the candidates and showed most candidates as having some understanding of ergonomics by giving a correct definition. Many of the candidates scored full marks on this question, which showed candidates stating the correct ergonomic factors. However, some responses showed candidates listing only aesthetic factors. This showed that candidates do not know the difference between ergonomics and aesthetics. In a few of the responses candidates incorrectly listed the steps in design process as ergonomic factors. Few of the weaker responses also showed candidates not having any knowledge of what a console was. It is important to emphasize and show how ergonomics is a part of the design process and not interchangeable with the design process.

Paper 2

Module 1

Question 1

This question tested candidates' ability to determine graphically the magnitude and type of forces for each member of a roof framing truss and to indicate the reactions. Many candidates attempted this question. The majority of them were able to determine the reaction of R1 and R2 graphically.

However, the second part of this question appeared to be more difficult, with less than 40 per cent of those who attempted the question being able to complete and indentify the forces and magnitude of each member of the framing truss.

Question 2

This question tested candidates' ability to calculate the various parameters of the involute gear and to construct a gear tooth profile. It was attempted by 42 per cent of the candidates with over 75 per cent giving satisfactory responses.

Many students were aware of the definitions and calculations pertaining to the involute gear terms. Many candidates were able to apply this information to the construction of the gear profile.

The weaker candidates confused the definition of terms and were unable to construct the gear profile accurately. Some candidates did the calculations accurately but were unable to produce the gear profile.

Attention in the classroom must be given to accuracy, completion and presentation of solutions for different examples.

Question 3

This question required candidates to reproduce the given parallelogram-shaped lamina with a vertical pole mounted in the centre. They had to determine the true angle between the pole and the lamina, the true shape of the lamina and label the true shape.

About 30 per cent of the candidates made errors reproducing the drawings. About 50 per cent of the candidates were able to successfully determine the angle between the pole and the lamina and a slightly larger number were able to project the true shape. Candidates who used the AUTOCAD program generally completed the question successfully. However, some printers (or plotting devices) were not able to print these drawings to a precise scale (e.g.1:1; 1:2; 1:5 etc). This presented a difficulty in verifying the accuracy of the drawings. Most candidates who determined the true angle between the pole and the lamina also found the true shape of the lamina.

Recommendations

Some candidates using the AUTOCAD program appear to produce similar results. Though it was doubtful that there was cheating on this question, as was evident on others, strict supervision is needed where AUTOCAD is used by candidates.

Module 2

Question 4

This question was a popular one, with approximately 95 per cent of the candidates attempting it. There were four parts to this question that asked for definition, application properties and samples of materials.

Part (a) was well done, as most candidates answered correctly. In Part (d) candidates were able to score well, as most had knowledge of the difference between Thermoplastic and Thermosetting plastic. This gave the candidates the edge for Part II of (d) by giving examples and uses from an easy recall.

As for Parts (b) and (c), candidates were weak in giving or identifying the properties, but the uses, candidates could give fairly well.

Perhaps, if instructors gave candidates research on these materials, the newly found knowledge would be recalled easily and accurately. These are materials that candidates see and feel, perhaps, everyday. Therefore researching them may enhance their ability to know them well.

Question 5

This question tested candidates' knowledge and application of the casting and moulding processes. They were required to give advantages and disadvantages of some processes. Candidates were also required to sketch two methods of manufacture.

Many candidates that attempted this question were unable to complete what was required or give clear reasons for each process stated.

Question 6

This question tested the candidates' knowledge and application of bearings and their ability to differentiate between journal and ball bearings.

This question attracted sixty-four responses many of which were poorly done. The marks ranged from zero to seventeen out of twenty-five. Sixteen (25 per cent) candidates scored 10 or more out of 25 with the marks clustering around 10, 11, 12, and 13.75 per cent of the candidates scored under 10 marks. This is cause for concern as the deficiencies were mainly in the same areas, function and application of journal bearing.

It is suggested that instructors pay more attention to this area as it is a critical area of the design of moving components.

Module 3

Question 7

This was not a popular question. The few students who answered it were able to describe the operation of a centrifugal clutch giving one example of its application. In regards to the sketching and labelling of the centrifugal clutch, few students were able to attempt the section with great success. The majority of candidates were able to state one main use and name two classes of couplings asked for.

The candidates performed reasonably well in describing the operation of the Oldham flexible coupling by the application of neatly labelled sketches.

Question 8

This question tested candidates' knowledge and understanding of designing, engineering materials, and methods of manufacturing, and applying these to the designing of an industrial wheelbarrow. It was attempted by over 90 per cent of the candidates, and was fairly well done. In most of the responses candidates were able to sketch a wheelbarrow and indicate the required components in Part (a).

Part (b) of the question, which required candidates to give details of how the wheel may be attached to the frame, was generally not well done. Only a few of the responses showed candidates being able to give appropriate details.

Part (c) was generally well done, with most candidates correctly explaining two ergonomic reasons.

Part (d) posed the greatest challenge, which required candidates to complete a table. Candidates were able to indicate the correct quantities of each component. Few were able to indicate correctly whether the component part was to be made or bought. Some candidates misinterpreted this part of the table by indicating a dollar figure (estimated price) in the make/buy column. Most candidates were unable to identify appropriate material and/or manufacturing methods for the component parts. Many candidates incorrectly named cast iron (material) and forging/casting (manufacturing method) for the handle/frame and the tray/bed.

Candidates should be able to select appropriate materials and manufacturing methods for various engineering components. This will require candidates' exposure to various engineering materials, their applications and limitations.

Question 9

This question tested candidates' ability to interpret design specifications. It was attempted by almost all candidates. Candidates considered the interpretation of the special feature to be optional while it was compulsory to the question. Candidates found Part (d) of the question to be difficult to answer.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2010

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

GENERAL COMMENTS

Five hundred and twelve candidates were entered for the 2010 examinations in Unit 1 and 312 for examinations in Unit 2. In Unit 1, 79 per cent of the candidates earned Grave V or above. In Unit 2, 82 per cent of the candidates earned Grave V or above. A large number of candidates continue to display poor drawing skills, limited design ability and a poor knowledge of ISO conventions. Candidates need to improve their knowledge of engineering components, materials and the manufacturing process. The performance on Internal Assessment continues to be very good.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

Module 1

Question 1

This question tested candidates' ability to produce an ellipse using the auxiliary circles method. It was very popular, with 90 per cent of candidates attempting it. Generally, the question was very well done with the majority of candidates successfully drawing the ellipse.

Question 2

This question tested candidates' knowledge of the function of a cam. Approximately 98 per cent of the candidates attempted the question with less than half of them being able to correctly draw the diagrams. The majority of candidates were able to correctly define the cam. However, diagrams drawn were incorrectly labelled by most candidates. Many candidates did not show the appropriate construction methods for the displacement diagrams of the given cam motions.

Attention must be given to accuracy and the correct labelling of the various types of displacement diagrams for the cam motions.

Question 3

This question tested candidates' ability to construct a resultant trapezium from a truncated right angle triangle and subsequently to find its centroid. Approximately 90 per cent of the candidates responded to the question using various methods. The most popular methods used were the trapezium method and resolving the shape into composites. Most of the candidates who used these methods were successful. Some candidates used the first derived area and the formula; however, they had difficulty locating the centroid. Approximately ten per cent of the candidates misinterpreted the diagram and found the centroid for the entire triangle. The candidates who used AutoCAD also had difficulty printing their drawings to scale. Special instructions must be given to centres that use AutoCAD reminding them to print all drawings to the correct size.

Module 2

Question 4

This question tested candidates' ability to construct the curve of intersection of two hexagonal prisms. The question was attempted by approximately 95 per cent of the candidates. The majority of them were unsuccessful in their attempt to correctly show the intersection of the two prisms. Most candidates, though able to reproduce the given drawing of the prisms and show the projection lines, were unable to plot and join the points correctly to show the intersection.

Question 5

This question tested candidates' understanding of a helix and their ability to construct two turns of a left hand system. Ninety per cent of the candidates attempted the question but half of them had challenges defining a helix. Those who gave a definition were only able to do so partially. Seventy per cent of the candidates demonstrated good knowledge and skill in the construction of the desired plotting of the curve.

Question 6

This question tested candidates' knowledge of auxiliary projection. It was attempted by approximately 98 per cent of the candidates with about 45 per cent of them giving satisfactory answers. Parts (a) and (b) tested candidates' knowledge of orthographic projection. This was done fairly well, but there were problems with regard to producing the plan from the given auxiliary elevation and subsequently the projection of the plan to produce the front elevation.

Module 3

Question 7

This question tested candidate's knowledge of limits and fits. It was compulsory and 52 per cent of the candidates responded. Many of them demonstrated knowledge of the meaning of clearance, interference and transition fits.

For Part (b), 30 per cent of the candidates showed full knowledge of basic sizes and tolerance.

Question 8

This question tested candidates' knowledge and skill in freehand sketching of various hand tools. The compulsory question was attempted by 90 per cent of the candidates, with the majority selecting and satisfactorily sketching Choice (i). Choices (ii), (iii) and (iv) were not well answered; the majority of candidates either opted not to sketch the mechanical devices or sketched them incorrectly.

Question 9

This question tested candidates' knowledge, application and drawing skills in the field of Mechanical Engineering Drawing. Candidates were required to draw a front view of a Pipe Clamp Bracket and a pipe secured by a U-Clamp with nuts. Sixty-one per cent of the candidates attempted this question.

The following observations were made:

- Fifty-nine per cent of the candidates were able to reproduce the Clamp Bracket and insert the pipe correctly.
- Twenty-five per cent of candidates were able to draw a U-Clamp.
- Twelve per cent of candidates were able to insert the nuts.
- Candidates had major difficulties drawing the U-Clamp and inserting the nuts correctly.
- Candidates had difficulty interpreting projection views (first angle and third angle).
- Candidates drew bolts instead of nuts.

Paper 02 – Essay Questions

Module 1

Question 1

This question tested candidates' ability to plot the locus of a point associated with a link mechanism. It also required candidates to fully label the diagram.

This question was generally well done by 80 per cent of the candidates who responded to it with the majority of them being able to correctly reproduce the given figure. However, after obtaining the attachment 'CD' on the given link, some candidates drew parallel lines for its alternate positions on the link 'AB', rather than obtaining independent 60-degree angles at each point.

A few of the responses showed candidates incorrectly drawing all the alternate link positions through 'B' as a fixed point rather than having 'B' moving in a horizontal straight line. Among the candidates that did not do well on this question were those who were only able reproduce the given figure and nothing further. Many candidates lost marks due to the inappropriate or non-labelling of the diagram as requested.

Question 2

This question tested candidates' ability to construct a cam diagram and cam profile. Candidates were required to produce an SHM, dwell, UV and UR using an inline, knife edge follower, the motion being anti-clockwise.

The question was attempted by approximately 92 per cent of the candidates with almost all giving satisfactory responses. Many of the candidates were aware of the cam displacement diagram and its function and relationship in creating the cam profile. There was also an awareness of the importance of the type of follower and the direction of rotation. Weaker candidates seemed to confuse the type of follower. Many candidates were unable to produce an accurate graph for uniform retardation, hence, their cam profile was inaccurate. Some candidates were confused by the rotation of the cam. Even though they produced an accurate cam displacement diagram, a few candidates could not transfer the points accurately to produce the cam profile.

It is recommended that greater emphasis be placed on the accuracy of work produced, even in the practice of printing when using AutoCAD.

Question 3

This question tested candidates' knowledge of centroids and ability to locate the centroid of a given figure and determine the second moment of area about its base (X-X). Approximately 25 per cent of the candidates attempted this question. Most candidates experienced difficulty constructing the given figure as a few dimensions were not specified. Three figures were possible using the available data, hence, candidates generally offered solutions within these ranges.

Module 2

Question 4

This question tested candidates' ability to determine and draw the curve of intersection between a cylinder and a cone and to further draw the development. Approximately 95 per cent of the candidates attempted this question. More than 50 per cent of those candidates were able to divide the circle into equal divisions. Some candidates did not draw the lines from the base to the apex of the cone. Almost all candidates did not know that they had to draw an auxiliary view in order to locate points for the curve of intersection. It appears as though candidates were not exposed to this type of intersection. Candidates who showed some understanding of the development of a cone were able to draw an arc equal in length to that of the cone. In addition, they were also able to make correct divisions to this arc. This set of candidates showed that they had knowledge of intersecting solids because they divided the cylinder in the given view and projected lines to the intersection area on the cone. There appears to be some confusion with regard to this topic. Some candidates drew a plan and then went about drawing the curve of intersection. This particular application, where there was a need to draw an auxiliary view in order to be able to plot points for the curve of intersection proved challenging for many candidates. Overall, the question was poorly done.

Question 5

This question tested candidates' knowledge of a helix and their ability to construct one. It was attempted by approximately 44 per cent of the candidates. Candidates were required to produce two coils of a square section right-hand spring. Most candidates understood the requirements of the question but lacked the graphical skills to produce a satisfactory response. However, those who understood and were able to perform scored in the range of 21–25 marks. Far too many candidates were unable to progress beyond producing a single helix. This indicated that candidates lacked the required level of practice necessary to give a satisfactory response. Candidates need to be given more practice exercises.

