



CARIBBEAN  
EXAMINATIONS  
COUNCIL

Caribbean Secondary  
Education Certificate®

# SYLLABUS

# INDUSTRIAL TECHNOLOGY

CXC 13/T/SYLL 15

Effective for examinations from May–June 2017



Correspondence related to the syllabus should be addressed to:

The Pro-Registrar  
Caribbean Examinations Council  
Caenwood Centre  
37 Arnold Road, Kingston 5, Jamaica

Telephone Number: + 1 (876) 630-5200  
Facsimile Number: + 1 (876) 967-4972  
E-mail Address: [cxcwzo@cxc.org](mailto:cxcwzo@cxc.org)  
Website: [www.cxc.org](http://www.cxc.org)

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Prince Road, Pine Plantation Road, St Michael BB11091



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## NOTE TO TEACHERS AND LEARNERS

This document CXC 13/T/SYLL 15 replaces the syllabus CXC 13/T/SYLL 00 issued in 2000.

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

First Published in 1977  
Revised in 1981, 1985 and 1992  
Revised 2000  
*Revised 2015*

### PLEASE NOTE



This icon is used throughout the syllabus to represent key features which teachers and learners may find useful.

# Syllabuses for Examinations in Industrial Technology Programmes

## ◆ RATIONALE

*The economic development and competitive edge of the region are inextricably linked to the application of technology in the manufacture and utilisation of goods and services. These considerations make it an imperative for the region to understand, develop and effectively apply competencies that directly impact the quality of our lives. The Industrial Technology syllabuses is a qualitative response by the Caribbean Examinations Council to the Technical and Vocational Education and Training (TVET) needs which are relevant to manufacturing and industrialisation in the Caribbean Region. The cognitive, psychomotor and affective outcomes aimed for in the syllabuses are geared at equipping students with a solid technical foundation for life-long learning and to enable the students to matriculate seamlessly into entry level occupations in a wide variety of careers and post-secondary institutions. Candidates may pursue career paths to include some of the professions in Engineering (Robotics, Fabrication and Civil), Designing (Spatial and Structural), and Education.*

*The changing nature of work and higher level skills requirements globally create a need for agreed regional standards in Competency Based Education Training and Assessment (CBETA). CBETA arose out of the need to improve occupational standards to meet the needs of industrial and economic changes. The School-Based Assessment (SBA) component of the Industrial Technology Syllabus will employ the principles of CBETA, through the integration of the Caribbean Vocational Qualification (CVQ) into the SBA. This integration is aimed at making knowledge, skills and attitudes more practical. A solid educational background (academic and technical) will be achieved through practical and project-based learning, designing and entrepreneurial processes. In this new approach, the CSEC technical subjects will facilitate the successful completion of relevant Level 1 CVQ Units of Competence. Candidates who successfully complete the CSEC examinations in the Industrial Technology will be awarded; the CSEC Technical Proficiency Certificate and where applicable recognition of competencies for the aligned CVQ Units.*

*The broad-range of interdisciplinary competencies aimed for in the Industrial Technology syllabuses will contribute to the development of the attributes of the Ideal Caribbean Person, as documented in the 2000 Caribbean Education Strategy. This person is one who is emotionally secure with a high level of self-confidence and self-esteem; is aware of the importance of living in harmony with the environment; demonstrates multiple literacies, independence and critical thinking; values and displays the creative imagination in its various manifestations and nurtures its development in the economic and entrepreneurial spheres in all areas of life.*

*In addition to the attributes listed above, the syllabuses will contribute to the development of all the UNESCO Pillars of Learning. These are learning to know, learning to do, learning to be, learning to live together and learning to transform oneself and society.*

## ◆ AIMS

The syllabuses aim to:

1. *acquire knowledge of both traditional and new materials, systems, and processes related to industry;*
2. *provide the students with an opportunity to understand the interrelationships among technologies, equipment, processes, materials and systems related to industry;*
3. *develop competencies in the application of manufacturing standards, processes, equipment, materials and tools for entry level employment (government, private sector and self) and life-long learning;*
4. *develop competencies through the processes of design management and communication, production and evaluation associated with construction and the manufacturing industries; and,*
5. *develop innovative and creative minds equipped for our knowledge and technology driven society.*

## ◆ ORGANISATION OF THE SYLLABUSES

The Industrial Technology Syllabuses comprise one Compulsory Core and three Options, organised in sections.

### **THE CORE**

The Core provides a flexible foundation for more detailed study aimed for in the three options. It is a combination of knowledge, skills and attitudes, pivotal to the programmes of study in Industrial Technology. The Core is, therefore, mandatory for all students. Teachers are required to integrate the competencies and processes in the Core with those of the respective Options. The Core is made up of the following Sections.

Section 1: *Fundamentals of Industry.*

Section 2: *Design Principles and Processes.*

Section 3: *Information Communication and Graphic Technologies.*

### **OPTIONS**

Each Option provides the foundation competencies relevant to industrial transformation and development in the Caribbean. The Options are listed below.

Option A: *Electrical and Electronic Technology.*

Option B: *Mechanical Engineering Technology.*

Option C: *Building and Furniture Technology.*

Candidates will complete the Core and at least **one** Option for certification. Institutions may also enter candidates for more than one Option. In this case, candidates will only be assessed once in the Core.

## ◆ SUGGESTED TEACHING AND LEARNING APPROACHES

To facilitate students' attainment of the objectives, teachers/facilitators are encouraged to engage students in the teaching and learning activities listed below.

1. Utilise resource persons from industry, subject specialists and practitioners to make presentations and perform demonstrations for students.
2. Establish partnerships with industries, other institutions and National Training Agencies to benefit from their expertise and resources (institutional and industry).
3. Demonstrate essential concepts using experiments, prototypes and instruments. Make use of video presentations where applicable and Internet-based simulations.
4. Utilise internal staff to assist students through team teaching.
5. Encourage team-based research, presentation and assessment.
6. Encourage students' participation in the development of the Quality Control Standards; this activity is a partnership between the teachers and the students. Teachers and students are, therefore, encouraged to determine the key components of quality and ensure that set standards are maintained.
7. Arrange for the exposure of students to the world of work through job placement, work experience, job shadowing and apprenticeship. This will ensure that students keep abreast with current industrial processes and resources.

## ◆ SUGGESTED TIMETABLE ALLOCATION

It is recommended that a minimum of six 40-minute periods per week, over two academic years or the equivalent be allocated to the syllabus. Single periods are not recommended.

### **ALLIED SUBJECTS**

Students should be encouraged to include the following subjects in their programme of study: English A, Information Technology, Environmental Science, Mathematics, Technical Drawing, Physics or Chemistry.

## ◆ CERTIFICATION

This syllabus will be assessed for the awards of both the Technical Proficiency and where applicable for recognition of CVQ competencies. Candidates will complete the Core and at least one Option for certification. Institutions may also enter candidates for more than one Option. In this case, candidates will only be assessed once in the Core. Candidate's performance will be indicated on the certificate by an overall numerical grade on a six-point scale as well as a letter grade for each of three profile dimensions, namely, Knowledge and Comprehension, Use of Knowledge and Practical Ability.



The School-Based Assessment component for this syllabus is aligned to selected units within the regional qualification of the Caribbean Vocational Qualification (CVQ). Through this integration, once all requirements for issuing the CVQ are met, every student with acceptable grades will receive a Statement of Competence to recognise their competencies in selected units (as detailed in Appendix 1) from the Level 1 Caribbean Vocational Qualification (CVQ) in:

- General Construction (CCBCG10102);
- Furniture Making (CCLMF10103);
- Electrical Installation (CCMEM11002); or,
- Metal Work Engineering (CCMEM10302).

The decisions to award competencies will be based on the quality and relevance of the pieces of evidence presented for the occupational area.

## ◆ DEFINITION OF PROFILE DIMENSIONS

In the examinations, items and questions will be classified according to the kinds of cognitive, affective and psychomotor competencies outlined in the following profile dimensions:

- (a) Knowledge and Comprehension;
- (b) Use of Knowledge; and,
- (c) Practical Ability.

### **Knowledge and Comprehension (KC)**

**Knowledge** The ability to identify, remember, and grasp the meaning of basic facts, concepts, principles, theories, technology and processes already learnt.

**Comprehension** The ability to:

- (a) understand basic *facts, concepts, principles, theories, processes* and construct meanings from them in contextualised and authentic situations; and,
- (b) explain, think, interpret, create, estimate meanings, and, use knowledge in contextualised and authentic situations.

### **Use of Knowledge (UK)**

**Application** The ability to:

- (a) *apply technical and non-technical knowledge, processes, methods, skills and technology to carry out a procedure and to perform a task or produce to the expected performance standards;*
- (b) *execute, construct, implement, compute and solve problems in contextualised and authentic situations;*

- (c) *receive, respond to, organise and value instruction in given or unfamiliar situations; and,*
- (d) *co-operate and value team work activities.*

**Analysis**

*The ability to:*

- (a) *identify and recognise the component parts of a whole and interpret the relationships between those parts;*
- (b) *make qualitative assessments and judgments based on criteria and standards; and,*
- (c) *compare, extrapolate, infer and distinguish between component parts and draw conclusions.*

**Synthesis**

*The ability to:*

- (a) *design, innovate, and integrate resources, to create a service or product; and,*
- (b) *make proposals for solving problems.*

**Evaluation**

*The ability to review, assess, investigate, contrast and make reasoned judgements and recommendations based on criteria and standards.*

**Practical Ability (PA)**

*The ability to:*

- (a) *use facts, concepts, principles, technology, formulae, theories, and processes to produce designs, drawings and make products to given performance standards;*
- (b) *demonstrate manipulative skills using equipment, tools, materials, processes, technology and other resources;*
- (c) *design and create new ideas, products and services based on performance standards;*
- (d) *demonstrate craftsmanship, creativity and communication skills based on performance standards; and,*
- (e) *respond to one's environment applying all the senses.*

◆ **FORMAT OF THE EXAMINATIONS**

*Certification for the Industrial Technology syllabuses will be based on two written Papers; Paper 01 and Paper 02 for the External Assessment and Paper 03 which is the School-based Assessment comprising the SBA Portfolio.*

## External Assessment

**Paper 01** (1 ¼ hours) This paper will consist of 60 multiple-choice items covering all Sections of the Core. Fundamentals of Industry, Design Principles and Processes and Information Communications Technology. Knowledge and Comprehension (KC) and Use of Knowledge (UK) will be tested in the ratio of 1:2.

The Paper will be worth 60 marks (1 mark for each item and will represent 20 per cent of the total score).

**Paper 02** (2 hours) This paper will consist of five compulsory structured response questions. Each Option (Electrical and Electronic Technology Mechanical Engineering Technology and Building and Furniture Technology) will have its own paper.

Each question on this paper for **all** three Options will be worth 18 marks. The marks are distributed across questions and profiles as indicated below:

Knowledge and Comprehension (KC) - 6 marks;  
Use of Knowledge (UK) - 6 marks; and,  
Practical Ability (PA) - 6 marks.

This paper will represent 30 per cent of the total score.

**School-Based Assessment (SBA)** The School-Based Assessment (Appendix 1), Paper 03, will consist of assignments displayed in the School Based Assessment Portfolio. The School-Based Assessment Portfolio will account for 50 marks distributed across the three profile dimensions (Knowledge and Comprehension, Use of Knowledge and Practical Ability). Appendix 2 provides a list of possible units for integration along with an exemplar.

## WEIGHTING OF INDUSTRIAL TECHNOLOGY PAPERS

The percentage weightings of the examination components for the Electrical and Electronic Technology, Mechanical Engineering Technology and Building and Furniture Technology Options are:

### EXTERNAL EXAMINATION

|                             | External Examination |                 |                                    |            |            |
|-----------------------------|----------------------|-----------------|------------------------------------|------------|------------|
| PROFILES                    | Paper 01<br>20%      | Paper 02<br>30% | Paper 03<br>(SBA PORTFOLIO)<br>50% | TOTAL      | %          |
| Knowledge and Comprehension | 20                   | 30              | 10                                 | 60         | 20         |
| Use of Knowledge            | 40                   | 30              | 20                                 | 90         | 30         |
| Practical Ability           | -                    | 30              | 120                                | 150        | 50         |
| <b>TOTAL</b>                | <b>60</b>            | <b>90</b>       | <b>150</b>                         | <b>300</b> | <b>100</b> |

## ◆ REGULATIONS FOR PRIVATE CANDIDATES

Candidates who do not attend school full-time may undertake the course as a private candidate. A private candidate is one not entered through a school or other approved educational institution.

Such a candidate must observe the following guidelines:

- (i) complete *all the components of the examination*;
- (ii) identify a teacher/tutor from a registered institution (school/technical institute/community college) who will assess and approve the candidate's submission for the School-Based Assessment component of the syllabus; and,
- (iii) submit to the Council on registration for the subject the name, school, and territory of the identified teacher/tutor.

## ◆ REGULATIONS FOR RESIT CANDIDATES



*Resit candidates must rewrite Papers 01 and 02 of the examination for the year in which they re-register. However, resit candidates who have earned a moderated score of 50 per cent or more of the maximum score for the School-Based Assessment component may elect not to repeat this component, provided they rewrite the examination no later than two years immediately following their first attempt.*

*Resit candidates who have obtained a moderated score of less than 50 per cent of the maximum score for the School-Based Assessment component must repeat the component at any subsequent sitting. Resit candidates may enter through schools, recognised educational institutions or the Local Registrar's Office.*

◆ **CORE**  
**SECTION 1: FUNDAMENTALS OF INDUSTRY**

**GENERAL OBJECTIVES**

*On completion of this Section, students should:*

1. *understand the organisation of an industry with special focus on the manufacturing and construction industries;*
2. *apply a working knowledge of codes and regulations governing the manufacturing and construction industries;*
3. *demonstrate an awareness of careers in the construction and manufacturing industries and the contributions made by people who work in them; and,*
4. *demonstrate skills in the application of workshop and worksite safety, health and maintenance practices through occupational safety and health management systems.*

**SPECIFIC OBJECTIVES**

*The students should be able to:*

1. *discuss the sectors and their roles within the construction and manufacturing industries;*
2. *create a basic organisational structure of the construction and manufacturing industries;*
3. *discuss the types of occupation levels and their functions in the construction and manufacturing industries;*
4. *analyse career paths and the requisite qualifications in the construction and manufacturing industries;*
5. *discuss codes and standards governing industrial processes, designs, materials and environmental practices;*
6. *practise occupational health, safety and welfare standards in the construction and manufacturing industries; and,*
7. *discuss the impact of industries on the social and economic well-being of Caribbean countries.*

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

### CONTENT

#### 1. Sectors and their roles

- (a) Definitions of:
  - (i) an industry:
    - a construction;
    - a manufacturing; and,
    - an electrical and electronic.
- (b) The construction sectors:
  - (i) residential;
  - (ii) industrial;
  - (iii) commercial; and,
  - (v) civic.
- (c) The roles of the following in the manufacturing sectors:
  - (i) engineering design;
  - (ii) industrial production; and,
  - (iii) industrial maintenance.

#### 2. Organisational structure

- (a) Organisational chart of personnel (managers, workers, tasks and relationships):
  - (i) top-down structure;
  - (ii) flat structure; and,
  - (iii) matrix.

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

### 3. Occupational levels and their functions

- (a) *Semi-skilled.*
- (b) *Skilled.*
- (c) *Technician supervisory.*
- (d) *Technologist/Master Craftsman.*
- (e) *Professional.*

### 4. Career paths and qualifications

- (a) *Construction industries:*
  - (i) *craftsmen /tradesmen - carpenters, electricians, electronics technicians, masons, plumbers, furniture makers, woodcrafters, upholsterers, painters; welders, machine operators and fitters;*
  - (i) *technical workers - technicians, technologists, finishing technicians; drafting and design technicians; and,*
  - (ii) *professional workers - electrical, mechanical, construction structural, civil and building service engineers, architects, quantity surveyors, construction project managers, planners.*
- (b) *Fundamentals of entrepreneurship:*
  - (i) *explaining the term “entrepreneurship”:*
    - *meaning and importance; and,*
    - *risk and success characteristics.*
  - (ii) *principles of entrepreneurship:*
    - *goal setting (short, medium, long term and decision making skills);*
    - *business plans;*
    - *success factors (marketing and promotion, customer satisfaction, competitiveness, leadership, management of production and efficiency, quality control);*

## **SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)**

- *government legislation;*
  - *lending institutions;*
  - *benefits; and,*
  - *risks.*
- (c) *Identifying entrepreneurship opportunities in the construction and manufacturing industries.*
- (d) *Self-employment opportunities in electrical and electronics, metalwork engineering, building construction and furniture productions.*

### **5. Codes and standards**

#### **5.1 Occupational Health and Safety Standards**

- (a) *Industry health and safety regulations:*
- (i) *legal responsibilities of employers; and,*
  - (ii) *general duties of employees.*
- (b) *Environmental safety practices.*
- (c) *Safety and maintenance standards.*
- (e) *Health and wellness standards.*
- (e) *Standards for fire prevention and response.*
- (f) *Basic First Aid standards.*
- (g) *Basic emergency response standards.*

#### **5.2 Electrical installation and electronics standards**

- (a) *Local and regional standards.*
- (b) *International standards:*
- (i) *IEEE (Institute of Electrical and Electronics Engineers) standards; and,*
  - (ii) *NEC (National Electrical Code) standards.*



## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

- (c) *Safety standards against hazards:*
  - (i) *electrical equipment;*
  - (ii) *electrical material (wires);*
  - (iii) *communication lines;*
  - (iv) *installation in buildings; and,*
  - (v) *semi-conductor materials and devices.*

### 5.3 Engineering production

- (a) *ASME (American Society of Mechanical Engineers) Codes.*
- (b) *WTO (World Training Organisation) codes.*
- (c) *ISO (International Standards Organisation).*

*Relating to:*

- (i) *components;*
- (ii) *processes, systems, equipment, material; and,*
- (iii) *ethics in engineering practices.*

### 5.4 Building Construction

*Standards (international and regional – ASNI-American National Standards Institute, BSI, ISO and CUBIC) relating to:*

- (a) *building designs, plans, contracts and construction;*
- (b) *building materials, finishing materials, systems and processes;*
- (c) *building construction and natural disasters; and,*
- (d) *furniture design, materials and construction.*

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

### 6. Occupational health, safety and welfare standards

- (a) *Practising safety standards for workshop and worksite:*
- (i) *inventory of materials, tools and equipment;*
  - (ii) *workshop/worksite layout diagrams;*
  - (iii) *listing of danger/hazard points;*
  - (iv) *preparing and posting safety signs and symbols in relevant areas of a workshop/worksite;*
  - (v) *marking out safety lanes;*
  - (vi) *using safety manuals for workshop and worksite tools and equipment;*
  - (vii) *using equipment guards and stop switches safely;*
  - (viii) *using the principles of ergonomics (machines, work stations, materials); and,*
  - (ix) *selecting and using Personal Protective Equipment - clothing, glasses, goggles, helmets, footwear, ear muffs and plugs, respirators, back brace.*
- (b) *Environmental safety practices:*
- (i) *types of industry, workshop and worksite wastes;*
  - (ii) *waste disposal methods; and,*
  - (iii) *recycling methods.*
- (c) *Safety and maintenance standards:*
- Using equipment, tools and materials associated with electrical installation, electronics, building construction and metal work engineering:
- (i) *rules and operating procedures for safe use of power, hand, and portable machine tools;*
  - (ii) *safety rules for using and storing materials, tools and equipment;*

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

- (iii) *labelled drawings and sketches showing safety features and safe use of equipment and tools;*
  - (iv) *maintaining workshop, worksite, equipment, materials and tools;*
    - *Types of maintenance in workshop/worksite activities (preventative, predictive, break down);*
    - *inspecting and analysing defects (vibration, wear and tear) in tools and machines;*
    - *using testing, measuring and safety devices;*
    - *developing and using maintenance schedules, checklists and duty roster; and,*
    - *using manufacturers' manuals (tools and machines).*
  - (v) *carrying out risk assessments - use of a trained person (safety warden) with staff and students using safety inspection checklists, safety reports (strengths, weaknesses) and schedule of activities to address weaknesses.*
- (d) *Standards for fire prevention and response:*
- (i) *rules for fire prevention in the workshop and on a worksite;*
  - (ii) *types of fires - class A, class B, class C, class D;*
  - (iii) *rules for handling the different types of fires;*
  - (iv) *types of firefighting equipment and their storage - fire extinguishers, fire hydrants, fire alarms, hoses, fire blankets (asbestos-free); and*
  - (v) *fire extinguishers.*
- (e) *Health and wellness standards:*
- (i) *observing personal hygiene and appearance standards;*
  - (ii) *practising wellness/fitness programme;*
  - (iii) *practising human relationship skills; and,*
  - (iv) *managing interpersonal conflicts.*

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

- (f) *Basic First Aid standards:*
  - (i) *definitions - first aid, first aider;*
  - (ii) *first Aid kit station;*
  - (iii) *treating of minor burns, electric shocks, wounds and bleeding, abrasions, injuries to bone ( strains, sprains);*
  - (iv) *practising recovery position and mouth-to-mouth resuscitation;*
  - (v) *procedures for reporting an accident and getting assistance; and,*
  - (vi) *preparing an accident report (use of standard accident report forms).*
  
- (g) *Basic emergency response standards.*
  
- (h) *Getting professional help when an accident occurs:*
  - (i) *listing of emergency numbers (police, fire services, hospital, ambulance, Red Cross, the defence force);*
  - (ii) *assessing and controlling hazardous substances – spillages and leakages of chemicals and other hazardous substances;*
  - (iii) *responding to evacuation alarm sounds;*
  - (iv) *using evacuation route maps, gathering points and bulletin boards;*
  - (v) *performing emergency procedures for fires and natural disasters (hurricanes, earthquakes, floods, tsunami, volcanoes); and,*
  - (vi) *maintaining accountability systems in emergency operations.*
  
- (i) *Types of workshop hazards:*

*Types of workshop, worksite accidents and preventative procedures – falls and slippages, strains, injuries caused by falling objects, improper use of machines, tools and equipment, inhalation of toxic fumes.*

## SECTION 1: FUNDAMENTALS OF INDUSTRY (cont'd)

### 7. *Impact of industries on the Caribbean*

(a) *Trade Blocks:*

- (i) CARICOM;
- (ii) CSME; and,
- (iii) CARIFORUM.

(b) *Entrepreneurial opportunities that lead to self-employment:*

- (i) *productivity and wealth creation;*
- (ii) *career and employment opportunities;*
- (iii) *personal advancement; and,*
- (iv) *entrepreneurial opportunities that lead to self-employment.*

## **SECTION 2: DESIGN PRINCIPLES AND PROCESSES**

### **GENERAL OBJECTIVES**

*On completion of this Section, students should:*

- 1. understand the design principles and processes used in the development and modification of industry goods and services; and,*
- 2. apply the design principles and processes used in industries.*

### **SPECIFIC OBJECTIVES**

*The students should be able to:*

- 1. explain the design principles;*
- 2. explain the design elements;*
- 3. discuss the design processes;*
- 4. explain the factors that determine the appropriateness of a design; and,*
- 5. use the principles, processes and elements of design.*

### **CONTENT**

#### **1. The Design Principles**

- (a) Line, direction and style.*
- (b) Shape and size.*
- (c) Colour.*
- (d) Texture.*
- (e) Space.*
- (f) Form.*

#### **2. The Design Elements**

- (a) Line:*
  - (i) weights; and,*
  - (ii) line types.*

## SECTION 2: DESIGN PRINCIPLES AND PROCESSES (cont'd)

- (b) *Colour.*
- (c) *Shades.*
- (d) *Hatching.*

### 3. **The Design Process**

- (a) *Identifying the problem.*
- (b) Critical analysis of a problem.
- (c) Generating alternative solutions.
- (d) Selecting the best solution.
- (e) Communication of the design ideas.
- (f) Development of working drawings.
- (g) Manufacture of the prototype/model (functions, ergonomics, material, construction, economy, aesthetics, virtual).
- (h) Testing and evaluation of the product.
- (i) Codes and conventions (ISO and BS – British Standards).

### 4. **Factors that determine the appropriateness of a design**

- (a) *Aesthetics.*
- (b) *Functionality.*
- (c) *Economics.*
- (d) *Environnent – resource conservation, environmental pollution.*
- (e) *Ergonomics.*
- (f) *Suitability of material.*
- (g) *Innovation.*
- (h) *Decoration.*
- (i) *Anthropometrics.*
- (j) *Selection of material.*



## SECTION 2: DESIGN PRINCIPLES AND PROCESSES (cont'd)

### 5. Use the principles, elements and processes of design

- (a) *Using sketches (manual or computer-aided) to design a simple product in the areas of:*
  - (i) *Electrical and Electronic Technology;*
  - (ii) *Building and Furniture Technologies; and,*
  - (iii) *Mechanical Engineering Technology.*
  
- (b) *Analysing a simple manufactured product in the areas of:*
  - (i) *Electrical and Electronic Technology;*
  - (ii) *Building Technology;*
  - (iii) *Mechanical Engineering Technology; and,*
  - (iv) *Preparing the analysis report:*
    - *findings (appropriateness of the design); and,*
    - *recommendations.*



## **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES**

### **GENERAL OBJECTIVES**

*On completion of this Section, students should:*

1. *understand the uses of multimedia computer systems in industry;*
2. *understand the operating principles of a multimedia computer system; and,*
3. *apply basic communication graphics and design software.*

### **SPECIFIC OBJECTIVES**

*The students should be able to:*

1. *discuss the uses of computers in industry;*
2. *describe the operating principles of a computer;*
3. *use communication devices to access and exchange information;*
4. *describe the basic principles of graphic communication;*
5. *perform simple tasks using design softwares; and,*
6. *describe modern trends in engineering technologies.*

### **CONTENT**

#### **1. Uses of computers in industry**

- (i) Word processing.
- (ii) Accounting/financial applications.
- (iii) Human resource applications.
- (iv) Material/inventory management.
- (v) Process control.
- (vi) Robotics.
- (vii) Research and development.
- (viii) Metrology.

## **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES (cont'd)**

### **2. Using the operating principles of a computer**

- (a) *Projects to include:*
- (i) storing, organising, retrieving and communicating information;
  - (ii) using software for creating, editing and publishing multimedia projects;
  - (iii) applying spread sheet development procedures – Writing formulae, using functions, enhancing spread sheet, creating charts, printing basic spread sheets and charts;
  - (iv) using productivity, application and presentation tools – scanners, digital cameras, camcorders, projectors, microphones, printers; and,
  - (v) using storage devices – hard drives, USB drives, compact disc, digital video disc.

### **3. Using communication devices to access and exchange information**

- (a) *Networks:*
- (i) Intranet (LAN);
  - (ii) Extranet (WAN); and,
  - (iii) Internet.
- (b) *Communication:*
- (i) Fibre;
  - (ii) WIFI;
  - (iii) GPRS; and,
  - (iv) Dial-up Connection.
- (c) *Devices:*
- (i) personal computers (PCs);
  - (ii) mini computers;
  - (iii) smart phones/tablets; and,
  - (iv) cell phones.

### **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES (cont'd)**

#### **4. Applying graphics communication techniques**

*Using computer based graphical techniques:*

- (a) *preparing pictorial drawings using CAD;*
- (b) *isometric, Oblique, Perspective;*
- (c) *preparing orthographic drawings using CAD; and,*
- (d) *explaining the importance of the basic principles of CAM.*

#### **5. Performing simple tasks using design soft wares**

- (a) *Media:*
  - (i) *sound;*
  - (ii) *pictures;*
  - (iii) *video;*
  - (iv) *animations; and,*
  - (v) *text.*
- (b) *Software:*

*Multimedia.*
- (c) *Developing presentations for example:*
  - (i) *PowerPoint;*
  - (ii) *Prezi; and,*
  - (iii) *Harvard graphics.*

#### **6. Modern trends in Engineering technologies**

- (a) *Computer numerical control machines.*
- (b) *Computer aided manufacturing.*
- (c) *Computer integrated manufacturing.*
- (d) *Virtual manufacturing.*



◆ **INDUSTRIAL TECHNOLOGY SYLLABUS**

***OPTION A: ELECTRICAL AND ELECTRONIC TECHNOLOGY***

## **OPTION A: ELECTRICAL AND ELECTRONIC TECHNOLOGY**

### **SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS**

#### **GENERAL OBJECTIVES**

*On completion of this Section, students should:*

- 1. apply knowledge of the units and theories associated with electrical principles and measurements;*
- 2. demonstrate safety practices in the application of electrical theories; and,*
- 3. apply the theories and concepts of related calculations and experimentations.*

#### **SPECIFIC OBJECTIVES**

The students should be able to:

- 1. discuss the structure of an atom;*
- 2. explain the electronic theory of current flow;*
- 3. analyse the principles of static electricity;*
- 4. outline the basic laws of electromagnetism;*
- 5. explain terminologies relating to electrical measurement and quantities;*
- 6. use electrical measuring instruments safely;*
- 7. verify the principle of Ohm's law from project data;*
- 8. apply the principles of resistance in determining electrical values;*
- 9. discuss the functions of various types of circuit devices;*
- 10. use the operating principles of AC and DC circuits;*
- 11. outline the operating principles of basic circuit configurations;*
- 12. calculate basic energy bills; and,*
- 13. describe the operating principles of electricity generating devices.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

### CONTENT

#### 1. *The structure of an atom*

- (a) *Diagrammatic representation of an atom.*
- (b) *Parts of the atom and their functions.*
- (c) *Nucleus and valence shells.*
- (d) *Differentiating between positively and negatively charged atoms:*
  - (i) *electron loss; and,*
  - (ii) *electron gain.*

#### 2. *The electronic theory of current flow*

- (a) *Definition of electricity.*
- (b) *Current flow.*
- (c) *Electron flow.*
- (d) *Effects of electricity:*
  - (i) *heating;*
  - (ii) *lighting;*
  - (iii) *chemical;*
  - (iv) *magnetic; and,*
  - (v) *use simple projects to demonstrate the operating principles of each effect safely.*
- (e) *Sources of Electromotive Force (emf) and the resistance of the circuit.*
- (f) *Difference between emf and potential difference (p.d).*

#### 3. *Principles of static electricity*

- (a) *Effects of friction on an object:*
  - (i) *built up of excess electrons; and,*
  - (ii) *storage of electric charge.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

(b) *Basic rules for an electric charge:*

(i) *like charges repel; and,*

(ii) *unlike charges attract.*

### 4. **Basic laws of electromagnetism**

(a) The Molecular theory of magnetism.

(b) Laws of magnetism.

(c) Types of magnetic materials and their uses:

(i) *ferromagnetic materials (soft and hard magnetic materials); and,*

(ii) *diamagnetic materials.*

(d) Using diagrams/sketches to show:

(i) *the Magnetic effects of electric current;*

(ii) *the Corkscrew rule;*

(iii) *the direction of magnetic field around a current carrying conductor;*

(iv) *restricting the effects of magnetic field produced by electric currents; and,*

(v) *plotting the direction of the magnetic field around a current carrying conduct and solenoid.*

(e) Winding a coil for simple electro magnets:

(i) *guidelines and procedures for a single conductor and an iron core;*

(ii) *noting the magnetic effects of the conductor and the iron core; and,*

(iii) *analysing the process of inducing a voltage across a coil.*

(f) Determining the direction of the magnetic field around a single conductor and solenoid:

(i) *Guidelines; and,*

(ii) *Conventional current and electron flow.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

- (g) *Analysing* the relationship between a current carrying conductor and the magnetic field surrounding the conductor:
  - (i) *left hand rule for electromagnetism;*
  - (ii) *analysing the application of Faraday's and Lenz' laws and motor and generator action;*
  - (iii) *properties of electromagnetic induction;*
  - (iv) *relationship of an electric current and the magnetic field surrounding the current;*
  - (v) *the motor action between two magnetic fields; and,*
  - (vi) *factors that affect induced current in a conductor within a magnetic field.*
- (h) Determining the direction of force between two current-carrying conductors in parallel:
  - (i) *magnetic field established by current;*
  - (ii) *magnetic circuit diagrams showing the current direction and flux direction in a magnetic field; and,*
  - (iii) *related calculations.*
- (i) Performing calculations to determine flux density and energy stored in a magnetic field:
  - (i) *magnetic motive force (MMF);*
  - (ii) *magnetic flux density; and,*
  - (iii) *magnetic circuit diagrams showing the current direction and flux direction in a magnetic field.*

### 5. **Electrical measurement and quantities**

- (a) The SI Units:
  - (i) coulomb;
  - (ii) ampere;
  - (iii) period;



## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (*cont'd*)

- (iv) electromotive force (emf);
- (v) power;
- (vi) current;
- (vii) energy;
- (viii) resistance;
- (ix) potential difference;
- (x) capacitance;
- (xi) inductance; and,
- (xii) frequency.

### 6. **Measuring instruments**

- (a) Features, functions and safe guidelines for using:
  - (i) multimeters;
  - (ii) moving coils; and,
  - (iii) digital meters.
- (b) Instruments to measure the properties of a circuit:
  - (i) volt-ohm meter;
  - (ii) digital volt-ohm meter;
  - (iii) oscilloscopes (identifying wave form patterns, measuring voltage and frequencies);
  - (iv) signal generators (supplying various waveforms to circuits); and,
  - (v) identifying factors that affect the sensitivity of instruments (damping and meter movement).
- (c) Linear and non-linear scales when using instruments:
  - (i) uses of linear and non-linear scales;
  - (ii) constructing and using linear and non-linear scales;

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

- (iii) range extensions;
- (iv) calculating series and shunt resistance for scale extensions; and,
- (v) series and shunts multimeter and switching arrangements.

### 7. **The principle of Ohm's law**

- (a) *Ohm's law as a relationship among voltage (p.d), resistance and power.*
- (b) *Plotting a graph between voltage (V) and current (I) and resistance (R) in a direct current circuit.*
- (c) *Constructing a simple electric circuit comprising ammeter, voltmeter, load and power supply.*
- (d) *Using Ohm's laws to:*
  - (i) *analyse the circuits in (b) and (c); and,*
  - (ii) *manipulate the formulae to solve algebraic equations for V, I and R using circuit diagrams and the triangle of Ohm's Law.*

### 8. **The principles of resistance**

- (a) *Definition of resistance.*
- (b) *Types of resistors:*
  - (i) *carbon film;*
  - (ii) *metal film;*
  - (iii) *wire wound;*
  - (iv) *SMD;*
  - (v) *VDR; and,*
  - (vi) *LDR.*
- (c) *Identifying resistor values from colour code for carbon resistors.*
- (d) *Drawing and connecting total resistance in series, parallel and series/parallel.*
- (e) *Calculating total resistance in series, parallel and series-parallel circuits.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

- (f) *Calculating total conductance of resistance in parallel.*
- (g) Using circuit diagrams to show current flows.
- (h) Calculating resistivity values:
  - (i) defining resistivity;
  - (ii) calculating conductor resistance for changes in length and cross-sectional area;
  - (iii) known factors (value, area, length); and,
  - (iv) equivalent resistance of series resistance.
- (i) Temperature coefficient of resistance:
  - (i) *change in material resistance produced by change in temperature:*
    - positive temperature coefficient;
    - negative temperature coefficient; and,
    - zero temperature coefficients.
  - (ii) identifying materials with positive, negative and zero temperature coefficients; and,
  - (iii) solving problems involving resistivity and temperature co-efficient of resistance.

### 9. **Circuit devices**

- (a) *Functions and features of:*
  - (i) protective devices (*fuses, circuit breakers*);
  - (ii) control devices (*switches, relays, starters, motors control and starters*); and,
  - (iii) variable resistors.

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

### 10. AC and DC Circuits

- (a) Flow of electricity in different materials:
  - (i) conductors; and,
  - (ii) insulators.
  
- (b) *Differences between AC and DC current with reference to:*
  - (i) sine wave;
  - (ii) cycle;
  - (iii) frequency;
  - (iv) period;
  - (v) amplitude;
  - (vi) average value;
  - (vii) r.m.s value;
  - (viii) phase; and,
  - (ix) applications.
  
- (c) Sources of AC and DC current:
  - (i) *electromagnetic generators;*
  - (ii) *electromagnetic alternators; and,*
  - (iii) *sketches showing e.m.f. sine wave, wave form, maximum, minimum and r.m.s. and average values.*
  
- (d) *Analysing* the basic components of a simple circuit:
  - (i) source of e.m.f.;
  - (ii) load and conductor;
  - (iii) control and protection (*switches and safety devices*);
  - (iv) diagrams and sketches;

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

- (v) connecting controls in electric circuits; and,
  - (vi) rheostats and potentiometers.
- (e) *Analysing the effects of reactive components:*
- Capacitor in AC and DC circuits:*
- (i) *uses;*
  - (ii) *values and colour codes;*
  - (iii) *reactive power;*
  - (iv) *quantity of charge;*
  - (v) *dielectric strength;*
  - (vi) *using Farad formulae;*
  - (vii) *constructing a simple capacitor (sketches and diagrams); and,*
  - (viii) *connecting capacitors in electrical circuit.*
- Inductance in AC and DC circuits:*
- (i) *self-inductance;*
  - (ii) *mutual inductance;*
  - (iii) *true power;*
  - (iv) *calculating inductance; and,*
  - (v) *connecting inductors in electrical circuits:*
    - *phasor and vector diagrams; and,*
    - *sketches and diagrams.*
  - (vi) *time constant and Lenz's laws.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

### 11. Basic circuit configurations (series and parallel circuits):

- (a) *Definitions:*
  - (i) *series circuit; and,*
  - (ii) *parallel circuit.*
- (b) *Characteristics of the operations of series and parallel circuits:*
  - (i) *power distribution rules; and,*
  - (ii) *relationship of current, voltage and resistance.*
- (c) *Verifying the operations of series and parallel circuits:*
  - (i) *connecting filament lamps in series and parallel circuits;*
  - (ii) *characteristics of the operations of series and parallel circuits;*
  - (iii) *using instruments to measure the properties of the circuits; and,*
  - (iv) *identifying the relationship of current, voltage and resistance.*
- (d) *Analysing the current and voltage relationships in series and parallel circuits:*
  - (i) *circuits (RL, RC and RCL);*
  - (ii) *phases;*
  - (iii) *current flow;*
  - (iv) *reactance (inductive, capacitance);*
  - (v) *impedance;*
  - (vi) *power factor;*
  - (vii) *apparent power; and,*
  - (viii) *active power.*
- (e) *Calculating total capacitance in series and parallel connected capacitance.*
- (f) *Calculating total inductance in series and parallel connected inductance.*

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

### 12. *Energy bills*

- (a) Reading a kwh meter:
  - (i) procedures for reading analogue and digital meters; and,
  - (ii) units of measurement for power and energy.
- (b) Calculating energy bills (flat and block rates).