Question 6

This question tested candidates’ ability to produce auxiliary views. Approximately 65 per cent of the candidates failed to show mastery of orthographic to auxiliary projection. Approximately 34 per cent of the candidates demonstrated that they had knowledge of converting orthographic projection to auxiliary whereas approximately 64 per cent of the candidates showed knowledge of the concept of how an auxiliary view looks. Generally, greater practice is needed in converting orthographic projection to auxiliary.

Module 3

Question 7

This question tested candidates’ knowledge of a lathe and their ability to produce neat, isometric sketches. It was attempted by approximately 37 per cent of the candidates with less than 50 per cent being able to produce proper free-hand, isometric sketches of these components and labelling them. The responses would suggest that more emphasis should be placed on proper free-hand sketching methods, machine shop components and labelling them, as these form part of the required syllabus.

Question 8

This question tested candidates’ knowledge of bearings and their ability to calculate maximum and minimum clearance and interference. It was fairly well attempted; however, most candidates demonstrated that they were unable to identify the specific bearing as a ‘double row ball bearing’. With the exception of about three candidates, the vast majority of them could only identify it as a ball-bearing. The calculations of the maximum and minimum clearance and interference were also fairly well done. The responses to Part (e) of the question were also fair.

Question 9

This question tested candidates’ knowledge of gears and link mechanisms as well as their uses. It also assessed candidates’ ability to produce neat free-hand sketches. Approximately 33 per cent of the candidates responded. The majority of candidates demonstrated knowledge of the rack and pinion arrangement. Most respondents however, failed to clearly represent the application of the ratchet to prevent the backward movement of the pinion. Most candidates also failed to correctly use arrows to indicate the movement of the rack relative to the movement of the pinion. Fewer candidates responded to Part (b) and of those who responded, the majority demonstrated knowledge and application in representing the slide and crank. In Part (c), most respondents were able to identify at least two uses for the mechanisms.

It is recommended that greater attention be paid to the application and uses of mechanisms in engineering. There is also need for candidates to improve their drawing skills.

UNIT 2

Paper 01 – Short Answer Questions

Module 1

Question 1

Candidates were asked to sketch a pillow block bearing and use reference balloons and a parts list to identify six areas on the component. Sixty-seven per cent of candidates attempted this question but the majority of them paid attention only to the first part of the question, which was to sketch. Candidates failed to attempt the other two parts of the question which asked for a balloon reference and a parts listing of the same areas on the component. Of the 67 per cent of candidates who responded to the question, the majority scored between two and four marks because of their failure to attempt the other parts of the question.

The responses to this question showed that (1) candidates are not familiar with this component and (2) that they did not read the question carefully to see that it was asking for three things — to sketch a specific component, to label it with reference balloons, and then to give a parts listing.

Candidates need more practice in identifying what questions ask for (breaking up the question into parts) as well as in how to respond to these questions.

Overall candidates show a lack of practice in sketching and labelling as well as, types of labelling is evident.

Question 2

This question challenged candidates to reproduce the given drawing, to produce the first and second auxiliary views and then to find the true angle between the line (P, E) and the plane (a, b, c).

The question was popular, 92 per cent of candidates attempted it although some merely reproduced the given drawing. A very small percentage of candidates obtained scores between four and eight marks, while the majority of scores were between two and three marks. The few candidates who scored between four and eight marks, tried to produce the first and third auxiliary and not to find the true angle between the line and the plane figure (a, b, c).

Overall, the responses showed a lack of practice in producing auxiliary projections. Teachers need to give more practice in this area.

Question 3

This question tested candidates' knowledge and application of gears in mesh by the calculation method. Seventy-three per cent of the candidates who sat the examination attempted it. Part (a), which required candidates to find the centre distance of the gears in mesh, was well done.

Part (b) was fairly well done. Approximately 50 per cent of the candidates who attempted this part of the question had knowledge of how to find the outside diameter. However, some candidates failed to multiply the addendum by two when adding to the pitch circle diameter.

Approximately 80 per cent of the candidates who attempted this question scored between seven and ten marks.

Module 2

Question 4

This question required candidates to state and briefly explain the four machining processes used to fabricate a piece of round bar.

The responses to this question were very good, with approximately 95 per cent of the candidates obtaining an average mark of 60 per cent. The majority of candidates experienced some level of difficulty stating and defining four machining processes, some were able to state at least two of the processes but unable to properly define them.

Teachers should provide students with practical workshop exercises to get them familiar with machine shop procedure.

The majority of candidates who attempted Part (b) were not able to distinguish between ergonomics and aesthetics, most of them responded by giving answers related to aesthetic improvement. Overall, responses to Part (b) were fair.

Question 5

This question tested candidates' knowledge of brass and bronze with respect to their components of manufacture. It also required an understanding of the chemical structure of two types of plastic.

Part (b) sought to assess candidates' knowledge of speciality brasses and their properties. For Part (c) candidates were asked to distinguish between thermoplastic and thermosetting plastic by listing a general difference between the two.

A moderate number of responses to Part (a) were satisfactory. This may indicate a deficient knowledge base in terms of brass and bronze and their manufacture. Less than 50 per cent of candidates gave a satisfactory response to this part of the question.

Part (b) was very poorly done as most candidates responded with incomplete answers or incorrect information. Candidates' responses indicated a lack of knowledge of speciality brasses, the properties of brass as a material in general, as well as specific properties of speciality brasses.

Candidates were well up to the task of differentiating between the two types of plastic. The majority of them explained the difference in reaction to melting or high temperatures. They answered this part very well and most scored full marks. Very few candidates did not score on this section.

The overall performance of candidates on this question was poor. Far too many of them scored 20 per cent or less of the marks available. Candidates seemed to have limited knowledge of brass and bronze as engineering materials and showed even less knowledge of speciality brasses and their specific mechanical properties.

Question 6

This question tested candidates knowledge of bearings and lubrication methods along with their sketching ability. It was compulsory and the responses to the question were average. Many candidates showed lack of knowledge of the grease nipple and were unsure about how to place the bearing and cap. More exposure to real life bearings (different types) and lubrication methods would greatly improve candidates understanding of the topic.

Question 7

This question tested candidates' knowledge of mechanisms that convert rotary motion to linear motion. It was compulsory and was attempted by 76 per cent of the candidates. Of the candidates who attempted this question, most had the basic knowledge of mechanisms that convert rotary motion to linear motion but only about 50 per cent gave three examples of these mechanisms. Additionally, a major weakness was that only about 40 per cent gave examples of mechanisms that convert rotary motion to linear motion in the form of couplings and gear train. The major strength in the responses of candidates is that most of those who attempted the question gave a rack and pinion as a mechanism.

Question 8

This question tested candidates' knowledge and application of a design process. Ninety-one per cent of those who sat the examination attempted this question. The majority of candidates did not follow the instructions given. Candidates were required to list the stages of a design process and then to match each to a given step. However, approximately 60 per cent of the candidates did not do this; instead, some of them explained all the steps in the given figure while others listed the stages but did not match each stage with the given steps.

Question 9

The question required candidates to derive and illustrate a design solution for a stated set of conditions. They were required to design a low cost belt clip, as a single unit, which was capable of being mass produced.

Candidates needed to present preliminary ideas and a final design for Part (a). Part (b) required that they identify the material and method of manufacturing. Most candidates failed to illustrate a preliminary idea and lacked advanced sketching skills. Generally, good design ideas were generated and some candidates displayed a good understanding of the design process.

Selection of material was fair but the actual construction/manufacturing choice was moderately done. Candidates seemed to have a limited knowledge with respect to material and material properties. Overall, the question was fairly well done.

UNIT 2

Paper 02 – Essay Questions

Module 1

Question 1

This question tested candidates' ability to determine, graphically, the magnitude of forces acting in each member and to determine the type of force acting in each member of a loaded roof truss. Many of the candidates who attempted this question were able to complete the truss and label it using Bows' notation. However, less than 30 per cent of these candidates were able to determine the magnitude and type of forces. The responses indicated that candidates did not understand or complete the module on simple framework.

Question 2

General observations regarding candidates' responses:

1. Approximately 25 per cent failed to show mastery of the calculations related to Spur Gears.

2. Approximately 72 per cent demonstrated ability, at the knowledge level, to illustrate the shape of a Spur Gear.

3. Approximately 54 per cent demonstrated ability at the application and drawing skill level, to construct a Spur Gear with an above average level of accuracy.

4. Approximately 70 per cent demonstrated ability at the knowledge, application and drawing skills levels, to calculate the parameters and construct the spur gears.

Remedial Suggestion: Greater practice is needed in the process of calculating the parameters and accurately displaying parameters as a graph.

Question 3

This question tested candidates' knowledge of skew lines and their ability to find the distance between the two lines. Approximately 60 per cent of the candidates attempted this question. About 30–40 per cent of the candidates were able to complete both auxiliary views correctly. Two or three candidates actually drew the outline of the cylinder in the second auxiliary view. The others measured the distance between the centre lines of the pipes. Only one candidate gained the maximum of 25 marks. A large number of candidates made errors in copying the given figure.

Module 2

Question 4

Generally, candidates answered Part (a) well. Most were able to get the five marks for the list of components relating to the lubrication system. Additionally, they were able to explain the lubrication cycle, the function of each component, and what happens to a bearing with no lubrication. Approximately 75 per cent of the candidates gained 15 out of the 25 marks. There was also a noticeable percentage of candidates gaining between 9 and 14 marks for Part (a). Further, a few candidates misinterpreted Part (a) to mean a lubrication cycle in general and did not relate it to a gasoline engine.

Part (b) proved challenging to candidates. A large percentage (90 per cent) did not perform well in this part of the question. It appeared that some students were unaware of the topic. More attention should be given to the stuffing-box.

Question 5

This was not a popular question and was attempted by only 52 per cent of the candidates. Candidates were expected to produce detailed sketches of the welding processes, list safety precautions and identify and use welding symbols.

In Parts (a) and (b), candidates produced weak responses even though they possessed theoretical knowledge of the solution.

Part (c) was done but the solution proved to be a general answer.

Part (d) was attempted by most of the candidates, with some of them being confused by the terminology used in the question. Some chose to explain the features of the symbol rather than to identify them.

In Part (e), candidates were asked to produce a sketch and include a welding symbol. Those who attempted it produced poor quality sketches.

It is recommended that candidates practise this type of question using a number of different scenarios. This would result in an improvement in the quality of responses. Placing charts in the classroom would also help.

Question 6

This question tested candidates' knowledge of sheet metal work and hand forging. It was attempted by 43 per cent of the candidates. Parts (a) (iii) and (b) (ii) were poorly done by most candidates. Some candidates demonstrated limited knowledge of these processes and even fewer understood the application of the two processes. It is recommended that candidates spend more time researching the above mentioned processes. Very few candidates did exceptionally well in responding to the question.

Module 3

Question 7

This question tested candidates' knowledge and ability to reproduce isometric drawings which included circles and curves. It was very popular with approximately 92 per cent of the candidates attempting it. The general level of performance was fairly good and most candidates showed that they understood what pictorial drawings were. The question required candidates to reproduce by free hand, the pictorial drawing given. Most candidates did this fairly well. The general area of weakness was seen in the illustration of the welded joints or the redesigned drawing. Many candidates redesigned the bracket but failed to show how the components were welded together.

Question 8

This question tested candidates understanding of design concept and the application of how to apply these concepts to the designing of a can opener, fabricated from steel. The question was attempted by approximately 76 per cent of the candidates.

Part (a), which required candidates to use sketches to show three preliminary design ideas, was fairly well done. Few of the responses showed candidates' inability to sketch three appropriate preliminary designs of a can opener. In some of the sketches, candidates presented knives, scissors and cutting pliers as the design ideas.

Part (b), which required candidates to explain their final design with the use of sketches, was not generally well done. Some candidates failed to use sketches to explain their final design, and only referred to one of the preliminary designs as the final design.

Part (c) was generally well done, with most candidates being able to discuss four ergonomic and aesthetic aspects of the opener. However, the responses indicated candidates' inability to fully distinguish between ergonomic and aesthetic features of a design. A further misinterpretation of this part of the question was evidenced by candidates stating four ergonomic aspects and four aesthetic aspects of the design.

Part (d) posed the least challenge as most of the candidates were able to give suitable explanations for chrome plating the opener.

Question 9

The question tested candidates' ability to represent by sketch and to explain the operation of the hydraulic drum and brake.

Fifty two per cent of the candidates attempted the question, representing 20 per cent of the total number of respondents.

The question was generally poorly done with most candidates demonstrating little knowledge of the application of the system. Most candidates presented a representative sketch with little or no written explanation of how the hydraulic drum and shoe brake should work.

The average mark for the question hovered between eight and ten; however, there were eight candidates who gained in the 20 marks and over.

Overall, based on the responses, it can be concluded that candidates' general knowledge of brakes and braking systems is weak.

It is therefore suggested that instructors use tours of mechanics' shops in order to allow students to observe the process of installing brake pads and shoes. Students can also explore the operating manuals for some vehicles from car dealers. Reinforcement can also be done by having students do individual or group research on braking systems. This can be further enhanced by randomly sketching the components that make up the system.

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.

<u>Assignment 1 – Centroids</u>

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.

<u>Assignment 2 – Cams</u>

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.

<u>Question 4</u>

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.

<u>Question 5</u>

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.

<u>Question 6</u>

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.

<u>Question 7</u>

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.

<u>Question 8</u>

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.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2012

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.

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 2012, the mean mark on Unit 1, Paper 01 was 43.20 per cent which was in excess of the 2011 figure by approximately 6.5 per cent but lower than the 2010 figure by about 7 per cent, while the Unit 1, Paper 02 mean was 23.14 per cent which was lower than the 2011 figure by 11 per cent and smaller than the 2010 figure by 10 per cent.

In 2011, the mean mark on Unit 2, Paper 01 was 29.31 per cent which was 13 per cent lower than the 2011 figure and 11.5 per cent lower than the 2010 figure, while the Unit 2, Paper 02 mean was 43.31 per cent which was 1.5 per cent lower than in 2011, but almost 4 per cent larger than in 2010.

Overall, on Unit 1 there was a slight reduction of about four per cent in the mean when compared with 2011 and a decline of about 8 per cent when compared with that of 2010. Overall, on Unit 2, the 2012 mean declined by about 6 per cent when compared with 2011 and about 2 per cent when compared with 2010. With respect to grade levels, the percentage of candidates receiving Grades I–V was 61.30 while on Unit 2 the corresponding percentage was 74.90.

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

Question 1

This question tested candidates' knowledge, ability and drawing skills. In particular, it tested the ability of candidates to project an auxiliary view from a cutting plane and so construct a parabola.

The question was very popular with candidates. Across the region, there were many different approaches. Approximately 80 per cent of the candidates reproduced the diagram but were unable to produce various aspects for the solution such as projecting a line downwards from the lines going to the apex, and connecting at the inclined line to plot the points at the plane.

Added to this, candidates were heavily challenged in attempting to create the true shape formed by plotting the points on the right angle to the plane.

Candidates would do well to pay more attention to the points of intersection through extended practice.

Question 2

This question tested candidates' knowledge and ability to determine graphically the centroid of a lamina.

Many candidates (approximately 80 per cent) did a very good job of this question. Candidates managed to reproduce the diagram which included semicircles, rectangles and triangles. However, there were challenges such as finding the centre of the triangle and determining the ratio line; thus the centroid was not located. Many candidates guessed where the centroid of the figure would be located.

Question 3

This question tested candidates' ability to construct the profile of a plate cam given the performance graph and identify the type of motion imparted to a follower.

The majority of candidates answered this question and approximately 80 per cent of them gave satisfactory responses. Many were successful in reproducing the performance graph, and were able to accurately divide the base and to project the points in order to create it. However, about 50 per cent of the candidates had difficulty producing the cam diameter to the required measurements and below the base line of the cam graph as expected. Nevertheless, the majority of candidates successfully plotted the points, and joined them with a relatively smooth curve in order to complete the drawing. It should be noted that approximately 40 per cent of the candidates either did not remember to specify the type of motion or it was incorrectly stated. Specific instructions must be given to all candidates using Auto Cad to include the scale used as well as *all* construction lines, since many candidates submitted responses of completed drawings without construction lines.

Module 2 – Solid Geometry

Question 4

This question tested candidates' knowledge, ability and drawing skills in producing the orthographic projection with hidden details of a component in first angle projection.

This was a very popular question. Approximately 90 per cent of the candidates gave satisfactory to excellent responses. Approximately 25 per cent of the candidates were not able to position the projections correctly; in addition, a few candidates lost marks for producing a third angle projection instead of a first angle.

It is recommended that teachers emphasize the importance of sketching and that greater attention be paid to the variation in projection method for orthographic projection.

Question 5

This question tested candidates' knowledge, ability and drawing skills in producing an auxiliary view of a component by projecting from an elevation onto a plane. Most candidates were able to project the auxiliary elevation.

Of the approximate 93 per cent of candidates who attempted this question, 24 per cent completed the auxiliary view correctly; 49 per cent misinterpreted the question and produced the incorrect view.

Common errors included:

- Incorrect angle of the inclined plane
- Incorrect view chosen for the projection of the line to the given plane
- Incorrect angle used in the projection of the line to the given plane
- Incorrect plotting of the points in relation to the view
- Joining of points to achieve the desired view

Question 6

This question tested candidates' knowledge, ability and drawing skills in constructing the development of a truncated cylinder and projecting an auxiliary view to obtain the true shape of one of the cut ends of the cylinder.

Although most candidates drew the given views accurately, it was surprising that many either were unable to construct the development of the cylinder or produce the true shape of the cylinder. Of the approximate 93 per cent of candidates who attempted the question, 25 per cent did the development and true shape correctly; 49 per cent did the development alone and 24 per cent attempted the question but could not complete it.

Candidates should pay particular attention to the following:

- Projected lines to generate the true shape must be at right angle to the cutting plane.
- The development must be plotted in relation to the seam that is chosen.
- The points must be connected using a smooth continuous curve.
- The development must be clearly labelled.

Module 3 – Mechanical Engineering Drawing

Question 7

This question tested candidates' knowledge and skills in the isometric sketching of keys used in various power transmission situations.

Candidates were required to recall the rectangular, gib-head, feather and Woodruff keys. Approximately 44 per cent of the candidates attempted this question and roughly 30 per cent of them gave satisfactory responses. Many of the candidates did not describe the keys or give their uses as required by the question. Furthermore, the majority of responses contained isometric sketches of the keys only, with very few candidates drawing each key and required shaft. In addition, over 80 per cent of the responses did not contain the feather-head key.

It is recommended that more emphasis be placed on the design section of Unit 1, Module 3.

Question 8

This question tested candidates' knowledge of the components inside an automobile engine, their relative motion, and candidates' ability and drawing skills in producing an assembly drawing of the components.

It was attempted by about 52 per cent of the candidates of which only 35 per cent gave satisfactory to excellent responses.

Part (a) was poorly attempted since most candidates misinterpreted what a line diagram is. Part (b) was also poorly done.

Part (c) of had maximum response, however, some candidates had difficulty assembling the components and thus lost marks for application.

It is recommended that more emphasis be placed on assembly and working drawings and the importance of freehand sketching.

Question 9

This question tested candidates' knowledge and ability in the redesigning of a shaft bracket to accommodate a shaft with a larger diameter.

It was attempted by 66 per cent of the candidates. Although the question had asked for a redesign of the bracket via freehand sketch in good proportion, quite a number of candidates reproduced the sketch with no modification. Most sketches were not of good proportion.

It is recommended that emphasis be placed on well-defined freehand sketches. Design modification must be evident in the sketches and explanatory notation must synthesize with drawing changes.

Paper 02 – Essay Questions

Module 1 – Plane Geometry

Question 1

This question tested candidates' ability to plot the locus of a point on a circular lamina rolling along a horizontal surface and changing direction up an inclined surface. This question, although optional, was very popular. It was attempted by approximately 83 per cent of the candidates with more than 50 per cent giving satisfactory responses. The first part of the response showed that a majority of the candidates were aware of the topic and some of its requirements. The second part of the construction proved to be difficult for some as the line changed direction.

Generally, candidates demonstrated a grasp of copying the given diagram and plotting the locus of a point on the rolling lamina. However, some candidates experienced difficulty plotting the path of the points when the line changed direction.

Only six candidates received full marks. Most candidates did not locate the common centre for the two surfaces and assumed that the lamina would have reached the eighth position before reaching the inclined surface when in fact it was in between the seventh and eighth positions. Many candidates divided the length of the surface into 12 divisions rather than marking off the arc of the divided circle on the circumference. The horizontal line was not the length of the circumference of the given circle.

Question 2

This question tested candidates' ability to determine the centroid of an irregularly shaped lamina using graphical integration and to calculate the second moment of area. A large number of candidates attempted this question but the majority only reproduced the drawing. About five per cent of the candidates scored between 19 and 25 marks. A large number of candidates had difficulty constructing the derived curve correctly. These candidates determined that the centroid was to be found in the vertical line through the centre line of the figure and not through the point of the base. Some candidates erred when determining the areas by graphical means. They did not use the midpoints between the main divisions to connect to the pole. A few candidates did not transform the given figure to a common horizontal base before applying graphical integration to find the area of the given figure as required.

Question 3

This question tested candidates' knowledge, ability and drawing skills in constructing the profile of a plate cam given the motion imparted to a roller follower oscillating at the end of a lever. About 54 per cent of the candidates attempted this question, 40 per cent of whom were able to give reasonable responses.

Of those candidates who answered poorly, many did not use the correct cam follower; using instead a knife edge or an offset roller follower.

The question required candidates to apply a pivoting arm roller follower to construct the cam profile, in which case the rotating centre of the pivot would be used to draw the arc representing the movement of the roller centre. On this arc, the rise and fall would be marked off.

Candidates should pay attention to this topic and they should note that different types of cam followers and their position influence the construction of the cam's profile.

Module 2 – Solid Geometry

Question 4

This question tested candidates' knowledge, ability and drawing skills in producing an auxiliary view of an octahedron looking in the given direction. Very few candidates attempted this question and those who did clearly demonstrated a lack of knowledge regarding the construction of first and second auxiliary projection.

The difficulty candidates encountered in their attempt at this question was knowing how to produce a plan and elevation to establish true lengths and auxiliary planes. Most candidates simply reproduced the given pictorial drawing and attempted to project lines from it.

Question 5

This question tested candidates' knowledge, ability and drawing skills in constructing the development of a truncated oblique cone. Candidates were required to reproduce the given figure and draw the development of the truncated cone with the joint as specified. It was a very popular question and was attempted by just over 91 per cent of the candidates.

Generally, candidates demonstrated good understanding of the given elevation and they divided the base circle and projected those divisions to the apex of the cone to commence the process of the development. However, the majority of candidates displayed a lack of knowledge in determining the true lengths. They also rotated one side of the elevation as given in their attempt to generate the development. They treated the oblique cone as a right cone and did not demonstrate an understanding of the difference.

Question 6

This question tested candidates' knowledge, ability and drawing skills in producing the plan from the front elevation of a cylinder passing through a sphere, and constructing the curves of interpenetration in the plan.

Seventy-one per cent of the candidates attempted this question.

Part (a) required candidates to draw the front elevation and plan of the sphere with the intersecting cylinder. Of the 363 candidates who attempted this question, 87 per cent scored less than 10 marks out of the allotted 25 marks.

In Part (b), candidates were required to construct the curve of intersection in the plan. As noted in Part (a) above, candidates were not able to perform the constructions necessary to obtain the correct curve of intersection. Quite a few did not show the cutting plane lines in addition to not projecting those lines from the sphere's circumference. The response of candidates indicates that many of them were not exposed to this method of construction to determine the curve of intersection.

It is recommended that candidates be exposed to the different methods of construction in determining the curve of intersection and when they should be applied.

Module 3 – Mechanical Engineering Drawing

Question 7

This question tested candidates' knowledge and drawing skills in producing a detailed working drawing of a shaft support, and determining the limits of the bore and shaft, and the type of fit. It also tested candidates' ability to understand and calculate tolerances, insert welding and machining symbols and produce working drawings. The question was attempted by over half of the candidates with under a third of them giving satisfactory responses.

Most candidates reproduced the given isometric, not giving working drawings of any type. Welding and machining symbols were left out of most answers. Dimensions were left off of some of the orthographic views drawn as working drawings, making them ineligible for maximum marks.

Most candidates read the inserted sheet and copied the correct figures but did not use the information to calculate the upper and lower limits correctly.

Greater emphasis should be placed on teaching the topic of tolerances and students should be reminded of what constitutes a working drawing.

Question 8

This question tested candidates’ knowledge and ability to design a seat belt system for an automobile seat, give details as to how it is latched shut, opened, anchored, how it retracts when released and suggest suitable materials for each component.

Forty-three per cent of candidates attempted this question. The majority of them simply drew the given diagram or their version of an existing seat belt. No attempt was made to show how the mechanism worked.

Candidates seemed not to be aware of the design process and the importance of clear diagrams with labels.

The importance of clear, appropriately scaled sketches using orthographic principles was not demonstrated.

Question 9

This question tested candidates’ knowledge and sketching ability in producing a neat, labelled isometric sketch of a metal machining lathe. Forty per cent of the candidates attempted the question. The majority of them answered the question satisfactorily, showing important details of the metal lathe, labelling correctly and drawing freehand in isometric projection.

Candidates who scored poorly did not correctly distinguish between a metal lathe and a wood turning lathe, and had poorly sketched drawings with few details.

UNIT 2

Paper 01 – Short-Answer Questions

Module 1 – Mechanics of Machines

Question1

This question was designed to test candidates' knowledge, application and drawing skills of gears. It was divided into three parts.

Candidates who attempted Part (a) gave satisfactory responses. Most candidates could not produce suitable sketches for the gears, especially for worm and worm wheel gears. Since three-dimensional figures would give more clarity to sketches that were required, some candidates who attempted this approach lost marks because of their poor drawing techniques. Some of these candidates also failed to describe the gears in writing.