### 13. *Electricity generating devices*

- (a) Types of electricity generating devices:
  - (i) primary cells; and,
  - (ii) secondary cells.
- (b) *Differences between primary and secondary cells:*
  - (i) *parts of the cells and their functions;*
  - (ii) *operating principles;*
  - (iii) *labelled sketches and diagrams of Leclanché, Mercury, Nickel Cadmium cells;*
  - (iv) *polarisation and local action; and,*
  - (v) *charging and discharging devices and their operating principles.*
- (c) Conduct simple experiments demonstrating the conversion of chemical energy to electrical energy:
  - (i) direct conversion from chemical to electrical energy in primary cells;
  - (ii) conversion of electrical to chemical energy in secondary cells; and,
  - (iii) uses of the energy converted from cells.

## SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENTS (cont'd)

- (d) Installing cells in series and parallel as a source of power:
  - (i) *schematic diagrams of cells connected in series and parallel; and,*
  - (ii) calculating voltage of cells connected in series and parallel - cell e.m., internal resistance, internal voltage, terminal p.d.
  
- (e) Charging and maintaining secondary cells:
  - (i) *guidelines and safety practices for lead-acid and alkaline cells;*
  - (ii) charging methods and levels;
  - (iii) charging calculations;
  - (iv) discharging and charging characteristics;
  - (v) *using the hydrometer and high rate discharge testers; and,*
  - (vi) *preparing electrolyte.*



## SECTION 2: ELECTRICAL AND ELECTRONIC DRAFTING

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *produce electrical and electronic drawings using the principles of computer-aided design and manual methods;*
2. *understand basic electronic signs and symbols; and,*
3. *display proficiency in the reading and interpretation of electrical and electronic plans, diagrams and representations.*

### SPECIFIC OBJECTIVES

The students should be able to:

1. *discuss the types of electrical and electronic drawings;*
2. *analyse various types of electrical plans and connection diagrams;*
3. *read and interpret plans for domestic and commercial circuits;*
4. *prepare simple electrical wiring diagrams and plans to engineering standards;*
5. *prepare schematic diagrams to engineering standards;*
6. *prepare flow and block diagrams to engineering standards; and,*
7. *explain electrical drawings to a construction team.*

### CONTENT

#### 1. and 7. *Electrical and electronic drawings*

- (a) *Types:*
  - (i) *electrical wiring diagrams; and,*
  - (ii) *schematic diagrams.*
- (b) *Uses, characteristics and sketches of each type.*
- (c) *Sketching block, flow and circuit diagrams.*
- (d) *Graphical standards and symbols for electrical and schematic diagrams.*

## SECTION 2: ELECTRICAL AND ELECTRONIC DRAFTING (cont'd)

### 2. *Electrical plans and connection diagrams*

- (a) *Components, connections and symbols of electrical plans:*
  - (i) plot plans;
  - (ii) residential and commercial;
  - (iii) internal distribution systems;
  - (iv) electrical distributions systems; and,
  - (v) signalling circuits.
- (b) *Components and connecting points in connection diagrams:*
  - (i) point to point diagrams;
  - (ii) base line diagrams;
  - (iii) high way diagrams; and,
  - (iv) lineless diagrams.

### 3. *Plans for domestic and commercial circuits*

- (a) Lines and symbols.
- (b) *Circuit routes and isolation points.*
- (c) *Wiring layout.*
- (d) *Specification of plans, circuit and sub-circuits.*
- (e) *Calculating loads.*
- (f) *Computing dimensions and outlet positions from plans:*
  - (i) length of circuits;
  - (ii) position of switches; and,
  - (iii) determining quantity and cost of materials from plans (cable, flexible cords, and accessories).

## SECTION 2: ELECTRICAL AND ELECTRONIC DRAFTING (cont'd)

### 4. **Electrical wiring diagrams and plans**

- (a) Guidelines *and techniques* for line work and notations:
  - (i) one-line diagram; and,
  - (ii) principles of operation of one-line diagram (symbols, type of distribution system, signalling circuits).
- (b) Converting one-line to three-line diagram and vice versa.
- (c) Designing and drawing basic electrical plans.

### 5. **Schematic diagrams**

- (a) Principles of operation of schematic diagrams.
- (b) *Drafting principles (references symbols position, sequence, symmetry and balance, line work specification).*
- (c) *Guidelines for simple wiring diagrams converted to schematic diagrams and vice versa.*
- (d) *Circuit connections.*

### 6. **Block and flow diagrams**

- (a) *Operating principles for block and flow diagrams.*
- (b) *Drafting principles, codes and regulations for:*
  - (i) *block diagrams for common large and small electronic systems - stages of a radio and television receiver/transmitter, stages of a computer;*
  - (ii) *flow diagrams showing the process of flow for electrical energy (heat, light, sound) in small appliances or battery operated gadgets; and,*
  - (iii) *symbols and sequencing of arrangements.*

## SECTION 3: ELECTRICAL POWER AND MACHINES

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand the principles of electrical power generation and production;
2. demonstrate proficiency in the use of electrical machines;
3. apply the theories and methods of calculation and experimentations to analyse and solve power and machine problems; and,
4. appreciate the importance of workshop and worksite safety and maintenance standards.

### SPECIFIC OBJECTIVES

The students should be able to:

1. differentiate among apparent power, true power and power factor;
2. discuss the basic sources of electrical generation and production;
3. explain the principal sources and conversion of primary energy used for the generation of electricity in the region;
4. compare the different types of a.c and d.c. electrical machines;
5. connect d.c. and single and three phase a.c. motors to supply mains;
6. maintain generators;
7. compare different types of transformers; and,
8. install and maintain a low voltage transformer.

### CONTENT

#### 1. Apparent power, true power and power factor

(a) Differences:

- (i) functions;
- (ii) mathematical relationships and units; and,
- (iii) engineering relationships.

## SECTION 3: ELECTRICAL POWER AND MACHINES (cont'd)

### 2. **Basic sources of electrical generation and production**

- (a) *Sources:*
- (i) *friction;*
  - (ii) *pressure;*
  - (iii) *heat;*
  - (iv) *light;*
  - (v) *chemical action; and,*
  - (vi) *electromagnetic induction.*
- (b) *Functions and characteristics of each source.*
- (c) *Advantages and disadvantages of each source.*

### 3. **Principal sources of primary energy**

*Non-renewable energy sources:*

*Fossil fuel – oil, coal, natural gas, mineral fuel (uranium).*

- (a) *Renewable energy sources:*
- (i) *solar;*
  - (ii) *wind;*
  - (iii) *tidal; and,*
  - (iv) *geothermal.*
- (b) *Production processes in:*
- (i) *an oil refinery;*
  - (ii) *fossil fuel power plant;*
  - (iii) *wind farm;*
  - (iv) *photovoltaic system; and,*
  - (v) *nuclear power plant.*

### SECTION 3: ELECTRICAL POWER AND MACHINES (cont'd)

- (c) *Primary energy and the Law of Thermodynamics.*
- (d) *Methods of converting primary energy to electrical energy:*

*Processes in:*

- (i) *steam-driven generators;*
- (ii) *internal combustion engine-driven generators; and,*
- (iii) *hydro-driven generators.*

#### 4. **AC and DC electrical machines**

- (a) *Types:*
  - (i) *generators;*
  - (ii) *motors; and,*
  - (iii) *transformers.*
- (b) *Parts and their functions.*
- (c) *Construction features and operating principles.*
- (d) *Codes and regulations.*
- (e) *Service and maintenance procedures.*
- (f) *Generator and motor related calculations: Power, synchronous speed, percentage slip (Lenz's law), induced e.m.f., turns, voltage and current ratios of transformers, power transformer efficiency.*

#### 5. **DC and single and three phase AC motors**

- (a) *Shunt, series and compound machines.*
- (b) *Relays and contactors.*
- (c) *Features:*
  - (i) *control circuits - push button station, relays, limit switch, fuses, manual contactor and motor starters, stop and start devices, output power, input power, efficiency and losses, commutator, speed control; and,*

### SECTION 3: ELECTRICAL POWER AND MACHINES (cont'd)

- (ii) circuit diagrams.
- (d) Installation, testing and dismantling procedures.
- (e) Reversing the direction of rotation for AC and DC motors:
  - (i) guidelines and circuit diagrams and safety procedures; and,
  - (ii) starters for single and three phase motors.

#### 6. AC generator

- (a) *Installation* tools, equipment, materials, guidelines and safety procedures.
- (b) Alternators: voltage fall and rise.
- (c) Terminal voltage.
- (d) Back e.m.f.
- (e) *Using checklists for measuring the standard of the completed work including:*
  - (i) alternators;
  - (ii) voltage fall and rise; and,
  - (iii) terminal voltage.

#### 7. Types of transformers

- (a) Types:
  - (i) low voltage;
  - (ii) single-phase;
  - (iii) three-phase; and,
  - (iv) current and voltage.
- (b) Uses.
- (c) Characteristics.

### SECTION 3: ELECTRICAL POWER AND MACHINES (cont'd)

- (d) Construction features and components.
- (e) Operating principles.
- (f) Calculations associated with transformers:
  - (i) calculating the turns, voltage and current ratios; and,
  - (ii) calculating power transformer efficiency (transformer losses, iron and copper losses, hysteresis, eddy current and copper).
- (g) Cooling methods:
  - (i) air;
  - (ii) water; and,
  - (iii) gas.

#### 8. **Low voltage transformer**

- (a) *Installation tools, equipment, materials, guidelines and safety procedures.*
- (b) *Checklists for measuring the standard of the completed work.*



## SECTION 4: ELECTRICAL INSTALLATION

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand the codes and regulations governing electrical wiring systems;
2. demonstrate skills in the installation of wiring systems for domestic and industry purposes;
3. understand the operating principles of lighting, cooling and heating systems;
4. demonstrate with accuracy the use of calculations and experimentations to solve related problems; and,
5. comply with safety and maintenance standards.

### SPECIFIC OBJECTIVES

The students should be able to:

1. *explain codes and regulations governing wiring systems;*
2. *explain terminologies associated with wiring systems;*
3. *distinguish between domestic and industrial installation;*
4. *explain the different categorises of electrical materials and their uses;*
5. *discuss the functions of basic wiring systems;*
6. *discuss the functions of basic electrical terminators;*
7. *conduct basic tests on wiring systems;*
8. *troubleshoot faults in wiring systems; and,*
9. demonstrate skills in electrical installation.

### CONTENT

#### 1. **Codes and regulations associated with wiring systems**

(a) *Regional codes:*

*J S 21 standards.*

## **SECTION 4: ELECTRICAL INSTALLATION (cont'd)**

- (b) *International codes:*
  - (i) *IEE wiring regulations; and,*
  - (ii) *NEC wiring regulations.*

### **2. Terminologies associated with wiring systems**

- (a) *Circuits.*
- (b) *Circuit symbols.*
- (c) *Electricity flows.*
- (d) *Generating apparatus.*
- (e) *Controlling apparatus.*
- (f) *Cables.*
- (g) *Wiring support.*

### **3. Domestic and industrial installation**

*Differences in:*

- (a) *domestic installation;*
- (b) *commercial; and,*
- (c) *industrial installation.*

### **4. Electrical installation materials**

- (a) *Categories:*
  - (i) *construction;*
  - (ii) *conducting;*
  - (iii) *resisting;*
  - (iv) *insulating;*
  - (v) *magnetic; and,*
  - (vi) *semi-conducting.*

## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

(b) *Examples and uses of each category.*

### 5. **Basic wiring systems**

(a) *Types:*

- (i) *radial system;*
- (ii) *ring circuit systems;*
- (iii) *distribution systems;*
- (iv) *security/fire alarm systems;*
- (v) *domestic telephone systems; and,*
- (vi) *motor starter systems.*

(b) *Functions of each wiring system.*

(c) *Sketches/schematic diagrams of each system.*

### 6. **Electrical terminators**

(a) *Types:*

- (i) *passive (a resistor); and,*
- (ii) *active (voltage regulator).*

(b) *Functions of each type.*

### 7. **Wiring systems' tests:**

(a) *Verification of polarity.*

(b) *Insulation resistance between conductors and between conductors and earth.*

(c) *Earth continuity conductor.*

(d) *Earth leakage.*

## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

- (e) *Circuit breakers.*
- (f) *Loop impedance.*

### 8. **Faults in wiring systems**

- (a) *Faults:*
  - (i) *overload circuits;*
  - (ii) *short circuits;*
  - (iii) *blowing of fuse;*
  - (iv) *tripping out of circuit breakers;*
  - (v) *cable faults; and,*
  - (vi) *coil and contact failures in motors.*
- (b) *Selecting fuses and circuit breakers for different types of household equipment.*
- (c) *Determining the rating of uses and circuit breakers for different types of equipment:*
  - (i) *fusing current;*
  - (ii) *fusing factor;*
  - (iii) *current rating; and,*
  - (iv) *loading.*
- (d) *Testing and replacing fuses and circuit breakers (types used in building and household equipment).*

### 9. **Performing electrical installation work**

#### 9.1 *Lighting fixtures*

- (a) *Types of lamps.*
- (b) *Types of lamp bases/sockets.*
- (c) *Making simple lighting calculations:*

## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

- (i) Illumination;
- (ii) inverse square law;
- (iii) cosine law; and,
- (iv) luminous intensity.

### 9.2 Types of wiring methods and terminations

- (a) Wiring methods and their uses:
  - (i) sheathed;
  - (ii) armoured cable; and,
  - (iii) light gauge (EMT and PVC conduits).
- (b) Methods of terminations:
  - (i) crimp;
  - (ii) wire wrap; and,
  - (iii) solder.

### 9.3 Fixtures for the operation of lighting and power circuits

- (a) Guidelines, standards and safety procedures for a single multi-phase operation using PVC sheathed cables:
  - (i) lighting and power circuits - One light and two lights in parallel using single pole control switches;
  - (ii) two lights with two-way and intermediate controls;
  - (iii) lighting circuits with four control points;
  - (iv) parts of the electric circuit;
  - (v) circuit/schematic diagrams; and,
  - (vi) testing procedures for:

## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

- polarity;
- earthing;
- continuity; and,
- earth leakage.

### 9.4 *Installing electrical PVC conduit and fixtures*

(a) *Guidelines, standards and safety procedures for:*

- (i) *conduit cutting, bending and joining procedures;*
- (ii) *a single multi-phase operation using PVC sheathed cable;*
- (iii) *installing one light using single pole switch and one light with three way controls;*
- (iv) *circuit/schematic diagrams; and,*
- (v) *testing procedures.*

### 9.5 *Installing cable and conduit to connect various types of domestic lighting devices;*

*Guidelines, standards and safety procedures for a single multi-phase operation using PVC sheathed cables:*

- (a) *filament, incandescent and discharge lamps (LPMV, HPMV);*
- (b) *special ceiling and wall fixtures;*
- (c) *security and emergency lighting devices;*
- (d) *circuit/schematic diagrams; and,*
- (e) *testing procedures.*

### 9.6 *Steel conduits*

Guidelines, standards and safety procedures for installation in:

- (a) *surface, masonry walls and concrete slabs;*
- (b) *masonry wall and concrete slabs;*

## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

- (c) *conduit cutting, bending and joining standards;*
- (d) *installing one light using a three way control;*
- (e) *circuit/schematic diagrams; and,*
- (f) *testing procedures.*

### 9.7 *Electrical accessories in walls and ceilings*

Guidelines, standards and safety procedures for:

- (a) *mounting boxes;*
- (b) *switches;*
- (c) *ceiling rose;*
- (d) *joint box;*
- (e) *circuit/schematic diagrams; and,*
- (f) *testing procedures.*

### 9.8 *Domestic single phase distribution board for a single phase domestic installation;*

Guidelines, standards and safety procedures of installation for:

- (a) *double pole isolating switch;*
- (b) *fuse;*
- (c) *miniature circuit breaker;*
- (d) *bus bars;*
- (e) *neutral block;*
- (f) *earthing block and equipment;*
- (g) *earthing of exposed metal;*
- (h) *circuit/schematic diagrams; and,*
- (i) *testing procedures.*



## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

### 9.9 Accessories for basic domestic single phase fixed equipment circuits to walls

*Guidelines, standards and safety procedures for installing:*

- (a) *double pole switch with neon indicator;*
- (b) *fixed equipment: electric cooker, fan;*
- (c) *circuit/schematic diagrams; and,*
- (d) *testing procedures.*

### 9.10 Trembler bell served by a double wound transformer

(a) *Guidelines, standards and safety procedures for:*

- (i) *constructing a double wound bell transformer;*
  - (ii) *installing;*
  - (iii) *the trembler bell circuit;*
  - (iv) *bell push;*
  - (v) *reset push; and,*
  - (vi) *variable contacts and continuous action relay.*
- (b) *Testing procedures.*

### 9.11 Connecting and testing burglar alarm circuits

*Guidelines, standards and safety procedures for:*

- (a) *normally open circuits;*
- (b) *normally closed circuits;*
- (c) *relays; and,*
- (d) *magnetic reed-switches.*



## SECTION 4: ELECTRICAL INSTALLATION (cont'd)

### 9.12 *Linking and terminating optical cables for Television and Internet applications*

*Guidelines, standards and safety procedures for:*

- (a) *optical Fibre applications; and,*
- (b) *installation and termination.*

## SECTION 5: FUNDAMENTALS OF ELECTRONICS

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *understand codes and regulations relating to electronics and electronic systems;*
2. *understand the basic operating principles of electronics;*
3. *demonstrate a working knowledge of circuit assembly tools and equipment in accordance with codes, regulations and instructional guidelines;*
4. *perform accurate calculations and experimentations to analyse and solve problems associated with circuits, input and output devices; and,*
5. *observe safety and maintenance standards.*

### SPECIFIC OBJECTIVES

The students should be able to:

1. *discuss the features and functions of basic electronic components;*
2. *compare analogue and digital systems;*
3. *explain the operating principles of thermoelectricity;*
4. *prepare solder joints;*
5. *explain the operating principles of basic semi-conductor devices and materials;*
6. *differentiate between filtering circuits and rectifying circuits;*
7. *construct a full and a half wave rectifier circuit;*
8. *use basic semi-conductor devices;*
9. *explain the functions of basic logic gates and their truth tables;*
10. *design circuits using truth tables and Boolean notation for a binary to decimal decoder;*
11. *construct combinational logic circuits using integrated circuits;*
12. *evaluate various types of multi-vibrators;*
13. *construct and test serial shift register and four bit counter circuits; and,*
14. *explain the production and use of electromagnetic radio and TV frequency waves.*

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

### CONTENT

#### 1. **Features and functions of basic electronic components**

- (a) *Diodes.*
- (b) *Transistors.*
- (c) *Thermistors.*
- (d) *Integrated circuits.*
- (e) *Composite circuits (RIC, R/L, C/L).*
- (f) *TRIACs, SCRs, LEDs.*

#### 2. **Comparing analogue and digital systems**

Differences:

- (a) *uses;*
- (b) *operating principles;*
- (c) *circuitry;*
- (d) *waveforms;*
- (e) *current variations;*
- (f) *signals; and,*
- (g) *frequency.*

#### 3. **The operating principles of thermoelectricity**

- (a) *Thermoelectric materials and devices.*
- (b) *Conduction and transportation of electrons.*
- (c) *Thermionic emissions.*
- (d) *Thermistor and Thermocouple principles and applications.*
- (e) *Researchers associated with thermoelectricity (Joule, Seebeck, Peltier, Thompson).*

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

### 4. Solder joints

- (a) Procedures for using soft and hard soldering and soldering irons.
- (b) Heat conduction.
- (c) Oxidation.
- (d) Oxidation removal.
- (e) Molecular action.
- (f) Conductor materials.
- (g) Flux.
- (h) Desoldering procedures.

### 5. Semi-conductor devices and materials

- (a) Diodes:
  - (i) p-n junction;
  - (ii) n-type devices;
  - (iii) p-type device;
  - (iv) LED;
  - (v) the electron theory;
  - (vi) doping;
  - (vii) exposure to light;
  - (viii) signal;
  - (ix) movement of positive holes; and,
  - (x) schematic diagrams and symbols.

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

(b) Transistors:

- (i) bipolar;
- (ii) field-effect;
- (iii) regions;
- (iv) electric field;
- (v) amplification;
- (vi) switching of signals; and,
- (vii) schematic symbols and diagrams.

(c) Thyristor:

- (i) layers (*n-p* type materials);
- (ii) switching and circuit-breaker functions;
- (iii) terminals;
- (iv) gate;
- (v) triggering characteristics;
- (vi) actions of the anode and cathode;
- (vii) holding power; and,
- (viii) schematic symbols and diagrams.

(d) Semi-conductor materials:

- (i) Electrical conductivity in:
  - silicon; and,
  - germanium.

### 6. Rectifier and filtering circuits

- (a) Bridge and bi-phase circuits.
- (b) Full-wave rectification (centre tap), smoothing circuits, LC/RC filter (pi-network).

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

- (c) Differences:
- (i) characteristics;
  - (ii) operating principles;
  - (iii) use of the power transformer in rectifier circuits;
  - (iv) action of the capacitors and inductors in filtering circuits; and,
  - (v) schematic diagrams.

### 7. **Full and half wave rectifier circuit;**

- (a) Guidelines, standards and safety procedures for:
- (i) use of the transformer;
  - (ii) use of the oscilloscope;
  - (iii) diodes;
  - (iv) resistors; and,
  - (v) capacitors.
- (b) Measuring and recording:
- (i) the input voltage; and,
  - (ii) disconnecting power.

### 8. **Basic semi-conductor devices**

#### 8.1 **DIODES**

- (a) *Guidelines, standards and safety procedures for:*
- (i) *p-type;*
  - (ii) *n-type;*
  - (iii) *Zener; and,*
  - (iv) *LED (Point-contact, photodiode).*

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

- (b) *Guidelines, standards and safety procedures for use in:*
  - (i) *analogue circuits; and,*
  - (ii) *digital circuits.*
- (c) *Testing procedures:*
  - (i) *current-voltage relationship (flow and restriction);*
  - (ii) *behaviour of the circuits; and,*
  - (iii) *charts and diagrams.*

### 8.2 TRANSISTORS

- (a) *Guidelines, standards and safety procedures for constructing amplifier circuits in different configurations:*
  - (i) CE;
  - (ii) CC;
  - (iii) CB;
  - (iv) advantages and selections of CE, CC, CB configurations; and,
  - (v) calculating transistor parameters using loadline.
- (b) *Testing the circuits:*
  - (i) *input/output phase relationship;*
  - (ii) *voltage gain;*
  - (iii) *current gain;*
  - (iv) *power gain;*
  - (v) *input resistance; and,*
  - (vi) *output resistance.*

## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

### 8.3 THYRISTORS

- (a) *Guidelines, standards and safety procedures for using SCRs, TRIACs, GTOs in:*
  - (i) *battery charging, dimmers and speed control;*
  - (ii) *comparing input and output comparisons;*
  - (iii) *power output;*
  - (iv) *direction;*
  - (v) *control; and,*
  - (vi) *regulation.*
- (b) *Schematic diagrams and sketches.*

### 9. **Basic logic gates and their truth tables**

- (a) *Definition of a logic gate.*
- (b) *Logic gates Boolean functions:*
  - (i) *AND;*
  - (ii) *OR;*
  - (iii) *NOT; and,*
  - (iv) *NAND.*
- (c) *Symbol for each logic function (IEEE standard):*
  - (i) *distinctive shape;*
  - (ii) *rectangular shape; and,*
  - (iii) *Boolean algebra between (A and B).*
- (d) *Truth tables – Binary system:*

*Visual representation of the switching function of:*

  - (i) *2-input logic gate for each logic function; and,*
  - (ii) *output for each logic function.*



## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

### 10. **Circuits using truth tables and Boolean notation for a binary to decimal decoder**

*Guidelines and standards for:*

- (a) *block diagram and truth table;*
- (b) *boolean notation; and,*
- (c) *circuit diagram of the system using AND and NOT gates.*

### 11. **Combinational logic circuits using integrated circuits**

- (a) Principles of the operation of integrated circuits.
- (b) Guidelines and standards for Programmable ICs:
  - (i) construction; and,
  - (ii) testing procedures.

### 12. **Types of multi-vibrators**

- (a) *Types:*
  - (i) *flip-flops or bi-stables;*
  - (ii) *a-stables; and,*
  - (iii) *mono-stables.*
- (b) *Uses.*
- (c) *Circuits diagrams.*
- (d) *Operating principles.*

### 13. **Serial shift register and four bit counter circuits**

*Guidelines and standards for:*

- (a) *sequential logic gates; and,*
- (b) *memory and counter circuits.*



## SECTION 5: FUNDAMENTALS OF ELECTRONICS (cont'd)

### 14. *Production and uses of electromagnetic radio and TV frequency waves*

- (a) Characteristics of magnetic waves.
- (b) Low and high frequency waves.
- (c) Uses.
- (d) Operating principles.
- (e) Describing the actions of a tuned circuit modulation in radio and TV circuits
  - receiving antennae for home radio and TV reception.
- (f) Explaining the sequence of stages in AM/FM radio and TV receiver/transmitter.

## ◆ WORKSHOP/LABORATORY FACILITIES

Recommended equipment for a class of 16  
(Students may, on occasion, work in groups of two or four).

| Equipment   | Quantity |
|---|----------|
| Work tables, complete with AC and DC variable voltages, socket outlets with main voltage.                                   | 5        |
| Store room (storage of materials, tools and projects).  | 1        |
| Test and repair bench, complete with facilities for sawing, boring, threading and testing devices for electrical repairs    | 1        |
| Half-inch drill press, 6" bench grinder and 4" mechanical vice  | 1        |
| Director-on-line starter  | 2        |
| Motor DC shunt  | 1        |
| Motor – single-phase; capacitance-start and inductance type, universal, permanent split-phase, shaded pole, capacitor motor | 1 each   |
| Motor – three-phase S.C. induction  | 1        |
| Battery charger   | 1        |
| Transformer: 120/240V 1KVA DRY TYPE T/F 12:24V Secondary  | 1        |

| Instruments                   | Quantity |
|-------------------------------|----------|
| Double beam 5" oscilloscope   | 2        |
| *Multimeter                   | 10       |
| Signal generator              | 2        |
| Galvanometer                  | 2        |
| Ammeter, D.C. (0-5A) scale    | 10       |
| Ammeter, A.C. (0-5A) scale    | 10       |
| Voltmeter, D.C. (0-100V)      | 10       |
| Voltmeter, A.C. (0-100V)      | 10       |
| Wattmeter (0-500W)            | 1        |
| Lightmeter                    | 1        |
| Insulation resistance tester  | 1        |
| kWh meter                     | 1        |
| Transistor tester             | 1        |
| Tachometer                    | 1        |
| Continuity tester             | 10       |
| Wire wound variable resistors | 10       |

\*Students should be encouraged to acquire their own instruments.



| <b>Tools</b>                                     | <b>Quantity</b> |
|--|-----------------|
| Electrician pliers – insulated                   | 10              |
| Slip joint pliers                                | 10              |
| Diagonal cutting pliers (nippers) – insulated    | 10              |
| Long nose pliers – insulated                     | 10              |
| Large and small screwdrivers, with assorted tips | 30              |
| Large adjustable wrench                          | 5               |
| Small adjustable wrench                          | 5               |
| Bending spring (PVC conduit)                     | 4               |
| Sets of open end spanners – metric               | 10              |
| Small tweezer set                                | 10              |
| E.M.T. benders (Half inch; three-quarter inch)   | 4               |
| Medium sized scissors                            | 2               |
| Plastic mallet                                   | 10              |
| 227g. Ball pein hammer                           | 10              |
| Portable drilling machine                        | 1               |
| *40w Soldering iron                              | 5               |
| Small metal files                                | 10              |
| Portable pipe vice                               | 5               |
| Allen wrench set                                 | 5               |
| Hacksaw and blade                                | 10              |
| Centre punch                                     | 10              |
| Small cold chisel                                | 10              |
| Sets of taps and dies                            | 2               |
| Tin snips (assorted)                             | 2               |

### **Consumables**

Ceiling roses, assorted plugs, switches, adapters, lamp holders, fuse, clips, circuit breakers, fluorescent fittings, wiring nails, conduit pipes, various types of solder, resin core solder flux, batteries, distilled water, cables (various sizes and cores), earth rod, insulation varnish, sealing wax, lighting rod.

### **Miscellaneous**

Various sizes of cables, assorted lamps and sockets, small compasses, bar and horseshoe magnets, assorted screws and nuts, primary and secondary cells, various types of solder, various values and types of capacitors, resistors, chokes.

**\* Students should be encouraged to acquire their own 40w soldering tools.** 

## SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS

### SYMBOLS

A list of electrical symbols to be used in the examination is provided. Electronic symbols are not included, as it is felt that such symbols are standard and most textbooks on the subject will list them.

### ELECTRICAL AND PHYSICAL QUANTITIES IN INTERNATIONAL SYSTEM UNITS (SI)

In keeping with the trend toward metrication, the syllabus is to be taught in SI units.

### SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS




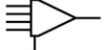
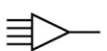







| GRAPHICAL SYMBOLS  |        |                       |        | INSTALLATION SYMBOLS  |        |
|--|--------|-----------------------|--------|---|--------|
| DESCRIPTION  | SYMBOL | DESCRIPTION           | SYMBOL | DESCRIPTION   | SYMBOL |
| PRIMARY OR SECONDARY CELL<br>LONG LIFE<br>REPRESENTS POSITIVE<br>SHORT LINE NEGATIVE |        | FUSE                  |        | ELECTRIC METER  |        |
| BATTERY OR PRIMARY OR SECONDARY CELL<br>ALTERNATIVE SYMBOL                           |        | FILAMENT LAMP OR BULB |        | SOCKET OUTLET OR CONVENIENCE OUTLET                         |        |
| EARTH/CHASSIS  |        | AMMETER               |        | SINGLE GANG SWITCH<br>TWO-WAY SWITCH PULL OR PENDANT SWITCH |        |
| TRANSFORMER  |        | VOLTMETER             |        | DISTRIBUTION BOARD<br>MAIN CONTROL                          |        |
| CROSSING OR CONDUCTORS<br>NO ELECTRICAL CONNECTION                                   |        | ELECTRIC BELL         |        | FILAMENT LAMP<br>WALL LAMP                                  |        |
| JUNCTION OR CONDUCTORS   |        | ELECTRIC BUZZER       |        | BELL PUSH   |        |
| FIXED RESISTOR   |        | RECTIFIER OR DOIDE    |        | FLOURESCENT LAMP  |        |
| VARIABLE RESISTOR  |        | SWITCH                |        | D.C. MOTOR  |        |
| CONDENSER OR CAPACITOR (FIXED)   |        | ALTERNATING CURRENT   |        | A.C. MOTOR  |        |
| CONDENSER OR CAPACITOR (VARIABLE)  |        | HEAD PHONE            |        | TWO WAY SWITCH  |        |
| WINDING OR DUCTOR, COIL  |        |                       |        | INTERMEDIATE SWITCH   |        |

## SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS (cont'd)

### LIST OF PHYSICAL QUANTITIES AND THEIR SYMBOLS


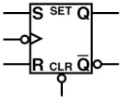
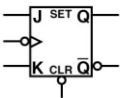
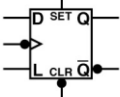
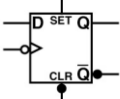
| NAME OF QUANTITY           | SYMBOL   | NAME OF QUANTITY                     | SYMBOL           |
|----------------------------|----------|--------------------------------------|------------------|
| <b>BASE QUANTITIES:</b>    |          | POWER                                | $P$              |
| ELECTRIC CURRENT           | $I$      | EFFICIENCY                           | $\eta$           |
| LENGTH                     | $l$      | PRESSURE                             | $P$              |
| MASS                       | $m$      | SPECIFIC HEAT CAPACITY               | $c$              |
| TEMPERATURE:               |          | HEAT CAPACITY                        | $C$              |
| CELSIUS                    | $\theta$ | WAVELENGTH                           | $\lambda$        |
| KELVIN                     | $T$      | PERIOD                               | $T$              |
| TIME:                      | $t$      | AMPLITUDE                            | $a$              |
|                            |          | FREQUENCY                            | $f$              |
| <b>DERIVED QUANTITIES:</b> |          | ELECTRIC CHARGE                      | $Q$              |
| VOLUME                     | $V$      | ELECTRIC INTENSITY OR FIELD STRENGTH | $E$              |
| AREA                       | $A$      | POTENTIAL AND POTENTIAL DIFFERENCE   | $V$              |
| ANGLE                      | $\theta$ | ELECTRIC CURRENT                     | $I$              |
| DENSITY                    | $\rho$   | ELECTRO-MOTIVE FORCE                 | $E, \mathcal{E}$ |
| RELATIVE DENSITY           | $\rho_r$ | RESISTANCE                           | $R$              |
| FORCE                      | $F$      | WEIGHT (GRAVITATIONAL FORCE)         | $W$              |
| MOMENT OF FORCE OR TORQUE  | $T$      | ACCELERATION DUE TO GRAVITY          | $g$              |
| DISPLACEMENT               | $s, x$   | MASS OF ELECTRON                     | $m_e$            |
| ENERGY                     | $E, W$   | CHARGE OF ELECTRON                   | $e$              |
| WORK                       | $W$      |                                      |                  |
| THERMAL ENERGY             | $E_H$    |                                      |                  |

SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS (cont'd)













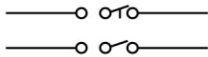
| <b>Analog and Digital Devices</b>   |                       |
|---|-----------------------|
| <i>Symbol</i>   | <i>Devices</i>        |
|    | Crystal               |
|    | Delay Element         |
|    | Tri-State Buffer      |
|    | Integrator            |
|    | Summing Amplifier     |
|  | Operational Amplifier |
|  | Inverter              |
|  | Buffer                |
|  | AND gate              |
|  | OR gate               |
|  | NAND gate             |
|  | NOR gate              |



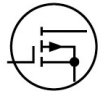
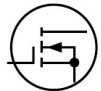
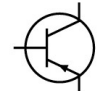

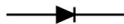


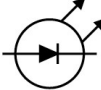
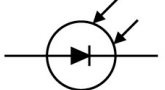
SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS (cont'd)

| Analog and Digital Devices (cont'd)   |                 |
|---|-----------------|
| <i>Symbol</i>   | <i>Devices</i>  |
|    | XNOR            |
|    | RS Flip-flop    |
|    | JK Flip-flop    |
|   | Latch Flip-flop |
|  | D Flip-flop     |

## SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS (cont'd)

| Fundamental Item (cont'd)   |              |
|---|--------------|
| <i>Symbol</i>   | <i>Usage</i> |
|    | Transducer   |
|    | Bell         |
|    | Microphone   |
|    | AC source    |
|   | DC source    |
|  | Speaker      |
|  | Lamp         |
|  | Motor        |
|  | Generator    |
|  | SPST switch  |
|  | SPDT switch  |
|  | DPST switch  |
|  | DPDT         |

**SELECTION OF SOME SYMBOLS USED IN ELECTRICAL DIAGRAMS (cont'd)**

| <b>Semiconductor Devices</b>  |  |
|---|--|
| <i>Symbol</i>   | <i>Devices</i>                           |
|    | MOSFET (P-Type)                          |
|    | MOSFET (N-Type)                          |
|    | BJT (PNP)                                |
|    | BJT (NPN)                                |
|  | Rectifier Diode                          |
|  | Zener Diode                              |
|  | Thyristor (silicon Controlled Rectifier) |
|  | Light emitting diode (LED)               |
|  | Photo-diode                              |

## ◆ RESOURCES

The following is a list of books and other printed material which may be used as resource material for the CXC Electrical and Electronic Technology Option. The list is not exhaustive or prescriptive, but indicates sources which may be appropriate for use by teachers and students.

- |                                      |   |
|--------------------------------------|---|
| Boylestad, R.                        | <i>Essentials of Circuit Analysis</i> . New Jersey: Pearson Prentice Hall, 2004.  |
| Brimicombe M.                        | <i>Electronics</i> . Cheltenham: Nelson Thornes Limited, 2002.  |
| Christopher, S.                      | <i>Electrical Installation for NVQ</i> . Cheltenham: Nelson Thornes Limited, 2004.  |
| Green, D.                            | <i>Higher Electrical Principles</i> (3 <sup>rd</sup> Edition). London: Addison Wesley Longman, 1997.                                      |
| Halls, M.                            | <i>Basic Electricity and Electrons: A complete course for CSEC, Volumes 1 and 2</i> . Kingston: Caribbean Education Publishers Ltd, 2011. |
| Hughes, E.                           | <i>Electrical Technology</i> (7 <sup>th</sup> Edition). London: Addison Wesley Longman, 1995.   |
| Morley A., Hughes, E. and Bolton, W. | <i>Principles of Electricity</i> (5 <sup>th</sup> Edition). London: Addison Wesley Longman, 1994.   |
| Morris, M.                           | <i>Electrical and Electronic Engineering Principles</i> . London: Addison Wesley Longman, 1994.   |
| Mullin, R. and Simmons, P.           | <i>Electrical Wiring, Residential</i> , 17 <sup>th</sup> Edition. Boston: Cengage Learning, 2012.   |
| Schuler, C.                          | <i>Electrical Principles and Applications</i> , 6 <sup>th</sup> Edition. New York: Glencoe McGraw-Hill, 2003.                             |
| Simmons, P.                          | <i>Electrical Grounding and Bonding</i> . Boston: Cengage Learning, 2015.   |
| Smith, R. and Stephen, H.            | <i>Electrical Wiring Industrial</i> , 15 <sup>th</sup> Edition. Boston: Cengage Learning, 2015.   |
| Steinberg, W. and Ford, W.           | <i>Electricity and Electronics – Basic</i> . Chicago: American Technical Society, 1972.   |
| Tocci, R, Widmer, N. and Moss, F.    | <i>Digital Systems: Principles and Application</i> , 10 <sup>th</sup> Edition. New Jersey: Pearson Education, Limited, 2013.              |

## RESOURCES (cont'd)

Thompson, F.G.

*Electrical Installation and Workshop Technology*,  
London: Longman and ELBS, 1992.

Revised CXC Teacher Resource Modules (Electrical).

Local Electrical Code/Regulations.

## ◆ GUIDELINES FOR INTEGRATING THE COMPETENCY BASED EDUCATION TRAINING AND ASSESSMENT APPROACH

### RATIONALE

*School-Based Assessment (SBA) is an integral part of candidates' assessment of the Industrial Technology offerings. It provides an opportunity to individualise a part of the curriculum to meet the needs of the students and facilitate 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. The SBA assists in the development of the critical skills and abilities emphasised by the subject and enhances the validity of the examination on which candidate performance is reported. It 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. In addition, the SBA caters to the multiple intelligences as various teaching and learning strategies are utilised to provide students with the skills needed in everyday life. Through the SBA, students are provided with multiple opportunities and ways to develop and demonstrate knowledge, skills and attitudes.*

*The SBA score is derived from the composite marks of the entries in the School-Based Assessment portfolio which include the related CVQ Units of Competency aligned to the content in the syllabus. The CVQ is an award which represents the achievement of a set of competencies that define the essential (core) work practices of an occupational area consistent with the levels articulated within the Regional Qualifications Framework. It aims at the development of the Ideal Caribbean Worker, seeks to facilitate the movement of skilled certified workers within the CSME, enhances the quality profile and investment attractiveness of the work/labour force of CARICOM states and harmonises TVET systems across the region. The recognition of Unit competencies for the Level 1 CVQ will adhere to the standardised procedures currently operational in schools offering the CVQ programmes.*

### SCHOOL-BASED ASSESSMENT PORTFOLIO

*As part of the School-Based Assessment, candidates will be required to produce a portfolio providing evidence of candidates' progress and learning over the duration of the programmes. The evidence represents the formative and summative assessments of the programmes and are a compilation of all the learning experiences from commencement to the end of the programme. The Portfolio must mirror the key competencies (knowledge, skills, attitudes) required for the labour market and continuing studies.*

*Since the portfolio is an accumulation of the candidates' on-going learning across the course of the two-year programme, it must be started at the commencement of the Industrial Technology Syllabuses. The guidelines provided in this document for selecting appropriate tasks are intended to assist teachers/facilitators and candidates in formulating assignments that are valid for the purpose of the SBA (Appendix II). The guidelines provided for the assessment of the assignments are intended to assist teachers/facilitators in awarding marks that are reliable indicators of the achievement of candidates in the SBA component of the Industrial Technology programmes.*

*For the effective delivery and assessment of this syllabus institutions must ensure the:*

- 1. availability of the resources, through partnerships with industries, firms and other institutions.*
- 2. comprehension of the assessment and certification requirements by all students.*
- 3. readiness of candidate to demonstrate his or her knowledge and skills.*
- 4. high teaching and assessment standards through the Quality Control Procedures.*
- 5. planning and organisation of authentic work experience opportunities which are critical for the development of competencies which are not achievable in the institution.*
- 6. commencement of the portfolios at the beginning of delivery of the programme.*
- 7. the availability of Internal Verifiers\*.*
- 8. the Use of Delivery and Assessment plans. These are indispensable quality control measures and are encouraged to be joint activities between the teachers/facilitators and students. They are developed at the beginning of the delivery of the programmes.*
- 9. monitoring of the completion and maintenance of the portfolio and ensuring the demonstration of competencies in all areas.*
- 10. the maintenance of the internal records for the portfolio.*

*\*An Internal Verifier is an employee of the institution and is responsible for ensuring the quality of the delivery and assessment of all the sections of the syllabus. The Internal Verifier assists the teachers/facilitators in the preparation of the delivery and assessment schedules and monitors the progress of the portfolio development as well as teachers' and students' record keeping. They support and work at ensuring accuracy and consistency in the application of the learning experience to achieve the acceptable levels of competence.*



## **ASSESSMENT**

*Assessments must produce evidence of the range and depth of skills, knowledge and application taught. Types of assessments may include teacher, peer, authentic and self-assessments. The tasks are to be structured to achieve a balance in both the formative (developmental) and summative (judgemental) roles of assessment.*

### **1. Peer/Group Assessment**

*Peer Assessment aims to develop the students' ability to make independent judgements by involving them in evaluating and making decisions on other student's work. It is used as a group work activity involving a variety of assessment methods to develop students' team work and cooperative learning skills.*

### **2. Self-Assessment**

*Self-Assessment aims to supplement teachers' assessment. It is an effective resource in allowing students to make judgements about their own learning and in allowing them to work at their own pace.*

### 3. Authentic Assessment

*Authentic assessment aims at providing a clear relationship with the knowledge, skills and attitudes being developed and the delivery and assessment activities. Authentic tasks are real and mirror realistic training which is transparent and evokes a strong commitment to study.*

## **METHODS OF ASSESSMENT**

*These may include:*

1. *oral and written examinations;*
2. *direct observation;*
3. *interviews;*
4. *demonstration of practical;*
5. *dual training (institution and industry. Effective for practicum);*
6. *learning contracts agreement between the staff and students;*
7. *computer-based assessment (provides flexibility in the time, location or even the questions being answered by students. Effective with multiple – choice questions); and,*
8. *portfolio assessment.*

## **PORTFOLIO ASSESSMENT**

*The portfolio is a student-centred communication approach that adequately reflects the teaching and learning experiences through authentic activities. This assessment provides teachers/facilitators an opportunity to participate in the progress of the students in a very broad context. This may include the observation of the students in exploring, experimenting, taking risks, developing creative solutions and learning to assess or make judgements about their own performances. The portfolio places a high premium on quality. It provides a strong feedback loop of continuous evaluation and improvement in teaching and learning. The portfolio is one of the major quality assurance vehicles for the provision of tangible and intangible evidence, attesting to the quality (relevance, validity, reliability) of educational delivery, assessment and outputs.*

*For the Industrial Technology Syllabus, students will compile a portfolio to provide evidence:*

1. *That clearly shows the students' progress. It is a compilation of all the learning experiences throughout the course and it is assessed by the internal verifier.*
2. *Of the certification requirements (evidence and certificate) for the Caribbean Vocational Qualification (CVQ).*



## **CHARACTERISTICS OF THE PORTFOLIO ASSESSMENT**

*Portfolio Assessment is multi-dimensional in nature and has the following characteristics of quality:*

- 1. It is continuous and ongoing. It provides both formative and summative evaluation opportunities for monitoring the students' progress while they work toward the achievement of the learning outcomes.*
- 2. It uses a wide variety of tangible and intangible evidence (practical and written), reflecting various aspects of the delivery and learning processes.*
- 3. It is reflective; providing students an opportunity to analyse their performance and track the development of their competencies.*
- 4. Assessment results are used to improve the delivery and learning processes.*

## **CHARACTERISTICS OF THE PORTFOLIOS**

***The portfolio is a compilation of students' work based on the teaching and learning experiences and should:***

- 1. reflect the performance outcomes and objectives of the programmes being undertaken (from the beginning of the delivery process to the stage of being competent);*
- 2. focus on the essential competencies which are performance-based;*
- 3. contain samples of work from the commencement of the programme to the end;*
- 4. contain evidence that represent a variety of assessment methods; and,*
- 5. contain the evidence of the students' formative and summative development.*

## **PLANNING THE PORTFOLIO**

*This is a collaborative activity between the teachers/facilitators and students.*

*Steps:*

- 1. Discuss with the students of the importance of the portfolio as a means of monitoring and evaluating their progress.*
- 2. Select the entries for the portfolio. These must reflect the learning outcomes and experiences.*
- 3. Organise the evidence (cover page, table of contents, performance outcomes, artefacts, literary work, evaluation, reflection). Please see Appendix III for the Portfolio Development process.*
- 4. Create an evaluation schedule.*

5. *Maintain and store.*
6. *Reflection on experiences by students. This can take the form of a journal and a learning log.*

### **EVALUATION OF THE PORTFOLIO**

*The teachers/facilitators are encouraged to use a variety of scoring strategies to evaluate the portfolio. The evaluation of the portfolio is a joint activity between the teachers and students. Both are involved in the selection of the criteria that will be used to assess and evaluate the evidence throughout the instructional period (formative) and at the end (summative). The use of a portfolio assessment rubric (cover design, authenticity of evidence, organisation of evidence, completeness, accuracy of information, self-reflective statement) is recommended for the portfolio evaluation.*

### **FEEDBACK**

*Feedback is an integral process in CBETA. High quality feedback consists of the following elements:*

1. *Clear criteria against which to judge the comments.*
2. *Detailed comments which are related to the performance of the students.*
3. *Comments that are geared at improvement.*

### **EVIDENCE FOR THE PORTFOLIO**

*The pieces of evidence MUST depict the candidates' developmental progress in each of the Section from which the evidence is derived. Where possible, it is advised that the Sections of the syllabus be integrated to give evidence of their full coverage.*

*The portfolio pieces must show the integration of CVQ Units where applicable. Teachers are encouraged to use the listing below as a guide to selecting pieces from each Section in the Industrial Technology syllabus:*

### **CORE**

#### **SECTION 1: FUNDAMENALS OF INDUSTRY**

*At least 10 pieces of evidence from Section 1:*

1. *The organisation of a selected construction industry.*
2. *The organisation of a selected manufacturing industry.*
3. *Selection of industry codes and standard.*
4. *A set of safety rules to be followed in a workshop or on the worksite.*

5. *Treatment procedure for each of three injuries which can occur in the workshop/worksite (burns, eye injuries, electric shock, bleeding, falls).*
6. *Student duty roster and a maintenance programme for the workshop/worksite (machines, tools, general upkeep).*
7. *A set of photographs of students demonstrating the use of protective gear and equipment while working in the workshop or on a worksite.*
8. *A report on an accident prepared by the student.*
9. *A small business plan.*

## **SECTION 2: DESIGN PRINCIPLES AND PROCESSES**

*At least three (3) pieces of evidence from Section 2:*

1. *The design principles, elements and processes.*
2. *Sketching of simple designs in related areas.*
3. *Report on the design analysis of a simple manufactured product.*

## **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES**

*At least three (3) pieces of evidence from Section 3:*

1. *Samples of projects prepared in the operating principles of a computer.*
2. *A PowerPoint presentation on modern trends in engineering technologies.*
3. *Two projects or assignments from the use of communication devices.*

## **OPTION A: ELECTRICAL AND ELECTRONIC TECHNOLOGY**

### **SECTION 1: ELECTRICAL PRINCIPLES AND MEASUREMENT**

*At least six (6) pieces of evidence from Section 1 that include:*

1. *labelled diagrams/sketches of the atom and its charges;*
2. *application of Ohm's laws in experimentations and computations;*
3. *practical projects, drawings, task sheets and performance reports, photographs, videos on:*
  - (a) *resistors/lamps connect in series and parallel (codes and industry specifications);*
  - (b) *resistivity and temperature coefficient measurement on electric motor windings;*

- (c) testing and servicing primary and secondary cells (codes and industry standards); and,
- (d) installing, reading and recording ammeter and voltmeter measurements in electric and electronic circuits (applying codes and industry standards).

## **SECTION 2: ELECTRICAL AND ELECTRONIC DRAFTING (MANUAL AND COMPUTER-ASSISTED DESIGN)**

At least six (6) pieces of evidence from Section 2 that include:

1. drawings detailing symbols and notations used in electrical and electronic drafting;
2. drawings showing line and block circuit representations in electrical and electronic circuits;
3. electronic schematic diagrams and electrical installation drawings; and,
4. working drawings from architectural plans.

## **SECTION 3: ELECTRICAL POWER AND MACHINES**

At least five (5) pieces of evidence from Section 3 that include:

1. sources of energy (primary, secondary, renewable) for generating electricity (detailed information);
2. practical projects, drawings, a set of photographs of work in progress, videos of work, performance reports relating to:
  - (a) connecting and operating capacitor start and inductor start single phase a.c. motors;
  - (b) connecting direct on line and reduced voltage a.c. motor starters; and,
  - (c) connecting and operating:
    - (i) autotransformers and double wound transformers; and,
    - (ii) a direct current motor (automobile starter).

## **SECTION 4: ELECTRICAL INSTALLATION**

At least six (6) pieces of evidence from Section 4 that include:

1. electrical Installation materials, uses, codes and regulations;
2. practical projects, drawings, a set of photographs of work in progress, videos of work, performance reports relating to:



- (a) *installing connecting and testing electrical fixtures in lighting and power sub-circuits;*
- (b) *installing electrical equipment to construct main and sub-main circuits in electrical installations;*
- (c) *completed electrical installations;*
- (d) *connecting and operating bell and indicator circuits; and,*
- (e) *four filament lamps and performing voltage measurements for:*
  - (i) *four lamps in series;*
  - (ii) *three lamps in parallel and in series with a fourth lamp;*
  - (iii) *two lamps in parallel and in series with two individual lamp; and,*
  - (iv) *two parallel combinations of two lamps each connected in series.*

## **SECTION 5: FUNDAMENTALS OF ELECTRONICS**

*At least six (6) pieces of evidence from Section 5 that include:*

1. *Practical projects, drawings, a set of photographs of work in progress, videos of work, performance reports relating to:*
  - (a) *identifying, selecting, conducting testing and static measuring of electronic components;*
  - (b) *constructing and operating half-wave, full-wave, centre top, full wave, budge and voltage doubler rectifier circuits;*
  - (c) *operating a two-stage and push-pull power amplifier; and,*
  - (d) *constructing and operating bistable and monstable multivibrators.*

### **PERFORMANCE INDICATORS**

1. *Portfolios.*
2. *Checklist.*
3. *Task Sheet.*
4. *Job Analysis Sheet.*

5. *Performance Criteria Sheet.*
6. *Quality Control Procedures.*
7. *Training and Assessment Plans.*
8. *Internal Verifier Records.*
9. *Internal Competency Records.*
10. *External Verifiers Records.*
11. *Moderation Reports.*

**INTEGRATION OF CVQ UNITS FOR THE SBA**

*The list presented below have been mapped to the content in the syllabus, teachers are encouraged to use this information as they develop activities and projects for the School-Based Assessment Component of the course:*

**CCMEM11002 Level I in Electrical Installation**

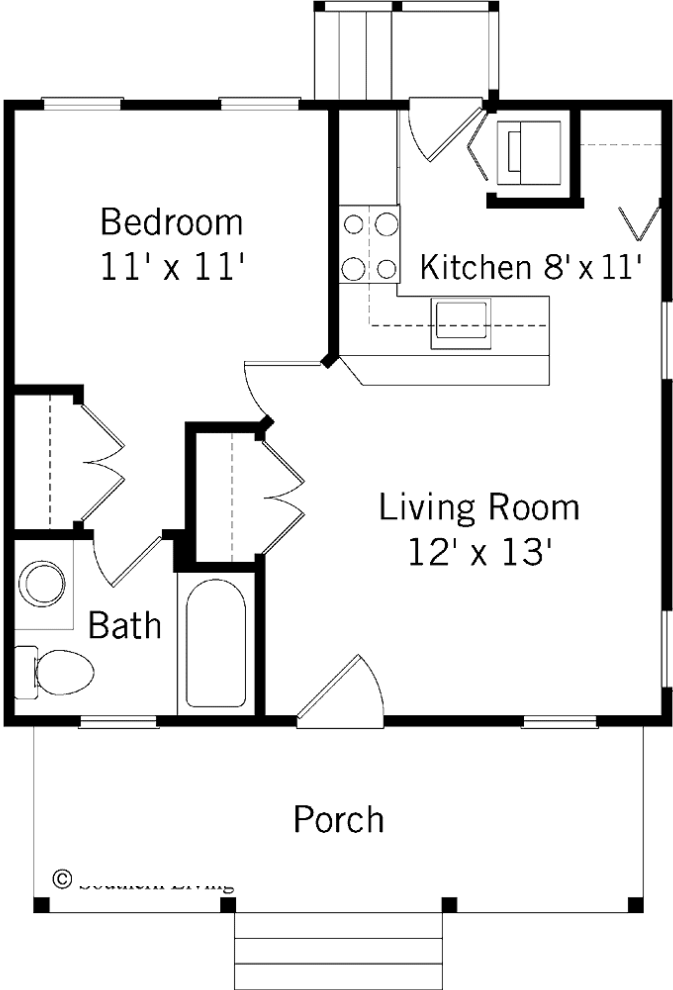
- (a) MEMCOR0141A Follow principles of Occupational Health and Safety (OH&S) in work environment.
- (b) MEMCOR0161A Plan to undertake a routine task.
- (c) MEMCOR0171A Use graduated measuring devices.
- (d) MEMCOR0191A Use hand tools.
- (e) MEMCOR0051A Perform related computations (basic).
- (f) MEMCOR0071A Electrical/Electronic measuring devices.
- (g) MEMCOR0091A Draw and interpret sketches and simple drawings.
- (h) MEMMAH0071A Perform manual handling and lifting.
- (i) MEMINS0071A Prepare for electrical conduits/wiring installation.
- (j) MEMINS0051A Cut, bend and install electrical conduit.
- (k) MEMINS0011A Install, terminate and connect electrical wiring.

**SCHOOL-BASED ASSESSMENT  
EXEMPLAR 1 – ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**ASSESSMENT PLAN**

This School-Based Assessment is aligned to Cut, bend and install electrical conduit (MEMINS0051A) and Install, terminate and connect electrical wiring (MEMINS0011A) in the Electrical Installation, Level I (CCMEM11002) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), Use hand tools (MEMCOR0191A) and Use electrical/electronic measuring devices (MEMCOR0071A) may also be assessed with this assignment.

**CANDIDATE:** \_\_\_\_\_ **ASSESSOR:** \_\_\_\_\_

| <b>Elements (MEMINS0051A)</b><br>1. Plan and prepare for installation.<br>2. Install conduits.<br>3. Inspect and notify of completion of work. | <b>Elements (MEMINS0011A)</b><br>1. Prepare for electrical wiring installation, termination and connection.<br>2. Install electrical wiring.<br>3. Connect electrical wiring. |
|--|---|
|   |   |



| Work Activities   | Assessment Methods   |
|---|--|
| <p>A client has presented you with the floor plan of a small apartment as shown above and require lights, plugs and a main breaker installed. You are required to design the electrical circuit, install electrical conduit and install, terminate and connect all electrical wiring. Two-way switching is required for the kitchen and living room.</p>  | <ol style="list-style-type: none"> <li>1. Practical demonstration.</li> <li>2. Oral questions.</li> <li>3. Process evaluation.</li> <li>4. Finished product evaluation.</li> </ol>   |
| Underpinning Knowledge and Skills   | Range  |
| <ul style="list-style-type: none"> <li>• safety and work procedures</li> <li>• regulations and other relevant codes</li> <li>• standards of quality</li> <li>• installation tools and equipment</li> <li>• materials used in installation</li> <li>• materials used for conduits</li> <li>• fabrication techniques</li> <li>• installation techniques</li> <li>• assembly/disassembly techniques</li> <li>• identify potential workplace hazards</li> <li>• preventative measures</li> <li>• work with electrically operated tools and equipment</li> <li>• read and interpret simple freehand sketches</li> <li>• measure accurately</li> <li>• communicate effectively</li> <li>• bend 90°, and offsets in conduits</li> <li>• cut, thread and ream conduits</li> <li>• install PVC and metal conduits</li> </ul> | <ul style="list-style-type: none"> <li>• marking out</li> <li>• cutting</li> <li>• bending</li> <li>• clamping</li> <li>• drilling/punching</li> <li>• screwing/bolting</li> <li>• cutting mitres</li> <li>• surface mount</li> <li>• flush mount</li> <li>• in PVC conduits up to 32mm</li> <li>• in metal not exceeding 25mm</li> <li>• using mechanical connectors</li> <li>• clamping</li> <li>• pin connection</li> </ul> |
| <p><b>Candidate's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Assessor's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Internal Verifier's Signature:</b> _____ <b>Date:</b> _____</p>  |  |

**SCHOOL-BASED ASSESSMENT**  
**EXEMPLAR 1 – ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**DIMENSIONS OF COMPETENCY**

This School-Based Assessment is aligned to Cut, bend and install electrical conduit (MEMINS0051A) and Install, terminate and connect electrical wiring (MEMINS0011A) in the Electrical Installation, Level I (CCMEM11002) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), use hand Tools (MEMCOR0191A) and Use electrical/electronic measuring devices (MEMCOR0071A) may also be assessed with this assignment.

| WORK ACTIVITY:  |  |
|---|--|
| A client has presented you with the floor plan of a small apartment shown above and require lights, plugs and a main breaker installed. You are required to design the electrical circuit, install electrical conduit and install, terminate and connect all electrical wiring. Two-way switching is required for the kitchen and living room.  |  |
| TASK SKILLS   | TASK MANAGEMENT SKILLS   |
| Candidate has to... <ul style="list-style-type: none"> <li>• Interpret activity</li> <li>• Follow health and safety requirements applicable to work environment</li> <li>• Select and accurately use the necessary tools, equipment</li> <li>• Comply with organisational policies and procedures including Quality Assurance requirements</li> <li>• Carry out correct procedures prior to and during installation processes</li> <li>• Identify and rectify typical faults and problems</li> <li>• Demonstrate safe and effective operational use of tools, plant and equipment</li> <li>• Interactively communicate with others to ensure safe and effective operations</li> </ul> | Prepare/ organise/co-ordinate by... <ul style="list-style-type: none"> <li>• Interpret and plan activity</li> <li>• Select tools, equipment and materials</li> <li>• Apply health and safety procedures</li> <li>• Organise work station</li> <li>• Work in a logical and sequential manner within the required time frame</li> </ul>      |
| CONTINGENCY MANAGEMENT SKILLS   | EMPLOYABILITY/ JOB ROLE/ ENVIRONMENT SKILLS  |
| What if ...? <ul style="list-style-type: none"> <li>• Tools and equipment are insufficient or unavailable</li> <li>• Material estimates are inaccurate</li> <li>• There are delays in sourcing materials</li> </ul>   | The candidate can ... <ul style="list-style-type: none"> <li>• Collect, analyse and organise information</li> <li>• Communicate ideas and information Plan and organise activities</li> <li>• Work with others and in team</li> <li>• Use mathematical ideas and techniques</li> <li>• Solve problems</li> <li>• Use technology</li> </ul> |

Assessor's Signature : \_\_\_\_\_ Date: \_\_\_\_\_

KEY  
 Competent - Range 3 and above  
 Not Yet Competent - below Range 3

**SCHOOL-BASED ASSESSMENT  
 EXEMPLAR 1 – ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**ASSESSOR EVALUATION**

This School-Based Assessment is aligned to Cut, bend and install electrical conduit (MEMINS0051A) and Install, terminate and connect electrical wiring (MEMINS0011A) in the Electrical Installation, Level I (CCMEM11002) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), use hand Tools (MEMCOR0191A) and Use electrical/electronic measuring devices (MEMCOR0071A) may also be assessed with this assignment.

**Institution/ Centre:** \_\_\_\_\_

**Candidate's Name:** \_\_\_\_\_

| ASSESSMENT CRITERIA  | ASSESSOR |   |   |   |   |
|--|----------|---|---|---|---|
|  | 1        | 2 | 3 | 4 | 5 |
| <b>1. OCCUPATIONAL HEALTH AND SAFETY</b>   |          |   |   |   |   |
| Candidate is appropriately attired in Personal Protective gear at all times  |          |   |   |   |   |
| Occupational Health and Safety (OH&S) requirements for tasks and workplace environment adhered to                                |          |   |   |   |   |
| All materials cleaned, stacked and stored for re-use or bundled for removal  |          |   |   |   |   |
| Worksite cleared of debris and unused materials.   |          |   |   |   |   |
| Tools and equipment cleaned, maintained and stored.  |          |   |   |   |   |
| <b>2. PROCESS</b>  |          |   |   |   |   |
| Tools and equipment selected consistent with job requirements  |          |   |   |   |   |
| Tools and equipment checked for serviceability and any faults reported or rectified  |          |   |   |   |   |
| Drawings accurately interpreted  |          |   |   |   |   |
| Conduits are installed in accordance with requirements, without damage or distortion to the surrounding environment or services. |          |   |   |   |   |
| Conduits are terminated and connected in accordance with requirements  |          |   |   |   |   |
| On-going checks of the quality of the work are undertaken in accordance with established procedures                              |          |   |   |   |   |
| Electrical wires are installed according to specifications   |          |   |   |   |   |
| Electrical wiring is connected   |          |   |   |   |   |
| Installations are made to specifications, manufacturers requirements and to safety and industry regulations                      |          |   |   |   |   |
| All cables, wires, conductors and installations are marked/tagged and labelled to specification                                  |          |   |   |   |   |
| All completed installations are tested for compliance  |          |   |   |   |   |
| Work completion is notified in accordance with established procedures  |          |   |   |   |   |
| <b>3. PRODUCT</b>  |          |   |   |   |   |
| Quality Assurance requirements recognized and adhered to in accordance with company's construction operations                    |          |   |   |   |   |
| Final inspections are undertaken to ensure the installed conduits conforms to requirements                                       |          |   |   |   |   |
| All conduit, and wiring are fixed to specifications  |          |   |   |   |   |
| All completed installations are tested for compliance  |          |   |   |   |   |
| Terminations/connections are made to specifications manufacturers' requirements and to safety and industry requirements          |          |   |   |   |   |
| All cables, wires, conductors and connections etc. are marked/tagged and labelled to specification                               |          |   |   |   |   |

**Comment/ Feedback:**

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**Rating Scale:**

1. Cannot perform this task.
2. Can perform this task with **constant** supervision and **considerable** assistance.
3. Can perform this task with **constant** supervision and **some** assistance.
4. Can perform this task satisfactorily with periodic supervision.
5. Can perform this task satisfactorily with little or no supervision.

**Assessor's Signature** : \_\_\_\_\_ **Date:** \_\_\_\_\_

**Candidate's Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

### Portfolio Development Guidelines

A portfolio is an organised convenient means of collection and presentation of materials which records and verifies a candidate's learning achievements and relates them to the depth and breadth of work required by each unit of the occupational standards. The depth and breadth of work should include a diversity of exhibits which reflects the following **criteria**:

- Writing, Reading and Comprehension Skills
- Critical Thinking and Problem Solving Skills
- Technology Skills
- Practical Skills
- Teamwork Skills

The outline of the portfolio should include information under the following headings:

- Cover Page
- Title Page
- Table of Contents
- Introduction
- Supporting Evidence (Depth and Breadth of Work)
- Self Assessment/Reflection

#### **Details of EACH Heading**

##### **Cover Page**

- Name of School
- Occupational Area CVQ Level 1
- Assessors Name
- Candidate's Name
- Year

##### **Title Page**

- Caribbean Vocational Qualification
- CVQ Level 1
- Occupational Area
- Year

##### **Table of Contents**

- By units
- Number pages

##### **Introduction**

- Portfolio of candidate to include personal data, background information on education/training experiences and expectations.

## **Supporting Evidence**

Provides information on the key formative and summative assignments/projects undertaken by the candidates to achieve the performance criteria in each unit on the Occupational Standards. All evidence supplied by the candidate should be reviewed by the assessor using the **criteria given**. **Evidence must be signed and dated on the date of the review by the assessor.**

### **Suggestions for supporting evidence:**

- Written Assignment
- Oral Questions (checklist format)
- Projects
- Work Samples
- Research Assignments
- Fieldtrip reports
- Summative evaluation of practical work
- Digital photographs of candidates performing critical tasks

### **Self-Assessment/Reflections**

Allows candidates to rate their performance against the requirements of the relevant unit/s of competency and allows candidates to reflect in writing whether their expectations have been achieved in the particular occupational area.

## **Summary**

*Each candidate* in every occupational area *must* prepare a portfolio which will showcase:

- Growth and development of the candidate during the two year period.

Portfolios *must* be kept for evaluation by the Internal Verifier, External Verifier and the Quality Assurance auditor of the Caribbean Examinations Council.

◆ **INDUSTRIAL TECHNOLOGY SYLLABUS**

**OPTION B: MECHANICAL ENGINEERING TECHNOLOGY**

## **OPTION B: MECHANICAL ENGINEERING TECHNOLOGY**

### **SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES**

#### **GENERAL OBJECTIVES**

*On completion of this Section, students should:*

- 1. develop an understanding of the fundamental scientific principles associated with engineering materials, tools and processes;*
- 2. understand the basic scientific principles governing metallurgy and materials engineering;*
- 3. develop a working knowledge of the selection, use and maintenance of materials and hand tools;*
- 4. demonstrate the use of materials, hand tools and processes in the efficient production of goods and services; and,*
- 5. appreciate the importance of engineering codes and regulations.*

#### **SPECIFIC OBJECTIVES**

*The students should be able to:*

- 1. distinguish among the methods used in the production of basic engineering materials and their uses;*
- 2. explain the factors to consider in selecting engineering materials;*
- 3. describe the functions of engineering hand tools;*
- 4. describe the response of solid materials to different type of forces applied to them;*
- 5. discuss the basic heat treatment methods for metals;*
- 6. perform basic heat treatment to ferrous and non-ferrous materials for specific purposes;*
- 7. perform bench work operations; and,*
- 8. discuss the operations of cutting tools.*



## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

### CONTENT

#### 1. *Methods used in the production of basic engineering materials and their uses*

- (a) Ferrous materials *and their alloys*:
  - (i) iron and steel;
  - (ii) sources;
  - (iii) production processes ;
  - (iv) diagrams and sketches of the production processes;
  - (v) properties; and,
  - (vi) uses.
  
- (b) Non-ferrous materials and their alloys:
  - (i) aluminium;
  - (ii) copper;
  - (iii) lead;
  - (iv) zinc; and,
  - (v) brass:
    - sources;
    - production processes;
    - sketches and diagrams of the production processes;
    - properties; and,
    - uses.
  
- (c) Plastics:
  - (i) thermoplastics;
  - (ii) polymers; and,

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

- (iii) co-polymers;
  - sources;
  - production processes;
  - sketch and diagrams of the production processes;
  - properties of various plastics; and,
  - uses.

### 2. **Engineering materials**

- (a) *The function of the finished product.*
- (b) *The design of the product.*
- (c) *Structural and mechanical properties of the material.*
- (d) *Cost of the material.*
- (e) *Wear resistance.*
- (f) *Corrosion resistance.*

### 3. **Engineering hand tools for bench work**

- (a) *Marking out.*
- (b) *Measurement.*
- (c) *Inspection and holding.*
- (d) *Labelled diagrams and sketches of hand tools.*

### 4. **Forces applied to solid materials**

- (a) *Response of engineering materials to:*
  - (i) *tension compression;*
  - (ii) *types of stresses;*
    - *shear stress; and,*
    - *normal stress;*

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

- (iii) strain;
- (iv) Young's Modulus; and,
- (v) modulus of rigidity.

### 5. Heat treatment methods

- (a) Concepts of heat production and transfer:
  - (i) Law of Thermodynamics (Zeroth and 1<sup>st</sup> Laws);
  - (ii) conduction;
  - (iii) convection; and,
  - (iv) radiation.
- (b) Heat treatment processes:
  - (i) annealing;
  - (ii) normalising;
  - (iii) case hardening; and,
  - (iv) tempering.
- (c) Functions of each process.
- (d) Sources of heat:
  - (i) ovens;
  - (ii) forges; and,
  - (iii) naked flames.
- (e) Cooling materials:
  - (i) water;
  - (ii) oil; and,
  - (iii) sand.

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

- (f) *The iron-carbon diagram.*
- (g) *The iron-carbon equilibrium.*

### 6. Heat treatment for ferrous and non-ferrous materials

- (a) *Safety guidelines, procedures and standards for annealing:*
  - (i) *ferrous material - iron, steel:*
    - *equipment;*
    - *temperature; and,*
    - *cooling materials.*
  - (ii) *non-ferrous materials - copper, aluminium, brass:*
    - *equipment;*
    - *temperature; and,*
    - *cooling materials.*
- (b) *Management of the stages of the heat treatment:*
  - (i) *recovery;*
  - (ii) *crystallisation; and,*
  - (iii) *grain growth.*

### 7. Bench work operations

- (a) *Safety guidelines, procedures and standards for simple projects using: hand tools and holding devices:*
  - (i) *vice;*
  - (ii) *files;*
  - (iii) *chisels; and,*
  - (iv) *hacksaws.*

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

(b) *Safety guidelines, procedures and standards for using hand and power saws to cut thin wall tubing and cut corners on light and heavy gauge metals:*

(i) *Chiselling:*

- *chip metal;*
- *Shear metal in vice; and,*
- *cut a groove.*

(ii) *Filling:*

- *file flat, concave and convex surfaces;*
- *cross file metal, draw file metal;*
- *test surface for flatness and squareness; and,*
- *polish metal using abrasives and finishing materials.*

(iii) *Drilling:*

- *preparing metal for drilling;*
- *drilling holes in metal;*
- *drilling pilot hole; and,*
- *countersinking holes.*

(iv) *Screw cutting:*

- *cutting external threads with dies;*
- *cutting pipe thread;*
- *cutting internal threads with taps; and,*
- *checking threads.*

### 8. **Cutting tools and tools maintenance**

(a) *Classification of cutting tools:*

(i) *Single point:*

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

- turning;
  - shaping; and,
  - boring tools.
- (ii) Double point:
- drills.
- (iii) Multi-point:
- milling cutters; and,
  - gear shaping cutters.
- (b) Features of cutting tools:
- (i) single point;
  - (ii) double point; and,
  - (iii) multi-point cutting tools.
- (c) Factors that affect the life of a cutting tool:
- (i) rake and clearance angles;
  - (ii) cutting speed;
  - (iii) depth of cut;
  - (iv) chip thickness;
  - (v) tool geometry; and,
  - (vi) material used for the cutting fluid (coolants and lubricants).
- (d) Diagram showing the theory of metal cutting:
- (i) forces acting at a tool point; and,
  - (ii) treatment of forces at the tool point.

## SECTION 1: MATERIALS, HAND TOOLS AND PROCESSES (cont'd)

- (e) Rake and clearance angles for cutting different materials with different cutting tools:
  - (i) ease of chip flow;
  - (ii) avoidance of rubbing of the tool with the machined surface;
  - (iii) chip formation;
  - (iv) techniques used in sharpening tools to control chips; and,
  - (v) Chip removal methods.
  
- (f) Types of cutting fluid and their uses:
  - (i) straight oil;
  - (ii) soluble oil; and,
  - (iii) synthetic oil:
    - Fluid pressure measurement and calculation.
  
- (g) Safety guidelines, procedures and standards for sharpening machine tools:
  - (i) sharpening cutting tools by using abrasive stones;
  - (ii) grinding lathe tools to required angles;
  - (iii) sharpening drills; and,
  - (iv) using coolants and lubricants.

## SECTION 2: GRAPHIC COMMUNICATION AND DESIGN

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *develop skills in preparing, reading and interpreting blueprint and design to engineering standards;*
2. *understand the principles of design in the identification and solutions of engineering problems; and,*
3. *develop proficiency in the application of computer-aided design/computer-aided manufacturing.*

### SPECIFIC OBJECTIVES

The students should be able to:

1. compare the basic methods of graphic communication used in engineering;
2. prepare orthographic drawings;
3. discuss the different types of pictorial drawings;
4. prepare engineering drawings;
5. read and interpret engineering drawings;
6. assess the design of basic engineering components; and,
7. design simple engineering products.

### CONTENT

#### 1. **Basic methods of graphic communication used in engineering**

(a) *Methods of graphic communication:*

(i) *pictures;*

(ii) *diagrams;*

(iii) *drawings - pictorial, orthographic, working drawing, assembly drawing;*

(iv) *geometrical drawing - surface developments, interpenetration of solids, projection of points, lines and planes; and,*

(v) *uses of models, notes and notation.*



## SECTION 2: GRAPHIC COMMUNICATION AND DESIGN (cont'd)

- (b) *Methods of preparing graphic communication:*
  - (i) *manual and Computer-Assisted Drawing (CAD);*
  - (ii) *functions of each method;*
  - (iii) *advantages and disadvantages of each method; and,*
  - (iv) *preparing samples using each method (photographs, sketches, drawings).*

### 2. **Orthographic drawings**

*AD and manual drawing principles for:*

- (a) *first angle projection; and,*
- (b) *third angle projection.*

### 3. **Pictorial drawings**

- (a) *Types:*
  - (i) *isometric;*
  - (ii) *oblique: cavalier; and,*
  - (iii) *perspective.*
- (b) *Functions of each type of pictorial drawing.*
- (c) *Drawing principles for each type of pictorial drawing.*
- (d) *Drawings and sketches using CAD and manual method:*
  - (i) *2-D CAD drawing; and,*
  - (ii) *3-D CAD drawing.*
- (e) *Applying the basic principles of CAM:*
  - (i) *principles of cutting tool axes;*
  - (ii) *identifying Z and X axis;*
  - (iii) *movement in the Z and X axes; and,*
  - (iv) *using absolute coordinates.*

## SECTION 2: GRAPHIC COMMUNICATION AND DESIGN (cont'd)

### 4. Engineering drawings

- (a) Types:
  - (i) multi-view;
  - (ii) sectional;
  - (iii) assembly; and,
  - (iv) auxiliary drawings.
- (b) Preparing multi view drawings of nuts, bolts, pins cam, gear and spring.
- (c) Preparing simple engineering geometric drawings:
  - (i) geometrical solids - prisms, pyramid;
  - (ii) surface development - prism, cones, cylinders, square pyramid inter-penetration;
  - (iii) lettering and dimensioning;
  - (iv) title block;
  - (v) notes and notation; and,
  - (vi) tolerance.

### 5. Reading and interpreting engineering drawings

Using samples of engineering drawing to:

- (a) explain ISO drawing standards;
- (b) read and convert measurements (imperial and metric);
- (c) read and interpret dimensions (size, location, hole);
- (d) read and interpret scales;
- (e) read and interpret drawing symbols - diameter, centreline, key, centre to centre, radius, inside diameter, outside diameter, countersink, counter bore, tapped hole, screw thread, datum points, tolerances (location and positioning);
- (f) views;

## SECTION 2: GRAPHIC COMMUNICATION AND DESIGN (cont'd)

- (g) *line types;*
- (h) *read and interpret notes and notation; and,*
- (i) *read and interpret parts list.*

### 6. **Engineering components**

- (a) Using the principles of design to assess the following features of selected machines, tools and components in the metalworking workshop/laboratory:
  - (i) construction;
  - (ii) assembly;
  - (iii) functional features and mechanism of hand tools and machines (relation of design to material utility, study of the principles of simple mechanisms); and,
  - (iv) functions of principal machine tool parts.
- (b) *Preparing the report of the assessment:*
  - (i) *introduction;*
  - (ii) *methodology;*
  - (iii) *findings;*
  - (iv) *conclusions; and,*
  - (v) *recommendations.*

### 7. **Engineering products**

- (a) Designing simple industry or household products or machine devices to be manufactured in the workshop.
- (b) Evaluating the design:
  - (i) function;
  - (ii) strength;
  - (iii) material;
  - (iv) economy; and,
  - (v) aesthetics.