Part (b) was generally well done by candidates who attempted Part (a), in that they could easily indicate the direction of movement on the gears.

Part (c) was also well done. The majority of candidates could give an example of a practical application of each gear drawn. However, a few candidates gave some vague responses.

Question 2

This question tested candidates' ability to understand and apply principles as they relate to graphically determining the magnitude of a force using their respective drafting skills. The underlying concepts of Bow's notation and the resolution of forces were the underpinning concepts/principles for mastery of this question.

Candidates' responses to the question were relatively low with most candidates not attempting the question. However, candidates who attempted this question generally reproduced the given figure. Candidates in general lacked the ability to apply the principles of Bow's notation and also found it quite difficult to apply the principles to resolve the forces acting in the cables as a result of the imposed load.

Candidates who did well on this question correctly applied the principle involved in graphically determining the magnitude of forces using the principles of Bow's notation and force diagrams. It is necessary for the concept of force diagrams and Bow's notation to be reinforced with candidates while allowing them to have the requisite amount of practice in order for the concepts to be entrenched using wide variables.

Question 3

This question required candidates to produce orthographic views (plan and front elevation) of two lines, and then project any auxiliary view from them.

The question tested candidates' knowledge and application of orthographic projection where a line in space is represented by a line drawn on a principal plane of projection, and is represented using the faces of the box which is positioned perpendicular to the parallel projector in order to obtain the views. Candidates were given the option to produce views using either first or third angle projection. Candidates were also tested on their ability to project an auxiliary view using any plane other than the principal plane of projection.

The question was a popular one, as 89 per cent of the candidates attempted it. Unfortunately, the responses to this question indicated a lack of understanding of the fundamentals of orthographic projection. Seventy-five per cent of the candidates who attempted the question failed to draw the correct orthographic views for the lines in Figure 2 (the given figure). Candidates demonstrated a lack of ability to make that transitional process from a three dimensional to a two dimensional space. Those who produced the orthographic views lacked the basic fundamental principles of obtaining an auxiliary view. Thirty per cent of the candidates scored at least 50 per cent of the total mark because they produced the plan and elevation but did not project the auxiliary view; other candidates who scored 61 per cent and above were able to project the correct auxiliary view.

Overall, performance on this question showed a deficiency in the amount of practice candidates received in producing orthographic drawings.

Module 2 – Engineering Materials and Process

Question 4

Part (a) tested candidates' ability to sketch two types of internal lubrication systems; (i) bath lubrication and (ii) splash lubrication. Part (b) asked candidates to sketch the O ring, V ring and U cup in operation with shaft and housing.

Part (a) was satisfactorily done by most candidates. However, candidates demonstrated a lack of ability in interpreting the splash lubrication system. As a result, over 65 per cent of them were reluctant to sketch a diagram that showed how the mechanism of the system would splash the lubricant. A significant number of candidates were able to sketch the bath lubrication system. Weaker candidates drew diagrams with only one gear.

Part (b) was generally well done by approximately 75 per cent of the candidates. The general concerns were either the space between the shaft and seal or the seal not in contact with the shaft. Additionally, sketches showed the seal positioned incorrectly in relation to the direction of the shaft.

Question 5

This question tested candidates’ knowledge of the use of an appropriate material for the manufacturing of the stabilizer bushings. It also required candidates to show an application of the bushing.

Approximately 80 per cent of the candidates failed to select the material most suitable for making the stabilizing bushing. Most candidates selected a metal which was inappropriate for the component. However, candidates described the manufacturing process for the metal they selected. Less than 50 per cent of candidates gave a satisfactory response to the manufacturing process of the material.

Approximately 90 per cent of the candidates selected a lubricant when none was required for the given bushing.

Approximately 67 per cent of the candidates who drew a freehand sketch to illustrate a typical application of the stabilizer bushing lacked the basic knowledge of sketching in either pictorial or orthographic format. In addition, candidates could not show or demonstrate how the bushing could be applied. It is recommended that teachers increase the amount of time students spend in problem-solving exercises involving freehand sketching using both formats.

Question 6

This question was designed to test candidates’ knowledge of a connecting rod with numbered parts. The question was divided into four parts. Part (a) required candidates to identify the bearings and bushings in the diagram showing a connecting rod with its parts numbered. Part (b) required candidates to identify two materials each, suitable for producing a bearing and a bushing respectively. Part (c) required candidates to explain the purpose of both bearings and bushings and Part (d) required them to explain why an interference fit should not be specified for the bearings.

Part (a) posed a great deal of difficulty. Candidates were unable to identify the proper location of the bearing to that of the bushing. They were also unaware of the correct name for the lower and upper bearings and some went as far as to label the entire diagram unnecessarily.

Part (b) was generally well done. Weaker candidates were reluctant to give more than one required material in the manufacturing of bearings and bushings. Some gave materials that were considered substandard.

Part (c) was generally well done with over 70 per cent of the candidates giving satisfactory responses. However, weaker candidates were not able to give adequate explanations of bearings and bushing as used in the connecting rod mechanism.

Part (d) was well done by candidates as 85 per cent of them demonstrated knowledge of why an interference fit should not be used for bearings. They were also able to explain the impact of interference fits as it relates to space and moving parts, but a large number of them made no mention of the impact of hydrodynamic pressure in lubricating the bearings.

Module 3 – Engineering Design Elements

Question 7

This question examined the following general objectives of Unit 2, Module 3:

- Understanding of the different methods of producing engineering components
- Knowledge of the materials for the production of engineering components
- Design principles with respect to ergonomics and aesthetics.

The question tested candidates' knowledge and understanding of engineering materials and processes in terms of the production of engineering components and the manufacturing process applied to specific components. There was investigation of candidates understanding of the role of specific factors related to the engineering design process with special emphasis on ergonomics and aesthetics. The drawing skills of candidates were not tested in this question.

This question was very popular and was attempted by about 92 per cent of the candidates; it was however not well done by candidates. Weaker responses gave the manufacturing processes to which the components can be applied instead of those processes which were carried out in the manufacture of the components. Indeed, fewer than 80 per cent of the candidates responded closely to the desired solution set.

Candidates were also required to match specific engineering processes with the engineering materials. They were required to identify a material on which the application of the specific process yields a good result. Weaker candidates failed to identify any such material but stronger candidates were able to correctly match process to material. This aspect of the question was not very well done; in most responses, materials were ill-matched to processes.

Although many candidates displayed knowledge of ergonomics and aesthetics as general terms, several failed to apply these terms to the actual design/manufacturing process. There was an observed challenge for several candidates to link these concepts in the factors of consideration within the manufacturing process especially where aesthetics was concerned.

Many candidates did not use technical script but preferred to present responses in cursive writing. A few examples of pen and ink presentations were also observed. This style of presentation was often visually unclear and untidy in the case of weaker candidates. It must be noted also that there seems to be a general trend to avoid the use of the drawing paper and to defer to the use of guided script and/or answer booklets in the presentation of answers.

The mean score of this question was below 51 per cent, with fewer than 33 per cent of candidates scoring seven marks or more. Candidates seemed to have the required knowledge but organized their responses poorly.

Question 8

This question tested candidates' knowledge and application of the design process. Part (a) was fairly well done. Most candidates outlined, briefly, the roles of the given stages in the design process. However, quite a few candidates had knowledge of the design process but failed to express them effectively. Some candidates also misinterpreted the various components of the design process. They confused the *analysis* stage with the *evaluation* stage.

Part (b) was also fairly well done. The majority of candidates knew various methods of presenting a design. However, some of these candidates gave responses that overlapped with each other, for example, pictorial drawings, detail drawings, working drawings, blueprint and AutoCAD presentations would have fallen under the same drawing method.

Part (c) was satisfactorily done. The majority of candidates could not apply concepts of the design process to define the design problem effectively. Candidates should be introduced to various scenarios from which they would be required to practise defining the engineering problem.

Question 9

This question tested candidates' knowledge and understanding of automobile braking systems. The diagram for this question was an excellent illustration of an exploded 3D view of a disassembled, part-numbered rear braking system for a vehicle.

Part (a) required candidates to identify any three parts of the labelled diagram and provide its name. A large percentage of candidates were successful in providing the correct name for the parts they chose. Many candidates incorrectly labelled Part 2 as the brake drum. Some candidates confused brake disk and brake shoes. Additionally, there was some misunderstanding in being able to identify the parts labelled 8, 6 and 5.

Part (b) required candidates to describe the functions of each part chosen in Part (a). A high percentage of the candidates provided suitable responses to this part, particularly in the function of the brake shoes and how the braking process is accomplished.

Candidates were asked in Part (c) to state three purposes for brakes. Nearly all the candidates who responded to this section gave correct responses. Some of them, however, repeated a previously stated function.

Part (d) required candidates to explain why it is not good to oil brakes. A very high percentage of them provided appropriate responses to this question.

Paper 02 – Essay Questions

Module 1 – Mechanics of Machines

Question 1

This question tested candidates' ability to use their drawing skills to construct three gear teeth using a given set of parameters. About 56 per cent of the candidates attempted this question. The scores ranged from 0 to 25 with most scores ranging from about 7 to 18 and a few in the range of 0–7 and 19–25.

Overall, there were signs that this topic was covered but the problem was to accurately construct the gear teeth and label them. Candidates who did this item in AutoCAD failed to turn on certain layers as well as to scale the drawing when printing. Most candidates displayed evidence of knowledge of where to draw the pressure line, but failed to make it tangential to the base circle as to the inner circle. Some candidates preferred the conventional method (approximate circle) over the involute method. All in all, a fair attempt was made by most candidates at this question but they could have done better if these points were addressed.

Question 2

This question tested candidates' knowledge and ability to determine graphically the reactions of a simply supported beam, draw the shear force and bending moment diagrams, and also find graphically the magnitude and position of the resultant.

This question was attempted by 84 per cent of the candidates; over 70 per cent of them were able to give better than satisfactory responses.

Candidates who did not give satisfactory responses were incorrect in their dimensioning and the placement of their load line, and were lacking in their ability to draw the horizontal lines to attain the required diagrams.

For improved performance, candidates need to spend more time on this topic, paying additional attention to the proper attainment of bending moment and shear force diagrams as this topic continues to form part of the required syllabus.

Question 3

This question tested candidates' knowledge, ability and drawing skills in constructing lines representing the shortest distance between two skew lines and correctly labelling the diagram. Generally this question was well done. Over 90 per cent of the candidates who attempted this question were able to reproduce the given views with correct dimensions. The production of the first auxiliary view was not too great a challenge and the majority of candidates were successful in doing so. The second auxiliary view was a little more challenging and about 60 per cent of the candidates successfully reached this stage. However, only about half of them were able to demonstrate any knowledge of the transfer of the shortest distance to the original elevation and plan.

The importance of neat labelling must be emphasized as too many candidates who otherwise gave a reasonable response were unable to get maximum marks because of poor labelling.

Module 2 – Engineering Materials and Processes

Question 4

This question tested candidates' knowledge of materials, their properties and uses. It required candidates to describe, give properties, uses and examples of the listed materials. Sixty-eight per cent of the candidates answered this question. Most candidates described ferrous metals and distinguished between the two types of plastics successfully. A large number of candidates were unsure of the description of grey cast iron. The area offering the greatest challenge was Part (c) which required candidates to give the properties and uses of the three alloying elements to steel namely molybdenum, chromium and chromium-vanadium. The part requiring candidates to describe and give one example of thermoplastics and thermosetting plastics was fully answered correctly by most candidates. Most candidates were satisfactory in their responses to the question.

Question 5

This question tested candidates' knowledge, design ability and drawing skills in the design of a shaft and housing assembly in which they were required to design suitable end covers, providing a means of lubricating and sealing the bearing, and securing the bearing in place using a collar and tab washer. This question was attempted by just over 57 per cent of the candidates, with just over 35 per cent giving satisfactory answers.

Most candidates reproduced the drawing but had difficulty correctly placing the bearing, tab washer and collar. The majority drew a ball bearing as opposed to a roller bearing even though the question stated that a heavy-duty roller bearing was to be used. The means of supplying lubricant to the bearing presented a challenge.

Candidates also opted to write about a method of sealing the assembly as opposed to incorporating it into the drawing. Greater emphasis should be placed on these types of sub-assemblies and their components.

Question 6

This question tested candidates' knowledge, ability and drawing skills in sketching the cross-sectional view of an automobile engine, and indicating the forward and return path of the lubricant. They were also required to state the type of lubricant used and the method of lubrication, while also listing the difference between oils and greases. Candidates were then required to state how the sump and engine is sealed and explain what damages may occur to an engine that runs out of lubricant.

Approximately half of the candidates attempted this question and approximately six per cent gained a mark of 18 and above. Points of note are as follows:

- Candidates continue to demonstrate poor standards with respect to technical sketching. Neat, well-proportioned and clear diagrams are required. Accuracy and good draughtsmanship is essential for GMED.
- Most candidates understood that liquid lubrication was required; the majority of them suggested oil.
- Most candidates had no knowledge regarding the lubrication of combustion engine.
- The interpretation of the problem posed a challenge to some. When asked about the difference between oil and grease about 90 per cent of the answers referred to the use of oil and grease in the engine.
- A large number of candidates (about 50 per cent) suggested welding the sump pan to the engine block, displaying a lack of knowledge of the inner working of a combustion engine.
- An absence of clear and concise technical terms when writing about the lack of lubrication in the engine was apparent. The topic was not well done.