## SECTION 3: PRODUCTION ENGINEERING

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. demonstrate a working knowledge of the operating principles of production tools, equipment and manufacturing processes;
2. develop skills in selecting the appropriate materials, tools and equipment for the production of goods and services;
3. develop proficiency in the use of calculations and the design process to analyse and solve problems relating to production engineering processes;
4. value the principles of quality and standards in the production of goods and services; and,
5. appreciate occupational health and safety standards.

### SPECIFIC OBJECTIVES

The students should be able to:

1. apply safe working practices, workshop and equipment maintenance techniques;
2. explain the processes used to shape metals;
3. differentiate between sand casting and die-casting techniques;
4. explain the features and operating principles of simple machines;
5. explain the functions of special parts, accessories and processes essential to the effective operation of productive engineering machines; and,
6. demonstrate competencies in a range of production engineering projects.

### CONTENT

1. **Safe work practices, workshop and equipment maintenance techniques**
  - (a) OHS standards.
  - (b) Safety rules for using hand tools and equipment.
  - (c) Predictive and preventative maintenance of hand tools and equipment.

## **SECTION 3: PRODUCTION ENGINEERING (cont'd)**

### **2. Processes used to shape metals**

- (a) Processes:
  - (i) casting;
  - (ii) forging;
  - (iii) rolling;
  - (iv) extrusion;
  - (v) sintering;
  - (vi) metal machining; and,
  - (vii) metal fabrication.
- (b) Functions of each process.
- (c) Equipment, tools and materials used in each process.
- (d) Sketches/diagrams depicting each process.
- (e) Safety guidelines and procedures applicable to each process.

### **3. Sand casting and die-casting techniques**

- (a) Definitions:
  - (i) sand casting; and,
  - (ii) die-casting.
- (b) Differences:
  - (i) operating principles;
  - (ii) equipment, materials and tools used;
  - (iii) temperature control and testing instruments;
  - (iv) advantages and disadvantages of each method;
  - (v) nature of the casting defects and their solutions;
  - (vi) labelled diagrams of sand casting and die-casting processes; and,
  - (vii) safety procedures in each technique.

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

#### 4. Features and operating principles of simple machines:

- (a) Types:
- (i) levers;
  - (ii) pulleys; and,
  - (iii) wheel and axel.
- (b) Operating principles:
- (i) levers;
  - (ii) pulleys; and,
  - (iii) wheel and axel.

#### 5. Functions of special parts, accessories and processes

- (a) Functions of different types of keys used in couplings:
- (i) square;
  - (ii) gib-headed;
  - (iii) tapered; and,
  - (iv) woodruff.
- (b) Types of couplings commonly used to transmit power from one machine to another:
- (i) rigid;
  - (ii) flexible; and,
  - (iii) gears.
- (c) Types of commonly used seals:
- (i) mechanical; and,
  - (ii) gasket/synthetic;
- (d) Features and functions of each type of seals.

## SECTION 3: PRODUCTION ENGINEERING (cont'd)

### 6. Production of engineering projects

#### 6.1 Performing Sheet Metal operations:

- (a) Layout and develop pattern for sheet metal work:
  - (i) safety guidelines, procedures and standards;
  - (ii) principles of pattern development for making simple templates:
    - radial line, parallel lines, simple triangulation;
  - (iii) layout from a datum and centre line;
  - (iv) layout and develop patterns for cylindrical and conical work;
  - (v) layout rectangular ducts;
  - (vi) layout pattern for transitional pieces; and,
  - (vii) cutting templates;
    - template designs;
    - safety procedures; and,
    - waste control strategies.
- (b) *Safety guidelines, procedures and standards for cutting sheet metal:*
  - (i) cutting sheet metal using hand shares or snips and foot-operated shears;
  - (ii) cutting a notch or corner;
  - (iii) punching holes in sheet metal;
  - (iv) cutting metal with a saw; and,
  - (v) cutting irregular shapes.
- (c) Bending and forming sheet metal.

*Safety guidelines, procedures and standards for bending and forming sheet metal by hand and on a brake:*

- (i) making angular bends;
- (ii) bending metal on the bar folder;

## SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (iii) forming bends with bending machine;
  - (iv) forming cylinders and cones on the slip-roll forming machine; and,
  - (v) forming metal using stakes.
- (d) Sheet Metal Fabrication.

Safety guidelines, procedures and standards for fabricating sheet metals:

- (i) designing and producing simple industry and household products in rectangular, cylindrical and conical shapes;
- (ii) calculating allowance for making seams and wired edges, length of material for edge;
- (iii) making seams and wired edge seams – lap, riveted, soldered, grooved, cap strip, standing, elbow, corner double;
- (iv) making bottom seams – lap, insert, single, double bottom; and,
- (v) fastening sheet metal using:
  - soldering (seams or joints);
  - riveting (use of mechanical fasteners: bolts, nuts, pins, rivets);
  - joining (spot welding); and,
  - polishing, colouring and protection of the product.

### 6.2 Soldering and de-soldering operations

*Safety guidelines, procedures and standards for soldering and de-soldering:*

- (a) Soft soldering:
  - (i) definitions and uses of soft soldering;
  - (ii) materials used;
  - (iii) lead/tin equilibrium diagrams;
  - (iv) melting range; and,
  - (v) fluxes (types and operations).



## SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (b) Performing hard soldering operations:

Safety guidelines, procedures and standards for silver soldering.

### 6.3 Hard soldering operations

*Safety guidelines, procedures and standards for hard soldering:*

- (a) *Brazing:*

- (i) definition and uses;
- (ii) filler metal;
- (iii) flux; and,
- (iv) application of the oxyacetylene flames.

- (b) Silver soldering:

- (i) definition and uses;
- (ii) filler metal;
- (iii) flux; and,
- (iv) application of the oxyacetylene flames.

### 6.4 Welding operations

*Safety guidelines, equipment, procedures and standards for welding operations*

- (a) Types of welding operations

- (i) fusion welding:
  - oxy-fuel gas welding;
  - gas metal arc welding;
  - gas tungsten arc welding;
  - resistance welding;
  - electric arc welding; and,
  - laser welding.

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (ii) solid state welding;
  - (iii) forge welding; and,
  - (iv) *resistance welding*.
- (b) Uses of each type of welding.
- (c) Materials, equipment, tools and accessories used in each type of welding.
- (d) Labelled diagrams.
- (e) Preparing for welding operations:
- (i) project designs, specifications and safety guidelines;
  - (ii) preparing materials;
  - (iii) measuring and related calculations;
  - (iv) cutting equipment and accessories;
  - (v) selecting welding process;
  - (vi) setting up equipment; and,
  - (vii) testing and adjusting parameters.
- (f) Different kinds of welding joints
- Safety guidelines, *specification and standards for:*
- (i) lap;
  - (ii) tee; and,
  - (iii) butt.
- (g) Different kinds of welding joints:
- (i) flat/horizontal;
  - (ii) vertical; and,
  - (iii) overhead.

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (h) Different types of welding techniques:
  - (i) *rightward; and,*
  - (ii) *leftward.*
- (i) Performing gas cutting and welding operations:
  - (i) project designs, specifications and safety guidelines;
  - (ii) materials - mild steel plate, plain carbon steel, aluminium and stainless steel;
  - (iii) oxy-fuel gas cutting;
  - (iv) plasma cutting; and,
  - (v) welding operations:
    - gas;
    - metal arc;
    - tungsten arc;
    - shielded metal arc; and,
    - resistance welding.
- (j) Preparing for electric arc welding:
  - (i) safety guidelines, procedures and standards;
  - (ii) materials:
    - mild steel plates of various thicknesses; and,
    - electrodes.
  - (iii) procedures for preparing plates;
  - (iv) practice in laying of weld bead and striking of the arc;
  - (v) performing electric arc welding using mild steel plate of various thicknesses;
    - project designs for welding joints (square groove butt, VEE groove butt, lap joints, TEE and corner joints in flat, vertical and horizontal positions); and,
    - scratching and tapping techniques.

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (k) Welding defects:
  - (i) identifying welding defects;
  - (ii) hot cracks;
  - (iii) cold cracks;
  - (iv) under cut;
  - (v) distortion;
  - (vi) lack of fusion;
  - (vii) porosity;
  - (viii) undercut;
  - (ix) lack of penetration;
  - (x) out of alignment;
  - (xi) excessive spatter;
  - (xii) weld decay;
  - (xiii) craters;
  - (xiv) causes of welding defects; and,
  - (xv) treating welding defects.

#### 6.5 Metrology

- (a) Measuring and computing:
  - (i) reading and measuring with rules, callipers, micrometres, vernier tools and surface plate;
  - (ii) calculating machine speed and feed; and,
  - (iii) calculating gear ratio.

## SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (b) Using testing, layout and measurement tools:
- (i) checking for flatness and squareness in work pieces;
  - (ii) measuring round and hollow stock;
  - (iii) measuring and laying out from datum;
  - (iv) measuring angles;
  - (v) preparing and applying layout fluids;
  - (vi) laying out flat work;
  - (vii) finding centre of round stock;
  - (viii) laying out round stock; and,
  - (ix) inspecting work for accuracy of dimension and form.

### 6.6 Machining operations

- (a) Power Saws
- (i) *Safety guidelines, procedures and standards for:*
    - cross-cut saws;
    - chop saws; and,
    - band saws.
  - (ii) Operations:
    - select and set speeds and feeds;
    - select materials (mild steel, cast iron) for sawing operations;
    - remove and replace saw blades;
    - measure and cut materials (angular and square cutting);
    - saw to scribed lines by using a metal band saw; and,
    - cut and weld band-saw blades for contour sawing.

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

(b) Drill Presses

(i) *Safety guidelines, procedures and standards for:*

- bench drill presses;
- radial arm drill presses; and,
- pedestal drill presses.

(ii) Setting machine controls:

- set up drill press vice;
- set up work in vice;
- set up work with different clamps and fittings;
- calculate and select machine speeds and feeds;
- determine reamer allowances for reaming after drilling; and,
- select drill bits.

(iii) Operations:

- ream;
- counter bore;
- counter sink;
- drill;
- centre drill;
- spot face; and,
- fit and remove tapered shank drills.

(c) Operating Grinding Machines:

(i) safety guidelines, procedures and standards for grinding machines:

- inspect grinding wheels;
- balance grinding wheels;

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- true grinding wheels; and,
  - dress grinding wheels.
  - (ii) attach and align work pieces for grinding;
  - (iii) select and set feeds and speeds for grinding machines;
  - (iv) grind parallel flat surfaces;
  - (v) grind to a shoulder; and,
  - (vi) grind a taper.
- (d) Centre lathe
- (i) Safety guidelines, procedures and standards for turning with chucks and between centres:
    - locate and drill centre hole on stock;
    - select tool bits – roughing, finishing, parting, screw cutting, recessing;
    - select materials – high carbon steel, high speed steel, satellite, carbide, ceramic;
    - set tool bit for turning – rakes and clearance of bits, angles of tool bits in the lathe, lathe dog-types and uses, driving plates;
    - check centres for alignment – live, dead, half and rotating centres;
    - mount work between centres;
    - calculate and set machine for correct speed and feed – cutting speed for different materials and spindle speeds;
    - turn between centres – rough and finished cuts; and,
    - use appropriate coolants/cutting fluids for different materials.
  - (ii) Mount and dismount various chucks – 3-jaw, universal, 4-jaw independent, collet, multi-size:
    - mount work in various chucks;
    - face work in chuck;
    - calculate tapers;

### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- cut taper using compound slide – using compound slide, taper attachment, offset centre and form tool;
  - cut a shoulder and or recess on work in the chuck;
  - turn work held in the chuck supported by tailstock; and,
  - part off work.
- (iii) Drilling:
- drill holes with tapered shank drill in tailstock – parts of a drill, size of pilot holes;
  - drill with straight shank bit held in a Jacob's chuck, drill in tailstock – drilling, reaming, counter-sinking, counter boring; and,
  - ream with reamer held in tailstock.
- (iv) Cut threads:
- select gear train - use of handbook or tables, comparison of angles and forms, calculate simple and compound gear train;
  - screw thread terms and definition (major and minor diameters, pitch, lead, crest;
  - cut external threads using stock and die (metric); and,
  - cut internal threads using tap.
- (v) Special operations:
- identify the face plate to be used for work piece – face plate, angle plate, clamps and fixtures;
  - fit and cut work on a mandrel – compound rest- adjustment. Kinds of mandrels – solid and expansion;
  - turn work piece on mandrel – Counter boring tools, tools post grinder;
  - set and turn work with fixed and travelling steadies – steady and follower rest, parts and uses;
  - knurl work; and,
  - counter bore work in lathe using a drill (blind holes).



### SECTION 3: PRODUCTION ENGINEERING (cont'd)

- (e) Milling machine:
- (i) safety guidelines, procedures and standards for operating vertical and horizontal milling machines operations;
  - (ii) select cutter for simple operations – plain and end mill cutters, arbours;
  - (iii) calculate and select cutting speed for size of cutter and material of work piece;
  - (iv) calculate and select rates of feed;
  - (v) mount and dismount cutters on spindle;
  - (vi) mount work in vice and check for parallelism – use of dial indicator to test parallelism;
  - (vii) adjust table for travel and depth of cut – use of calibrated dial;
  - (viii) choose correct coolants and cutting fluids for different materials;
  - (ix) surface-mill work on horizontal /vertical milling machines – up-cut (conventional) and down-cut (climb) milling); and,
  - (x) calculate simple indexing – dividing head principle.
- (f) *Surface grinder*
- (i) safety guidelines, procedures and standards for performing grinding operations:
    - working devices (chucks, grinding wheels);
    - calculate speeds and feeds; and,
    - select appropriate coolant.

## SECTION 4: ART METAL WORK

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. demonstrate a working knowledge of decorative metal craft through the production of basic household and commercial products; and,
2. appreciate the principles of quality and standards in the production of engineering goods and services.

### SPECIFIC OBJECTIVES

The students should be able to:

1. explain the basic processes used in art metal work;
2. use different kinds of ornamental metal to prepare basic household and commercial products; and,
3. apply different finishing and decoration techniques using prescribed guidelines and standards.

### CONTENT

#### 1. Processes used in art metal work

##### (a) Shaping metals

*Safety guidelines, procedures and standards for shaping metals:*

- bending;
- drawing down;
- upsetting;
- punching and drifting;
- fullering;
- flattening;
- swaging;
- twisting;
- cutting; and,
- scrolling.

## SECTION 4: ART METAL WORK (cont'd)

(b) *Finishing*

*Safety guidelines, procedures and standards for:*

- *enamelling;*
- *etching; and,*
- *hammering.*

(c) *Uses and operational procedures of each process.*

(d) *Materials, tools and equipment uses in each process.*

### 2. **Ornamental metal for basic household and commercial products**

(a) *Safety guidelines, procedures and standards in using:*

- (i) *aluminium;*
- (ii) *brass;*
- (iii) *copper;*
- (iv) *gold; and,*
- (v) *silver.*

(b) *Processes:*

- (i) *rolling;*
- (ii) *hollowing; and,*
- (iii) *raising.*

### 3. **Finishing and decoration techniques**

*Decoration techniques:*

- (a) *enamelling;*
- (b) *etching; and,*
- (c) *hammering.*

## ◆ WORKSHOP/LABORATORY FACILITIES

Recommended equipment for a class of 16.

This list provided is for a general Mechanical Engineering laboratory for the syllabus sections identified.

### **Machine Shop**

|   |   |
|---|---|
| Lathe 9"/255mm swing, quick change gear box 36"/900mm bed pedestal base (desirable) | 1 |
| Lathe 12"/300mm swing, quick change gear box, 48"/1200mm pedestal base (desirable)  | 1 |

### **Recommended Accessories**

|  |        |
|--|--------|
| Draw in Collet Chuck assembly (for 9"/225mm swing lathe)   | 2 sets |
| Independent four jaw and universal chucks  | 2 sets |
| (for 9"/225mm swing lathe) Sizes 6"/150mm  | 1 set  |
| (for 12"/300mm swing lathe) Size 8"/220mm  |        |
| Universal 3-jaw chuck Sizes 6"/150mm   | 2 sets |
| (for 9"/225mm swing lathe) Sizes 8"/200mm  | 1 set  |
| (for 12"/300mm swing lathe)  |        |
| Lathe Dogs with cranked on straight tails to suit driving plates provided with Lathes - 1/2"/13mm, 3/4"/16mm, 1"/25mm, 1 1/2"/30mm |        |
| Jacob's Chuck 0" – 1/2"/13mm complete with taper shank and sleeve to fit tailstock of both lathes                                  | 1      |
| Tool holders – left, right and straight  | 2 sets |
| Fixed steady   | 2      |
| Travelling steady  | 2      |
| Knurling Tool, with coarse, medium and fine knurls (straight and diagonal)   | 2      |
| Driving plates   | 2      |
| Boring Bar with holder   | 2      |
| Rotating centre with taper shank and sleeve  | 2      |
| Parting Tool with holder   | 2      |
| Threading tool   | 2      |
| Metric Screw pitch gauge   | 1 set  |
| Prepared tool bits   | 2 sets |
| Tool Blanks to fit tool holders  | 10     |
| pieces   |        |
| Live centres   | 2      |
| Dead Centres   | 4      |
| Face plate 8"/200mm  | 2      |

### Additional Tools

|  |        |
|--|--------|
| Callipers - Outside 6"/150mm           | 3      |
| Inside 6"/150mm                        | 3      |
| Hermaphrodite 6"/150mm                 | 3      |
| Rule Depth Gauge                       | 1      |
| Micrometers – 0 – 25mm                 | 3      |
| Vernier Calliper – 15cm                | 1      |
| Surface Gauge with fine adjustment     | 3      |
| Vee blocks with clamps                 | 2 sets |
| Dial Test Indicator with magnetic base | 2      |
| Engineer's Square 16cm                 | 3      |
| Dividers 15cm                          | 2      |
| Combination/Centre drill Nos. 1-5      | 2 sets |
| Lead Hammer/mallet                     | 3      |
| Precision Spirit Level                 | 1      |
| Rules, steel, 15cm                     | 8      |
| 30 cm                                  | 8      |

### Milling Machine

|   |   |
|---|---|
| Universal model with longitudinal transverse and vertical feed, 1"/25mm arbor with collars and spherical nut, guard for cutters, micrometre collars graduated in metric measure | 1 |
|---|---|

### Recommended Accessories

|   |       |
|---|-------|
| Assortment of cutters for horizontal and vertical milling | 1 set |
| Machine vice (6" jaw)                                     | 1     |

### Drill Press

|   |                      |
|---|----------------------|
| Drill press 15"/375mm floor type, 0-1/2"/13mm Jacob's chuck with tapered shank, drill drift | 1 set                |
| Drill press vice – 4"/100mm jaw   | 1                    |
| G Clamps – 4"/100mm   | 4                    |
| G Clamps – 6"/150mm   | 2                    |
| Parallel Clamps   | 2                    |
| Countersink drills  | 2 sets               |
| Centre Punches  | 10                   |
| Scribers  | 16                   |
| Drills (metric sizes) 3 – 13mm in steps of 0.2mm  | 2 sets               |
| 13 – 20mm in steps of 0.5mm   | 1 set<br>(desirable) |

## Grinders

|  |    |
|--|----|
| Grinders, bench type mounted on pedestal with eye shields 8"/200mm wheels,<br>1/2-1 h.p. | 1  |
| Wheel Dressers   | 1  |
| Safety glasses   | 16 |

## Additional

|                      |   |
|----------------------|---|
| Oil cans (pump type) | 2 |
| Safety rags bin      | 1 |
| Grease gun           | 1 |

## Recommended Accessories

|                                       |   |
|---------------------------------------|---|
| Tool holder –swivel                   | 1 |
| Vice – 4"/100mm jaws with swivel base | 1 |
| Vee Block with clamps                 | 2 |
| U Clamps and bolts                    | 6 |

## Horizontal Spindle Surface Grinding Machines

|  |             |
|--|-------------|
| Table Travel – 8"/450mm                        | (desirable) |
| Cross Feed – 8"/200mm                          | (desirable) |
| 1300mm Permanent Magnetic Chuck – 2" or 300 mm | (desirable) |

## Bench Metal

|   |        |
|---|--------|
| Bench Vice  | 16     |
| Tap and die set – 1/8"/3mm to 1/2"/12mm<br>3/8"/10mm – 3/4"/16mm (optional) | 1      |
| Chisels Cold – flat, cape, round nose, diamond                              | 2 sets |

## Wrenches

|  |        |
|--|--------|
| Adjustable - 6"/150mm and 8"/200mm           | 1 each |
| Stilton – 8"/200mm and 14"/350mm             | 1 each |
| Hand Drill 0-1/4"/6mm                        | 1      |
| Toolmakers clamps                            | 2      |
| Hand vice                                    | 2      |
| Vice Grip pliers (small)                     | 1      |
| Vice Grip pliers (large)                     | 1      |
| Files – assorted sizes and cuts              |        |
| Needle files                                 | 1 set  |
| File card                                    | 2      |
| Hand lever shears to cut up to 1/8" material | 1      |
| Pliers – side cutting, diagonal, long nose   | 1 set  |
| Feeler Gauge                                 | 1      |
| Extractor Set                                | 1      |
| Drift Punch                                  | 1      |
| Pin Punches                                  | 1 set  |

## Sheet Metal

|   |                       |
|---|-----------------------|
| Bar Folder 24"/600mm slip roll forming machine with rollers for wire edged<br>24"/600mm rollers | 1 each<br>(desirable) |
| Pan and box brake (24")   | 1                     |

## Stakes

|                             |   |
|-----------------------------|---|
| Solid Mandrel               | 1 |
| Hatchet                     | 1 |
| Creasing                    | 1 |
| Bick Iron                   | 1 |
| Square Head                 | 1 |
| Round Head                  | 1 |
| Bench Bar for stakes in use | 1 |

## Soldering

|                                  |              |
|----------------------------------|--------------|
| Soldering Furnace (gas operated) | 1 (optional) |
| Square Pointed copper 16 oz      | 1 pair       |
| Electric Soldering Iron          | 2            |

## Snips

|                                  |   |
|----------------------------------|---|
| Straight 6"/150mm – 10"/250mm    | 6 |
| Curved 6"/150mm – 10"/250mm      | 2 |
| Combination 6"/150mm – 10"/250mm | 2 |

## Saws

|                      |   |
|----------------------|---|
| Hacksaw – 12"/300 mm | 3 |
| Sheet metal hacksaw  | 2 |
| Jeweller's saw       | 2 |
| Junior hacksaw       | 2 |

## Hammers

|                    |   |
|--------------------|---|
| Ball Pein – 16oz   | 3 |
| Ball Pein – 8 oz   | 2 |
| Cross Pein – 12 oz | 2 |
| Cross Pein – 8oz   | 2 |
| Straight Pein      | 2 |

## Mallets

|                  |   |
|------------------|---|
| Rawhide          | 2 |
| Rubber           | 2 |
| Boxwood, bossing | 4 |
| Raising          | 2 |

### **Screwdrivers**

|                                      |        |
|--------------------------------------|--------|
| Phillips head (small, medium, large) | 1 each |
| Standard (small, medium, large)      | 2      |

### **Additional**

|                                   |              |
|-----------------------------------|--------------|
| Hand groovers – assorted sizes    | 3            |
| Hand seamers 3"/75mm jaws         | 2            |
| Scroll former                     | 1 (optional) |
| Radius Gauge                      | 1            |
| Wire Gauge                        | 1            |
| Air Acetylene Torch               | 1 (optional) |
| Rules, Stainless Steel 24" /600mm | 2            |
| Callipers, Outside 12"/300mm      | 1 (optional) |
| Callipers, Inside 12"/300mm       | 2 (optional) |
| Smith's Square, 18"/450           | 1            |

### **Welding – Oxy-Acetylene (Complete)**

|                               |              |
|-------------------------------|--------------|
| Welders Goggles with lenses   | 6            |
| Sparklighter with flint       | 2            |
| Steel Brushes                 | 4            |
| Carver Clamps, assorted sizes | 1            |
| Acetylene Manifold            | 2            |
| Oxygen manifold               | 1 (optional) |

### **Electric Arc Welding**

|   |              |
|---|--------------|
| A.C./D.C. Electric arc welder with cables, ground clamp and electric holder 180-300 amps        | 1            |
| Welding helmets with slide-in lens holder   | 3            |
| Double station oxyacetylene work table, each working surface 3' x 18", covered with fire bricks | 1 (optional) |
| Metal table for arc welding with enclosure and canvas curtain                                   | 1            |
| Chipping hammer   | 1            |
| Metal Inert Gas Welding Set   | 1            |
| Tungsten Inert Gas Welding set  | 1            |



## ◆ RESOURCES

The following is a list of books and other printed material which may be used for the CXC Mechanical Engineering Technology Unit. The list is not exhaustive or prescriptive, but indicates sources which may be appropriate for use by teachers and students.

- |                                |   |
|--------------------------------|---|
| Austin, V.                     | <i>Workshop Theory</i> . London: MacMillan Educational, 1990.   |
| Bedford J.                     | <i>Metal Craft Theory and Practice, 2<sup>nd</sup> Edition. New International Metric Standard</i> , London: J Murray, 2008. |
| Cary, H. and Helzer, S.        | <i>Modern Welding Technology</i> . New Jersey: Pearson Education, Limited, 2011.  |
| Chapman, W.                    | <i>Workshop Technology – Parts 1 and 11</i> . London: Edward Arnold, 1974.  |
| Driscoll, T. and Hibberson, E. | <i>Metalwork Projects for Secondary Schools</i> . London: Macmillan Caribbean, 1997.  |
| Everette, L. and Barhorst, A.  | <i>Dynamics for Engineering Practices</i> . Texas: M3P Engineering Publications, 2011.                                      |
| Feirer, J.                     | <i>General Metals</i> . New York: McGraw-Hill Book Company, 1990.   |
| Feirer, J.                     | <i>Machine Tool Metalworking – Principles and Practices</i> (3rd Edition). New York: McGraw-Hill Book Company, 1990.        |
| Gerrish, H.                    | <i>Technical Dictionary – Technical Terms Simplified</i> . Illinois: The Goodhart Wilcox Company Inc. South Holland, 1982.  |
| Gibson S.                      | <i>Practical Welding</i> . London: Macmillan Education, 1994.   |
| Kirkcaldy, C.                  | <i>Metalwork</i> . London: Addison Wesley Longman, 1997.  |
| Ludwig, O.                     | <i>Metalworking Technology and Practice</i> . New York: McKnight, 1990.   |
| Nise, N.                       | <i>Control Systems Engineering</i> . New Jersey: Wiley, 2014.   |
| Petit, T.                      | <i>Craft Education: Metal Work Design</i> . London: Edward Arnold, 1990.  |
| Sackey J.                      | <i>Metal Work Technology, The Motivate Series</i> . London: Macmillan Education, 2007.                                      |

## RESOURCES (cont'd)

- Smith, R. *Forging and Welding* – Revised Edition. New York: McKnight, 1990.
- Thomas, G. *Metalwork Technology* – (Metric Edition). London: John Murray, 1986.

## ◆ GLOSSARY OF TERMS

| <b><u>WORD/TERM</u></b> | <b><u>DEFINITION/MEANING</u></b>  |
|-------------------------|---|
| 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   |

| <b><u>WORD/TERM</u></b> | <b><u>DEFINITION/MEANING</u></b>  |
|-------------------------|---|
| estimate                | make an approximate quantitative judgement  |
| 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   |

**WORD/TERM**

**DEFINITION/MEANING**

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

## ◆ GUIDELINES FOR INTEGRATING THE COMPETENCY BASED EDUCATION TRAINING AND ASSESSMENT APPROACH

### RATIONALE

*School-Based Assessment (SBA) is an integral part of candidates' assessment of the Industrial Technology offerings. It provides an opportunity to individualise a part of the curriculum to meet the needs of the students and facilitate 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. The SBA assists in the development of the critical skills and abilities emphasised by the subject and enhances the validity of the examination on which candidate performance is reported. It 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. In addition, the SBA caters to the multiple intelligences as various teaching and learning strategies are utilised to provide students with the skills needed in everyday life. Through the SBA, students are provided with multiple opportunities and ways to develop and demonstrate knowledge, skills and attitudes.*

*The SBA score is derived from the composite marks of the entries in the School-Based Assessment portfolio which include the related CVQ Units of Competency aligned to the content in the syllabus. The CVQ is an award which represents the achievement of a set of competencies that define the essential (core) work practices of an occupational area consistent with the levels articulated within the Regional Qualifications Framework. It aims at the development of the Ideal Caribbean Worker, seeks to facilitate the movement of skilled certified workers within the CSME, enhances the quality profile and investment attractiveness of the work/labour force of CARICOM states and harmonises TVET systems across the region. The recognition of Unit competencies for the Level 1 CVQ will adhere to the standardised procedures currently operational in schools offering the CVQ programmes.*

### SCHOOL-BASED ASSESSMENT PORTFOLIO

*As part of the School-Based Assessment, candidates will be required to produce a portfolio providing evidence of candidates' progress and learning over the duration of the programmes. The evidence represents the formative and summative assessments of the programmes and are a compilation of all the learning experiences from commencement to the end of the programme. The Portfolio must mirror the key competencies (knowledge, skills, attitudes) required for the labour market and continuing studies.*

*Since the portfolio is an accumulation of the candidates' ongoing learning across the course of the two-year programme, it must be started at the commencement of the Industrial Technology Syllabuses. The guidelines provided in this document for selecting appropriate tasks are intended to assist teachers/facilitators and candidates in formulating assignments that are valid for the purpose of the SBA (Appendix II). The guidelines provided for the assessment of the assignments are intended to assist teachers/facilitators in awarding marks that are reliable indicators of the achievement of candidates in the SBA component of the Industrial Technology programmes.*

*For the effective delivery and assessment of this syllabus institutions must ensure the:*

1. *Availability of the resources, through partnerships with industries, firms and other institutions.*
2. *Comprehension of the assessment and certification requirements by all students.*
3. *Readiness of candidate to demonstrate his or her knowledge and skills.*
4. *High teaching and assessment standards through the Quality Control Procedure.*
5. *Planning and organisation of authentic work experience opportunities which are critical for the development of competencies which are not achievable in the institution.*
6. *Commencement of the portfolios at the beginning of delivery of the programme.*
7. *The availability of Internal Verifiers\*.*
8. *The Use of Delivery and Assessment plans. These are indispensable quality control measures and are encouraged to be joint activities between the teachers/facilitators and students. They are developed at the beginning of the delivery of the programmes.*
9. *Monitoring of the completion and maintenance of the portfolio and ensuring the demonstration of competencies in all areas.*
10. *The maintenance of the internal records for the portfolio.*

*\*An Internal Verifier is an employee of the institution and is responsible for ensuring the quality of the delivery and assessment of all the sections of the syllabus. The Internal Verifier assists the teachers/facilitators in the preparation of the delivery and assessment schedules and monitors the progress of the portfolio development as well as teachers' and students' record keeping. They support and work at ensuring accuracy and consistency in the application of the learning experience to achieve the acceptable levels of competence.*



## **ASSESSMENT**

*Assessments must produce evidence of the range and depth of skills, knowledge and application taught. Types of assessments may include teacher, peer, authentic and self-assessments. The tasks are to be structured to achieve a balance in both the formative (developmental) and summative (judgemental) roles of assessment.*

1. *Peer/Group Assessment*

*Peer Assessment aims to develop the students ability to make independent judgements by involving them in evaluating and making decisions on other student's work. It is used as a group work activity involving a variety of assessment methods to develop students' team work and cooperative learning skills.*

2. *Self-Assessment*

*Self-Assessment aims to supplement teachers' assessment. It is an effective resource in allowing students to make judgements about their own learning and in allowing them to work at their own pace.*

3. *Authentic Assessment*

*Authentic assessment aims at providing a clear relationship with the knowledge, skills and attitudes being developed and the delivery and assessment activities. Authentic tasks are real and mirror realistic training which is transparent and evokes a strong commitment to study.*

### **METHODS OF ASSESSMENT**

*These may include:*

1. *oral and written examinations;*
2. *direct observation;*
3. *interviews;*
4. *demonstration of practical;*
5. *dual training (institution and industry. Effective for practicum);*
6. *learning contracts agreement between the staff and students;*
7. *computer-based assessment (provides flexibility in the time, location or even the questions being answered by students. Effective with multiple – choice questions); and,*
8. *portfolio assessment.*

### **PORTFOLIO ASSESSMENT**

*The portfolio is a student-centred communication approach that adequately reflects the teaching and learning experiences through authentic activities. This assessment provides teachers/facilitators an opportunity to participate in the progress of the students in a very broad context. This may include the observation of the students in exploring, experimenting, taking risks, developing creative solutions and learning to assess or make judgements about their own performances. The portfolio places a high premium on quality. It provides a strong feedback loop of continuous evaluation and improvement in teaching and learning. The portfolio is one of the major quality assurance vehicles for the provision of tangible and intangible evidence, attesting to the quality (relevance, validity, reliability) of educational delivery, assessment and outputs.*



*For the Industrial Technology Syllabus, students will compile a portfolio to provide evidence:*

- 1. That clearly shows the students progress. It is a compilation of all the learning experiences throughout the course and it is assessed by the internal verifier.*
- 2. Of the certification requirements (evidence and certificate) for the Caribbean Vocational Qualification (CVQ).*

### **CHARACTERISTICS OF THE PORTFOLIO ASSESSMENT**

*Portfolio Assessment is multi-dimensional in nature and has the following characteristics of quality:*

- 1. It is continuous and ongoing. It provides both formative and summative evaluation opportunities for monitoring the students' progress while they work toward the achievement of the learning outcomes.*
- 2. It uses a wide variety of tangible and intangible evidence (practical and written), reflecting various aspects of the delivery and learning processes.*
- 3. It is reflective; providing students an opportunity to analyse their performance and track the development of their competencies.*
- 4. Assessment results are used to improve the delivery and learning processes.*

### **CHARACTERISTICS OF THE PORTFOLIOS**

*The portfolio is a compilation of students' work based on the teaching and learning experiences and should:*

- 1. reflect the performance outcomes and objectives of the programmes being undertaken (from the beginning of the delivery process to the stage of being competent);*
- 2. focus on the essential competencies which are performance-based;*
- 3. contain samples of work from the commencement of the programme to the end;*
- 4. contain evidence that represent a variety of assessment methods; and,*
- 5. contain the evidence of the students' formative and summative development.*

### **PLANNING THE PORTFOLIO**

*This is a collaborative activity between the teachers/facilitators and students.*

*Steps:*

- 1. Discuss with the students of the importance of the portfolio as a means of monitoring and evaluating their progress.*

2. *Select the entries for the portfolio. These must reflect the learning outcomes and experiences.*
3. *Organise the evidence (cover page, table of contents, performance outcomes, artefacts, literary work, evaluation, reflection). Please see Appendix III for the Portfolio Development process.*
4. *Create an evaluation schedule.*
5. *Maintain and store.*
6. *Reflection on experiences by students. This can take the form of a journal and a learning log.*

### **EVALUATION OF THE PORTFOLIO**

*The teachers/facilitators are encouraged to use a variety of scoring strategies to evaluate the portfolio. The evaluation of the portfolio is a joint activity between the teachers and students. Both are involved in the selection of the criteria that will be used to assess and evaluate the evidence throughout the instructional period (formative) and at the end (summative). The use of a portfolio assessment rubric (cover design, authenticity of evidence, organisation of evidence, completeness, accuracy of information, self-reflective statement) is recommended for the portfolio evaluation.*

### **FEEDBACK**

*Feedback is an integral process in CBETA. High quality feedback consists of the following elements:*

1. *Clear criteria against which to judge the comments.*
2. *Detailed comments which are related to the performance of the students.*
3. *Comments that are geared at improvement.*

### **EVIDENCE FOR THE PORTFOLIO**

*The pieces of evidence MUST depict the candidates' developmental progress in each of the Section from which the evidence is derived. Where possible, it is advised that the Sections of the syllabus be integrated to give evidence of their full coverage.*

*The portfolio pieces must show the integration of CVQ Units where applicable. Teachers are encouraged to use the listing below as a guide to selecting pieces from each Section in the Industrial Technology syllabus:*

## **CORE**

### **SECTION 1: FUNDAMENALS OF INDUSTRY**

*At least 10 pieces of evidence from Section 1*

1. *The organisation of a selected construction industry.*
2. *The organisation of a selected manufacturing industry.*
3. *Selection of industry codes and standard.*
4. *A set of safety rules to be followed in a workshop or on the worksite.*
5. *Treatment procedure for each of three injuries which can occur in the workshop/worksite (burns, eye injuries, electric shock, bleeding, falls).*
6. *Student duty roster and a maintenance programme for the workshop/worksite (machines, tools, general upkeep).*
7. *A set of photographs of students demonstrating the use of protective gear and equipment while working in the workshop or on a worksite.*
8. *A report on an accident prepared by the student.*
9. *A small business plan.*

### **SECTION 2: DESIGN PRINCIPLES AND PROCESSES**

*At least three (3) pieces of evidence from Section 2*

1. *The design principles, elements and processes.*
2. *Sketching of simple designs in related areas.*
3. *Report on the design analysis of a simple manufactured product.*

### **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES**

*At least three (3) pieces of evidence from Section 3*

1. *Samples of projects prepared in the operating principles of a computer.*
2. *A PowerPoint presentation on modern trends in engineering technologies.*
3. *Two projects or assignments from the use of communication devices.*

## OPTION 2: MECHANICAL ENGINEERING TECHNOLOGY

### SECTION 1: Materials, Hand Tools and Processes

At least six (6) pieces of evidence from Section 1

1. *a list of Mechanical Engineering materials and their properties;*
2. *methods of separation of metals from their ores (include drawings/photographs);*
3. *pictures of projects showing students properly attired and performing operations in filing, chiselling, thread cutting and other operations;*
4. *heat treatment of a small hand tool:*
  - (a) *punch; and,*
  - (b) *cold Chisel.*
5. *Provide a report detailing the tool, the properties to be enhanced and the heat treatment process used.*

### SECTION 2: GRAPHIC COMMUNICATION AND DESIGN (MANUAL AND COMPUTER-ASSISTED DESIGN)

At least five (5) pieces of evidence from Section 2 that include:

1. *steps in the Design process;*
2. *samples of pictorial, multi-view, sectional and auxiliary drawings; and*
3. *design of a mechanism to satisfy an engineering need:*
  - (a) *transmission Drive;*
  - (b) *lifting mechanism; and,*
  - (c) *provision of a report detailing the design process including conceptualisation and preliminary design indicating detailed drawings and other information.*

### SECTION 3: PRODUCTION ENGINEERING

At least six (6) pieces of evidence from Section 3 that include:

1. *processes used to shape metals;*
2. *reports on the operating processes of sand and die-casting techniques; and,*

3. *designs/Photographs of Machining, Sheet metal and Welding projects completed step by step by students:*

**Sheet metal project:**

- (a) *letter box;*
- (b) *tool box;*
- (c) *gardening water can;*
- (d) *feed trough; and,*
- (e) *others.*

**Machining and welding project:**

- (a) *clamp;*
- (b) *vice; and,*
- (c) *chipping hammer.*

**SECTION 4: ART METAL WORK**

*At least three (3) pieces of evidence from Section 4 that include:*

- 1. *pictures/drawing of the processes used in shaping metals; and,*
- 2. *pictures/drawings of basis household and commercial products made using ornamental metal.*

**PERFORMANCE INDICATORS**

- 1. *Portfolios.*
- 2. *Checklist.*
- 3. *Task Sheet.*
- 4. *Job Analysis Sheet.*
- 5. *Performance Criteria Sheet.*
- 6. *Quality Control Procedures.*
- 7. *Training and Assessment Plans.*
- 8. *Internal Verifier Records.*
- 9. *Internal Competency Records.*
- 10. *External Verifiers Records.*
- 11. *Moderation Reports.*

**INTEGRATION OF CVQ UNITS FOR THE SBA**

*The list presented below have been mapped to the content in the syllabus, teachers are encouraged to use this information as they develop activities and projects for the School-Based Assessment Component of the course:*

**CCMEM10302 Level I in Metal Work Engineering**

- (a) MEMCOR0141A Follow principles of Occupational Health and Safety.
- (b) MEMCOR0161A Plan to undertake a routine task.
- (c) MEMCOR0171A Use graduated measuring devices.
- (d) MEMCOR0191A Use hand tools.
- (e) MEMCOR0051A Perform related computations (basic).
- (f) MEMCOR0081A Mark off/out (general engineering).
- (g) MEMCOR0121A Classify engineering materials (basic).
- (h) MEMCOR0091A Draw and interpret sketches and simple drawings.
- (i) MEMCOR0111A Use power tools.
- (j) MEMFAB0041A Carry out mechanical cutting operations (basic).
- (k) MEMFAB0151A Prepare for oxyacetylene/metal arc welding processes.
- (l) MEMMPO0021A Perform general machining operations.
- (m) MEMMAH0071A Perform manual handling and lifting.



| Underpinning Knowledge and Skills   | Range  |
|---|--|
| <ul style="list-style-type: none"> <li>• Workplace and equipment safety requirements including relevant OH&amp;S guidelines and regulations</li> <li>• Materials (ferrous and non-ferrous)</li> <li>• Bench, pedestal and surface grinders</li> <li>• Conventional milling machine</li> <li>• Conventional metal turning lathes</li> <li>• General machining processes operations or activities</li> <li>• Hand tools, measuring instruments and equipment</li> <li>• Materials relative to cutting processes</li> <li>• materials preparation</li> <li>• Manual handling</li> <li>• Engineering measurement</li> <li>• Related calculations</li> <li>• Drawings, sketches and instructions</li> <li>• Hand tools and equipment</li> <li>• Materials handling whilst operating tools</li> <li>• Workshop procedures</li> <li>• Work safely to instructions</li> <li>• Select appropriate tools for material usage</li> <li>• Use tools correctly</li> </ul> | <ul style="list-style-type: none"> <li>• Machining is undertaken on one or more of a range of standard machine tools.</li> <li>• Work is undertaken under supervision to predetermined specifications and standards of quality and safety.</li> <li>• Machines may include lathes, mills, planers, shapers, drills, slotters, surface grinders.</li> <li>• Materials may include standard ferrous and non-ferrous materials.</li> <li>• Operations and set up carried out on those machines are straightforward and may include parallel cutting, slotting, planing, drilling, knurling, cutting flats, non-precision surface grinding operations.</li> <li>• Surface grinding operations covered by this unit are those requiring magnetic chucks and grinding of flat surfaces.</li> <li>• Machining parameters include speeds, feeds, stops, coolant and cutting lubricants.</li> <li>• Hacksaws, hammers, punches.</li> <li>• Hand tools for cleaning, lubricating, tightening and hand sharpening and adjustments.</li> </ul> |
| <p><b>Candidate's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Assessor's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Internal Verifier's Signature:</b> _____ <b>Date:</b> _____</p>  |  |



**SCHOOL BASED ASSESSMENT**  
**EXEMPLAR 1 - OPTION B – MECHANICAL ENGINEERING TECHNOLOGY**

**DIMENSIONS OF COMPETENCY**

This School-Based Assessment is aligned to Use hand tools (BCGCOR01911A) and Perform general machining operations (MEMMPO0021A) in the Metalwork Engineering, Level I (CCMEM1030) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), Use graduated measuring devices (MEMCOR0171A) and Mark off/out (general engineering) (MEMCOR0081A) may also be assessed with this assignment.

| WORK ACTIVITY:  |   |
|---|---|
| A client has provided the drawing of a mounting bracket to you for manufacture. The bracket is to be manufactured from medium carbon steel using a combination of hand tools and machining operations.  |   |
| TASK SKILLS   | TASK MANAGEMENT SKILLS  |
| Candidate has to <ul style="list-style-type: none"> <li>• Interpret activity</li> <li>• Follow health and safety requirements applicable to work environment</li> <li>• Select and accurately use the necessary tools and equipment</li> <li>• Comply with organisational policies and procedures including Quality Assurance requirements</li> <li>• Carry out correct procedures prior to and during machining processes</li> <li>• Use hand tools correctly</li> <li>• Identify and rectify typical faults and problems</li> <li>• Demonstrate safe and effective operational use of tools and equipment</li> <li>• Interactively communicate with others to ensure safe and effective operations</li> </ul> | Prepare/ organise/ co-ordinate by <ul style="list-style-type: none"> <li>• Interpret and plan activity</li> <li>• Select tools, equipment and materials</li> <li>• Apply health and safety procedures</li> <li>• Organize work station</li> <li>• Work in a logical and sequential manner within the required time frame</li> </ul>                   |
| CONTINGENCY MANAGEMENT SKILLS   | EMPLOYABILITY/ JOB ROLE/ ENVIRONMENT SKILLS   |
| What if ...? <ul style="list-style-type: none"> <li>• Tools are insufficient or unavailable</li> <li>• There is a power outage while machining</li> <li>• Material estimates are inaccurate</li> </ul>  | The candidate can ... <ul style="list-style-type: none"> <li>• Collect, analyse and organise information</li> <li>• Communicate ideas and information</li> <li>• Plan and organise activities</li> <li>• Work with others and in team</li> <li>• Use mathematical ideas and techniques</li> <li>• Solve problems</li> <li>• Use technology</li> </ul> |

Assessor's Signature : \_\_\_\_\_ Date: \_\_\_\_\_

KEY  
 Competent - Range 3 and above  
 Not Yet Competent - below Range 3

**SCHOOL BASED ASSESSMENT  
 EXEMPLAR 1 - OPTION B –MECHANICAL ENGINEERING TECHNOLOGY**

**ASSESSOR EVALUATION**

This School-Based Assessment is aligned to Use hand tools (BCGCOR01911A) and Perform general machining operations (MEMMPO0021A) in the Metalwork Engineering, Level I (CCMEM1030) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), Use graduated measuring devices (MEMCOR0171A) and Mark off/out (general engineering) (MEMCOR0081A) may also be assessed with this assignment.

**Institution/ Centre:** \_\_\_\_\_

**Candidate's Name:** \_\_\_\_\_

| ASSESSMENT CRITERIA  | ASSESSOR |   |   |   |   |
|--|----------|---|---|---|---|
|  | 1        | 2 | 3 | 4 | 5 |
| <b>1. OCCUPATIONAL HEALTH AND SAFETY</b>   |          |   |   |   |   |
| Candidate is appropriately attired in Personal Protective gear at all times                            |          |   |   |   |   |
| Occupational Health and Safety (OH&S) requirements for tasks and workplace environment adhered to      |          |   |   |   |   |
| All equipment and safety devices are used according to legislative requirements                        |          |   |   |   |   |
| Tools and equipment cleaned, maintained and stored.  |          |   |   |   |   |
| Materials are stored for re-use or disposal  |          |   |   |   |   |
| <b>2. PROCESS</b>  |          |   |   |   |   |
| Tools and equipment selected consistent with job requirements  |          |   |   |   |   |
| Tools and equipment checked for serviceability and any faults reported or rectified                    |          |   |   |   |   |
| Drawings accurately interpreted  |          |   |   |   |   |
| Appropriate methods and sequencing are selected for fabrication process                                |          |   |   |   |   |
| Marking out is carried off/out is carried out to specifications  |          |   |   |   |   |
| Datum points are correctly established   |          |   |   |   |   |
| Dimensions transferred are correct and appropriate   |          |   |   |   |   |
| Sequence of operations are followed to ensure maximum efficiency                                       |          |   |   |   |   |
| Tools are mounted and positioned correctly   |          |   |   |   |   |
| Machining parameters are set for job requirements and maximum tool life                                |          |   |   |   |   |
|  |          |   |   |   |   |
| <b>3. PRODUCT</b>  |          |   |   |   |   |
| Quality Assurance requirements recognized and adhered to in accordance with manufacturing operations   |          |   |   |   |   |
| Components are checked with appropriate instruments or gauges to ensure compliance with specifications |          |   |   |   |   |
| Finished surfaces are in accordance with requirements  |          |   |   |   |   |
| Joints are smooth and conform to the requirements of good engineering practices                        |          |   |   |   |   |

**Comment/ Feedback:**

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**Rating Scale:**

1. Cannot perform this task.
2. Can perform this task with **constant** supervision and **considerable** assistance.
3. Can perform this task with **constant** supervision and **some** assistance.
4. Can perform this task satisfactorily with periodic supervision.
5. Can perform this task satisfactorily with little or no supervision.

**Assessor's Signature** : \_\_\_\_\_ **Date:** \_\_\_\_\_

**Candidate's Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

### Portfolio Development Guidelines

A portfolio is an organised convenient means of collection and presentation of materials which records and verifies a candidate's learning achievements and relates them to the depth and breadth of work required by each unit of the occupational standards. The depth and breadth of work should include a diversity of exhibits which reflects the following **criteria**:

- Writing, Reading and Comprehension Skills
- Critical Thinking and Problem Solving Skills
- Technology Skills
- Practical Skills
- Teamwork Skills

The outline of the portfolio should include information under the following headings:

- Cover Page
- Title Page
- Table of Contents
- Introduction
- Supporting Evidence (Depth & Breadth of Work)
- Self-Assessment/Reflection

#### **Details of EACH Heading**

##### **Cover Page**

- Name of School
- Occupational Area CVQ Level 1
- Assessors Name
- Candidate's Name
- Year

##### **Title Page**

- Caribbean Vocational Qualification
- CVQ Level 1
- Occupational Area
- Year

##### **Table of Contents**

- By units
- Number pages

##### **Introduction**

- Portfolio of candidate to include personal data, background information on education / training experiences and expectations.

## **Supporting Evidence**

Provides information on the key formative and summative assignments / projects undertaken by the candidates to achieve the performance criteria in each unit on the Occupational Standards. All evidence supplied by the candidate should be reviewed by the assessor using the **criteria given**. **Evidence must be signed and dated on the date of the review by the assessor.**

### **Suggestions for supporting evidence:**

- Written Assignment
- Oral Questions (checklist format)
- Projects
- Work Samples
- Research Assignments
- Fieldtrip reports
- Summative evaluation of practical work
- Digital photographs of candidates performing critical tasks

### **Self-Assessment/Reflections**

Allows candidates to rate their performance against the requirements of the relevant unit/s of competency and allows candidates to reflect in writing whether their expectations have been achieved in the particular occupational area.

### **Summary**

*Each candidate* in every occupational area *must* prepare a portfolio which will showcase:

- Growth and development of the candidate during the two year period.

Portfolios *must* be kept for evaluation by the Internal Verifier, External Verifier and the Quality Assurance auditor of the Caribbean Examination Council.

◆ **INDUSTRIAL TECHNOLOGY SYLLABUS**

**OPTION C: BUILDING AND FURNITURE TECHNOLOGY**

## **OPTION C: BUILDING AND FURNITURE TECHNOLOGY**

### **SECTION 1: THE NATURAL AND BUILT ENVIRONMENT**

#### **GENERAL OBJECTIVES**

*On completion of this Section, students should:*

- 1. understand the components of the natural and built environment;*
- 2. understand environmental issues and their impact on the built and natural environment;*
- 3. appreciate the influence of other cultures on local and regional building styles; and,*
- 4. understand the principles that govern building industry.*

#### **SPECIFIC OBJECTIVES**

*The students should be able to:*

- 1. discuss the components of the natural environment;*
- 2. discuss the components of the built environment;*
- 3. assess the impact of environmental pollution on the natural and built environment;*
- 4. discuss the influence of other cultures on local building styles; and,*
- 5. discuss the principles that govern the building construction industry.*

#### **CONTENT**

##### **1. Natural environment**

*(a) Definitions:*

- (i) the natural environment; and,*
- (ii) the built environment.*

*(b) Components of the natural environment:*

- (i) the eco-system;*
- (ii) the atmosphere;*
- (iii) the geosphere; and,*

## SECTION 1: THE NATURAL AND BUILT ENVIRONMENT (cont'd)

(iv) *diagrams.*

### 2. **Built environment**

- (a) *Definition for the built environment.*
- (b) *Environmental polices relating to land management practices, use and restrictions.*
- (c) *Buildings and infrastructure to satisfy humans' needs (including homes, communities, cities, industries, bridges, roads).*
- (d) *Technology (materials, energy, finances, methods and systems used to construct the built environment).*
- (e) *Labelled diagrams.*

### 3. **Impact of environmental pollution on the natural and built environment**

- (a) **Effects of climate change:**
  - (i) *definition of climate change;*
  - (ii) *reasons for increase in natural disasters (flooding, hurricane, acid rain, earthquakes);*
  - (iii) *reasons for decrease in water resources (flow and quality); and,*
  - (iv) *reasons for decrease in soil quality (loss of organic matter and soil fertility, erosion of soil).*
- (b) **Risk management strategies:**
  - (i) *the KYOTO Protocol; and,*
  - (ii) *local, regional and international convention, treaties and sustainable development practices.*

### 4. **The influence of other cultures on Caribbean building styles.**

Features of the following architecture in Caribbean building styles:

- (a) *British;*
- (b) *French;*
- (c) *Indian; and,*





## SECTION 1: THE NATURAL AND BUILT ENVIRONMENT (cont'd)

(d) American.

### 5. Principles of the building construction industry

(a) Classification of buildings:

- (i) residential;
- (ii) commercial; and,
- (iii) social/civic industrial.

(b) Basic building structures:

- (i) solid;
- (ii) framed;
- (iii) sub-structure; and,
- (iv) super structure.

(c) Basic building elements:

- (i) foundations;
- (ii) walls;
- (iii) floors;
- (iv) roofs; and,
- (v) openings (doors, windows).

(d) Site works:

- (i) site work layout, planning and co-ordination plans with surveyors;
- (ii) excavation;
- (iii) grading;
- (iv) back filling;
- (v) drainage;
- (vi) drive way;

## SECTION 1: THE NATURAL AND BUILT ENVIRONMENT *(cont'd)*

- (vii) *septic and sewer systems; and,*
  - (viii) *landscaping.*
- (e) *Building construction documents:*
- (i) *site specification document;*
  - (ii) *architectural plans;*
  - (iii) *surveyor's plan;*
  - (iv) *working drawings;*
  - (v) *bill of quantities;*
  - (vi) *the hydrosphere; and,*
  - (vii) *labelled diagrams of each component.*

## SECTION 2: SITE WORK OPERATIONS

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *develop a working knowledge of the fundamentals of basic site work; and,*
2. *appreciate the importance and levels of preparation for site work operations.*

### SPECIFIC OBJECTIVES

The students should be able to:

1. *discuss the factors to be considered when choosing a building site;*
2. *prepare for site works operations;*
3. *explain the methods of clearing a building site;*
4. *explain the purposes of hoarding;*
5. *lay out simple buildings/structures; and,*
6. *prepare for an excavation.*

### CONTENT

#### 1. Choosing a building site

(a) *Factors:*

- (i) *soil-load bearing capacity;*
- (ii) *cohesive and non-cohesive soils;*
- (iii) *correct foundation:*
- (iv) *accessibility;*
- (v) *cost;*
- (vi) *topography;*
- (vii) *history;*
- (viii) *availability of utilities;*

## SECTION 2: SITE WORK OPERATIONS (cont'd)

- (ix) zoning;
- (x) prospect;
- (xi) aspect;
- (xii) location;
- (xiii) size; and,
- (xiv) climate.

### 2. Site work operations

- (a) Types of documentations:
  - (i) Building design; and,
  - (ii) Construction documents.
- (b) Knowledge of the contractor's responsibilities.
- (c) Construction of temporary shelters and services:
  - (i) site offices;
  - (ii) sanitary facilities;
  - (iii) equipment and material storage;
  - (iv) water;
  - (v) electricity;
  - (vi) gas; and,
  - (vii) telephone.
- (d) Access road.
- (e) Types of equipment for:
  - (i) digging;
  - (ii) lifting; and,

## SECTION 2: SITE WORK OPERATIONS (cont'd)

(iii) *fixing and measuring.*

(f) *Safety and maintenance standards (workers, use and storage of equipment).*

### 3. **Methods of clearing a building site**

(a) *Safety guidelines, procedures and standards for manual and mechanical methods.*

(b) *Operations:*

(i) *strip site;*

(ii) *cutting trees;*

(iii) *demolish old buildings;*

(iv) *earthing;*

(v) *salvaging;*

(vi) *disposing; and,*

(vii) *removal of debris, old stumps old cars.*

### 4. **Hoarding**

(a) *Definition of hoarding.*

(b) *Purposes:*

(i) *protection of the public;*

(ii) *protection of materials;*

(iii) *general security; and,*

(iv) *reduction of interference and interruptions.*

### 5. **Laying out simple buildings/structures**

(a) *Safety guidelines, procedures and standards for manual and mechanical methods:*

(i) *square and rectangular buildings; and,*

## SECTION 2: SITE WORK OPERATIONS (cont'd)

- (ii) *site datum use.*
  
- (b) *Measuring/Calculating:*
  - (i) *the distance from the site boundary to the building line on the working drawing; and,*
  - (ii) *using Pythagoras theorem (3:4:5) and builder's square to check squareness.*
  
- (c) *Establishing levels:*
  - (i) *using spirit level aqua level and datum pegs; and,*
  - (ii) *introduce laser level.*
  
- (d) *Using profiles boards to establish:*
  - (i) *foundation trench lines and levels; and,*
  - (ii) *foundation wall lines and levels.*

### 6. **Preparing an excavation**

- (a) *Safety guidelines, procedures and standards for manual and mechanical methods.*
  
- (b) *Operations:*
  - (i) *digging to recommended levels in the subsoil;*
  - (ii) *measuring the depth of the excavation (level, boning rod);*
  - (iii) *supporting sides of trenches; and,*
  - (iv) *removal of excavated soil.*

## SECTION 3: BASIC ARCHITECTURAL DRAWINGS

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. develop proficiency in the production of basic architectural drawings using manual and CAD standards; and,
2. develop proficiency in the reading, preparation and interpretation of architectural plans.

### SPECIFIC OBJECTIVES

Students should be able to:

1. prepare detailed drawings;
2. prepare sectional views;
3. apply the principles of geometric construction; and,
4. read and interpret site plans.

### CONTENT

#### 1. Drawings

(a) Using guidelines and standards to prepare:

- (i) details of windows in masonry block wall (frame, glass fixing, sill, awning, sliding, sash, casement, pivot);
- (ii) details of doors;
- (iii) timber staircase;
- (iv) roof member;
- (v) floors (timber and concrete upgrade);
- (vi) columns (timber and concrete);
- (vii) beams; and,
- (viii) carcass (framed, box and panel).

## SECTION 3: BASIC ARCHITECTURAL DRAWINGS (cont'd)

### 2. Sectional views

*Using guidelines and standards for the following sectional views of buildings and building components:*

- (a) *a timber floor;*
- (b) *roof members ( rafter, ridge, plate, battens, covering);*
- (c) *timber stair-case;*
- (d) *broken out sections of a building (masonry block walls; and,*
- (e) *doors and windows.*

### 3. Geometrical Construction

- (a) *Types.*
- (b) *Principles of geometrical construction.*

### 4. Architectural drawings or site plans

*Sources:*

- (a) *Plot plans to include:*
  - (i) *property lines;*
  - (ii) *shape, location and size of the building;*
  - (iii) *elevation of each corner of the site;*
  - (iv) *utilities;*
  - (v) *septic tanks;*
  - (vi) *scale of the drawing; and,*
  - (vii) *property description.*
- (b) *Foundation plans to include:*
  - (i) *footings;*
  - (ii) *columns;*
  - (iii) *foundation walls;*



### SECTION 3: BASIC ARCHITECTURAL DRAWINGS (cont'd)

- (iv) *floor joists;*
  - (v) *drains;*
  - (vi) *footing/foundation sections and details;*
  - (vii) *dimensions;*
  - (viii) *scale of the drawing; and,*
  - (ix) *notation.*
- (c) *Floor plans to include:*
- (i) *dimensions;*
  - (ii) *interior and exterior walls;*
  - (iii) *doors;*
  - (iv) *windows;*
  - (v) *plumbing fixtures;*
  - (vi) *electrical fixtures;*
  - (vii) *stairs;*
  - (viii) *door and window schedules;*
  - (ix) *scale of the drawing; and,*
  - (x) *notation.*

## SECTION 4: TIMBER TECHNOLOGY

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand the characteristics, uses, parts and properties of timber and timber products;
2. develop skills in selecting, treating, and storing timber and timber products; and,
3. develop a working knowledge of the preparation of timber for production purposes.

### SPECIFIC OBJECTIVES

Students should be able to:

1. discuss the main classification of trees;
2. identify the parts of the cross-section of a tree;
3. explain the methods of processing timber;
4. explain the methods of seasoning timber;
5. identify different types of defects associated with timber; and,
6. explain the methods of timber preservation.

### CONTENT

#### 1. Classification of trees:

(a) Classification of trees:

- (i) hard woods (including mahogany, teak, oak, birch); and,
- (ii) soft woods (including cedar, pine and red wood).

#### 2. Parts of a tree and their functions:

- (a) cambium layer;
- (b) growth ring;
- (c) pith;
- (d) xylem and phloem;



## SECTION 4: TIMBER TECHNOLOGY (cont'd)

- (e) bark;
- (f) sapwood;
- (g) heartwood; and,
- (h) labelled diagrams of the cross section of a tree trunk.

*Properties of hardwood and soft wood:*

- (a) grain direction;
- (b) texture;
- (c) colour;
- (d) strength;
- (e) weight; and,
- (f) durability.

### 3. **Methods of processing timber**

- (a) *Conversion of lumber:*
  - (i) plain/flat sawing (through and through sawing, slab sawing);
  - (ii) quarter sawing;
  - (iii) tangential sawing; and,
  - (iv) radial sawing.
- (b) *Types of timber boards according to:*
  - (i) sizes (boards, lath, posts); and,
  - (ii) grading (select timber for commercial purposes).
- (c) *Dress and rough timber:*

*Guidelines, materials, equipment and standards for the following finishes;*

- (i) Flat;
- (ii) Straight.

## SECTION 4: TIMBER TECHNOLOGY (cont'd)

- (d) Storage of timber products.
- (e) Methods of wood preservation:
  - (i) applying paints and varnishes;
  - (ii) brushing and spraying with preservative;
  - (iii) pressure treatments; and,
  - (iv) dipping.

### 4. **Methods of seasoning timber**

- (a) *Definition of seasoning.*
- (b) *Natural: Air-drying.*
- (c) *Artificial method: Kiln-drying.*
- (d) *Procedures and standards for each natural and artificial method.*
- (e) *New and developing methods:*
  - (i) *chemical;*
  - (ii) *micro wave energy;*
  - (iii) *conditioning; and,*
  - (iv) *press drying.*
- (f) *Calculating moisture content.*
- (g) *Advantages and disadvantages of artificial and natural methods of seasoning.*

### 5. **Timber defects**

- (a) *Natural defects:*
  - (i) *shakes; (star, heart, cup and ring);*
  - (ii) *knots; (dead, arris, splay, face, live);*
  - (iii) *warps;*

## SECTION 4: TIMBER TECHNOLOGY (cont'd)

- (iv) *bowing;*
- (v) *twists; and,*
- (vi) *splits.*
- (b) *Artificial defects caused by (termites, fungi, beetles).*
- (c) *Characteristics of each defect.*
- (d) *Methods of treating natural and artificial defects.*

### 6. **Timber Preservation**

- (a) *Types:*
  - (i) *Oil;*
  - (ii) *Water soluble; and,*
  - (iii) *Organic.*
- (b) *Characteristics of a good preservative.*
- (c) *Preservation methods.*

## SECTION 5: BUILDING TECHNOLOGY

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. understand the operating principles of tools, equipment and materials used in building construction processes;
2. understand the principles of the building construction industry;
3. develop competency in basic building construction operations; and,
4. appreciate safety, maintenance and quality standards.

### SPECIFIC OBJECTIVES

The students should be able to:

1. explain the production of common building construction materials
2. discuss the uses of different types of building construction material;
3. discuss the uses of different types of building construction tools and equipment;
4. demonstrate skills in the safe use of materials, tools, equipment and processes in a range of building construction operations;
5. demonstrate carpentry skills in the construction of building components;
6. explain the principles of the building construction industry; and,
7. demonstrate basic plumbing skills.

### CONTENT

#### 1. Building construction materials:

- (a) Aggregates:
  - (i) gravel;
  - (ii) sand;
  - (iii) crushed stone;
  - (iv) limestone;
  - (v) granite; and,



## SECTION 5: BUILDING TECHNOLOGY (cont'd)

(vi) *tests for aggregates (silt content).*

(b) Cement:

(i) Portland Cement (ordinary, quick setting, modified, water proof);

(ii) slaked or white lime; and,

(iii) building blocks.

### 2. Uses of construction materials

(a) *Boards:*

(i) plywood;

(ii) laminated boards;

(iii) *hardboards;*

(iv) *plastic foam board;*

(v) *cement board;*

(vi) gypsum wall board; and,

(vii) MDF (Medium Density Fibreboard).

(b) *Plastics:*

(i) PVC;

(ii) *polymer resin;*

(iii) *thermoplastics;*

(iv) *thermosetting plastics; and,*

(v) *environmental issues surrounding the use of plastics (burning, disposal).*

(c) *Wall Materials:*

(i) bricks;

(ii) *building blocks (cement-based, glass);*

(iii) stones;

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (iv) concrete; and,
  - (v) timber.
- (d) Concrete:
- Types:
- (i) stressed concrete; and,
  - (ii) pre-stressed concrete.
- (e) Aggregates.
- (f) Mortar.
- (g) Roof materials (aluminium sheeting, tiles, plastic, shingles, concrete).
- (h) Floor materials (tiles, boards, stone-based and plastic-based, concrete).

### 3. Building tools and equipment

- (a) Tools:
- (i) brick and block laying;
  - (ii) cutting;
  - (iii) marking;
  - (iv) finishing;
  - (v) measuring;
  - (vi) levelling;
  - (vii) percussion/impelling;
  - (viii) boring;
  - (ix) gripping/holding; and,
  - (x) excavating.



## SECTION 5: BUILDING TECHNOLOGY (cont'd)

(b) *Equipment:*

(i) *ladders;*

(ii) *scaffolds;*

- *using and dismantling simple scaffolds;*

- *guidelines, procedures and standards for:*

- *timber and metal scaffolds of less than 2m height; and,*

- *guidelines procedures and standards for dismantling the scaffolds.*

(iii) *mixing machines;*

(iv) *mobile elevating machines;*

(v) *vibrators;*

(vi) *wheel barrow;*

(vii) *bucket; and,*

(viii) *skip.*

(c) *Labelled diagrams.*

(d) *Operating principles.*

(e) *Safety, maintenance and storage.*

### 4. Building construction operations

#### 4.1 Preparing mortar

(a) *Defining mortar.*

(b) *Materials and their use:*

(i) *sand;*

(ii) *water;*

(iii) *cement;*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (iv) *properties of sand, cement and water;*
- (v) *tools and equipment;*
- (vi) *guidelines for preparing mortar (calculations of materials based on proportion and using manual and mechanical means);*
- (vii) *standards for the finished products; and,*
- (viii) *guidelines, standards and procedures for applying mortar (as a binding and as the finishing agent).*

### 4.2 Preparing concrete

- (a) *Definition.*
- (b) *Guidelines and standards for preparing concrete:*
  - (i) *materials, tools and equipment for preparing standard mixes; and,*
  - (ii) *differentiating between stressed and pre-stressed concrete.*
- (c) *Concreting operations:*
  - (i) *preparing standard mixes;*
  - (ii) *batching/proportioning concrete;*
    - *ratio of cement to sand;*
    - *ratio of water to cement;*
    - *batching by weight, volume, strength, homogeneity;*
    - *reduction of waste; and,*
    - *water tightness.*
  - (iii) *compacting concrete;*
  - (iv) *moisture loss control;*
  - (v) *adjusting water content;*
  - (vi) *curing concrete (methods – spray, sandbags, ponding);*
  - (vii) *testing concrete (slump, cube and compression tests); and,*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

(viii) *placing concrete (precautions – time between mixing and placing, transporting, height of pour).*

### 4.3 **Constructing a concrete foundation**

- (a) Types of foundation:
  - (i) strip – (simple, narrow, deep, wide, stepped);
  - (ii) raft;
  - (iii) pad; and,
  - (iv) short-bored piles.
- (b) Characteristics and uses of each type.
- (c) Guidelines, materials, tools and equipment for preparing a:
  - (i) strip foundation; and,
  - (ii) standards for the finished project.

### 4.4 **Constructing formwork**

- (a) *Uses.*
- (b) Materials, tools, equipment and guidelines for constructing a timber formwork.
- (c) Standards for the completed projects.
- (d) Safety procedures and methods of dismantling the formwork.

### 4.5 **Constructing lintels and beams**

- (a) *Definition and uses of:*
  - (i) *lintels; and,*
  - (ii) *beams.*
- (b) Guidelines, procedures and standards for constructing lintels and beams.

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

### 4.6 Constructing walls

- (a) *Types of walls:*
  - (i) load-bearing;
  - (ii) non-load bearing;
  - (iii) exterior; and,
  - (iv) partition.
- (b) Guidelines, procedures and standards for:
  - (i) each type of wall; and,
  - (ii) type of bonding.
- (c) Guidelines, procedures and standards for finishing using:
  - (i) rendering;
  - (ii) plastering;
  - (iii) screeding;
  - (iv) painting; and,
  - (v) tiling.

### 4.7 Performing steel-fixing operations

- (a) Fabricating reinforcement matting:  
Materials, tools, equipment, guidelines and standards for:
  - (i) strip foundation matting;
  - (ii) pad foundation matting;
  - (iii) *size and number of steel bars in matting;*
  - (iv) *shape and size of links;*
  - (v) *spacing of links;*
  - (vi) *length of matten and hookends; and,*
  - (vii) *preparation of jig link.*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

(b) *Fabricate reinforcement cages:*

*Materials, tools, equipment, guidelines and standards for:*

- (i) *column and beam reinforcement cage;*
- (ii) *square, rectangular and L-shaped stirrups;*
- (iii) *single and right angle hook and end bars;*
- (iv) *lintel; and,*
- (v) *belt beam.*

(c) Reinforcement drawings for mattings and cages.

### 5. **Basic Carpentry skills**

#### 5.1 **Constructing roofs**

(a) Functions of a roofs.

(b) Types of roofs:

- (i) lean-to;
- (ii) flat (concrete and timber);
- (iii) gable;
- (iv) hip roof; and,
- (v) hipped and valley.

(c) Roof members and their functions:

- (i) rafters (common, hip, jack);
- (ii) plates;
- (iii) ridge;
- (iv) ties;
- (v) purlins; and,
- (vi) *laths.*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (d) *Purpose of the eaves:*
- (i) *protection of roof members;*
  - (ii) *protection of walls;*
  - (iii) *aesthetics (appearance); and,*
  - (iv) *ventilation.*
- (e) *Types of ceilings and their functions:*
- (i) *suspended;*
  - (ii) *closed boarded;*
  - (iii) *functions:*
    - *tying together opposite walls and roofs;*
    - *supporting upper floors;*
    - *aesthetics; and,*
    - *insulation.*
- (f) *Advantages of using trusses:*
- (i) *economy of time, strength, material, money;*
  - (ii) *weight reduction;*
  - (iii) *ease of prefabrication; and,*
  - (iv) *quality control.*
- (g) *Guidelines, procedures and standards for constructing a single roof using trussed rafters.*
- (h) *Rafter calculations:*
- (i) *number of rafters;*
  - (ii) *length of rafters (Pythagoras method, framing and square method; and,*
  - (iii) *angle of rafters (pitch).*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (i) *Selecting and applying coverings (corrugated sheets, shingles, tiles, asphalt, felt building integrated photovoltaic materials).*

### 5.2 Constructing doors

- (a) Functions of doors:
  - (i) protection/security;
  - (ii) privacy;
  - (iii) ventilation;
  - (iv) lighting;
  - (v) sound insulation; and,
  - (vi) aesthetics.
- (b) Types of doors:
  - (i) panelled;
  - (ii) *French*;
  - (iii) *match boarded*;
  - (iv) *flush (interior)*; and,
  - (v) louvered doors.
- (c) Guidelines, procedures and standards for *constructing a panel door*.
- (d) *Guidelines, procedures and standards for installing the door*.
- (e) *Selecting ironmongery for doors* (locks, knobs, holders, restricters, hasp and staples, hinges, latches, tower bolts).

### 5.3 Constructing windows

- (a) *Functions of windows*:
  - (i) *lighting and ventilation*;
  - (ii) *sound reduction*; and,

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (iii) *aesthetics.*
- (b) *Types of windows:*
  - (i) *louvre (timber, metal and glass strips);*
  - (ii) *casement windows;*
  - (iii) *hopper;*
  - (iv) *awning;*
  - (v) *sliding (vertical and horizontal); and,*
  - (vi) *pivot.*
- (c) *Guidelines, procedures and standards for constructing:*
  - (i) *mortise and tenon joints for a window frame (incorporate this activity with the Furniture Manufacturing section);*
  - (ii) *a window sill (joints, grooves, weather bars, capillary and anti-capillary grooves);*
  - (iii) *applying the process of glazing (weather strips, glazing, putty, plain glass, sheet glass, wire glass); and,*
  - (iv) *selecting ironmongery (hinges, stays, fasteners, tower bolts, tracks).*

### 5.4 **Constructing floors**

- (a) *Functions of floors.*
- (b) *Types of floors:*
  - (i) *concrete on grade; and,*
  - (ii) *timber (single and double).*
- (c) *Trimming of floor for stairwell.*
- (d) *Floor members and their functions:*
  - (i) *joists;*
  - (ii) *bridging;*
  - (iii) *sub-floor;*



## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (iv) *skirting;*
  - (v) *header;*
  - (vi) *wall plates; and,*
  - (vii) *floor boards.*
- (e) Calculating:
- (i) floorboards;
  - (ii) joists; and,
  - (iii) *depth of joist.*
- (f) Guidelines, procedures and standards for *constructing a basic timber floor:*
- (i) *choice of timber and characteristics;*
  - (ii) *design of boards (plain, tongue and groove);*
  - (iii) cutting joists;
  - (iv) nailing header joists;
  - (v) installing bridging;
  - (vi) fixing boarding; and,
  - (vii) applying finishing.

### 5.5 Constructing a simple stair case

- (a) Functions of a staircase:
- (i) *allows access from floor to floor; and*
  - (ii) *an emergency escape.*
- (b) explaining terminologies relating to stairs:
- (i) riser;
  - (ii) thread;
  - (iii) run;

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (iv) rise;
  - (v) stringer;
  - (vi) head room;
  - (vii) handrail;
  - (viii) Newel posts; and,
  - (ix) balusters.
- (c) Calculating:
- (i) numbers of risers;
  - (ii) numbers of threads;
  - (iii) total going; and,
  - (iv) stair safety and comfort using formula.
- (d) Guidelines, procedures and standards for:
- (i) *a timber staircase;*
    - *laying out (straight flight);*
    - *cut members;*
    - *construct joints; and,*
    - *assemble parts.*
  - (ii) *installation of the staircase.*

### 5.6 Basic plumbing and related services

- (a) Principles of plumbing:
- (i) types of pipes;
  - (ii) pipe *materials;*
  - (iii) pipe fittings;
  - (iv) methods of joining pipes;

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (v) trap seals;
  - (vi) valves (application); and,
  - (vii) non-return valves.
- (b) Principles of roof drainage and disposal:
- (i) pitch/slope;
  - (ii) gutters;
  - (iii) bends;
  - (iv) down pipes;
  - (v) soak-aways;
  - (vi) inspection chambers;
  - (vii) drain runs; and,
  - (viii) vents.
- (c) Types of drainage systems:
- (i) one pipe;
  - (ii) two pipes; and,
  - (iii) operating principles of the types of drainage systems.
- (d) *Types of plumbing tools and equipment:*
- (i) *tools (Measuring, cutting, bending, pointing, fixing and installation);*
  - (ii) *equipment (cutting, bending treading, boring); and,*
  - (iii) *fittings (taps, valves).*
- (e) *Traps, elbow, bends, tee, branch.*
- (f) *Functions of tools and equipment.*
- (g) *Nails, screws.*

## SECTION 5: BUILDING TECHNOLOGY (cont'd)

- (h) *Performing basic plumbing calculations:*
  - (i) *volume and capacity of storage tanks; and,*
  - (ii) *area, circumference and perimeter measurements for rectangles, squares, cylinders.*
- (i) *Guidelines, procedures and standards for installing pipes for domestic water supply:*
  - (i) *installing plastic and steel pipes for cold water systems; and,*
  - (ii) *testing and inspecting the systems.*
- (j) *Explaining the methods of sewage disposal:*
  - (i) cesspools;
  - (ii) septic tanks;
  - (iii) absorption pits;
  - (iv) soakaways;
  - (v) disposal fields (filter beds);
  - (vi) chemical chambers; and,
  - (vii) characteristics, advantages and disadvantages of each method.