Module 3 – Engineering Design Elements

Question 7

This question tested candidates' knowledge of the parts and workings of a braking system and their drawing skills. It required candidates to label an automotive brake system and complete a cross-sectional view of where the wheel is situated. Candidates' performance on labelling the given diagram was average and they showed a fair understanding of how the disc brake works.

Given the sketches of the cross-sectional view where the wheel is positioned, candidates showed a lack of knowledge in this area; very few were able to show some kind of sketch and these attempts were weak. In preparing for the examination, a car specimen could be used to explain the disc brake system and explain its function. Also, allowing candidates to sketch and label what they see before relating it to a diagram could be useful.

Question 8

This question tested candidates' knowledge of the design process and their sketching ability. Candidates were required to suggest three possible solutions to a rigid stool which was to be redesigned so that it would be able to swivel. They were further asked to outline a detailed reference of this mechanism as it applied to one of their possible solutions.

Part (a) was not done well. More than 85 per cent of the candidates were not able to clearly define the problem. In quite a few instances they just restated the problem that was already given.

For Part (b), the majority of the candidates were able to sketch three possible solutions and explain some aspects of them.

Part (c) was also well done. The majority of candidates suggested some kind of bearing mechanism in their design of the stool swivel. Approximately 76 per cent of the candidates scored 13 or more marks out of 25.

In Part (d), the total marks allotted for choice of materials was received by the majority of candidates. They selected an appropriate material and gave the properties.

Overall, responses to this question were above average with 88 per cent of the candidates attempting the question.

Question 9

This question required candidates to make a well-proportioned, labelled, cutaway freehand sketch of a motor and centrifugal pump directly coupled.

The question was not very popular, with just over 25 per cent of the candidates attempting it. Showing an appropriate means of coupling the shaft of the motor onto the pump was the difficulty encountered by most candidates; a small percentage of candidates also did not show the pump and motor coupled, while some only drew either the pump or the motor. Most candidates were able to give an appropriate application of the centrifugal pump.

Paper 03 – School-Based Assessment (SBA)

In 2012, the SBAs showed marginal improvement as teachers and students alike are becoming more familiar with the contents of the syllabus and what is required by CXC. We expect this trend to continue and that a good standard across the Caribbean is achieved in the very near future.

Both Units 1 and 2 produced work of a very high standard. That being said, it seemed some schools were not too familiar with the contents of the syllabus and what was required. This was revealed during moderation of the SBAs. This occurrence must be eradicated.

UNIT 1

As with last year, the standard of work produced in Modules 1 and 2 continue to grow with time but Module 3 seems to receive less attention in the development of skills, especially in the area of design. Assignment 5 was only satisfactorily done.

In this session of moderation, 61 centres were registered and six of these did not submit any SBA samples for moderation. Most centres (60 per cent of them) submitted the requested five samples per centre with the majority of the remaining 40 per cent submitting only one sample, mostly due to the fact that only one student was registered for the subject.

The quality of the folders presented was generally good with only a few centres producing work below the CAPE standard. However, it must be noted that not all students or entire folders were guilty of this.

Of the 55 centres that submitted folders, only three schools submitted both the GMED 1-1 and the GMED 1-3 forms. Of those two forms, only one was helpful in that it provided a breakdown indicating how the teachers marked each student. The GMED 1-1 form was revised in 2004 and, with minor adjustments to the Assignment 5 criteria, would be preferred. That being said, about 65 per cent of the schools printed out the schemes and submitted them with marks. These scores are important during the moderation process as they provide the moderator with information regarding how the teacher would have graded the student and then the appropriate recommendation can be made if necessary.

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, CD or flash drive gets damaged in transit, as has happened before. If there is an issue with printing from AutoCAD, then simply export/copy the drawing into Microsoft Word and print it from there.

A much larger percentage of schools submitted the questions given to the students for the SBA and this was pleasing to see. Thus, it should be reiterated that all schools submitting SBA samples should submit the assignment questions as well. This would be very useful during the moderation process.

In terms of grading, 51 per cent of grades were acceptable this year when compared to grades that were unacceptable (lenient, severe or inconsistent) which shows that though improvement is evident, there is still some distance to go.

It should be noted that students are only required to submit one drawing per assignment and each on its own sheet of drawing paper, except for Assignment 4 which is done on A4 paper. Too many drawings on one sheet create confusion at times. Teachers are reminded that they are required to submit six original drawings for the Unit 1 SBA.

Brief Summary of Each Assignment

<u>Assignment 1 – Centroids</u>

There was much improvement in this area, falling only by misunderstanding of the calculations required to find the centroid especially using first and second moments or lack of knowledge of how to find the centroid from calculations. In this session, using the first and second moment method was very popular. However, many solutions came directly from the textbook. Approximately 70 per cent of the centroids were very well done.

<u>Assignment 2 – Cams</u>

Once again, this topic was very well done with only cam centres and directions of rotation missing. The cam displacement diagrams and their profiles were generally well labelled. There were some students who did not align the graph to the profile and provided little or no construction. Teachers must ensure that in the SBA, attention is paid by students to detail and to correctness.

<u>Assignment 3 – Development and Interpenetration</u>

Approximately 85 per cent of the work done was satisfactory. However, the use of straight lines to build/produce a curve must be discouraged. Some students have been using curve drawing apparatus (French and Flexi curves) to obtain a smooth curve. But if this method is used, the resulting curve must be seamless and very smooth.

If students use CAD software to produce this assignment, they should have a good understanding of line weights, line types and layers (if they intend to use layers).

<u>Assignment 4 – CAD</u>

Drawing using CAD software is very popular now, with a growing number of schools submitting all of their work 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*.

Many of the CDs or flash drives submitted did not open due to the fact that versions older than AutoCAD 2006 are not currently supported by the computer used during marking.

Assignment 5 – Design

The design process continues to be challenging for most students. The basic steps of the design process needs to be adhered to even though what is required is not as in-depth as Unit 2.

The design needs to be coherent, flowing from point/stage to point/stage with justification of the best design chosen, final sketches and final drawings.

Too many folders lacked good organization. Some designs seem to have been thrown together. A write-up must be included in the design in order to convey what the design is all about. This was lacking in many cases.

Assignment 6 – Assembly/Engineering Drawing

This assignment was generally well done (about 90 per cent of the time). Some drawings were very impressive in terms of the attention to detail and layout.

What was noted, however, was that many of the questions given were from a popular textbook known for having the solutions to the assembly drawings at the back of the book so a student's true potential at assembling was not always evident.

Some students got very deep into the assignment; going way pass the CAPE level and using 3D modelling.

Recommendations

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

- Some students handwrote their reports for Assignment 5, but they were not legible (very difficult to read). Thus we suggest that reports be typed in a legible font (Times New Roman, Arial, 12-font, etc.) and submitted.

- Generally, when using CAD software, students should choose line colours and line weights that make the outline of the drawing stand out. Outlines should be thicker.

- Again, AutoCAD Assignment 4 must be prepared in such a way that students' answers are different in each case (because it is easy to copy and paste). For example, a possible question might be *Draw an isometric from a given orthographic projection with different low points A, B, C and D* for different candidates.

- Finally, teachers of CAPE GMED should meet and discuss questions for the SBA and examinations and generally brainstorm so as to keep that subject and its content relevant and to attain a reasonable standard in delivery across the centres.

UNIT 2

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. Approximately 75 per cent of students lost marks because they did not follow the guidelines outlined by the syllabus in terms of the layout and content of the portfolios. The standard of the drawings also showed marginal improvement, faltering only in respect of basic alignment and construction techniques.

In moderation for Unit 2, there were 46 centres registered of which 42 centres submitted folders. Approximately 57 per cent of those 42 centres submitted the required five samples with the majority of those remaining submitting only two samples, mostly due to the number of candidates in a particular centre being small.

The quality of the folders presented for moderation was poorer this year when compared to 2011. Once again, the issue of a standard across all centres comes to the fore. Some design projects were very difficult and were graded severely, whilst others were quite simple and almost received full marks. Some portfolios were poorly organized or laid out.

The GMED 2-1 form was not submitted at all; hence a breakdown of teachers' marks was not always forthcoming. However, quite a few schools printed the mark scheme and submitted that along with the portfolio.

When submitting work in AutoCAD, candidates 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, CD or flash drive gets damaged in transit, as has happened before. If there is an issue with printing from AutoCAD, then simply export/copy the drawing into Microsoft Word and print it from there.

Over 52 per cent of the grades received were acceptable with most of the others being lenient or severe. Thus, like Unit 1, there is still some distance to go in terms of standards.

Some schools must be commended for the detail they placed in the research phase of the design. However, such elaborate research sometimes borders on irrelevance and must be monitored by the teacher who must keep students focused and on track.

Brief Summary of the Design Phases

In the development of the project (Phases 1, 2 and 3), students generally understood the process involved and supplied moderate to good information regarding their project. Missing, however, were proper work programmes and a good analysis/synthesis of the design of the project.

The use of CAD this year was only satisfactory, with quite a number of schools submitting work that could be described as being poor. Some schools were excellent but it was evident that those schools had a thriving GMED program. Those students who did not submit any CAD either had no CAD software at the school or they had limitations in getting access to the CAD software (mostly due to time allocation).

Most students fell down in the areas of technical and project reporting due to a lack of understanding of what was required for submission. It should be stated that good information was provided during the reporting but oftentimes it was irrelevant and took the reader too long to get to the information actually dealing with the design in question. The communication of the information contained in the report needed to be better organized and more logical, for example, Step 1 should have been followed by Step 2 and so on.

Generally the content of the portfolios was fair and provided enough evidence of a design process and the elements thereof. About 15 per cent of the portfolios received were packed like playing cards held together by paper clips at times. Again, students are encouraged to take pride in the work they do or submit.

In terms of the interactive presentation, about 70 per cent of the schools provided proof of such and showed the breakdown of the marks accordingly.

Recommendations

- Teachers should receive a draft of the report, make corrections if necessary, and send it back to students for final adjustments before final submission. Submission of unfinished reports or reports with errors and corrections should be discouraged.

- Teachers need to ensure that students stay on task and submit all relevant information for the report. Students should be kept focused and gently guided to the completion of their reports.

- Teachers are encouraged to develop a checklist of the item/content of the portfolio needed for submission. Such as:
  - ✓ Phase 1 – Conceptualization
  - ✓ Phase 2 – Design of project
  - ✓ Phase 3 – Work programme
  - ✓ Use of CAD
  - ✓ Project Report:
    - Proposal
    - Scope and specifications
    - Constraints and limitations
    - Final design (sketches, detailed drawing and so on)
    - Logical communication
  - ✓ Good Content
  - ✓ Evidence of an interactive presentation

  This information does not necessarily have to be itemized, but it has to be present in the design portfolio.

- Teachers are encouraged to submit the GMED 2-1 form which is very useful during the moderation process.

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)

<u>Question 4</u>

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.

<u>Question 5</u>

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.

<u>Question 9</u>

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)

<u>Question 1</u>

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.

<u>Question 8</u>

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.

<u>Question 9</u>

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.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATIONS

MAY/JUNE 2015

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

GENERAL COMMENTS

This subject consists of two units — Unit 1 and Unit 2. Each unit comprises two papers. Both Papers 01 and 02 in Unit 1 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 2015, the mean mark on Unit 1, Paper 01 was 36.75 per cent which was comparable with the 2014 figure of 36.12 per cent. The Unit 1, Paper 02 mean was 27.87 per cent compared with 35.98 per cent in 2014.

In 2015, the mean mark on Unit 2, Paper 01 was 52.61 per cent compared with 44.44 per cent for 2014. The Unit 2, Paper 02 mean was 43.40 per cent compared with 42.21 for 2014.

Overall, on Unit 1, there was a decline in performance compared with 2014. Overall, on Unit 2, there was an improvement in performance compared with 2014. With respect to grade levels, the percentage of candidates earning Grades I–V for Unit 1 was 59.5 per cent compared with 69.8 per cent for 2014. Overall, on Unit 2, the percentage of candidates earning Grades I–V was 88.9 per cent compared with 84.8 per cent for 2014.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

Module 1: Plane Geometry (Questions 1–3)

<u>Question 1</u>

Candidates were required to construct an ellipse using the eccentricity method and to construct a tangent and normal to the curve produced. Approximately 60 per cent of candidates attempted this question. In general, the majority of candidates had knowledge of the ellipse, normal and tangent. However, knowledge of the eccentricity of the ellipse was rare among most of them. The majority of candidates scored poorly on application and drawing skills. Candidates must focus on understanding the eccentricity method of the ellipse and practise their application and drawing skills.

Question 2

Candidates were required to construct the centroid of a quadrilateral using any method. Approximately 75 per cent of the candidates attempted this question, with over 80 per cent of them giving favorable responses. Candidates who used the rectangular method were able to divide the sides into three equal parts and construct the rectangle to find the centroid. Some candidates used the ratio method and many of them successfully divided the figure into two triangles; however, some of them had difficulty finding the centre (centroid) of the triangles and also finding the centroid of the figure. Some candidates divided the angles of the triangles instead of dividing the sides. Others however, after finding the centres, went on to successfully find the centroid of the figure. It should also be noted that many candidates did not show construction lines, especially those using AutoCAD. It is important that construction lines be shown in order to follow the solution to the problem.

Question 3

Candidates' knowledge, application and drawing skills were tested in this question. Part (a) required candidates to complete a performance diagram for a plate cam and draw the outline of the cam. In Part (b), candidates had to change the uniform acceleration to uniform deceleration and show how the plate cam would change on the diagram.

The majority of candidates attempted this question. However, approximately 75 per cent of them completed the performance profile only and did not attempt the cam outline. Most candidates had a problem finishing the profile, where, instead of showing uniform acceleration and uniform deceleration, they drew uniform retardation. This problem also led to candidates only completing one of the cam outlines for the question. Candidates had the general knowledge and the drawing skills to complete the question but the application of knowledge was their main challenge.

Module 2: Solid Geometry (Questions 4–6)

Question 4

This question asked candidates to produce orthographic views of a bracket drawn in pictorial. Overall, about 80 per cent of candidates were able to produce a front elevation that was good enough to gain at least 75 per cent of the marks allotted. Even though candidates attempted the front elevation, about 50 per cent of them had difficulty finding the correct position of the web for the bracket. If students are given the opportunity to produce engineering components in pictorial projection, they would have a greater appreciation for analysing every intricate detail that is needed to draw orthographic views.

Question 5

This question asked candidates to draw the plan and auxiliary views of a cylinder lying on its side. Approximately 70 per cent of candidates were able to draw a plan view of the cylinder. Projecting the auxiliary view posed the biggest challenge for candidates. Approximately 80 per cent were unable to accurately draw the view. Students need to be provided with opportunities to construct these cylinders using cartridge paper or wooden blocks to understand the views that may be produced when looking at the cylinder in all directions, especially at different angles.

Question 6

This question tested candidates' ability to draw the surface development of a truncated square-based prism with a hole in the slanted face. Approximately 55 per cent of candidates attempted this question with approximately 10 per cent of them scoring satisfactory marks. Part (a) was fairly well done. Many candidates started the development but did not complete it. A number of candidates either incorrectly completed the required ellipse on the slanted face or simply drew a circle.

Part (b) was fairly well done. Some candidates showed knowledge of material usage but failed to arrange the development to minimize it. Part (c) was fairly well done. It required candidates to indicate folding lines on the development. However, a less than satisfactory number of candidates completed this part of the question.

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

Question 7

This question consisted of two parts. In Part (a), candidates were required to number the parts and complete a parts listing with the appropriate materials. Part (b) asked candidates to describe how the gate valve worked. The question was attempted by 65 per cent of candidates with 40 per cent of them demonstrating good knowledge of how to draw the parts listing and choose the appropriate materials for the parts. The remaining candidates did not bother to draw the lines for the table while some opted to use letters instead of the required numbers to identify each component. Although most candidates had a basic idea of what was needed in the parts list, some did not provide the required number of parts and others did not select materials to complete the table. Only two candidates included bolts in their parts lists.

Forty per cent of the candidates who attempted Part (b) showed a basic understanding of how the gate valve functioned, while 30 per cent showed a better understanding of how each component was involved in the functioning of the valve. It is recommended that candidates pay attention to what is required in the question and that more emphasis is placed on components and their materials.

Question 8

This question required candidates to produce a sketch of a cable clamp fully disassembled in an exploded isometric view. They were also required to draw a typical welding symbol and describe its components. Approximately 85 per cent of candidates attempted this question and over 60 per cent of them gave favourable sketches of the disassembled exploded isometric view. For Part (b), approximately 30 per cent of candidates gave satisfactory drawings of a welding symbol with descriptions. The majority of those candidates who attempted the sketch in Part (a), successfully produced disassembled drawings, however, many of these were either not exploded or were not drawn in isometric. Candidates who gave responses for the welding symbol either did not draw a complete symbol or did not label or describe its components. It is suggested that teachers spend additional time sketching exploded isometric drawings as well as reviewing welding symbols with descriptions of their components.

Question 9

This question was designed to test candidates' knowledge, application of knowledge and drawing skills. The question was divided into three parts. Part (a) tested candidates' ability to sketch, freehand and in good proportion, a typical ball pein (peen) hammer. Part (b) tested candidates' knowledge of the features of the hammer that gave it its name, while in Part (c), candidates were required to name four given engineering components.

The question was attempted by more than 60 per cent of candidates with 45 per cent of the responses being classified as satisfactory. The majority of candidates was unable to correctly sketch the hammer and state the feature that gave it its name. Two common errors were (i) using a ball as the starting point to develop a possible image of the tool; and (ii) thinking that the word *pein* should have been 'pin' and therefore candidates incorporated pins into the sketch of the hammer. Less than 30 per cent of candidates who attempted Part (c) were able to correctly name all four components.

Unfortunately, more than 50 per cent of candidates who used AutoCAD to answer the other questions did not attempt the sketch question. In one particular case, a candidate used AutoCAD to produce the sketch of the hammer.

It is recommended that more emphasis is placed on freehand sketching and that students are given exposure to more engineering components.

Paper 02 – Essay Questions

Module 1: Plane Geometry (Questions 1–3)

Question 1

This question was divided into three parts and tested candidates' ability to (a) construct a hyperbola given its eccentricity, (b) construct a parabola given that the focus and directrix are 30 mm apart and the vertex is 15 mm from the directrix and (c) draw a tangent to the parabola at a point P below the focus of the parabola. The question was attempted by approximately 37 per cent of candidates. Responses showed that the majority of candidates was unaware of the construction procedures used to trace the path of a point for specified curves.

Approximately 98 per cent of candidates who attempted to construct the hyperbola showed knowledge of reproducing the given distance between the focal point and directrix along the axis. However, most of them lacked the ability to position the vertex using the given eccentricity. Of the candidates who placed the vertex in the correct position, most of them were unable to apply the processes to trace the path of the point. Only ten per cent of candidates were able to successfully trace the path for the hyperbola. In addition, the majority of candidates failed to produce the required drawing skills necessary to produce a smooth hyperbolic curve.

Part (b) was well done by approximately 50 per cent of the candidates. They showed knowledge of using the eccentricity with a ratio of 1:1 from focal point to curve and curve to directrix, for constructing a parabola. Though Part (b) required candidates to construct the parabola on the same drawing for Part (a), some candidates plotted the curves on separate diagrams.

In Part (c), candidates located point P at random points, though they were told to locate it directly below the focus of the parabola. The accepted geometrical procedure for the construction of a tangent proved to be a challenge for most candidates. There were too many cases where candidates drew lines tangentially to the curve without any evidence of the construction procedure.

Teachers should review the construction method for tracing the path of a point using the eccentricity method and the construction of tangents to various curves.

<u>Question 2</u>

This question required candidates to find the second moment of area of a bracket with a circular hole through it. This was not a popular question. Only 55 per cent of candidates who sat the examination attempted this question. The responses suggested that most candidates were not comfortable dealing with the question or probably were more equipped to solve the other questions in this module.

Even though the question did not specify the method which candidates were to use, approximately 90 per cent of them who attempted this question used a graphical method for determining the *second moment of area.*

Most candidates who attempted to use a graphical method to derive a solution could only reproduce the given figure. Most candidates who went beyond reproducing the figure showed good knowledge of how to divide the figure into a number of parts, setting a pole and projecting lines in order to find the first and second derived figures. However, some of these candidates were unable to derive the same for the hole.

Candidates who used the calculated method to solve the problem, demonstrated their knowledge and application of knowledge to find the areas and moments of the different shapes that formed the given figure. However, most were unable to determine the *second moment of area* for the entire figure.

<u>Question 3</u>

In this question, candidates were required to (a) reproduce a given drawing of a cam, cam shaft and follower and (b) construct a fully labelled displacement diagram for the cam based on the centre of the roller follower. This question, although optional, was very popular. It was attempted by approximately 90 per cent of candidates. Responses to this question showed that the majority of candidates were only able to replicate the cam drawing and were unaware of the general requirement for the performance curve and profile of the cam. This was evident in the fact that the majority of candidates only gave a response to Part (a).

Approximately 30 per cent of candidates understood the rise and fall of the performance curve and that it should begin and terminate at the lowest point, but they did not have the knowledge to construct this curve accurately. The majority of candidates also divided the cam into 12 equal segments from the centre (middle) of the cam itself, and not from the middle of the cam shaft.

Candidates seemed not to know how to transfer points from the performance curve onto the cam profile. Candidates showed very limited knowledge over the entire scope of this question. Candidates ably applied their knowledge as they were able to label the different drawings and components correctly. The drawing skills of candidates varied widely throughout with many of them being below par for candidates at the advance level. Several free-hand curves were drawn, incorrect dimensions used and components omitted.

Module 2: Solid Geometry (Questions 4–6)

<u>Question 4</u>

In this question, candidates were given a pictorial drawing of a bracket and were required to (a) produce the plan, (b) project the front elevation, (c) draw an auxiliary view of the sloped feature only, (d) add dimensions for the holes and slot and (e) indicate machining symbols. Eighty per cent of candidates attempted the question. While the majority of candidates was able to produce the plan and front elevation, some had difficulty aligning the views correctly. It was also evident that producing the auxiliary view posed major problems for candidates overall.

It was also observed that candidates lacked dimensioning skills, were unable to produce proper arrow heads and incorrectly dimensioned curves and circles when attempting to show radii and diameters. It was also evident that the majority of candidates lacked knowledge of machining symbols and how to indicate them.

Recommendations

- Candidates must have knowledge of the principles of orthographic projection, the use of projection lines and the formation of curves, circles and slopes and how they are seen in the various elevations. For example, the circle on the sloped face of the diagram in this question when viewed as either a front or side elevation would be seen as an ellipse.
- It is recommended that teachers place more emphasis on auxiliary views. Students must learn the correct construction method and concepts using the traditional method of drawing, so that if they choose to use CAD those principles would be used.
- The principles of dimensioning curves and arcs, the use of arrow heads and extension lines, and the correct placement of these dimensioning components is to be encouraged.

<u>Question 5</u>

This question showed a right hexagonal pyramid with the top and bottom truncated at 45º and 30º respectively. Candidates were required to (a) draw a front elevation, (b) draw an end elevation, (c) complete a plan and (d) project an auxiliary view from the plan at 30°.

The main concern regarding this question was the inability of most candidates to correctly convert the pictorial drawing to orthographic projection. They had difficulty laying out the views in either first-angle or third-angle orthographic projection. For instance, candidates produced two views (front and end) in first-angle projection and the plan in third-angle orthographic projection. In this case, they were unable to produce an accurate projection of the required auxiliary view.

The features of the truncated sections were not well represented due to the inability of candidates to correctly project the respective points.

It is suggested that teachers review and allow students more time to practise the principles of orthographic projection, particularly how the respective views are positioned, whether using first-angle or third-angle orthographic projection.

Question 6

This question was attempted by 50 per cent of the candidates. It tested their ability to construct the curve of intersection formed between a right cone and a right circular cylinder. Additionally, candidates were required to draw a development of the cylinder and label the given drawing. The question also tested candidates' knowledge of and ability to use the method of taking horizontal sections parallel to the base of the cone through a common point of intersection to construct the curve of intersection between the right cone and the right circular cylinder. A second method that could have been used is vertical radial lines on the surface of the cone to identify common points of intersection.

The majority of candidates was able to successfully reproduce the given views. However, the major challenge faced by some candidates was an inability to identify the common points of intersection between the two solids and projecting these points onto the elevation regardless of the method used to draw the curve of intersection. This challenge resulted in some candidates being unable to attempt the second part of the question to construct the development of the cylinder since they were unable to identify the common points of intersection. Most candidates failed to label the drawing.

Candidates using AutoCAD and other computer drawing programs are reminded that they must pay special attention when printing to ensure that drawings are scaled/printed full size.

Module 3 – Mechanical Engineering Drawing

Question 7

This question tested candidates' knowledge, application of knowledge and drawing skills on a set of working drawings for the assembly of a knuckle joint. Candidates were required to (a) draw the knuckle joint with its parts fully assembled and (b) complete balloon referencing and parts listing (item list and materials specification) for the assembly. This was a fairly popular question, with 60 per cent of candidates attempting it.

In Part (a), most candidates drew a sectional front elevation of the assembled components, with approximately 50 per cent of them placing the components in the correct positions. It was found that many candidates joined parts 1 and 2 at the break, while others went on to draw an assembly plan view. A few candidates drew a three-dimensional assembly.

For Part (b), approximately 60 per cent of candidates knew how to complete the balloon referencing for the assembly. However, most of them did not use the correct pointer (whether it was the arrow or point needed on the end of the line attached to the balloon) to touch the components. Even though most of these same candidates listed the parts and part numbers, they did not specify the quantity of the components required. Several candidates scored maximum marks for providing a complete listing of materials.