## SECTION 6: FURNITURE TECHNOLOGY

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *understand the features of furniture design as influenced by different periods and styles;*
2. *develop skills in the use and maintenance of furniture materials, tools and equipment;*
3. *demonstrate the operating principles of production tools, materials, equipment and processes in the manufacture of furniture products; and,*
4. *appreciate safety, maintenance and quality standards.*

### SPECIFIC OBJECTIVES

The students should be able to:

1. *discuss the features of furniture designs associated with different periods and styles; and,*
2. *demonstrate the safe use of furniture materials, tools and equipment in the production of basic furniture products.*

### CONTENT

#### 1. **Features of furniture designs**

- (a) *16<sup>th</sup> century:*
  - (i) *Queen Anne; and*
  - (ii) *Georgian.*
- (b) *17<sup>th</sup> century: Victorian.*
- (c) *19 – 21<sup>st</sup> century (contemporary):*
  - (i) *art deco;*
  - (ii) *bauhaus; and,*
  - (iii) *tapered and carved legs and components.*
- (d) *Preparing a portfolio of furniture designs for each style and period.*



## **SECTION 6: FURNITURE TECHNOLOGY (cont'd)**

### **2. Basic furniture manufacturing**

#### **2.1 Furniture manufacturing projects**

*Guidelines, procedures and standards for the selection, safe use and maintenances of:*

- (a) nuts and bolts;*
- (b) hinges;*
- (c) handles;*
- (d) knobs;*
- (e) staples;*
- (f) glass;*
- (g) metal;*
- (h) upholstery materials; and,*
- (i) dressed timber products.*

#### **2.2 Furniture making tools**

- (a) Guidelines, procedures and standards for the selection, safe use and maintenances of:
  - (i) measuring and marking out tools;
  - (ii) cutting and boring tools;
  - (iii) holding and supporting devices; and,
  - (iv) finishing and abrasives tools and materials;
- (b) Power hand tools:
  - (i) portables electric drills;
  - (ii) circular saw;
  - (iii) planers;
  - (iv) sanders (belt and orbital;

## SECTION 6: FURNITURE TECHNOLOGY (cont'd)

- (v) routers;
  - (vi) jig saws;
  - (vii) automatic pins and staple drivers; and,
  - (viii) nail gun.
- (c) Cutting and shaping with hand tools

Guidelines, procedures and standards for simple project identification and designs to include the following operations:

- (i) layout, cut chamfers and irregular shapes;
- (ii) shape with spoke shaves;
- (iii) chisel along and across grains;
- (iv) cut and pare with a chisel;
- (v) bore and drill holes; and,
- (vi) countersink holes.

### 2.3 Furniture equipment

- (a) *Guidelines, procedures and standards for the selection, safe use and maintenance of:*
- (i) mounting and removing saw blades;
  - (ii) ripping;
  - (iii) cross cutting;
  - (iv) cut mitering;
  - (v) rebating;
  - (vi) bevelling;
  - (vii) chamfering;
  - (viii) grooving; and,
  - (ix) cleaning, greasing, oiling.

## SECTION 6: FURNITURE TECHNOLOGY (cont'd)

(b) Guidelines, procedures and standards for operating and maintaining the band saw:

Cutting:

- (i) a mitre;
- (ii) tenons;
- (iii) curves;
- (iv) circles;
- (v) irregular patterns;
- (vi) *mounting and removal of blades; and,*
- (vii) *greasing and oiling.*

(c) *Guidelines, procedures and standards for operating and maintaining the planer:*

Operations:

- (i) surfacing; and,
- (ii) thicknessing.

(d) *Guidelines, procedures and standards for operating and maintaining the jointer:*

Operations:

- (i) surfacing;
- (ii) edging;
- (iii) chamfering;
- (iv) bevelling;
- (v) tapering; and,
- (vi) rebating.



## SECTION 6: FURNITURE TECHNOLOGY (cont'd)

(e) *Guidelines, procedures and standards for operating and maintaining the drill press:*

Operations:

- (i) boring;
- (ii) drilling; and,
- (iii) *mortising.*

(f) *Guidelines, procedures and standards for operating and maintaining the wood turning lathe:*

Cutting:

- (i) tapers;
- (ii) cylinders;
- (iii) *turning between centres;*
- (iv) *face plate turning; and,*
- (v) concave and convex shapes.

(g) Guidelines, procedures and standards for operating and maintaining the grinder:

Operations:

Using the grinder to grind various types of tools.

### 2.4 Production processes:

(a) Preparing woodworking Joints:

- (i) types of joints and their uses:
  - widening joints (butt, dowel butt, tongue and groove, rebate);
  - framing joints (mitre, halving joint, dowelled, mortise and tenon); and,
  - carcass joints (rebate dovetail, housing, tee).

## SECTION 6: FURNITURE TECHNOLOGY (cont'd)

- (ii) designing simple projects using different types of joints; and,
  - (iii) *guidelines, procedures and standards for the finished projects.*
- (b) Assembling frames:
- (i) guidelines, procedures and standards for constructing simple household furniture; and,
  - (ii) operations:
    - gluing;
    - cramping up;
    - squaring up; and,
    - winding.
- (c) Apply lipping to board material: Guidelines, procedures and standards for the following materials:
- (i) pre-glued;
  - (ii) iron on-tape; and,
  - (iii) corner edging.

### 2.5 Furniture Manufacturing

- (a) *Using construction, assembling and finishing techniques to:*
- (i) *make and install wall and floor level cabinets:*
    - *cupboard;*
    - *counter tops (include sink cut out); and,*
    - *shelves.*
  - (ii) *standards for the completed projects.*

## SECTION 6: FURNITURE TECHNOLOGY (cont'd)

- (b) *Constructing basic household furniture using carved and turned shapes. Including:*
- (i) *preparing for finishing (nail and screw holes treatment, wood sanding, apply filler, stain and sealer);*
  - (ii) *applying finishing (lacquer, water and oil based, wax, enamel);*
  - (iii) *installing hardware (drawers, doors); and*
  - (iv) *standards for the finished projects.*
- (c) *Perform basic upholstering operations*
- Guidelines, procedures and standards for:*
- (i) *prepare and assemble frames;*
  - (ii) *cutting coverings;*
  - (iii) *locating position of webbing;*
  - (iv) *tacking and stretch webbing;*
  - (v) *attaching burlap;*
  - (vi) *rolling edges on wood;*
  - (vii) *applying stuffing;*
  - (viii) *cutting covers to fit specific shapes;*
  - (ix) *padding surface; and,*
  - (x) *making pleats.*

## ◆ WORKSHOP/LABORATORY FACILITIES

Recommended equipment for a class of 16 in Building Technology and Furniture Manufacturing

| ITEM  | QUANTITY |
|---|----------|
| <b><u>Machines Tools</u></b>  |          |
| Chop saw/Electric Mitre saw   | 1        |
| Circular saw  | 1        |
| Band (Minimum 350mm Dia)  | 1        |
| Sabre (Jig) saw   | 1        |
| Radial-Arm (Min. Dia) saw   | 1        |
| Jointer (150mm Min)   | 1        |
| Thickness Planer (300mm)  | 1        |
| Drill Press (with morticing attachment)                               | 1        |
| Finishing Sander  | 1        |
| Belt Sander (75 x 600mm)  | 1        |
| Electric Hand-Drill   | 2        |
| Wood Lathe – 300mm Gap  | 1        |
| Air compressor (1 h.p.)   | 1        |
| <b><u>Portable Electric Tools</u></b>                                 |          |
| Portable Router (1 ½ h.p.)  | 1        |
| Circular Saw  | 1        |
| Drill   | 1        |
| Planer  | 1        |
| Sander  | 1        |
| <b><u>Pneumatic Tools</u></b>   |          |
| Nail gun  | 2        |
| Staple Gun  | 1        |
| Sander  | 1        |
| Spray Gun (set)   | 1        |
| <b><u>Safety Equipment</u></b>  |          |
| Biological Equipment  | 16       |
| Safety Glasses  | 16       |
| Respirators   |          |
| Desk Masks (disposable)   |          |
| Leather Gloves  |          |
| <b><u>Technology Equipment</u></b>                                    |          |
| Computer  | 6        |
| Printer   | 1        |
| Scanner   | 1        |
| Multimedia Projector  | 1        |
| Television  | 1        |
| Interactive board   | 1        |
| Software – CAD/CADD/CAM, Windows Productivity tools, Graphic Packages |          |

| ITEM | QUANTITY |
|------|----------|
|------|----------|

**Hand Tools**

**Squares**

|   |   |
|---|---|
| Sliding Bevel   | 5 |
| Try   | 5 |
| Framing   | 5 |
| Builders' Square (3:4:5) (to be fabricated in workshop) | 2 |

**Hand Saws**

|                            |   |
|----------------------------|---|
| Hand: Rip, Cross Cut, Back | 5 |
| Coping                     | 3 |

**Clamps**

|                             |    |
|-----------------------------|----|
| G (100, 150 and 200mm)      | 12 |
| Bar (1200mm with extension) | 6  |

**Bits**

|  |   |
|--|---|
| Braces and 3 sets of bits sizes 6mm – 32mm – 3mm intervals | 3 |
| Expansion  | 3 |
| High Speed   | 3 |
| Drill (3m – 13mm)  | 3 |
| Spade Bits ( set)  | 1 |
| Router Bits (set)  | 1 |
| Forstern Bits (set)  | 1 |
| Hole Saw (set)   | 1 |
| Dado Head  | 1 |

**Wood Chisel**

|                                    |   |
|------------------------------------|---|
| Bevel Edge (3mm – 25mm)            | 3 |
| Firmer (3mm – 25mm)                | 3 |
| Mortising (6mm – 13 mm)            | 3 |
| (Lathe) Turning tools – Heavy Duty | 1 |

**Planes**

|             |   |
|-------------|---|
| Jack        | 6 |
| Smoothing   | 4 |
| Fore        | 1 |
| Block Plane | 4 |

**Hammers**

|              |    |
|--------------|----|
| Claw hammers | 10 |
|--------------|----|

| ITEM                              | QUANTITY |
|-----------------------------------|----------|
| Sledge Hammers (2kg)              | 2        |
| Warrington Hammers                | 2        |
| <b>Mallets</b>                    |          |
| (Wooden) Mallets                  | 20       |
| Rubber Mallets                    | 2        |
| <b>Knives</b>                     |          |
| Utility knives                    | 6        |
| Marking knives                    | 10       |
| Putty knives                      | 6        |
| <b>Measuring and Layout Tools</b> |          |
| Marking Gauges                    | 10       |
| Mortise Gauges                    | 10       |
| Dividers                          | 6        |
| Calipers (internal and external)  | 6        |
| Nail Punches                      | 6        |
| 30m Measuring Tapes               | 2        |
| 5m Measuring Tapes                | 5        |
| Spirit Level (600mm long)         | 3        |
| Spirit Level (1200mm long)        | 3        |
| Chalk Line                        | 4        |
| Line Level                        | 6        |
| <b>Screwdrivers</b>               |          |
| Flat end (Assorted Sizes)         | 10       |
| Phillips (Assorted sizes)         | 10       |
| <b>Spoke Shaves</b>               |          |
| Flat                              | 4        |
| Round                             | 4        |
| Hatchet                           | 1        |
| <b>Additional Tools</b>           |          |
| Crowbars                          | 2        |
| Steel Fixers Nippers              | 2        |
| Pliers                            | 2        |
| Shares                            | 2        |
| Pick-Axes                         | 2        |
| Oil stones                        | 3        |

| ITEM                                       | QUANTITY |
|--|----------|
| Shovels (long and short handles)           | 4        |
| Trowels                                    | 6        |
| Steel Floats                               | 6        |
| Wood Floats (to be fabricated in workshop) | 6        |
| Trammel                                    | 1        |
| Hack Saw (with replacement blades)         | 2        |
| Cabinet Scrapers                           | 2        |
| Tile Cutter                                | 1        |
| Roller Stands                              | 2        |
| Extractor/Paint Bay                        | 1        |

## ◆ RESOURCES

The following is a list of books that may be used as resource material for the CXC Building Technology syllabus. The list is not exhaustive or prescriptive, but indicates sources which may be appropriate for use by teachers and students.

- Chudley, R. *Construction Technology*. London: Addison Wesley Longman, 1999.
- Greeno, R. *Principles of Construction*, (2<sup>nd</sup> Edition). London: Addison Wesley Longman, 1995.
- Hilton, F. *Carpentry and Joinery in the Tropics*. London: Addison Wesley Longman, 1997.
- Seeley, I. *Building Technology*. London: MacMillan, 1974.
- Kummer, N.  
Bielefeld, B. *Basic Masonry Construction*. Switzerland: Birkhauser-Publishers for Architecture, 2007.
- Kern, H. *Essential Guide to the Steel Square: Facts, Shortcuts and Problem Solving Secrets for Carpenters, Woodworkers and Builders*. Pennsylvania: Fox Chapel Publishing Company, 2007.
- Brotuck, T and  
Bielefeld, B. *Basic Roof Construction*. Switzerland: Birkhäuser-Publishers, 2007.
- PHCC Staff and Ater *Plumbing 201, 4<sup>th</sup> Edition*. Virginia: PHCC Educational Foundation, 2014.
- Newman, J. *Advanced Concrete Technology*. Oxford: Butterworth-Heinemann, 2003.
- Roger, S. *Opportunities in Carpentry Careers*. Illinois: VGM Career Horizons, 2007.
- Wagner, W. and Smith,  
H. *Modern Carpentry Workbook: Essential Skills for the Building Trades, 11<sup>th</sup> Edition*. Illinois: Goodheart-Willcox Publisher, 2007.
- Megson, T *Structural and Stress Analysis*. Oxford: Butterworth-Heinemann, 2005.
- Halliday, S. *Sustainable Construction*. Oxford: Butterworth-Heinemann, 2008.
- Incorporated Master Builders Association of Jamaica* *Basic Construction Manual for a Single Storey Domestic Dwelling*. Kingston: Incorporated Master Builders Association of Jamaica, 2008.
- ABC Building Dictionary*
- Revised CXC Teacher Resource Manuals (Building) Numbers 1-12*
- Local Building Code*



## ◆ GLOSSARY OF TERMS

| <u>WORD/TERM</u> | <u>DEFINITION/MEANING</u>   |
|------------------|---|
| 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   |

| <b><u>WORD/TERM</u></b> | <b><u>DEFINITION/MEANING</u></b>  |
|-------------------------|---|
| estimate                | make an approximate quantitative judgement  |
| 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   |

**WORD/TERM**

**DEFINITION/MEANING**

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

## ◆ GUIDELINES FOR INTEGRATING THE COMPETENCY BASED EDUCATION TRAINING AND ASSESSMENT APPROACH

### RATIONALE

*School-Based Assessment (SBA) is an integral part of candidates' assessment of the Industrial Technology offerings. It provides an opportunity to individualise a part of the curriculum to meet the needs of the students and facilitate 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. The SBA assists in the development of the critical skills and abilities emphasised by the subject and enhances the validity of the examination on which candidate performance is reported. It 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. In addition, the SBA caters to the multiple intelligences as various teaching and learning strategies are utilised; to provide students with the skills needed in everyday life. Through the SBA, students are provided with multiple opportunities and ways to develop and demonstrate knowledge, skills and attitudes.*

*The SBA score is derived from the composite marks of the entries in the School-Based Assessment portfolio which include the related CVQ Units of Competency aligned to the content in the syllabus. The CVQ is an award which represents the achievement of a set of competencies that define the essential (core) work practices of an occupational area consistent with the levels articulated within the Regional Qualifications Framework. It aims at the development of the Ideal Caribbean Worker, seeks to facilitate the movement of skilled certified workers within the CSME, enhances the quality profile and investment attractiveness of the work/labour force of CARICOM states and harmonises TVET systems across the region. The recognition of Unit competencies for the Level 1 CVQ will adhere to the standardised procedures currently operational in schools offering the CVQ programmes.*

### SCHOOL-BASED ASSESSMENT PORTFOLIO

*As part of the School-Based Assessment, candidates will be required to produce a portfolio providing evidence of candidates' progress and learning over the duration of the programmes. The evidence represents the formative and summative assessments of the programmes and are a compilation of all the learning experiences from commencement to the end of the programme. The Portfolio must mirror the key competencies (knowledge, skills, attitudes) required for the labour market and continuing studies.*

*Since the portfolio is an accumulation of the candidates' ongoing learning across the course of the two-year programme, it must be started at the commencement of the Industrial Technology Syllabuses. The guidelines provided in this document for selecting appropriate tasks are intended to assist teachers/facilitators and candidates in formulating assignments that are valid for the purpose of the SBA (Appendix II). The guidelines provided for the assessment of the assignments are intended to assist teachers/facilitators in awarding marks that are reliable indicators of the achievement of candidates in the SBA component of the Industrial Technology programmes.*

*For the effective delivery and assessment of this syllabus institutions must ensure the:*

- 1. Availability of the resources, through partnerships with industries, firms and other institutions.*
- 2. Comprehension of the assessment and certification requirements by all students.*
- 3. Readiness of candidate to demonstrate his or her knowledge and skills.*
- 4. High teaching and assessment standards through the Quality Control Procedures.*
- 5. Planning and organisation of authentic work experience opportunities which are critical for the development of competencies which are not achievable in the institution.*
- 6. Commencement of the portfolios at the beginning of delivery of the programme.*
- 7. The availability of Internal Verifiers\*.*
- 8. The Use of Delivery and Assessment plans. These are indispensable quality control measures and are encouraged to be joint activities between the teachers/facilitators and students. They are developed at the beginning of the delivery of the programmes.*
- 9. Monitoring of the completion and maintenance of the portfolio and ensuring the demonstration of competencies in all areas.*
- 10. The maintenance of the internal records for the portfolio.*

*\*An Internal Verifier is an employee of the institution and is responsible for ensuring the quality of the delivery and assessment of all the sections of the syllabus. The Internal Verifier assists the teachers/facilitators in the preparation of the delivery and assessment schedules and monitors the progress of the portfolio development as well as teachers' and students' record keeping. They support and work at ensuring accuracy and consistency in the application of the learning experience to achieve the acceptable levels of competence.*



## **ASSESSMENT**

*Assessments must produce evidence of the range and depth of skills, knowledge and application taught. Types of assessments may include teacher, peer, authentic and self-assessments. The tasks are to be structured to achieve a balance in both the formative (developmental) and summative (judgemental) roles of assessment.*

### **1. Peer/Group Assessment**

*Peer Assessment aims to develop the students ability to make independent judgements by involving them in evaluating and making decisions on other student's work. It is used as a group work activity involving a variety of assessment methods to develop students' team work and cooperative learning skills.*

## 2. Self-Assessment

*Self-Assessment aims to supplement teachers' assessment. It is an effective resource in allowing students to make judgements about their own learning and in allowing them to work at their own pace.*

## 3. Authentic Assessment

*Authentic assessment aims at providing a clear relationship with the knowledge, skills and attitudes being developed and the delivery and assessment activities. Authentic tasks are real and mirror realistic training which is transparent and evokes a strong commitment to study.*

### **METHODS OF ASSESSMENT**

*These may include:*

1. *oral and written examinations;*
2. *direct observation;*
3. *interviews;*
4. *demonstration of practical;*
5. *dual training (institution and industry. Effective for practicum);*
6. *learning contracts agreement between the staff and students;*
7. *computer-based assessment (provides flexibility in the time, location or even the questions being answered by students. Effective with multiple – choice questions); and,*
8. *portfolio assessment.*

### **PORTFOLIO ASSESSMENT**

*The portfolio is a student-centred communication approach that adequately reflects the teaching and learning experiences through authentic activities. This assessment provides teachers/facilitators an opportunity to participate in the progress of the students in a very broad context. This may include the observation of the students in exploring, experimenting, taking risks, developing creative solutions and learning to assess or make judgements about their own performances. The portfolio places a high premium on quality. It provides a strong feedback loop of continuous evaluation and improvement in teaching and learning. The portfolio is one of the major quality assurance vehicles for the provision of tangible and intangible evidence, attesting to the quality (relevance, validity, reliability) of educational delivery, assessment and outputs.*

*For the Industrial Technology Syllabus, students will compile a portfolio to provide evidence:*

- 1. That clearly shows the students progress. It is a compilation of all the learning experiences throughout the course and it is assessed by the internal verifier.*
- 2. Of the certification requirements (evidence and certificate) for the Caribbean Vocational Qualification (CVQ).*

### **CHARACTERISTICS OF THE PORTFOLIO ASSESSMENT**

*Portfolio Assessment is multi-dimensional in nature and has the following characteristics of quality:*

- 1. It is continuous and ongoing. It provides both formative and summative evaluation opportunities for monitoring the students' progress while they work toward the achievement of the learning outcomes.*
- 2. It uses a wide variety of tangible and intangible evidence (practical and written), reflecting various aspects of the delivery and learning processes.*
- 3. It is reflective; providing students an opportunity to analyse their performance and track the development of their competencies.*
- 4. Assessment results are used to improve the delivery and learning processes.*

### **CHARACTERISTICS OF THE PORTFOLIOS**

***The portfolio is a compilation of students' work based on the teaching and learning experiences and should:***

- 1. reflect the performance outcomes and objectives of the programmes being undertaken (from the beginning of the delivery process to the stage of being competent);*
- 2. focus on the essential competencies which are performance-based;*
- 3. contain samples of work from the commencement of the programme to the end;*
- 4. contain evidence that represent a variety of assessment methods; and,*
- 5. contain the evidence of the students' formative and summative development.*

### **PLANNING THE PORTFOLIO**

*This is a collaborative activity between the teachers/facilitators and students.*

*Steps.*

- 1. Discuss with the students of the importance of the portfolio as a means of monitoring and evaluating their progress.*

2. *Select the entries for the portfolio. These must reflect the learning outcomes and experiences.*
3. *Organise the evidence (cover page, table of contents, performance outcomes, artefacts, literary work, evaluation, reflection). Please see Appendix III for the Portfolio Development process.*
4. *Create an evaluation schedule.*
5. *Maintain and store.*
6. *Reflection on experiences by students. This can take the form of a journal and a learning log.*

### **EVALUATION OF THE PORTFOLIO**

*The teachers/facilitators are encouraged to use a variety of scoring strategies to evaluate the portfolio. The evaluation of the portfolio is a joint activity between the teachers and students. Both are involved in the selection of the criteria that will be used to assess and evaluate the evidence throughout the instructional period (formative) and at the end (summative). The use of a portfolio assessment rubric (cover design, authenticity of evidence, organisation of evidence, completeness, accuracy of information, self-reflective statement) is recommended for the portfolio evaluation.*

### **FEEDBACK**

*Feedback is an integral process in CBETA. High quality feedback consists of the following elements:*

1. *Clear criteria against which to judge the comments.*
2. *Detailed comments which are related to the performance of the students.*
3. *Comments that are geared at improvement.*

### **EVIDENCE FOR THE PORTFOLIO**

*The pieces of evidence MUST depict the candidates' developmental progress in each of the Section from which the evidence is derived. Where possible, it is advised that the Sections of the syllabus be integrated to give evidence of their full coverage.*

*The portfolio pieces must show the integration of CVQ Units where applicable. Teachers are encouraged to use the listing below as a guide to selecting pieces from each Section in the Industrial Technology syllabus:*

### **CORE**

#### **SECTION 1: FUNDAMENALS OF INDUSTRY**

*At least 10 pieces of evidence from Section 1*

1. *The organisation of a selected construction industry.*





2. *The organisation of a selected manufacturing industry.*
3. *Selection of industry codes and standard.*
4. *A set of safety rules to be followed in a workshop or on the worksite.*
5. *Treatment procedure for each of three injuries which can occur in the workshop/worksite (burns, eye injuries, electric shock, bleeding, falls).*
6. *Student duty roster and a maintenance programme for the workshop/worksite (machines, tools, general upkeep).*
7. *A set of photographs of students demonstrating the use of protective gear and equipment while working in the workshop or on a worksite.*
8. *A report on an accident prepared by the student.*
9. *A small business plan.*

## **SECTION 2: DESIGN PRINCIPLES AND PROCESSES**

*At least three (3) pieces of evidence from Section 2*

1. *The design principles, elements and processes.*
2. *Sketching of simple designs in related areas.*
3. *Report on the design analysis of a simple manufactured product.*

## **SECTION 3: INFORMATION COMMUNICATION AND GRAPHIC TECHNOLOGIES**

*At least three (3) pieces of evidence from Section 3*

1. *Samples of projects prepared in the operating principles of a computer.*
2. *A PowerPoint presentation on modern trends in engineering technologies.*
3. *Two projects or assignments from the use of communication devices.*

## **OPTION C: BUILDING AND FURNITURE TECHNOLOGY**

### **SECTION 1: THE NATURAL AND BUILT ENVIRONMENT**

*At least three (3) pieces of evidence from Section 1 that include:*

*Selection of a building and an explanation on how history, materials, culture and climate factors influence its design (Include photographs and site visits).*

## **SECTION 2: SITE WORK OPERATIONS**

*At least five (5) pieces of evidence from Section 2 that include:*

- 1. a completed checklist used in selecting a building site (temporary shelter, access road, services, and others);*
- 2. pictures/photographs of excavation methods; and,*
- 3. pictures/photographs of students laying setting out a building (step by step).*

## **SECTION 3: BASIC ARCHITECTURAL DRAWING**

*At least five (5) pieces of evidence from Section 3 that include:*

- 1. drawing projects (pictorial, detailed, exploded assembly, sectional);*
- 2. information on and sketches of the various types of carcass construction (framed, framed and panelled, solid end, solid); and,*
- 3. a design/redesign of a building component to solve simple functional problems in one of the categories, namely:*

*Categories*

- (a) Foundations.*
  - (a) Walls.*
  - (b) Floors.*
  - (c) Roofs.*
  - (d) Stairs.*
- 4. evidence of a plan sheet which include isometric drawing; orthographic drawing; list of materials with parts, size, materials and cost; list of steps or procedures.*

## **SECTION 4: TIMBER TECHNOLOGY**

*At least five (5) pieces of evidence from Section 4 that include a:*

- 1. research on the conversion of timber;*
- 2. research on the seasoning methods of wood; and,*
- 3. presentation on timber defects and their treatment.*

## **SECTION 5: BUILDING TECHNOLOGY**

*At least six (6) pieces of evidence from Section 5 that include:*

- 1. labelled sketches of at least six building tools and equipment;*
- 2. a collage or samples of various types of materials used in Carpentry; and,*
- 3. pictures/drawings of students using selected building tools, equipment and operations.*

## **SECTION 6: FURNITURE TECHNOLOGY**

*At least six (6) pieces of evidence from Section 6 that include:*

- 1. pictures/models of completed projects; and,*
- 2. samples of materials used in furniture construction, upholstery and finishing.*

## **PERFORMANCE INDICATORS**

- 1. Portfolios.*
- 2. Checklist.*
- 3. Task Sheet.*
- 4. Job Analysis Sheet.*
- 5. Performance Criteria Sheet.*
- 6. Quality Control Procedures.*
- 7. Training and Assessment Plans.*
- 8. Internal Verifier Records.*
- 9. Internal Competency Records.*
- 10. External Verifiers Records.*
- 11. Moderation Reports.*

**INTEGRATION OF CVQ UNITS FOR THE SBA**

*The list presented below have been mapped to the content in the syllabus, teachers are encouraged to use this information as they develop activities and projects for the School-Based Assessment Component of the course:*

**CCBCG10102 Level I in General Construction**

- (a) BCGCOR0011A Carry out OH&S requirements.
- (b) BCGCOR0021A Plan and organize work.
- (c) BCGCOR0031A Draw and interpret simple drawings.
- (d) BCGCOR0041A Carry out measurements and calculations.
- (e) BCGCOR0051A Use hand and power tools.
- (f) BCGCOR0061A Use small plant and equipment.
- (g) BCGMAS0101A Carry out concreting to simple forms.
- (h) BCGCOR0111A Handle construction materials and safely dispose of waste.
- (i) BCGMAS0181A Mix cementitious materials (mortar and concrete).

**CCLMF10103 Level I in Furniture Making** - supports the Furniture Technology section of the syllabus.

- (a) LMFFMK0021A Operate basic woodworking machine.
- (b) LMFFMK0031A Use furniture making hand and power tools.
- (c) LMFFMK0122A Set up, operate and maintain basic static machines.
- (d) LMFFMK0161A Construct furniture using leg and rail method.
- (e) LMFFMK0222A Select timbers for furniture production.

**SCHOOL BASED ASSESSMENT**  
**ASSESSMENT PLAN**  
**EXEMPLAR 1 - OPTION C - BUILDING AND FURNITURE TECHNOLOGY**

This School Based Assessment is aligned to Carry out concreting to simple forms (BCGMAS0101A) and Mix cementitious materials (mortar and concrete) (BCGMAS0181A) in the General Construction, Level I (CCBCG10102) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), use hand and Power Tools (BCGCOR0051A) and use small plant and equipment (BCGCOR0061A) may also be assessed with this assignment.

**CANDIDATE:** \_\_\_\_\_ **ASSESSOR:** \_\_\_\_\_

|   |   |
|---|---|
| <p><b>Elements (BCGMAS0101A)</b></p> <ul style="list-style-type: none"> <li>• Select tools and equipment</li> <li>• Erect and strip simple formwork</li> <li>• Place and tie reinforcement</li> <li>• Place concrete</li> <li>• Clean up</li> </ul>   | <p><b>Elements (BCGMAS0181A)</b></p> <ul style="list-style-type: none"> <li>• Plan and prepare work</li> <li>• Select and batch materials for mixing</li> <li>• Mix concrete</li> <li>• Mix mortar</li> <li>• Clean up</li> </ul> |
|   |   |
| <b>Work Activities</b>  | <b>Assessment Methods</b>   |
| <p>Your school requires additional outdoor seating for use by students during break and lunch sessions. Your building team has been presented with the drawings above and asked to complete five such benches. These benches are to be made of reinforced concrete in-situ and are to be anchored to the ground using reinforced concrete footings. You are required to layout and excavate the footings and install the benches using the required formwork.</p> | <ul style="list-style-type: none"> <li>• Practical demonstration</li> <li>• Oral questions</li> <li>• Finished product evaluation</li> </ul>  |

| Underpinning Knowledge and Skills   | Range   |
|---|---|
| <ul style="list-style-type: none"> <li>• Appropriate workplace and equipment safety practices</li> <li>• select and use hand tools and equipment to include levelling equipment accurately and safely</li> <li>• Concrete and formwork materials</li> <li>• Measure, proportion, transport and place concrete in keeping with industry standards</li> <li>• Measure and calculate ratio and proportion</li> <li>• simple formwork and reinforcement components</li> <li>• Select and handle materials appropriate to concreting processes</li> <li>• Use power tools and hand tools</li> <li>• Mix concrete by hand and with machine</li> <li>• Read, interpret and follow instructions</li> <li>• Communicate effectively</li> <li>• Determine range of mortar additives including plasticisers and their application</li> <li>• Work effectively with colleagues to execute task</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Materials.</b> Sand, coarse aggregate, Portland cement, Additives, Colouring (where appropriate)</li> <li>• <b>Simple forms and excavations.</b> Post holes, trench foundations, pad foundations, slabs, pathways, simple concrete aprons, channels, garden edges</li> <li>• <b>Formwork (edging forms).</b> Edge boards, pegs, struts, bracing</li> <li>• <b>Concrete finishes.</b> Wood floated, steel floated and broom brushed</li> <li>• <b>Personal protective equipment.</b> Overalls, boots, hard hat/cap, safety glasses/goggles, gum boots, face masks, waterproof pants and jacket.</li> <li>• <b>Concrete placement.</b> Shovel, wheelbarrow, Chute and pump line</li> <li>• <b>Mixtures.</b> Concrete and mortar mixed to correct specifications</li> <li>• Work is to be undertaken in a team situation or individually under supervision.</li> <li>• Reporting of faults may be verbal or written.</li> <li>• OH&amp;S requirements are in accordance with Statutory requirements</li> </ul> |
| <p><b>Candidate's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Assessor's Signature:</b> _____ <b>Date:</b> _____</p> <p><b>Internal Verifier's Signature:</b> _____ <b>Date:</b> _____</p>  |   |

**SCHOOL BASED ASSESSMENT**  
**EXEMPLAR 1 - OPTION C - BUILDING AND FURNITURE TECHNOLOGY**

**DIMENSIONS OF COMPETENCY**

This School Based Assessment is aligned to Carry out concreting to simple forms (BCGMAS0101A) and Mix cementitious materials (mortar and concrete) (BCGMAS0181A) in the General Construction, Level I (CCBCG10102) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), use hand and Power Tools (BCGCOR0051A) and use small plant and equipment (BCGCOR0061A) may also be assessed with this assignment.

| <b>WORK ACTIVITY:</b>   |  |
|---|--|
| <p>Your school requires additional outdoor seating for use by students during break and lunch sessions. Your building team has been presented with the drawings above and asked to complete five such benches. These benches are to be made of reinforced concrete in-situ and are to be anchored to the ground using reinforced concrete footings. You are required to layout and excavate the footings and install the benches using the required formwork.</p>   |  |
| <b>TASK SKILLS</b>  | <b>TASK MANAGEMENT SKILLS</b>  |
| <p>Candidate has to</p> <ul style="list-style-type: none"> <li>• Interpret activity</li> <li>• Follow health and safety requirements applicable to work environment</li> <li>• Select and accurately use the necessary tools, equipment</li> <li>• Comply with organisational policies and procedures including Quality Assurance requirements</li> <li>• Carry out correct procedures prior to and during construction processes</li> <li>• Mix concrete and mortar to work specifications</li> <li>• Identify and rectify typical faults and problems</li> <li>• Demonstrate safe and effective operational use of tools, plant and equipment</li> <li>• Interactively communicate with others to ensure safe and effective operations</li> </ul> | <p>Prepare/ organise/ co-ordinate by</p> <ul style="list-style-type: none"> <li>• Interpret and plan activity</li> <li>• Select tools, equipment and materials</li> <li>• Apply health and safety procedures</li> <li>• Organise work station</li> <li>• Work in a logical and sequential manner within the required time frame</li> </ul>                   |
| <b>CONTINGENCY MANAGEMENT SKILLS</b>  | <b>EMPLOYABILITY/ JOB ROLE/ ENVIRONMENT SKILLS</b>   |
| <p>What if ...?</p> <ul style="list-style-type: none"> <li>• Tools and equipment are insufficient or unavailable</li> <li>• Material estimates are inaccurate</li> <li>• There are delays in sourcing materials</li> </ul>  | <p>The candidate can ...</p> <ul style="list-style-type: none"> <li>• Collect, analyse and organise information</li> <li>• Communicate ideas and information</li> <li>• Plan and organise activities</li> <li>• Work with others and in team</li> <li>• Use mathematical ideas and techniques</li> <li>• Solve problems</li> <li>• Use technology</li> </ul> |

**Assessor's Signature** : \_\_\_\_\_ **Date:** \_\_\_\_\_

KEY  
 Competent - Range 3 and above  
 Not Yet Competent - below Range 3

**SCHOOL BASED ASSESSMENT  
 EXEMPLAR 1 - OPTION C - BUILDING AND FURNITURE TECHNOLOGY**

**ASSESSOR EVALUATION**

This School Based Assessment is aligned to Carry out concreting to simple forms (BCGMAS0101A) and Mix cementitious materials (mortar and concrete) (BCGMAS0181A) in the General Construction, Level I (CCBCG10102) Regional Occupational Standard. Carry out OH&S requirements (BCGCOR0011A), use hand and Power Tools (BCGCOR0051A) and use small plant and equipment (BCGCOR0061A) may also be assessed with this assignment

**Institution/ Centre:** \_\_\_\_\_

**Candidate's Name:** \_\_\_\_\_

| ASSESSMENT CRITERIA   | ASSESSOR |   |   |   |   |
|---|----------|---|---|---|---|
|   | 1        | 2 | 3 | 4 | 5 |
| <b>1. OCCUPATIONAL HEALTH AND SAFETY</b>  |          |   |   |   |   |
| Candidate is appropriately attired in Personal Protective gear at all times                                   |          |   |   |   |   |
| Occupational Health and Safety (OH&S) requirements for tasks and workplace environment adhered to             |          |   |   |   |   |
| All materials cleaned, stacked and stored for re-use or bundled for removal                                   |          |   |   |   |   |
| Pour site and surrounds cleared of concrete spills and other debris and surface left in safe condition        |          |   |   |   |   |
| Worksite cleared of debris and unused materials.  |          |   |   |   |   |
| Tools and equipment cleaned, maintained and stored.   |          |   |   |   |   |
| Surface for hand mixing concrete or mortar is safe and prepared according to work instruction                 |          |   |   |   |   |
| <b>2. PROCESS</b>   |          |   |   |   |   |
| Tools and equipment selected consistent with job requirements   |          |   |   |   |   |
| Tools and equipment checked for serviceability and any faults reported or rectified                           |          |   |   |   |   |
| Drawings accurately interpreted   |          |   |   |   |   |
| Formwork accurately erected   |          |   |   |   |   |
| Reinforcing materials accurately selected   |          |   |   |   |   |
| Reinforcing components safely handled and carried to required position  |          |   |   |   |   |
| Formwork/excavation cleaned of excess material and debris prior to concrete placement.                        |          |   |   |   |   |
| Concrete correctly proportioned and mixed and/or safely transported by wheelbarrow and placed under direction |          |   |   |   |   |
| Pump line/chute controlled and concrete placed as directed  |          |   |   |   |   |
| Formwork accurately stripped on instruction   |          |   |   |   |   |
| <b>3. PRODUCT</b>   |          |   |   |   |   |
| Quality Assurance requirements recognised and adhered to in accordance with company's construction operations |          |   |   |   |   |
| Surface of concrete finished as directed to specified finish  |          |   |   |   |   |
| Concrete consolidated under direction and screeded to finished levels as directed                             |          |   |   |   |   |
| Concrete spread as directed to specified levels   |          |   |   |   |   |



**Comment/ Feedback:**

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**Rating Scale:**

1. Cannot perform this task.
2. Can perform this task with **constant** supervision and **considerable** assistance.
3. Can perform this task with **constant** supervision and **some** assistance.
4. Can perform this task satisfactorily with periodic supervision.
5. Can perform this task satisfactorily with little or no supervision.