Question 8

This question tested candidates' ability to select appropriate fits for a pulley to run loosely and to state the classification of fit selected. They were also required to draw the bush and fully dimension it. A fair number of candidates were able to select the pulley assembly. However, a number of candidates were unable to state the classification of the fit selected. A fair attempt was made in drawing the bushing; however, some candidates had a challenge hatching the bushing as there was evidence of inconsistency. In addition, dimensioning techniques were not in keeping with established drawing conventions.

Question 9

This was not a very popular question. Less than 20 per cent of candidates attempted it. Candidates were required to (a) state the meaning of each of the features labelled A–H used in the production drawing, (b) sketch, freehand and in good proportion, an orthographic, sectioned view of a non-return valve and (c) use arrows to show the fluid flow through the valve.

Candidates found it difficult to identify all the machining features; most candidates could not identify 50 per cent of the features on the drawing. Additionally, the diagrams produced in relation to the valve were poorly done with only a few candidates producing an accurate diagram. Some candidates also lacked understanding of the valve operation as they produced an inaccurate flow direction in relation to operation of the valve.

It is therefore recommended that teachers revise the various machining symbols and conventions and provide for independent practice by students in relation to the identification of these features. Additionally, teachers should revisit the construction and operation of types of valves, in particular the correct flow direction of the different types.

Paper 03 – School-Based Assessment (SBA)

There was an increase in registration of approximately 13 per cent which yielded an approximate 10 per cent increase in submissions. Two hundred and fifty-six samples were submitted for moderation this year from 68 centres. Forty-two centres submitted the requested five samples.

It is becoming increasingly concerning that the SBA submissions for CAPE GMED (an advanced level certificate) so closely mirror those of CSEC Technical Drawing (an ordinary level certificate), especially in the areas of Development/Interpretation (Assignment 3)

There is the concern that some teachers are awarding full marks for incorrect solutions. This was observed a few times in the past, but was dismissed as an oversight on the part of the teacher. This year, however, these occurrences are far too many, and from several centres, for them not to be mentioned. Care must be taken by teachers to ensure that there is fairness and validity in their marking processes.

As was the case last year, many more centres are submitting the assignments given along with the portfolios which gave the moderators a clear idea of what students were asked to do. In cases where the task was below the CAPE standard, the moderators chose not to mark down students but addressed the teachers in the moderation feedback.

In the syllabus, it is stated that for the Unit 1 SBA, the composition of the drawing portfolio must meet the following:

- It must consist of six assignments.
- Two assignments must be set on each module.
- At least one assignment from each module must be CAD based.

Students completing one assignment from each module using a CAD-based programme continues to be a challenge. A number of centres already meet this requirement but we are still not seeing a sharp reduction in the number of those centres which do not. Approximately 35–40 per cent of centres did not meet this criterion. It must be noted that consideration was given to those centres that either did not have any CAD software or those that did not have printers or teachers capable of teaching using CAD software. Authorities in schools are reminded that trial versions for schools are available online free of cost and should be considered.

The labelling of drawings was not done well and it seemed as if emphasis was not placed on proper labelling technique. This area needs to be revisited.

<u>Assignment 1 – Centroids</u>

Generally good work was done on this assignment. It would seem more effort was placed on it. There were a few calculation errors but nothing major. Some centres were guilty of asking students to find the centroid of simple square/rectangular shapes. More complex shapes are required to challenge students a bit more.

<u>Assignment 2 – Cams</u>

Cams continue to be well done generally. However, there were some solutions marked as correct that had serious errors in construction. Curve sketching also posed a problem and it appeared as if line quality has declined for those drawing cams using the traditional method of drawing. Those using CAD software did not have this problem, for obvious reasons. If questions are not sent with the solutions, it becomes difficult to moderate without knowing what the teacher asked the student to prepare. Cam data is important as this details the way the cam is to operate. This information needs to be available for moderation to be successful.

<u>Assignment 3 – Development and Interpenetration</u>

There was a decline in the quality of performance on this assignment this year, with approximately 70 per cent of the samples being those suited for CSEC or lower. It is important that students have an understanding of solid geometry and working in space. It is equally important that the knowledge gathered addresses students' needs and meets the requirements for the course. Triangulation and auxiliary projections, two examples of topics appropriate for this level, can be explored further.

<u>Assignment 4 – CAD</u>

Though the syllabus only asks for students to produce drawings using CAD software, teachers must ensure that such drawings are of relevance to CAPE GMED and that students are challenged to excel.

Simple isometric blocks are not acceptable. Students should produce *solid geometric solutions* and the options are many. Choices can include pictorial projections, orthographic projections, auxiliary views, interpenetration, developments and helical threads and springs.

Assignment 5 – Design

There has been a decline in the attention placed on the design solution. Only a moderate number of samples showed clear design parameters, three alternate designs, and the selection/justification of the best design. The final drawing, and the way information was communicated was generally adequate. Teachers need to emphasize the need for three alternative designs which lead to the selection of the best design. This process expands the mind and builds the creativity and ingenuity of students. It must be noted that three alternative designs do not suggest three different design concepts but three alternatives to the same design solution.

If a class collects data as a group to satisfy a design solution, each student *must* then on his/her own, compile and produce his/her own design portfolio based on the data collected.

Assignment 6 – Engineering Drawing

This assignment continues to be a strong point in the SBA. Samples were exceptional this year and are this trend is expected to continue. An area to be addressed however, is that of sectioning — What is sectioned? And, how is it sectioned? It is commendable that there was a decline in cases where students used the same assignment for both Assignment 4 and Assignment 6.

Recommendations

When submitting marks for moderation, the breakdown of each mark should be submitted — teachers should either copy the mark scheme and enter the marks or prepare their own forms using the mark scheme as a base and submit the forms. These breakdowns are critical and provide insight into the reasons a student received a particular mark.

Teachers must ensure that at least one drawing per module is CAD based. There were too many blank CDs this year and teachers are encouraged to ensure that the appropriate work/assignments are copied to the CD before submission.

If the case arises that group work is done on the design of a concept, then each student must prepare his/her own solutions. The data will be the same but the sketches, the write-up and the final drawings must be students' own work. There should be no group submission of portfolios/projects.

All construction lines must be shown, whether or not the drawing is by the traditional method or is CAD based.

Teachers should encourage students to correctly build their portfolios of work. Putting loose papers into a document folder or stapling a hand written page to a final drawing should be discouraged. Students must be encouraged to take pride in the portfolio and organize the information/contents in a logical/systematic way that the reader can follow. The inclusion of titles, headings, tables of contents, page numbers, for example, all make the project readable and logical.

The write-up in the design assignment is important since it communicates to the reader, in a logical way, the thought process that underlies the assignment. Students should track the design process from start 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. The information in the write-up must flow and be related to the design. Trying to fit everything onto one sheet including the write-up does not help readability and in many cases, causes confusion. Note also that handwritten portfolios often pose challenges for the moderator due to illegibility of the handwriting style. Typed text is better.

UNIT 2

Paper 01 – Short Answer Questions

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

Question 1

This question required candidates to redraw a given space diagram, construct a vector diagram for the system and determine the magnitude and direction of the equilibrant. Ninety per cent of candidates attempted this question. However, a few of them were unable to complete the question because they did not redraw the given space diagram. Most candidates were able to satisfactorily construct the vector diagram and determine the direction of the equilibrant. Some candidates appear to be unsure of the use of scales, while others were unsuccessful in drawing the 80° angle. This may have been due to the unavailability of a protractor.

Students should be reminded that questions may be set with angles other than set-square angles. They should also be reminded to draw given space diagrams before proceeding to draw vector diagrams.

Question 2

Candidates were required to (a) sketch three consecutive teeth, in mesh, of an involute-toothed pinion and rack and (b) label the addendum, circular pitch and the pressure angle sketched in Part (a). Candidate performance was fairly good. The difficulties candidates faced in this question was that they were not all exposed to the labelling of gears and meshed gears. The weak attempt by some candidates at sketching the required gears was evidence that those candidates may not have been exposed to this type of gear system. Candidates need to be exposed to the sketching and labelling of all types of gear systems and should be able to relate to the functions of gears as this may minimize the chances of misunderstanding similar questions in future.

Question 3

In this question, candidates were given an isometric view of a triangle, abc, and were required to (a) project the front elevation and plan of the triangle, (b) find and state the angle, abc, and (c) fully label the drawing. The solution required candidates to know that since two edges of the triangle lie on the vertical and horizontal planes that these were already true lengths. This meant that candidates had to find the only unknown true length of the triangle. They were also required to plot one point each to complete the elevation and plan respectively. Seventy-six per cent of candidates attempted this question. Some of them were able to plot/construct both the elevation and plan of the triangle. Of these, approximately half were able to successfully determine the required true angle of the given triangle.

It is clear that teachers need to provide more examples and find new ways of instructing students to draw orthographic views of lamina from pictorial drawings. Further work is also required to improve students' knowledge and skills with true lengths, true angles and true shapes.

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

Question 4

In this question, candidates were required to (a) draw an arc-welding operation of a SMAW plant showing how to weld a joint with a coated electrode, (b) label the plant and (c) sketch a face shield and hand glove. Most candidates attempted this question and most of them were able to sketch and label the plant. Unfortunately, a small percentage of candidates drew the acetylene plant instead of the SMAW plant. Some candidates failed to properly label the plant and also did not complete part of what the question asked: to show the welding of a joint with a coated electrode. Candidates need to carefully read the questions and highlight what the question is asking. This should help eliminate candidates omitting parts of the question.

Question 5

Candidates were required to (a) sketch exploded views of a double row ball bearing and a tapered roller bearing, (b) name the components of the bearings and (c) state the importance of the ball and tapered rollers in bearings.

Eighty-six per cent of candidates attempted this question. Most of them did not produce exploded views of the bearings, but drew a partial sectional view instead. Most candidates knew the purpose of ball bearings; however, 40 per cent of them were unable to state the purpose of tapered rollers. Candidates had the greatest difficulty sketching the exploded roller bearings. It is clear that more work is required on freehand sketching of bearings as this is the greatest weakness.

Question 6

This question required candidates to (a) draw bath and splash internal lubricating systems that can be used for lubricating multiple bearings, (b) draw one split-ring (piston-ring) seal that can be used in compressors, pumps and internal combustion engines and (c) state one function of piston-ring seals in automobiles. Seventy-five per cent of candidates attempted this question. Approximately half the candidates drew the bath lubrication twice and confused it with forms of splash lubrication. For Part (b), most candidates did not clearly illustrate the different end treatments of the split-ring. Additionally, some of them did not clearly grasp the concept of the function of a piston-ring.

In this regard, it is recommended that teachers use more models and manipulatives where possible, so as to make the practical applications more concrete for students.

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

Question 7

Candidates were given a figure of a belt drive system and were required to (a) sketch two ways of using an idler pulley to tension it, (b) label selected parts of the sketch produced in (a), and (c) describe two ways in which the belt drive system could be made safe.

Most candidates answered this question. However, several of them appeared to be unclear on how to place the idlers in relation to the driver, particularly as far as direction was concerned. Many candidates did not label the required parts correctly. Over 75 per cent of candidates confused *how to make the belt drive system safe* with *how to make the belt drive system more efficient*.

Question 8

This question tested candidates' knowledge of and their ability to apply knowledge of manufacturing processes to two mass-produced engineering components. Part (a) had varying responses. Some were accurate in both identifying and explaining the manufacturing process. Most candidates were able to identify but were unable to explain the manufacturing process and a few were completely incorrect. It is suggested that all methods of casting be taught and clearly differentiated.

In Part (b), where candidates were to find two reasons why different processes were required, the majority of candidates partially answered the question, referring to only one of the engineering components displayed. Part (c) was the best answered part, with candidates readily identifying the best materials used to make each component.

Question 9

This question tested candidates' knowledge, application and design skills. Candidates were required to analyse a mouse, then explain four of its major ergonomic properties. They were required to use sketches to illustrate their answer.

Overall, this was a well-done question. The majority of candidates gained marks for all sections. Some candidates would have lost marks for design skills by not attempting to sketch or for using poor sketching skills. Most candidates would have gained marks for application, because they were able to identify the features of the mouse but were unable to explain why it was an important or effective feature.

Paper 02 – Essay Questions

Module 1: Mechanics of Machines (Questions 1-3)

Question 1

In this question, candidates were given a simply supported beam with three concentrated loads. They were required to (a) find graphically, the magnitude of the reactions R_1 and R_2 and (b) verify analytically, the magnitude of the reactions. This question was very popular amongst candidates as 95 per cent of them attempted it. To solve this question, candidates would have been expected to (i) draw accurate load diagrams to scale, given the requisite information, (ii) construct a polar polygon diagram to find the resolution of forces acting on the beam and (iii) use bending moments to compute the reaction caused by loads acting on the beam.

In response to this item, most candidates were able to accurately produce the load diagrams to meet the specification given. Some candidates did not use Bow’s Notation when seeking to solve the problem. This was a major error as Bow’s Notation is a critical component of the solution. Emphasis must be placed on the use of Bow’s Notation when drawing load diagrams.

The resolution of forces by computation also proved to be a challenge for candidates as approximately 60 per cent of them did not complete this task accurately. Additionally, approximately 30 per cent of candidates did not accurately read off the reaction from the polar diagram.