**Assessor's Signature** : \_\_\_\_\_ **Date:** \_\_\_\_\_

**Candidate's Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

### Portfolio Development Guidelines

A portfolio is an organised convenient means of collection and presentation of materials which records and verifies a candidate's learning achievements and relates them to the depth and breadth of work required by each unit of the occupational standards. The depth and breadth of work should include a diversity of exhibits which reflects the following **criteria**:

- Writing, Reading and Comprehension Skills
- Critical Thinking and Problem Solving Skills
- Technology Skills
- Practical Skills
- Teamwork Skills

The outline of the portfolio should include information under the following headings:

- Cover Page
- Title Page
- Table of Contents
- Introduction
- Supporting Evidence (Depth & Breadth of Work)
- Self Assessment/Reflection

#### **Details of EACH Heading**

##### **Cover Page**

- Name of School
- Occupational Area CVQ Level 1
- Assessors Name
- Candidate's Name
- Year

##### **Title Page**

- Caribbean Vocational Qualification
- CVQ Level 1
- Occupational Area
- Year

##### **Table of Contents**

- By units
- Number pages

##### **Introduction**

- Portfolio of candidate to include personal data, background information on education / training experiences and expectations.

### **Supporting Evidence**

Provides information on the key formative and summative assignments / projects undertaken by the candidates to achieve the performance criteria in each unit on the Occupational Standards. All evidence supplied by the candidate should be reviewed by the assessor using the **criteria given**. **Evidence must be signed and dated on the date of the review by the assessor.**

#### **Suggestions for supporting evidence:**

- Written Assignment
- Oral Questions (checklist format)
- Projects
- Work Samples
- Research Assignments
- Fieldtrip reports
- Summative evaluation of practical work
- Digital photographs of candidates performing critical tasks

#### **Self-Assessment/Reflections**

Allows candidates to rate their performance against the requirements of the relevant unit/s of competency and allows candidates to reflect in writing whether their expectations have been achieved in the particular occupational area.

#### **Summary**

*Each candidate* in every occupational area *must* prepare a portfolio which will showcase:

- Growth and development of the candidate during the two year period.

Portfolios *must* be kept for evaluation by the Internal Verifier, External Verifier and the Quality Assurance auditor of the Caribbean Examination Council.

**Western Zone Office**  
**13 April 2015**

# CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Secondary Education Certificate®



## INDUSTRIAL TECHNOLOGY

### Specimen Papers and Mark Schemes/Keys

**Specimen Papers:** - Paper 01  
Paper 02 Option A (Electrical and Electronic Technology)  
Paper 02 Option B (Mechanical Engineering Technology)  
Paper 02 Option C (Building and Furniture Technology)

**Mark Schemes and Keys:** - Paper 01  
Paper 02 Option A (Electrical and Electronic Technology)  
Paper 02 Option B (Mechanical Engineering Technology)  
Paper 02 Option C (Building and Furniture Technology)



**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**

**C A R I B B E A N   S E C O N D A R Y   E D U C A T I O N   C E R T I F I C A T E ®  
E X A M I N A T I O N**

**I N D U S T R I A L   T E C H N O L O G Y**

**S P E C I M E N   P A P E R**

**P a p e r   0 1 – G e n e r a l   P r o f i c i e n c y**

*75 minutes*

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This test consists of 60 items. You will have 75 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. 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.
4. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

In drawings, thin short dashes represent

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

Sample Answer



The best answer to this item is “hidden details,” so answer space (B) has been shaded.

5. If you want to change your answer, erase it completely before you fill in your new choice.
6. 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 this item later. Your score will be the total number of correct answers.
7. You may do any rough work in this booklet.
8. Figures are not necessarily drawn to scale.

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

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1. When a safety hazard cannot be eliminated, students should
  - (A) avoid the hazard
  - (B) ignore the hazard
  - (C) guard or mark off the hazard
  - (D) share the information with other students
  
2. The MOST common injury causing absence from work is
  - (A) burns
  - (B) back injury
  - (C) broken bones
  - (D) cuts and bruises
  
3. Workers practice good housekeeping in the workplace to
  - (A) prevent accidents
  - (B) improve productivity
  - (C) prevent equipment failure
  - (D) organise tools and equipment
  
4. Personal protective equipment (PPE) must be maintained by the
  - (A) worker
  - (B) employer
  - (C) safety officer
  - (D) work supervisor
  
5. Which of the following types of fire extinguishing materials is BEST used on oil fires?
  - (A) Foam
  - (B) Water
  - (C) Dry powder
  - (D) Carbon dioxide (CO<sub>2</sub>)
  
6. Which of the following represents the size relationship of the parts of a whole?
  - (A) Line
  - (B) Scale
  - (C) Shape
  - (D) Proportion
  
7. Colours are said to be contrasting if they are
  - (A) dark in value
  - (B) light in value
  - (C) bright and intense
  - (D) different in lightness and darkness
  
8. Which of the following factors determine the appropriateness of a design?
  - (A) Aesthetics, functionality, economic, environment
  - (B) Functionality, convention, communication, environment
  - (C) Environment, manufacture, evaluation, economic
  - (D) Communication, evaluation, functionality, solution
  
9. In which stage of the design process, is detailed costing of a product BEST made?
  - (A) Generating ideas
  - (B) Developing a chosen solution
  - (C) Researching and specifications
  - (D) Planning and realising the chosen solution

- 10.** Detailed orthographic drawings are BEST used to show
- (A) early stages of product development
  - (B) 3D views of a finished product
  - (C) the dimensions of a finished product for manufacturing
  - (D) how mechanical components fit together to make a product
- 11.** Which stage of the design process is likely to involve mathematical models?
- (A) Identifying the problem and the brief.
  - (B) Researching and specifications.
  - (C) Developing the chosen solution.
  - (D) Planning and realising the chosen solution.
- 12.** It is important to annotate freehand sketching to
- (A) explain the thinking behind the visual images
  - (B) show the proposed solution in 3D
  - (C) enable them to be used in production drawing
  - (D) enable numerical manipulation
- 13.** At which stage in the design process, would orthographic drawings be MOST relevant?
- (A) Generating ideas
  - (B) Developing the chosen solution
  - (C) Planning and realising the chosen solution
  - (D) Testing and evaluating the chosen solution
- 14.** The role of a quantity surveyor is to
- (A) prepare working drawings
  - (B) set out a building on a site
  - (C) prepare a bill of quantities
  - (D) manage the finances of a construction project
- 15.** Which of the following members of the building team carries the greatest level of responsibility on a construction site?
- (A) Trade foreman
  - (B) Project manager
  - (C) Contractor
  - (D) Civil engineer
- 16.** A technical worker in construction and manufacturing industries is paid more than a skilled or semi-skilled worker because they have
- (A) a better position
  - (B) highly academic qualifications
  - (C) higher levels of knowledge and skills
  - (D) greater production output

- 17.** A top down structure in an organisational chart shows a
- (A) hierarchical relationship between workers
  - (B) horizontal relationship between workers
  - (C) hierarchical and horizontal relationship between categories of workers
  - (D) hierarchical and horizontal relationship between each worker
- 18.** The role of civil and structural engineering is to produce buildings for
- (A) domestic use only
  - (B) the banking sector
  - (C) industrial use
  - (D) public use
- 19.** Which of the following are standards used in building construction?
- (A) ANSI, BSI, ISO standards
  - (B) CUBIC, CARIFORUM, ISO standards
  - (C) Building regulation, ABNSI, BSI
  - (D) ANSI, CUBIC, ISO standards
- 20.** Which of the following names is given to a group of computers in an organization that are connected to each other?
- (A) The internet
  - (B) An intranet
  - (C) An extranet
  - (D) A subnet
- 21.** In the area of computer communications, smart phones and tablets are connected to computer networks via
- (A) fibre optic cables
  - (B) dial-up network connections
  - (C) GPRS technologies
  - (D) WiFi technologies
- 22.** Which of the following is NOT a form of pictorial drawing?
- (A) Orthographic
  - (B) Isometric
  - (C) Oblique
  - (D) Cavalier
- 23.** Which of the following are used for developing and presenting project work?
- I. PowerPoint
  - II. Autocad
  - III. Prezi
  - IV. Excel
- (A) I only
  - (B) I and II only
  - (C) II and III only
  - (D) I, II, III and IV



- 24.** In the area of Information and Communication Technologies, the term multimedia is BEST defined as, “The combined use of
- (A) animations in computer applications only.
  - (B) sound and video in computer applications only.
  - (C) sound, pictures, video and animations in computer applications.
  - (D) sound, pictures, video, animations and text in computer applications.
- 25.** Which of the following is the CORRECT sequence in the design of products or services?
- (A) Preliminary design, screening, concept generation, evaluation and improvement, prototyping and final design
  - (B) Concept generation, screening, preliminary design, prototyping and final design, evaluation and improvement
  - (C) Preliminary design, screening, concept generation, prototyping and final design, evaluation and improvement
  - (D) Concept generation, screening, preliminary design, evaluation and improvement, prototyping and final design
- 26.** A path made by a moving point is a
- (A) line
  - (B) shape
  - (C) space
  - (D) texture
- 27.** Which of the following are three-dimensional forms?
- (A) Cylinders, cubes, spheres, cones
  - (B) Circles, squares, rectangles, triangles
  - (C) Cylinders, triangles, cubes, cones
  - (D) Circles, cylinders, cubes, cones
- 28.** Artists create visual weight with
- (A) balance
  - (B) emphasis
  - (C) pattern
  - (D) rhythm
- 29.** Which of the following factors MOST influence the success of an innovation?
- (A) Timing, aesthetic, ergonomics
  - (B) Marketing, product demand, timing
  - (C) Available technologies, economy, durability
  - (D) Product demand, available technologies, aesthetics
- 30.** When is a design solution MOST appropriate?
- (A) When it is recyclable.
  - (B) When it meets the budget.
  - (C) When it is multifunctional
  - (D) When it meets the needs of the client.

**31.** When using a grinder, the eyes should be protected by

- (A) wearing gloves
- (B) wearing goggles
- (C) holding the work firmly
- (D) holding the work on the tool rest

**32.** Earthing, bonding and protective devices in electrical installations will

- (A) stop circuit overload
- (B) eliminate electric faults
- (C) reduce the risk of electric shock
- (D) reduce the risk of electrical fires

**33.** When must employers identify possible workplace hazards?

- (A) When the need arises
- (B) When directed to by authorities
- (C) Before workers return from lunch
- (D) Before making changes to work practices

**34.** Which of the following should you do, if you see some co-workers doing a job in a way that could cause them to get hurt?

- (A) Ignore them
- (B) Run for cover
- (C) Inform your supervisor
- (D) Tell your co-workers you are concerned and why you are concerned.

**35.** Which of the following should be done if your PPE needs to be repaired?

- (A) Take your PPE home to fix
- (B) Share with a co-worker until yours can be fixed
- (C) Tell your supervisor and get your PPE replaced
- (D) Carry on with your task; it won't matter if you don't use PPE this one time

**36.** Ergonomics is the science of

- (A) worker comfort
- (B) making work simpler
- (C) determining the work attitude to adopt
- (D) fitting the job or work environment to the worker

**37.** Which of the following is NOT a part of the design process?

- (A) Product selection
- (B) Identifying the problem
- (C) Critical analysis of the problem
- (D) Development of working drawings

**38.** Which of the following is NOT a factor in determining the appropriateness of a design?

- (A) Shade
- (B) Aesthetics
- (C) Functionality
- (D) Suitability of material

**Item 39** refers to the following statements.

- I. Development of working drawings.
- II. Communication of design ideas.
- III. Selection of the best solution.

**39.** Which of the statements above are stages in the design process?

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

**40.** A product developer has completed the prototype of a product he was developing. Which of the following is the next sequential step to completing the design process?

- (A) Analyzing the problem
- (B) Testing and evaluating
- (C) Generating alternative solutions
- (D) Communication of the design ideas

**41.** A product developer is designing a number of products for a client who specifies that the products are to be used by persons of various weights and heights. Which of the following factors should he consider during the design process?

- (A) Economics
- (B) Functionality
- (C) Anthropometrics
- (D) Suitability of material

**42.** The area around machines should be

- (A) free from scraps
- (B) waxed and smooth
- (C) clearly painted in red
- (D) stacked with useful material

**43.** The most effective agent to use when putting out an electrical fire is

- (A) sand
- (B) water
- (C) oxygen
- (D) carbon dioxide

**44.** In mouth-to-mouth artificial respiration, tilting the head backwards ensures

- (A) a clear airway into the victim's lungs
- (B) a good supply of blood to the victim's brain
- (C) effective breathing in position for the rescuer
- (D) automatic rise and fall of the victim's chest

**45.** Which of the following should be carried out LAST when treating an unconscious person who has had an electric shock?

- (A) Treating burns
- (B) Loosening tight clothing
- (C) Keeping airways to the lungs clear
- (D) Administering artificial respiration

**46.** The immediate action which should be taken to assist a person suffering from the effect of toxic fumes is to

- (A) seek medical assistance
- (B) apply artificial respiration
- (C) open all doors and windows
- (D) remove the person from the danger

**47.** Which of the following devices is MOSTLY used to input data to a computer system?

- (A) UPS
- (B) Keyboard
- (C) Mouse pad
- (D) Floppy disk

**48.** Computer-aided manufacturing is the use of computer software to

- (A) reduce the amount of labour intensive activities
- (B) control the manufacture of high quality parts
- (C) move work pieces around the manufacturing plant
- (D) control machine tools and related machinery in the manufacturing of work pieces

**Item 49** refers to the following statements.

- I. Create a faster production process.
- II. Use only the required amount of material.
- III. Produce components and tooling with more precise dimensions.

**49.** Which of the statements above are purposes of computer-aided manufacturing?

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

**50.** Which of the following operations is NOT done using computer numerically controlled machines?

- (A) Milling
- (B) Turning
- (C) Filing
- (D) Plasma cutting

**51.** Entrepreneurship is the capacity and willingness to

- (A) create a business opportunity
- (B) manage a business belonging to someone else
- (C) take a business beyond the development stage
- (D) develop, organize and manage a business venture

52. Which of the following is NOT a characteristic of an entrepreneur?

- (A) Low work ethic
- (B) Good technical skills
- (C) Key personal attributes
- (D) Strong managerial competencies

53. Which of the following individuals is responsible for the design of private and commercial buildings?

- (A) Architect
- (B) Civil engineer
- (C) Quantity surveyor
- (D) Structural engineer

Item 54 refers to the following tradesmen in the construction industry.

- I. Mason
- II. Electrician
- III. Upholsterer

54. Which of the tradesmen listed above are involved in building a domestic dwelling house?

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

55. Which of the following groups of tradesmen are responsible for applying finishes to buildings?

- (A) Painters, machine operators, fitters, plumbers
- (B) Painters, plumbers, carpenters, electricians
- (C) Fitters, plumbers, machine operators, carpenters
- (D) Welders, electricians, carpenters, fitters

Item 56 refers to the following statements.

- I. Reduces greenhouse gas emissions
- II. Reduces the amount of waste sent to landfills and incinerators
- III. Prevents pollution by reducing the need to collect new raw materials

56. Which of the statements are benefits of recycling?

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

57. Which of the following is NOT a method of recycling?

- (A) Reusing
- (B) Screening
- (C) Composting
- (D) Energy recovery

Item 58 refers to the following statements.

- I. Requires minimum land.
- II. Can be operated in any weather.
- III. Refuse volume is reduced considerably.

**58.** Which of the above statements are advantages of incineration?

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

**59.** Group project work completed by some students was displayed on the school's intranet. What benefit does this have over publishing the work on the internet?

- (A) Work cannot be copied.
- (B) The intranet is safe from viruses.
- (C) Hyperlinks to other websites cannot be used.
- (D) The projects remain private within the school.

**60.** In information technology, WAN stands for

- (A) Wide Array Net
- (B) WAP Area Network
- (C) Wide Area Network
- (D) Wireless Area Network

**END OF TEST**

| CSEC Industrial Technology – Specimen 2015 |     |                    |
|--|-----|--------------------|
| Item                                       | Key | Syllabus Reference |
| 1  | C   | 1:5.1              |
| 2  | B   | 1:5.1              |
| 3  | A   | 1:5.1              |
| 4  | A   | 1:6:a (viii)       |
| 5  | C   | 1:6: d (iii)       |
| 6  | D   | 2:1:6              |
| 7  | D   | 2:2:b & c          |
| 8  | A   | 2:4:c(ii)          |
| 9  | B   | 2:3:c              |
| 10   | C   | 2:3:e              |
| 11   | C   | 2:3:e              |
| 12   | A   | 2:3:c              |
| 13   | B   | 2:3:d              |
| 14   | C   | 1:4:a(iii)         |
| 15   | B   | 1:4:a              |
| 16   | C   | 1:3                |
| 17   | C   | 1:2:a (i)          |
| 18   | D   | 1:1:b (iii)        |
| 19   | A   | 1:5.5:a            |
| 20   | B   | 3:2:a (i)          |
| 21   | D   | 3:3:a              |
| 22   | A   | 3:4: a(i)          |
| 23   | B   | 3:2:a (iv)         |
| 24   | D   | 3:1                |
| 25   | D   | 2:3                |
| 26   | A   | 2:2:a              |
| 27   | A   | 2:1:f              |
| 28   | C   | 2:2:a              |
| 29   | B   | 2:2 (v)            |
| 30   | D   | 2:5:c              |
| 31   | B   | 1:6:a(viii)        |
| 32   | C   | 1:5.2:c            |
| 33   | D   | 1:5.1:a (i)        |
| 34   | D   | 1:5.1:d            |
| 35   | C   | 1:6:a (ix)         |
| 36   | D   | 2:4:e              |
| 37   | A   | 2:3                |
| 38   | A   | 2:4                |
| 39   | D   | 2:3                |
| 40   | B   | 2:3                |
| 41   | C   | 2:4                |
| 42   | A   | 1:6:c (i)          |
| 43   | D   | 1:6:d (iii)        |
| 44   | A   | 1:6:f (iv)         |

| CSEC Industrial Technology – Specimen 2015 |     |                    |
|--|-----|--------------------|
| Item                                       | Key | Syllabus Reference |
| 45   | A   | 1:6:f (iii)        |
| 46   | D   | 1:6:i              |
| 47   | B   | 3:2:a (iv)         |
| 48   | D   | 3:6:b              |
| 49   | D   | 3:6:b              |
| 50   | C   | 3:6:c              |
| 51   | D   | 1:4:b (i)          |
| 52   | A   | 1:4:b              |
| 53   | A   | 1:4:a 9 (ii)       |
| 54   | A   | 1:4:a (i)          |
| 55   | B   | 1:4:a (i)          |
| 56   | D   | 1:6:b (iii)        |
| 57   | B   | 1:6:b (iii)        |
| 58   | D   | 1:6:b (ii)         |
| 59   | D   | 3:3:a (i)          |
| 60   | C   | 3:3:a (il)         |



**SPEC 2015/01337020**



**TEST CODE 01337020**

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**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®  
EXAMINATION**

**OPTION A – ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**SPECIMEN PAPER**

**Paper 02 – Technical Proficiency**

*2 hours 10 minutes*

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of FIVE compulsory questions.
2. Each question is worth 18 marks.
3. All working must be CLEARLY shown.
4. Use sketches where necessary to support your answers.
5. Silent non-programmable calculators may be used.
6. You are advised to take some time to read through the paper and plan your answers.

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**Answer ALL Questions.**

1. (a) (i) State Ohm's law in words and symbols. **(2 marks)**
- (ii) Explain briefly the term 'resistivity of a material'. **(2 marks)**
- (iii) Explain briefly the term 'temperature coefficient of a material'. **(2 marks)**
- (b) Two resistors of 10 ohms and 40 ohms are connected in parallel. A third resistor of 5 ohms is connected in series with the combination and a direct current supply of 240 volts is supplied to the ends of the complete circuit.
- (i) Produce a circuit diagram of the complete circuit. **(6 marks)**
- (ii) Calculate the current in each resistor. **(3 marks)**
- (iii) Calculate the total resistance in the circuit. **(3 marks)**
- Total 18 marks**
2. (a) (i) State the difference between primary and secondary cells. **(2 marks)**
- (ii) State TWO safety precautions which should be observed when charging secondary cells. **(2 marks)**
- (iii) State the TWO **main** indicators of a FULLY charged lead-acid cell and describe ONE instrument that can be used to measure ONE of the indicators. **(2 marks)**
- (b) A 6 ohm resistor is connected across a lead-acid battery. The potential difference across the battery terminals is 20 V for the open-circuit condition and 18 V when the circuit is closed.
- (i) Using the symbol for a lead-acid cell, produce a drawing showing the number of cells and polarity of each cell and the battery. **(3 marks)**
- (ii) Produce a circuit diagram of the complete circuit when it is in the closed condition. **(3 marks)**
- (iii) Calculate the internal resistance of the lead-acid battery. **(3 marks)**

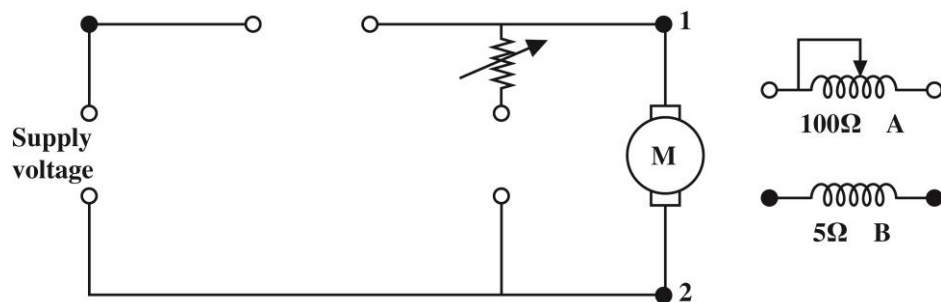
- (iv) Calculate the charging current required to charge a 100 AH battery at the 8-hour charging rate.

**(3 marks)**

**Total 18 marks**

- 3. (a) (i) State Lenz's law and Faraday's law of electromagnetic induction. **(2 marks)**
- (ii) Define mutual inductance and self-induction in electrical circuits. **(2 marks)**
- (iii) Define the term 'electrostatic screening in transformers'. **(2 marks)**

- (b) Figure 1 shows the incomplete sketch of a compound wound direct current motor circuit. The missing windings are shown separately.



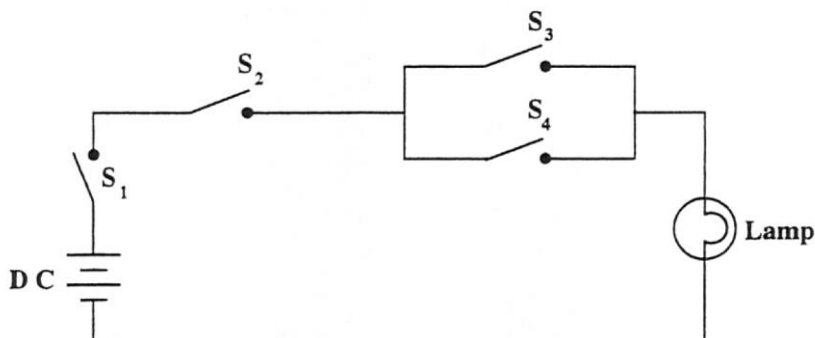
**Figure 1**

- (i) In your answer booklet, draw the complete circuit, insert the windings A and B in their positions in the motor circuit, and show the polarity of the direct current supply to the motor. **(3 marks)**
- (ii) Produce circuit drawings for series, shunt and compound connected direct current machines. **(3 marks)**
- (iii) State TWO different ways in which the speed of a motor can be increased. **(3 marks)**
- (iv) Explain the effect on the performance of the motor if terminals 1 and 2 are interchanged.

**(3 marks)**

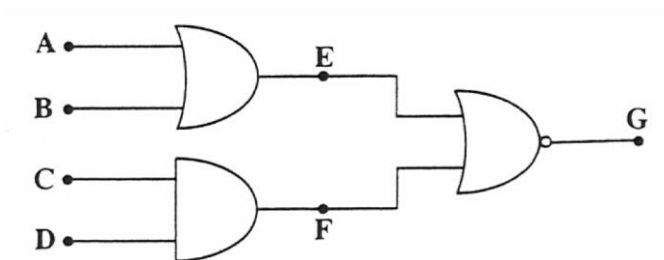
**Total 18 marks**

4. Figure 2 shows an electric lamp which is controlled by the switches  $S_1$ ,  $S_2$ ,  $S_3$  and  $S_4$ .



**Figure 2**

- (a) (i) Name THREE semi-conductor devices which are used as fast switching elements in the construction of logic circuits. (3 marks)
- (ii) Name the TWO logic gates that can replace the four switches and the combinational gate that can replace the switching arrangement in the circuit. (3 marks)
- (iii) Using the three switches,  $S_2$ ,  $S_3$  and  $S_4$ , as inputs and the electric lamp as an output, draw the truth table of the circuit. (Assume that the open state of the switches is represented by logic 0, and the closed state is represented by logic 1 and that the state of switch  $S_1$ , is logic 1 or is closed.) (6 marks)
- (b) A logic circuit is shown in Figure 3.



**Figure 3**

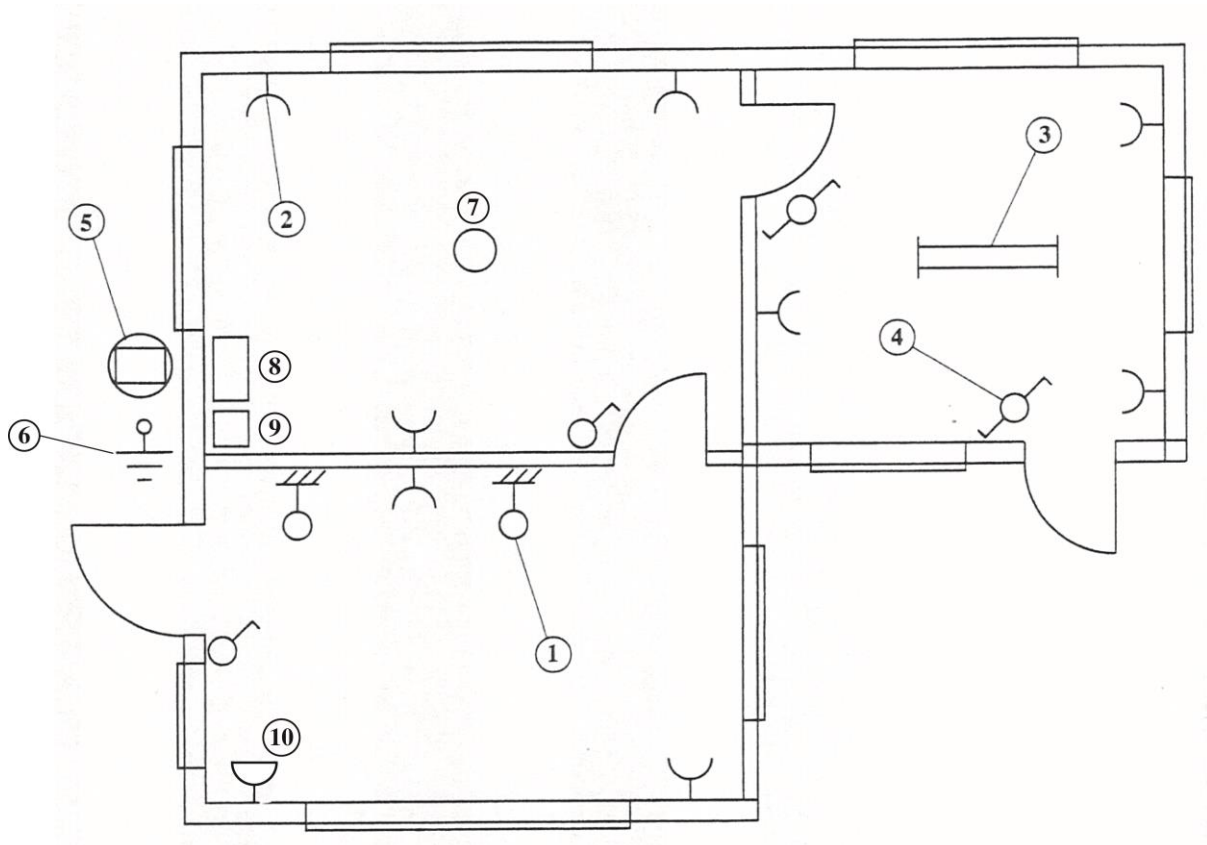
A, B, C and D represent inputs to the circuit. Derive expressions for output

- (i) E  
 (ii) F  
 (iii) G

**(6 marks)**

**Total 18 marks**

5. Figure 4 shows the electrical floor plan of a building with items labelled 1 to 10.



**Figure 4**

- (a) (i) In your answer booklet, write the numbers 1, 2, 3, 4, 5 and 6. Next to EACH number, write the name of the electrical item it represents. **(3 marks)**
- (ii) Explain briefly the MAIN function of any THREE electrical items named in (a) (i) above. **(3 marks)**
- (b) (i) Using standard drawing symbols, produce a single line drawing of a three-phase, four-wire industrial electrical installation that shows the supply authority's service entrance, energy meter, main control, main distribution board, power control and lighting control. **(6 marks)**

(ii) State ONE electrical safety test that must be conducted on all new installations **before** the power supply is connected to the circuit.

**(1 mark)**

(iii) Outline the procedure for conducting insulation resistance tests between the conductors, and between the conductors and earth in a completed electrical installation.

**(5 marks)**

**Total 18 marks**

**END OF TEST**

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EXAMINATION**

**OPTION A – ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**PAPER 02 – TECHNICAL PROFICIENCY**

**SPECIMEN PAPER**

**SOLUTIONS AND MARK SCHEME**

**Solutions – Question 1**(a) (i) Ohm's law

The current (I) flowing in a circuit varies directly to the voltage (V) and indirectly to the resistance (R) at a constant temperature.

Relationship:

$$1 = \frac{V}{R} \quad \text{OR} \quad V = IR \quad \text{OR} \quad R = \frac{V}{I}$$

**(2 marks)**

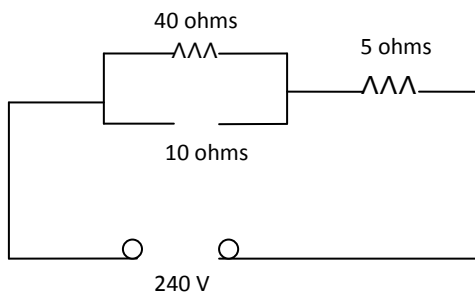
(ii) The resistivity of a material is the resistance of a unit cube of the material measured across opposite faces of the cube.

**(2 marks)**

(iii) The temperature coefficient of a material is the increase in the resistance of a one ohm resistor of the material when it is subjected to a rise in temperature of one degree centigrade.

**(2 marks)**

(b) (i)

**(6 marks)**

|                            |                |
|----------------------------|----------------|
| Parallel connection        | <b>2 marks</b> |
| Series connection          | <b>1 mark</b>  |
| Supply voltage             | <b>1 mark</b>  |
| Series-parallel connection | <b>2 marks</b> |

(b) (ii) Current through each resistor

$$I_t = V_s/R_t$$

$$= 240/13 = 18.46 \text{ amps} = \text{current through the 5 ohm resistor}$$

**(1 mark)**

Voltage across the parallel group

$$8 \text{ ohms} \times 18.46 = 147.69 \text{ V}$$

Current through 40 ohm resistor

$$147.69/40 = 3.69 \text{ amps}$$

**(1 mark)**



-3-

Current through 10 ohm resistor  
 $147.69/10$   
 $= 14.769$  amps

**(1 mark)**

$$(b) \quad (iii) \quad \frac{1}{R_p} = \frac{1}{40} + \frac{1}{10} = \frac{1}{40} + \frac{4}{40}$$

$$= \frac{5}{40} = \frac{1}{8}$$

$$R_p = 8 \Omega$$

$$R_T = 8 \Omega + 5 \Omega$$

$$= 13 \Omega$$

**(3 marks)****Total 18 marks****Solutions – Question 2**

(a) (i) The primary cell cannot be recharged while the secondary cell can be recharged. **(2 marks)**

(ii) The room must be well ventilated

The charging rate by the manufacturer should be observed.

Correct polarity must be observed when connecting cells to charger device.

**1 mark each for any TWO (2 marks)**

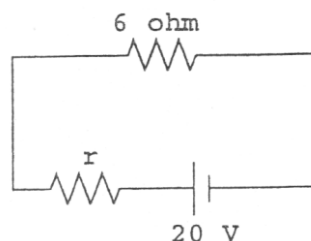
(iii) • Lead — acid cell consists of two sets of plates immersed in an electrolyte of dilute sulphuric acid.

• The plates are constructed in the form of lead grids which serve as a frame to support the active paste; a mixture of lead oxides and sulphuric acid.

• During charging the active material is converted to lead dioxide on the positive electrode and to spongy lead on the negative electrode.

**(2 marks)**

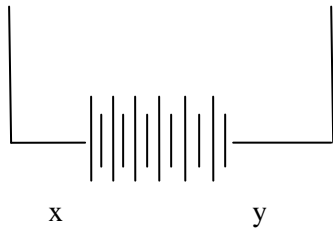
(b) (i)



Open circuit – 20 V  
 Closed circuit – 18 V

**(3 marks)**

(b) (ii)

**(3 marks)**

(b) (iii)

$$\begin{aligned}
 I &= \frac{V}{R} \\
 &= \frac{18}{6} \\
 &= 3 \text{ amps}
 \end{aligned}$$

**(3 marks)**

(b) (iv)

$$\begin{aligned}
 r &= \frac{v}{I} = \frac{(\text{open ckt} - \text{closed ckt})^v}{I} \\
 &= \frac{20-18}{3} \\
 &= \frac{2}{3} \\
 &= 0.67 \Omega
 \end{aligned}$$

Battery capacity = A × HRS  
Capacity = AH

$$\text{Charging current} = \frac{100 \text{ AH}}{8 \text{ HOURS}}$$

Charging Current = 12.5 A

**(3 marks)****Total 18 marks**

**Solutions – Question 3**

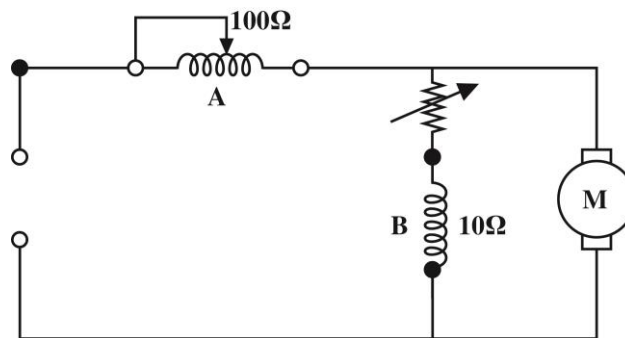
(a) (i) Lenz’s law: The induced electromotive force produces a current that opposes the motion producing it. **(1 mark)**

Faraday’s law: Relative motion between a conductor and lines of magnetic force so that the conductor cuts lines of force and e.m.f is induced in the conductor. **(1 mark)**

(ii) When charging current in a circuit induces an e.m.f in the circuit, the induced emf is a self-induced e.m.f. **(2 marks)**

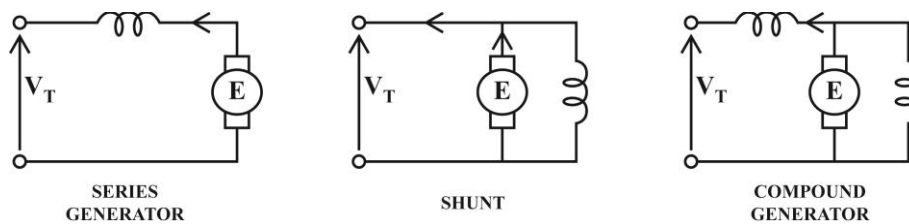
(iii) Earthed metal screen between the windings of the transformer to reduce the capacitive effect of the windings. **(2 marks)**

(b) (i)



**(3 marks)**

(ii)



**(3 marks)**

(iii) To increase the speed, increase the supply voltage or increase the fluid strength. **(3 marks)**

(iv) The direction of rotation will change. **(3 marks)**

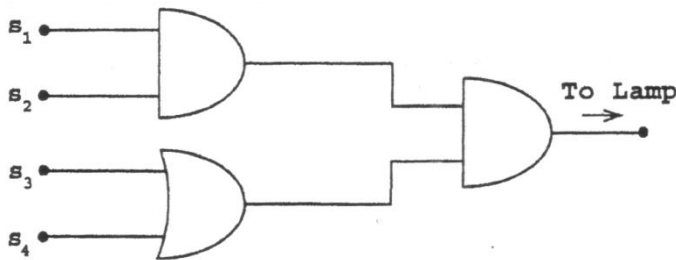
**Total 18 marks**

**Solutions – Question 4**

(a) (i) Three semiconductor devices are: transistors, thyristors and Silicon Control Rectifiers **(3 marks)**

(ii) Two logic gates: AND Gate, OR Gate  
NAND/NOR **(3 marks)**

(iii) Equivalent logic circuit



| S <sub>2</sub> | S <sub>3</sub> | S <sub>4</sub> | Output (Lamp) |
|----------------|----------------|----------------|---------------|
| 0              | 0              | 1              | 0             |
| 0              | 1              | 0              | 0             |
| 0              | 1              | 1              | 0             |
| 1              | 0              | 0              | 0             |
| 1              | 0              | 1              | 1             |
| 1              | 1              | 0              | 1             |
| 1              | 1              | 1              | 1             |

**(6 marks)**

-7-

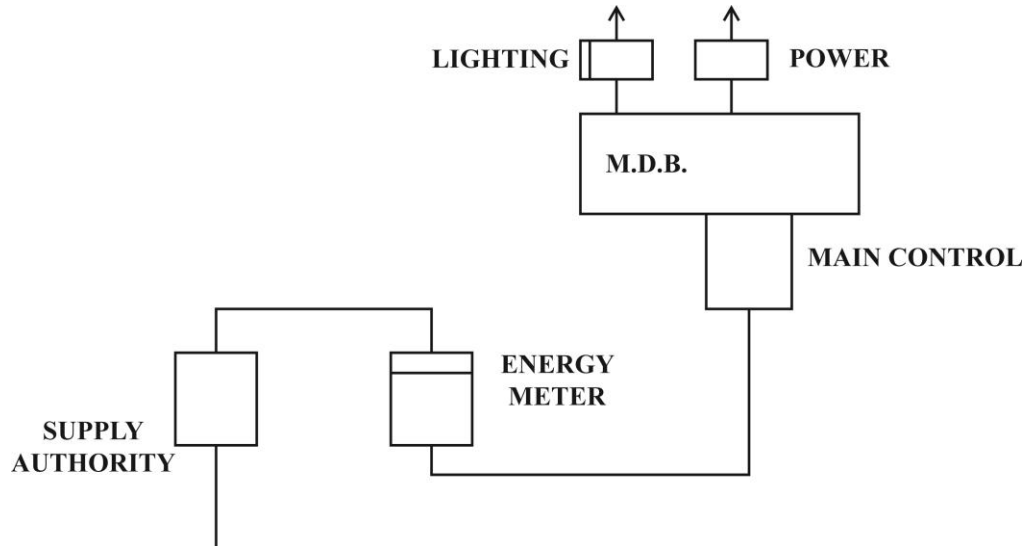
- (b) (i) At E:  
 $E = A + B$   
**(2 marks)**
- (ii) At F:  
 $F = C.D$   
**(2 marks)**
- (iii) At G:  

$$\overline{G = (A+B) + (C.D)}$$
**(2 marks)**

**Total 18 marks****Solutions – Question 5**

- (a) (i) (1) Wall lamp  
 (2) Socket outlet  
 (3) Fluorescent lamp  
 (4) Two-way switch  
 (5) Electric meter  
 (6) Earth  
**1 mark for every TWO (3 marks)**
- (ii) (1) Wall lamp is a filament lamp installed on a wall.  
 (2) Socket outlet is used to connect portable appliances to the electric supply.  
 (3) Fluorescent lamp is used to produce electric lighting.  
 (4) Two-way switch is used to switch a lamp on and off from two positions.  
 (5) Electric meter is used to measure the amount of electrical energy used by the consumer.  
 (6) Earth — connects the installation to the general mass of earth.  
**1 mark each for any THREE (3 marks)**

(b) (i)

**1 mark each****(6 marks)**

- (ii) Earth-fault loop impedance test  
(Recheck) polarity test using a voltmeter or approved test lamp

Functional testing:

Operation of protective devices (for example, residual current device – RCD)

**(1 mark)**

- (iii)
1. Remove all lamps.
  2. Close all switches and circuit breakers.
  3. Disconnect appliances.
  4. Test between the phase conductor and earth for every distribution circuit.
  5. Test between the neutral conductor and earth for every distribution circuit.