It is recommended that teachers give students additional activities related to the construction of load diagrams which include resolution of the reaction graphically and by computation as this will increase students’ ability to respond to these items. Candidates using CAD should be cautious as they sometimes do not use appropriate scales which make interpreting questions difficult for examiners. Students and teachers must place greater emphasis on this aspect of the curriculum and allow for independent practice by students prior to the examination.

<u>Question 2</u>

This question tested candidates’ knowledge, application of knowledge and drawing skills to calculate and construct two gear profiles using the involute and approximate involute methods. Additionally, they were required to compare the two gear teeth profiles. The question was attempted by 55 per cent of candidates.

For Part (a), calculations were poorly done. Approximately, 80 per cent of candidates correctly calculated the pitch circle and pitch; however, major misinterpretation was observed between the addendum and addendum circle as well as the dedendum and dedendum circle.

Most candidates had knowledge of the involute method for Part (b); however, construction was poorly done due to the inability to construct a correct involute and copying of the gear teeth.

Part (c) was either not attempted or poorly done, which showed lack of knowledge of any approximate construction method. Some of the candidates who used AutoCAD did not attempt the approximate involute method and either left out or turned off some layers before printing. Also, the use of an inappropriate scale was observed.

Part (d), which asked candidates to state the difference between the teeth profiles constructed, was not answered by most candidates.

It is recommended that emphasis be placed on knowing the terminology of a gear and practice of approximate involute methods whether candidates are using traditional or CAD methods of drawing.

Question 3

This question tested candidates' knowledge, application and drawing skills in determining the angle between the triangle in edge view and the horizontal plane, using the auxiliary view method. They were also required to correctly label the diagram. This question was attempted by 43 per cent of the candidates and, generally, was fairly well done.

For Part (a), more than half of the candidates were able to construct the given views with the correct dimensions. Even though some had difficulty constructing the views, they showed knowledge of the auxiliary method. The construction of the first auxiliary view had minor problems. Some candidates did not construct the first auxiliary plane parallel to a side of the triangle. This resulted in incorrect measurements affecting the final measurement of the angle between edge view and the horizontal plane. The alternative method was fairly well done by candidates. However, a few candidates drew the auxiliary plane perpendicular to the incorrect reference line/projected line.

Some candidates, who used AutoCAD, used the incorrect scale and paper which resulted in inaccurate measurements. Additionally, it seemed that some candidates either left out or turned off layers before printing.

Candidates should pay particular attention to the following:

- Constructing correct elevations and plan view.
- Projecting the first auxiliary view to determine the true length of a line.
- In determining the edge view in the second auxiliary view, lines are projected from the true length of the first auxiliary.

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

Question 4

This question required candidates to demonstrate their knowledge of the forging process. Sixty-eight per cent of candidates who wrote the paper attempted this question. In Part (a), candidates were required to draw the anvil and ball-peen hammer, while Part (b) required candidates to label five features on the drawing of the anvil. Only five per cent of candidates were able to accurately draw both. Most candidates did not draw proportionately or show the requisite details. The labelling of the anvil was also poorly done.

Parts (c) to (e) required candidates to demonstrate their knowledge of and application of different forging processes. Approximately 60 per cent of the candidates were unable to accurately answer these parts. The basic difference between drop forging and upset forging was not known by candidates. Attention needs to be placed on the description of the processes.

Part (f) was the most popular part of the question. Candidates were required to outline the safety precautions associated with the forging process. Ninety-five per cent of candidates answered this part accurately.

Question 5

This question required candidates to apply their knowledge and drawing skills in solving problems concerning journal bearings and overcoming friction by the use of lubricants. The question was divided into five sections. In Part (a), 70 per cent of the candidates were able to display a process for lubricating the bearings using an oil groove; however, only 40 per cent were able to correctly draw a journal bearing assembly.

Most candidates who attempted Part (b) were unable to correctly complete all three subsections. The bushed journal bearing assembly was not properly half-sectioned in most cases and a plan view was shown in most.

In Part (c), 95 per cent of candidates who attempted the question were able to answer. Part (d) tested candidates' ability to draw a diagram to illustrate one use of a flanged O-ring and a flat gasket. Ninety-five per cent of candidates were unable to display the recommended diagrams for the O-ring. Candidates were able to draw a gasket; however, they were unable to produce a drawing that properly demonstrates how the gasket was used as a static seal.

Part (e) required candidates to give two advantages of using a gasket in a flange joint. Over 90 per cent of candidates were able to give at least one advantage of the use of the gasket in a flanged joint.

Question 6

This question tested candidates' ability to draw, freehand, the complete front elevation of a typical pillow block bearing and bushing. Approximately 78 per cent of candidates attempted this question with 17 per cent being able to answer all parts of the question.

Part (a) was generally well done my most candidates with 72 per cent of them able to label the block correctly. Some candidates were able to show the required block bearing and bushing. However, 60 per cent of the candidates were unable to show where the mounting screws and bushing were located.

In Part (b), more than 70 per cent of candidates were able to show how the radial and axial loads were applied to the block and most were correct in relating the load directions to the shaft. Over 60 per cent of candidates were able to correctly attempt Part (c). Most candidates selected materials that were metals but were not able to identify the required metal that was to be used. Part (d) presented some challenge to most candidates. Very few candidates were able to list three materials from which the bushing is made.

Part (e) was attempted by over 80 per cent of candidates; however, only 20 per cent were able to give two correct advantages of journal (sliding) bearings over roller bearings. Some candidates lacked the ability to list even one correct advantage. Similarly, for Part (f), very few candidates were able to list two advantages of roller bearings over ball bearings.

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

Question 7

In Part (a), candidates were required to draw a sectional view of a Hooke’s type universal joint and describe its operation. The two yokes keyed to the ends and the shafts and the spider solutions were expected. The yokes-keyed method was the primary approach taken by most candidates and 70 per cent of them sketched it successfully.

Part (b) required candidates to show the main functional difference between a clutch and a rigid coupling. Most candidates who attempted this part of the question were unable to correctly explain the difference between a clutch and a rigid coupling. While most of them provided a good explanation for the clutch, they were unable to explain what a rigid coupling was.

Most candidates who attempted Part (c) were able to correctly draw the solid flanged coupling arrangement. A small percentage showed the arrangement in an isometric view. It positively indicated that those candidates knew the correct arrangement of the flange and the location of bolts and shafts.

Part (d) provided a bit of a challenge for candidates to explain what will happen if the two shafts in (c) are not exactly aligned and are connected by a rigid coupling. Only a few candidates were able to state that excess bearing wear, misalignment, damage or even vibration may occur in this situation.

Question 8

The question was very popular amongst candidates with approximately 95 per cent of all candidates selecting it. It was aimed at assessing candidates’ ability to:

- Apply the stages of the design process to a given context, in this case a laptop device.
- Design a device to include special devices.
- Redesign the component to include prescribed components.
- List primary material component.
- State the manufacturing process for the device.

In response to this item, most candidates were able to present a design that was feasible and were able to redesign the device to include a special component. The listing of material for use in the design was very well done as candidates demonstrated a wide array of material selection.

The application of the design stages to the given task of the design of the device was a concern as approximately 50 per cent of candidates were unable to apply the stages or list the stages involved. Additionally, the manufacturing processes for the construction of the devices were not properly identified by candidates.

It is therefore recommended that teachers place greater emphasis on the application of the design stages to the design of components/devices, paying close attention to the selection of the material and process to be used to manufacture these components. Candidates using CAD should be cautious as they sometimes do not use appropriate scales, which make interpreting questions difficult for examiners.

Question 9

This question required candidates to demonstrate their knowledge of the design process. Candidates were to explain the difference between the fabrication of a metal chair and the moulding of a plastic chair. Eighty per cent of candidates who wrote the paper attempted this question.

Fifty-four per cent of the candidates answered Part (a) by stating that the chair could be fabricated through the process of sand casting. This process can be used to fabricate the chair; however, the processes of laying out, cutting, using a jig then welding the parts was what was required. Only ten per cent of candidates answered the question in this fashion.

Parts (b) and (c) were well done, as candidates knew the process of moulding and cost comparison between fabrication and moulding well. Candidates, however, lost marks in the listing of the ergonomic factors as they listed general factors instead of addressing factors associated with the design of each chair.

Paper 03 – School-Based Assessment (SBA)

Forty-eight centres were registered for Unit 2. One school did not submit samples for moderation. Teachers' scores were acceptable approximately 53 per cent of the time, which was a welcomed 13 per cent increase when compared with 2014. The remaining 47 per cent varied from lenient to severe.

There was a general sense that the syllabus and the requirements for Unit 2 are not being closely followed. For example, there is to be a technical report prepared which is a separate document from the project report and this technical report is required for use when making the presentation of the final design solution in class. Teachers are again encouraged to guide students in all aspects of completing an adequate design portfolio.

There were many great ideas and some truly awesome conceptual sketches. However, many students were weak when moving from concept to implementation. Approximately 35 per cent of the portfolios lacked the functionality expected for a CAPE level student. This went beyond simplicity to the point where some projects were outright impossible which speaks to the evaluation of the concepts put forward in the project. Students and teachers are reminded that mechanical engineering concepts are expected in the design portfolio.

It was very clear that some of the portfolios submitted were not the best that they could be. This conclusion was adopted because about 55–60 per cent of the portfolios moderated had suggested corrections given by the teacher, which were not done. These corrections ranged from grammatical errors to including labels to correcting drawing mistakes and so on. Had these things been done, better results would have been evident.

The Design Process

Phase 1 – Conceptualization of the Project

This phase was well done and students must be encouraged for their active minds and creative approaches to problem solving. On a note of caution, however, this creativity must not stay at concept stage, which has been happening too frequently. Teachers are encouraged to guide students during the development of their projects and help them to foster a good work ethic which will be seen in the quality of work submitted. Also, when a lot of attention is given to research and then very little effort is placed on the actual design process and all that it entails, it produces a bulky portfolio of little worth in terms of design criteria.

Phase 2 – Design of the Project

Students displayed high levels of creativity. There was a decrease in the number of instances where only one concept (sketch) was put forward and one orthographic projection done. However, there were still too many occurrences of this. Teachers should note that between seven and ten marks should be awarded for more than three different design solutions as stated in the syllabus, and not for presenting three or fewer solutions. The overall performance was good with some really exceptional sketches, working drawings and final drawings.

Phase 3 – The Work Programme

Generally, a fairly good effort was made here with better collated statements of how the project was approached, better use of software and clear statements outlining the scheduling of the tasks. Most students cited their sources but too many did not, and that is a matter this has to be addressed by teachers before submission.

Use of CAD Software

AutoCAD was the dominant software of choice and most students (approximately 80 per cent) showed good competence in the use of the software. Teachers are encouraged to insist that students label all their drawings and utilize the concept of line weights to assist the definition and clarity of the drawings. Students are asked to supply the list of commands used along with an electronic copy of the drawing, and it was pleasing to see a drastic reduction in F2 command submissions. Teachers and students are encouraged to check the electronic copy being submitted to ensure that the documents have actually been saved. There were too many blank CDs submitted this year.

The Project Report

This is a very important document that must be submitted as it outlines the process taken in completing the design portfolio. Approximately 40 per cent of students produced adequate reports detailing their design process while others produced aspects or parts of the report in a loose manner. Though many of the required aspects were included, there was little or no cohesion. Attention must be given to the use of correct grammar and spelling and when corrections are made students should address these areas and then resubmit the report. Students must be aware that the Constraints and Limitations section of the design portfolio should specify the issues encountered in the problem-solving process of the portfolio and the strategies employed. It is not intended to capture personal issues encountered by the student.

Contents of the Portfolio

Though most students submitted what was required, the quality of the contents of the portfolio (especially the reporting aspects) needs improvement. Encouragement should be given to students by teachers to take pride in their work as budding engineers.

The Interactive Presentation

Teachers need to provide evidence that this part of the portfolio has been done. Those students who presented their projects to an audience also submitted a printed copy of the slides along with the mark scheme used by their teachers. Submitting printed slides of the presentation is good but certainly not necessary as an electronic copy could be included on the CD or flash drive with the drawings. This should help reduce printing costs.

Recommendations

The enthusiasm which students displayed in research must be used in actually building the substantial parts of the design portfolio: sketches, working drawings, final drawings, reports, and the project details.

Portfolios should be neatly presented with clearly arranged sections as outlined in the syllabus.

A minimum of three design solutions of the same problem should be submitted and the best solution chosen and justified. That chosen solution should be exploited to its fullest potential: detailed working drawings, final drawings, etc.

Teachers are to be critically involved in the design process and should guide students on their path to building successful design portfolios. In this regard, teachers need to help students move from concept to implementation.

Teachers are asked to submit a breakdown of the marks awarded according to the syllabus.

When corrections are to be made, students should be given the opportunity to do so, time permitting, so as not to submit a portfolio filled with teachers' comments and suggestions.

Students are encouraged to be as creative as possible; however, their concepts should be functionally practical.

Plagiarism is not tolerated and there are heavy penalties for doing such. Copying and pasting directly from websites is discouraged and should not to be found in the design portfolio. Students using existing designs as their own will not be allowed and will be appropriately moderated.