**(1 mark each)****(5 marks)****Total 18 marks**

**SPEC 2015/01347020**



**TEST CODE 01347020**

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**INDUSTRIAL TECHNOLOGY**

**OPTION B – MECHANICAL ENGINEERING TECHNOLOGY**

**SPECIMEN PAPER**

**Paper 02 – Technical Proficiency**

*2 hours 10 minutes*

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of FIVE compulsory questions.
2. Each question is worth 18 marks.
3. Use sketches where necessary to support your answers.
4. Silent non-programmable calculators may be used.
5. You are advised to take some time to read through the paper and plan your answers.

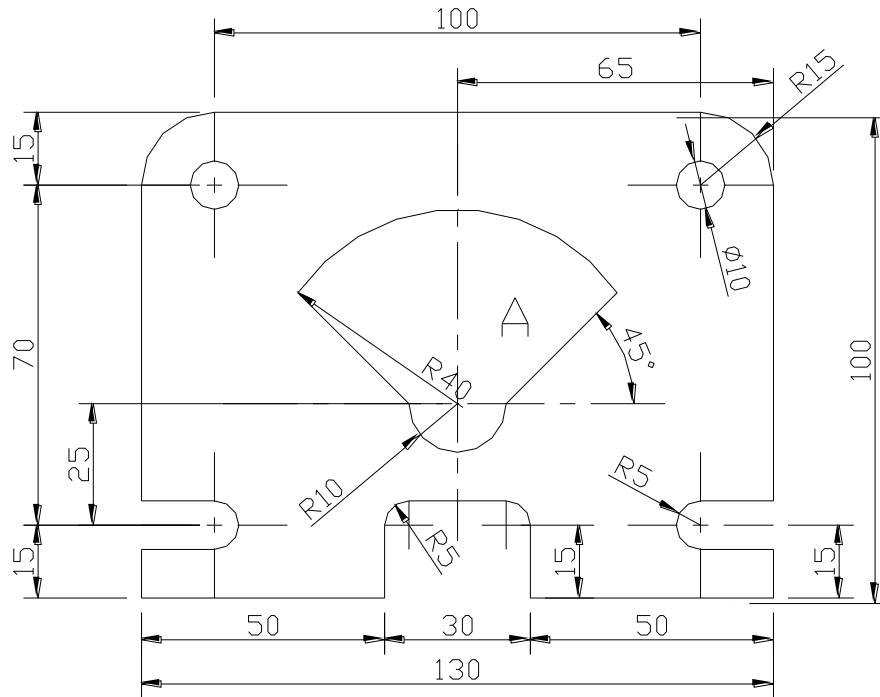
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**Answer ALL Questions.**

1. Figure 1 shows a template to be produced from a sheet of mild steel, 3 mm thick, 130 mm long and 100 mm wide.



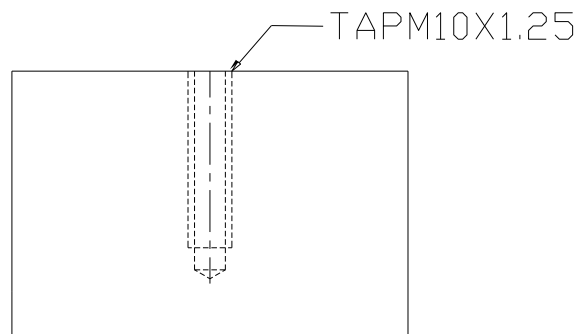
**Figure 1**

- (a) (i) List the tools and equipment necessary for marking out the template. **(2 marks)**
- (ii) List the steps of procedure to be followed to mark out the template as shown. **(6 marks)**
- (b) (i) Explain ONE procedure for cutting out the area labelled 'A' on the drawing. **(4 marks)**
- (ii) Explain how the procedure in (b) (i) above could be carried out without going outside of the layout lines for the slot. **(2 marks)**
- (c) (i) State TWO safety precautions to be observed when using marking-out tools. **(2 marks)**
- (ii) State TWO safety precautions to be observed when cutting out the slot in (b) (i) above. **(2 marks)**

**Total 18 marks**



2. Figure 2 shows a threaded hole in a component. The hole was threaded using M10 X 1.50 mm taps. While carrying out the threading operation a tap broke in the hole and had to be removed before the job could be completed.

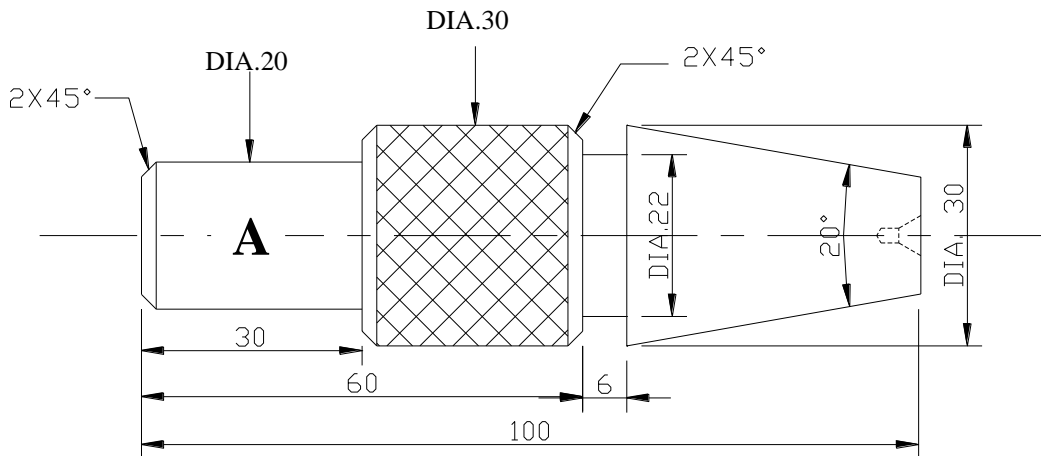


**Figure 2**

- (a) (i) List the steps of procedure to be followed to reduce the risk of tap breakage while threading the hole in a component. **(6 marks)**
- (ii) Explain ONE method of removing a broken tap from a partially threaded hole. **(3 marks)**
- (b) (i) List any THREE types of cold chisels used in the workshop. **(3 marks)**
- (ii) Explain the use of each of the THREE types of cold chisels named in (b) (i) above. **(3 marks)**
- (iii) List THREE precautions that should be observed while using a chisel in the workshop. **(3 marks)**

**Total 18 marks**

3. Figure 3 shows a component that is to be produced on the centre lathe from a piece of mild steel stock 32 mm in diameter by 105 mm long.



**Figure 3**

- (a) With the aid of sketches, list the steps of procedure for making the component. **(6 marks)**
- (b) List the tools to be used in the procedure in (a) above. **(2 marks)**
- (c) Explain the procedure for producing the knurled section of the component in (a) above. **(4 marks)**
- (d) State TWO precautions to be observed while producing the knurl in (c) above. **(2 marks)**
- (e) Calculate the spindle speed that is to be used to produce the section marked 'A' on Figure 3, if the cutting speed of the material is 30 m/min. **(2 marks)**
- (f) State TWO safety precautions that should be observed while working on the centre lathe. **(2 marks)**

**Total 18 marks**

4. (a) An oxy-acetylene torch was lit and a sooty flame was produced.
- (i) Sketch the sooty flame. **(2 marks)**
  - (ii) Name the sooty flame. **(1 mark)**
  - (iii) Explain the reason for the sooty particles. **(2 marks)**
- (b) Explain the procedure for lighting the torch and adjusting it to produce an oxidizing flame, assuming the cylinder valves are open. **(4 marks)**
- (c) Copy the following table into your answer booklet and complete the welding and brazing columns to match the factor column.

| <b>Factor</b>            | <b>Welding</b> | <b>Brazing</b> |
|--------------------------|----------------|----------------|
| 1. Filler rod material   |                |                |
| 2. Type of flame         |                | Carburizing    |
| 3. Fusion of work pieces |                |                |

**(3 marks)**

- (d) A steel bar is to be formed by welding two shorter lengths each of diameter 15 mm using the metal arc welding process. With the aid of sketches, list the steps of procedure to be followed to ensure strength and dimensional accuracy of the finished product. **(4 marks)**
- (e) State TWO safety precautions to be observed when using oxy-acetylene welding equipment. **(2 marks)**

**Total 18 marks**

5. Figure 4 shows the general outline of an incomplete arrangement of a hoist and hook unit. The shaft, B, which is placed horizontally, supports the hook, C, and is held in position by a housing.

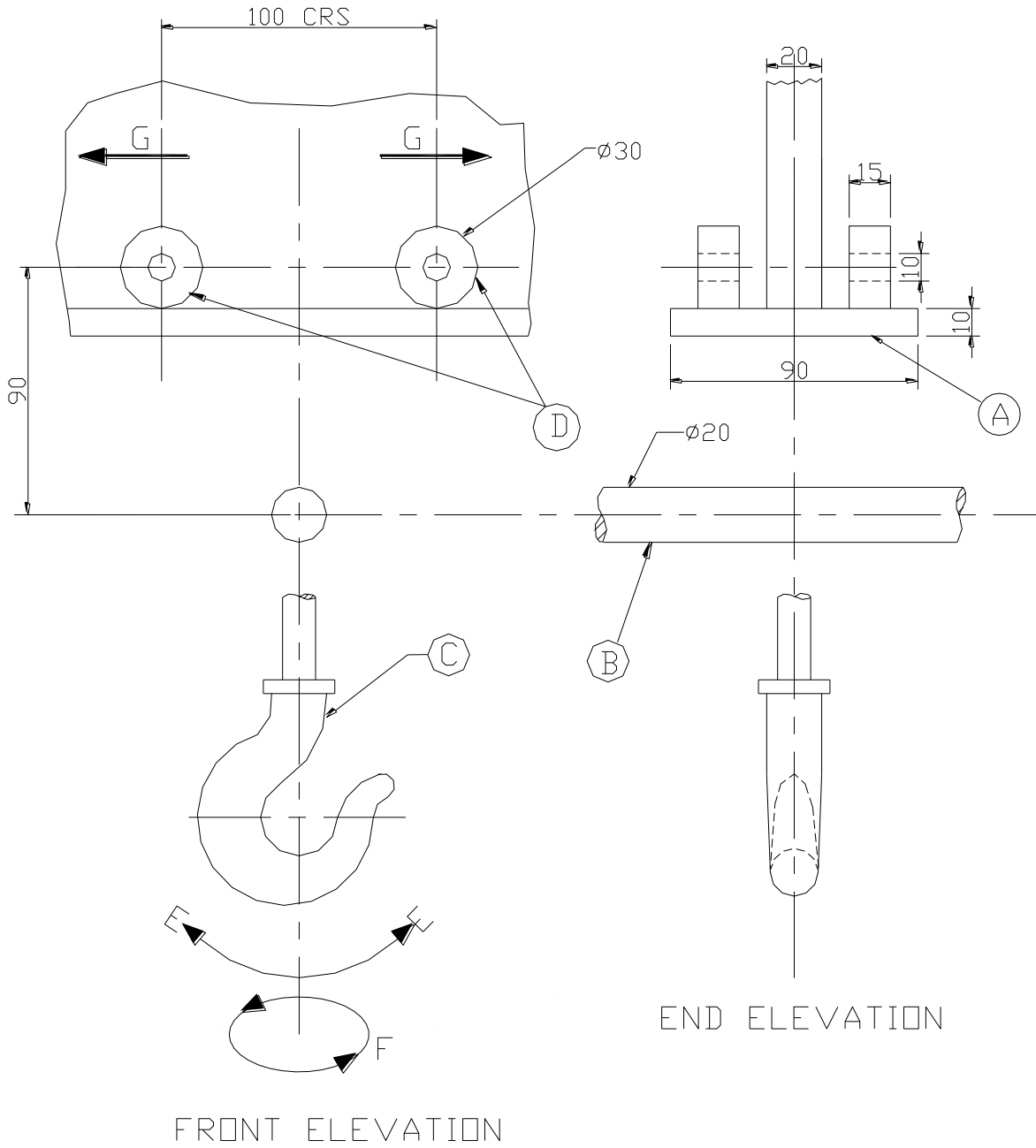


Figure 4

**You are required to design:**

- (a) A housing for the shaft which can be made by fabrication or casting
- (b) A method of attaching the hook, C, to the shaft, B

Your design should clearly show the following:

- (i) The shaft, A, in position in the housing and supported by two bronze bushings inserted into the housing  
**(6 marks)**
- (ii) The shaft, B, free to rotate about its axis so as to facilitate the swinging movement of the hook, C, as indicated by arrow E and free to rotate through 360° as indicated by arrow F  
**(6 marks)**
- (iii) A means of retaining the shaft, B, in the housing in order to prevent axial movement  
**(6 marks)**

**Total 18 marks**

**END OF TEST**

**CARIBBEAN EXAMINATIONS COUNCIL  
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**INDUSTRIAL TECHNOLOGY**

**OPTION B – MECHANICAL ENGINEERING TECHNOLOGY**

**PAPER 02 – TECHNICAL PROFICIENCY**

**SPECIMEN MARK SCHEME**

Industrial Technology  
Option B – Mechanical Engineering Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUES. | Knowledge and Comprehension  | Marks |       | Use of Knowledge  | Marks |       | Practical Skills  | Marks |       |
|-------|--|-------|-------|---|-------|-------|---|-------|-------|
|       |  | B/D   | Total |   | B/D   | Total |   | B/D   | Total |
| 1.    | (a) (i)<br><u>List of tools and equipment</u><br>- Surface plate<br>- Surface gauge<br>- Scriber<br>- Divider<br>- Hammer<br>- Rule<br>- Protractor<br><br>(c) (i)<br><u>Safety precautions when marking out</u><br>- Do not mark the surface of the surface plate<br>- Place tools in centre of table<br><br>(c) (ii)<br><u>Safety precautions when cutting out slots</u><br>- Wear gloves<br>- Wear goggles<br>- Do not remove chips with bare hands | 2     |       | (b) (i)<br><u>Procedure for cutting out</u><br>- Centre punch<br>- Chain drill<br>- Chisel/Hacksaw<br>- File<br><br>(b) (ii)<br><u>Procedure to remain within lines</u><br>- Punch centres within the layout lines<br>- Drill inside layout lines<br>- File to touch layout lines<br><br><b>Two marks for 3 in sequence;<br/>One mark for 2 in sequence</b> | 4     |       | (a) (ii)<br><u>Procedure for Marking out</u><br>1. Coat with layout die.<br>2. Mark all horizontal lines.<br>3. Scribe all vertical lines.<br>4. Locate and mark radii.<br>5. Locate and draw circles.<br>6. Mark angles.<br>7. Outline template. | 6     |       |
|       |  |       | 6     |   | 6     |       |   | 6     |       |

Industrial Technology  
Option B – Mechanical Engineering Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUES. | Knowledge and Comprehension   | Marks |       | Use of Knowledge  | Marks |       | Practical Skills  | Marks |       |
|-------|---|-------|-------|---|-------|-------|---|-------|-------|
|       |   | B/D   | Total |   | B/D   | Total |   | B/D   | Total |
| 2.    | (b) (i)<br><u>Types of cold chisels</u><br>- Flat<br>- Cape or cross-cut<br>- Round nose<br>- Diamond point<br><br><b>Any three – 1 mark each</b><br><br>(b) (iii)<br><u>Precautions</u><br>- Remove mushroom from head of chisel<br>- Hold chisel firmly and correctly<br>- Maintain correct angle<br><br><b>1 mark each</b> | 3     |       | (a) (ii)<br><u>Removal of broken tap</u><br>- Tap extractor<br>- Use of EDM machine to burn tap<br>- Use a pliers if enough tap is exposed<br><br>(b) (ii)<br><u>Use Of Chisels</u><br>- Flat to cut flat sheets, small rivets, bolts and nuts<br>- Cape/cross-cut to clean out grooves<br>- Round nose to cut round grooves and correct the start of wrongly drilled holes<br>- Diamond point to chip in corners<br><br><b>Any three – 1 mark each</b> | 3     |       | (a) (i)<br><u>Steps of Procedure</u><br>1. Select correct tap and drill bit.<br>2. Drill required hole.<br>3 Start tap squarely.<br>4. Use taps in sequence.<br>5. Back-up to break chips.<br>6. Use lubricant.<br><br><b>1–6 in sequence 6 marks</b><br><br><b>1–5 in sequence 5 marks</b><br><b>1–4 in sequence 4 marks</b><br><b>1–3 in sequence 3 marks</b><br><br><b>1–2in sequence 2 marks</b><br><br><b>1 mark for every 3 not in sequence</b> | 6     |       |
|       |   |       | 6     |   | 6     |       |   | 6     |       |



Industrial Technology  
Option B – Mechanical Engineering Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUES. | Knowledge and Comprehension  | Marks |       | Use of Knowledge  | Marks |       | Practical Skills  | Marks |       |
|-------|--|-------|-------|---|-------|-------|---|-------|-------|
|       |  | B/D   | Total |   | B/D   | Total |   | B/D   | Total |
| 3.    | <p>(b)<br/><u>Tools for making component</u></p> <ul style="list-style-type: none"> <li>- Facing tool</li> <li>- Right hand turning tool</li> <li>- Centre drill</li> <li>- Parting tool</li> <li>- Knurling tool</li> <li>- Tailstock centre</li> </ul> <p><b>Any three – 1 mark each</b></p> <p>(d)<br/><u>Precautions while producing knurl</u></p> <ul style="list-style-type: none"> <li>- Ensure tool is on centre.</li> <li>- Ensure correct speed.</li> <li>- Ensure both rollers are in contact with work.</li> </ul> <p><b>Any two – 1 mark each</b></p> | 2     |       | <p>(c)<br/><u>Procedure for producing knurl</u></p> <ul style="list-style-type: none"> <li>- Select required knurling tool.</li> <li>- Centre knurling tool.</li> <li>- Set spindle speed to ¼ turning speed.</li> <li>- Bring tool in contact with work.</li> <li>- Engage automatic feed.</li> <li>- Feed tool and reverse direction of travel until depth is achieved.</li> </ul> <p><b>6 in sequence – 4 marks</b><br/><b>5 in sequence – 3 marks</b><br/><b>4 in sequence – 2 marks</b><br/><b>3 in sequence – 1 mark</b></p> <p>(e)<br/><u>Calculation of spindle speed</u></p> $\frac{CS \times 1000}{\pi D} \quad \mathbf{1 \text{ mark}}$ $\frac{30 \times 1000}{3.142 \times 20} \quad \mathbf{1 \text{ mark}}$ $= 478 \text{ rpm}$ | 4     |       | <p>(a)<br/><u>Steps of procedure for making component</u></p> <ol style="list-style-type: none"> <li>1. Face</li> <li>2. Turn A</li> <li>3. Chamfer</li> <li>4. Turn material</li> <li>5. Face</li> <li>6. Centre drill</li> <li>7. Cut to dia. 30</li> <li>8. Cut 6 mm gap, 4 deep</li> <li>9. Chamfer area to be knurled</li> <li>10. Set compound slide for taper</li> <li>11. Cut taper</li> <li>12. Knurl</li> </ol> <p><b>12 in order – 6 marks</b><br/><b>10 in order – 5 marks</b><br/><b>8 in order – 4 marks</b><br/><b>6 in order – 3 marks</b><br/><b>4 in order – 2 marks</b><br/><b>2 in order – 1 mark</b></p> | 6     |       |

| QUES. | Knowledge and Comprehension   | Marks |       | Use of Knowledge | Marks |       | Practical Skills | Marks |       |
|-------|---|-------|-------|------------------|-------|-------|------------------|-------|-------|
|       |   | B/D   | Total |                  | B/D   | Total |                  | B/D   | Total |
| 3.    | (f)<br><u>Safety precautions</u><br>- Ensure the chuck key is not left in the chuck<br>- Do not wear loose clothing<br>- Wear goggles<br><br><b>Any two – 1 mark each</b> | 2     |       |                  |       |       |                  |       |       |
|       |   |       | 6     |                  | 6     |       |                  |       | 6     |

Industrial Technology  
Option B – Mechanical Engineering Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

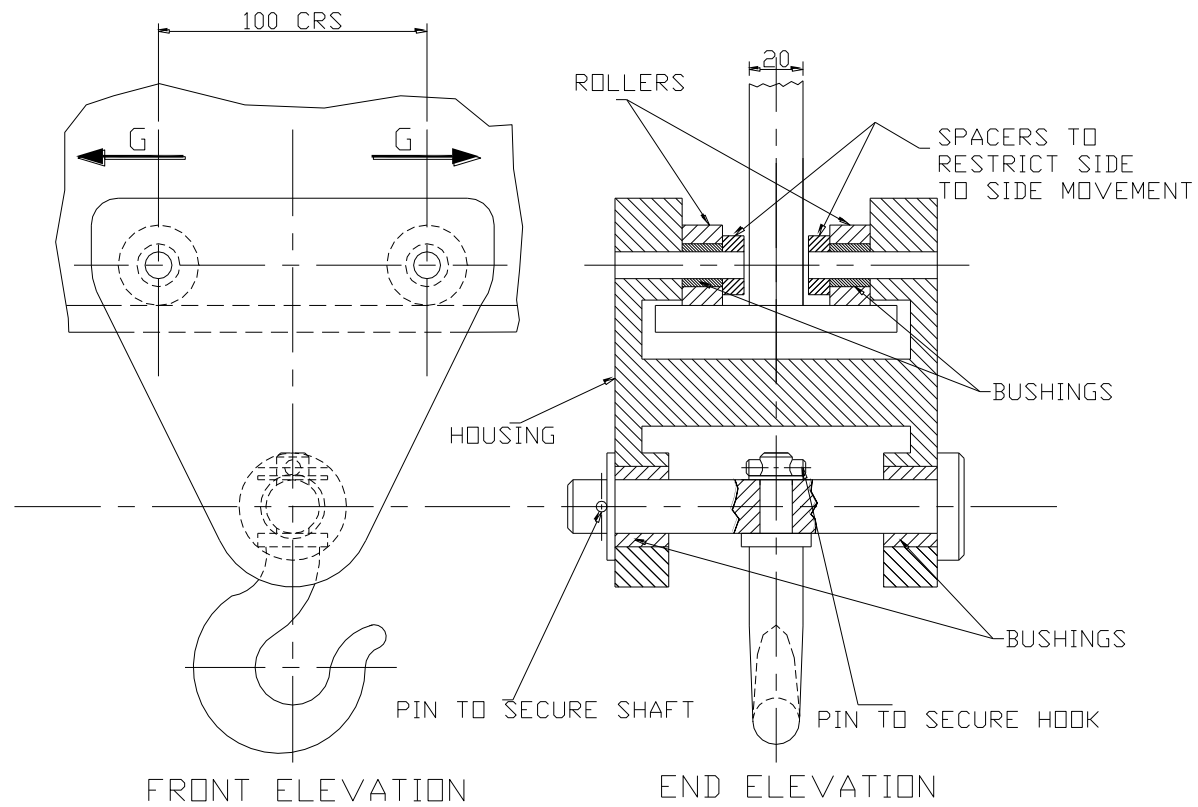
| QUES.  | Knowledge and Comprehension   | Marks   |       | Use of Knowledge  | Marks |       | Practical Skills   | Marks |       |         |           |         |                     |      |           |               |         |             |                  |        |           |
|--|---|---|-------|---|-------|-------|--|-------|-------|---------|-----------|---------|---------------------|------|-----------|---------------|---------|-------------|------------------|--------|-----------|
|  |   | B/D   | Total |   | B/D   | Total |  | B/D   | Total |         |           |         |                     |      |           |               |         |             |                  |        |           |
| 4.   | (c)   | 3   |       | (b)<br><u>Lighting and adjusting torch to get an oxidizing flame</u><br><br><ul style="list-style-type: none"> <li>- Open acetylene valve about half turn.</li> <li>- Ignite acetylene with torch lighter.</li> <li>- Open oxygen needle valve.</li> <li>- Adjust both valves to get desired flame (more oxygen).</li> </ul><br><b>4 in order – 4 marks</b><br><b>3 in order – 3 marks</b><br><b>2 in order – 2 marks</b> | 4     |       | (d)<br><br><u>SKETCH</u><br><br><u>Steps of procedure</u><br>1. Chamfer ends.<br>2. Support in angle iron.<br>3. Clamp pieces.<br>4. Make root pass.<br>5. Remove slag/clean.<br>6. Make series of passes.<br>7. Repeat steps 5 – 6 until cavity is filled.<br><br><b>5/6 in order – 4 marks</b><br><b>4 in order – 3 marks</b><br><b>3 in order – 2 marks</b><br><b>2 in order – 1 mark</b> | 4     |       |         |           |         |                     |      |           |               |         |             |                  |        |           |
|  | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">FACTORS</th> <th style="width: 33%;">WELDING</th> <th style="width: 33%;">BRAZING</th> </tr> </thead> <tbody> <tr> <td>Filler rod material</td> <td>Same</td> <td>Different</td> </tr> <tr> <td>Type of flame</td> <td>Neutral</td> <td>Carburizing</td> </tr> <tr> <td>Fusion of pieces</td> <td>Fusion</td> <td>No fusion</td> </tr> </tbody> </table><br><b>Five correct – 3 marks</b><br><b>Every 2 correct (less than 5) – 1 mark each</b> |   |       |   |       |       |  |       |       | FACTORS | WELDING   | BRAZING | Filler rod material | Same | Different | Type of flame | Neutral | Carburizing | Fusion of pieces | Fusion | No fusion |
|  | FACTORS   |   |       |   |       |       |  |       |       | WELDING | BRAZING   |         |                     |      |           |               |         |             |                  |        |           |
|  | Filler rod material   |   |       |   |       |       |  |       |       | Same    | Different |         |                     |      |           |               |         |             |                  |        |           |
| Type of flame  | Neutral   | Carburizing   |       |   |       |       |  |       |       |         |           |         |                     |      |           |               |         |             |                  |        |           |
| Fusion of pieces   | Fusion  | No fusion   |       |   |       |       |  |       |       |         |           |         |                     |      |           |               |         |             |                  |        |           |
| (e)<br><u>Safety Precautions</u><br><ul style="list-style-type: none"> <li>- Wear goggles.</li> <li>- Wear gloves.</li> <li>- Remove all combustibles.</li> <li>- Point flame away from body.</li> </ul><br><b>Any two – 1 mark each</b> | 2   | (a) (iii)<br><u>Reason for sooty flame</u><br>Only acetylene is burning.<br>Little or no oxygen is in the mixture of gases.<br>High carbon content. | 2     | (a) (i)<br><u>Sketch the sooty flame</u>  | 2     |       |  |       |       |         |           |         |                     |      |           |               |         |             |                  |        |           |
| (a) (ii)<br><u>Name the sooty flame</u><br>Luminous  | 1   |   | 6     |   | 6     | 6     |  |       |       |         |           |         |                     |      |           |               |         |             |                  |        |           |

Industrial Technology  
Option B – Mechanical Engineering Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUES. | Knowledge and Comprehension | Marks |       | Use of Knowledge   | Marks |       | Practical Skills   | Marks |       |
|-------|-----------------------------|-------|-------|--|-------|-------|--|-------|-------|
|       |                             | B/D   | Total |  | B/D   | Total |  | B/D   | Total |
| 5.    | <u>Drawing</u>              |       |       | <u>Mechanisms/Methods</u>  |       |       | <u>Function</u>  |       |       |
|       | Neatness                    | 2     |       | Shaft A in housing supported by bushings.  | 2     |       | Shaft “A” in housing supported by bushings.  | 2     |       |
|       | Clarity of details          | 2     |       | Shaft A free to rotate to facilitate swinging of hook and rotation through 360°. | 2     |       | Shaft “B” free to rotate to facilitate swinging of hook and rotation through 360°. | 2     |       |
|       | Proportionality             | 2     |       | Shaft is retained in housing.  | 2     |       | Shaft is retained in housing.  | 2     |       |
|       |                             |       | 6     |  |       | 6     |  |       | 6     |

Industrial Technology  
 Option B – Mechanical Engineering Technology  
 Paper 02 – Technical Proficiency  
 Specimen Mark Scheme

POSSIBLE SOLUTION TO QUESTION 5



**SPEC2015/01357020**

**CARIBBEAN EXAMINATIONS COUNCIL  
CARIBBEAN SECONDARY EDUCATION CERTIFICATE®  
EXAMINATION**

**INDUSTRIAL TECHNOLOGY  
OPTION C – BUILDING AND FURNITURE TECHNOLOGY**

**SPECIMEN PAPER**

**Paper 02 – Technical Proficiency**

*2 hours 10 minutes*

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of FIVE compulsory questions.
2. Use sketches when necessary to support your answers. All sketches should be done to proportion.
3. Silent non-programmable calculators may be used.
4. You are advised to take some time to read through the paper and plan your answers.

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

## BUILDING AND FURNITURE TECHNOLOGY

### LIST OF FORMULAE

Candidates should refer to the following list of formulae for assistance in answering questions.

#### ROOF CALCULATIONS

##### TRUE LENGTH OF COMMON RAFTER WITH OVERHANG

- Overhang = Rise/Run = X/overhang  
Value of X = (Rise × Overhang)/Run  
Value of X + Original Rise = Total Rise  
Run + Given Overhang = Total Run
- $\frac{\text{Rise}}{\text{Span}} = \text{Pitch}$
- Pitch × Span = Rise  
(Pythagoras' Theorem)
- The Length of Rafter =  $\sqrt{\text{Total Rise}^2 + \text{Total Run}^2}$

#### STAIR DESIGN CALCULATIONS

Formula for calculating tread and rise dimensions

- $2R + T$  OR  $2R + G = 550 \text{ mm to } 700 \text{ mm}$   
Where R = rise, G = going and T = tread

#### CONCRETE BLOCK WALL CALCULATIONS

- $\frac{\text{Area of Wall}}{\text{Area of Block}} = \text{No. of blocks}$

#### MOISTURE CONTENT OF TIMBER

- % Moisture Content =  $\frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$

#### DEPTH OF FLOOR JOIST

- $\frac{\text{Span in mm}}{24} + 50 \text{ mm} = \text{Depth in (mm)}$

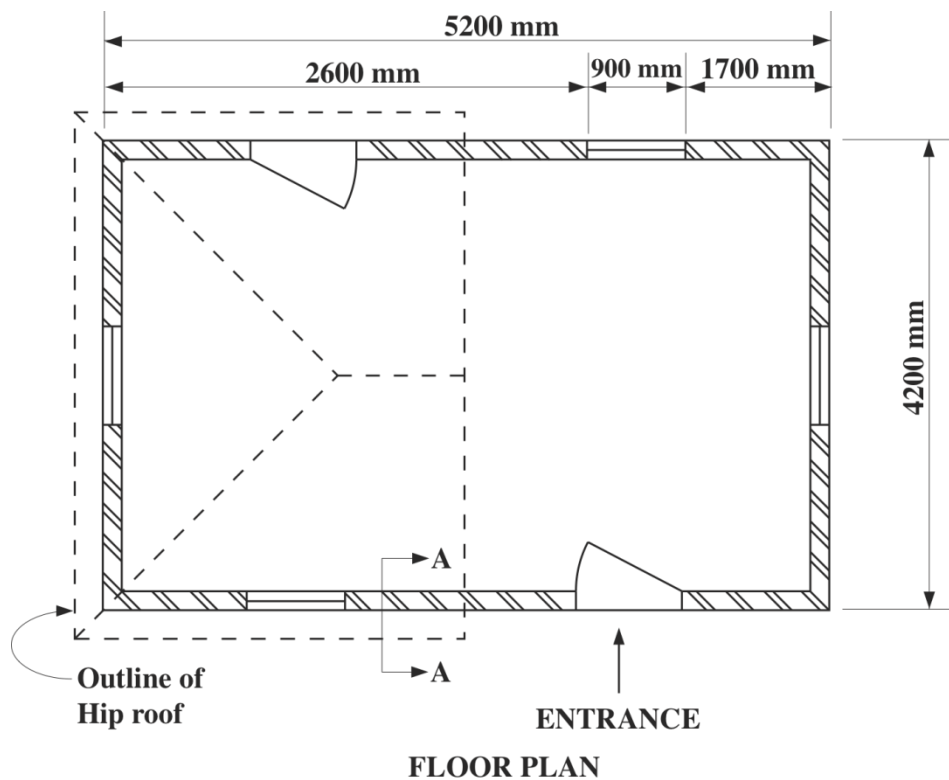
**Answer ALL Question.**

**This paper contains metric dimensions only. You should work your answers in the metric system.**

1. Figure 1 shows the floor plan of a small building that is constructed with 150 mm hollow concrete block walls. The dimensions are as indicated on the plan. The floor is 100 mm thick reinforced concrete slab on grade. The building is covered with a hip roof which has a rise of 1.4 m and the rafters are placed at 400 mm centres. The overhang is 300 mm all around. The sizes of the members are as follows.

- Rafters 50 mm × 150 mm
- Fascia 25 mm × 250 mm
- Wall plate 50 mm × 100 mm. Bolted to the ring/belt beam which is 150 mm wide × 250 mm deep

(NOTE: The eave is not boxed and the roof is covered with corrugated (zinc) galvanized sheets.)



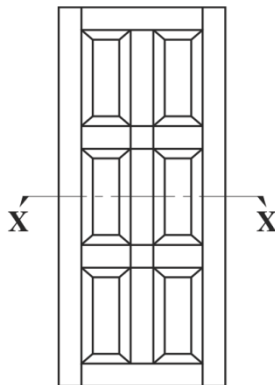
**Figure 1. Floor Plan**



- (a) Produce a neat, labelled single-line sketch of the plan of the roof portion outlined in Figure 1. **(6 marks)**
- (b) (i) List, in sequence, **THREE** processes involved in safely excavating a strip foundation with a depth of 1.4 metres. **(3 marks)**
- (ii) Name **THREE** tools or pieces of equipment required for digging a strip foundation manually. **(3 marks)**
- (c) A foundation is to be built on a gentle sloping site.
- (i) Name, with reason, a suitable foundation to be used at this site. **(2 marks)**
- (ii) Produce a drawing which illustrates your answer to (c) (i). **(4 marks)**

**Total 18 marks**

2. (a) State **TWO** reasons for stripping a building site. **(2 marks)**
- (b) State **TWO** temporary services a well-managed building site should provide. **(2 marks)**
- (c) State **TWO** functions of the external walls of a building. **(2 marks)**
- (d) (i) Explain how corner profile boards are positioned when setting out a small building **(4 marks)**
- (ii) Explain, with the aid of drawings, **ONE** method of ensuring that the corners of a small building are at  $90^\circ$ . **(2 marks)**
- (e) Figure 2 shows a panel door



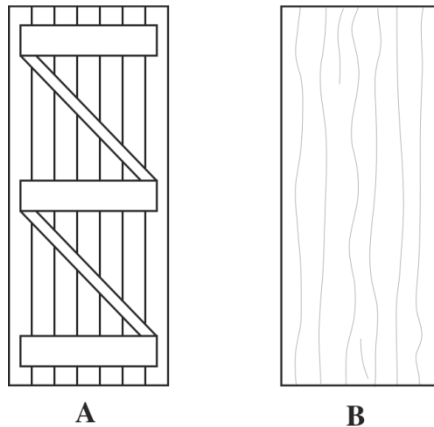
**Figure 2. Panel Door**

Make a neat sketch of the horizontal section X-X **(6 marks)**

**Total 18 marks**

3. (a) State FOUR functions of a window. **(4 marks)**
- (b) Make a single line sketch of
- (i) a louvre window
  - (ii) a casement window
  - (iii) an awning window **(6 marks)**

- (c) **Figure 3** shows two doors labelled A and B.



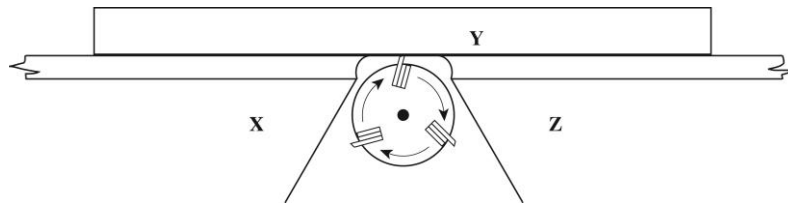
**Figure 3. Two doors**

Using labels A and B, name EACH of the doors shown in Figure 3. **(2 marks)**

- (d) A stair has a total rise of 2.6 m. It has risers 200 mm in height and treads 250 mm in width. Calculate the
- (i) total number of risers in the staircase
  - (ii) total number of treads in the staircase
  - (iii) total going of the staircase. **(6 marks)**

**Total 18 marks**

4. Figure 4 shows the side view of a surface planer or jointer with three parts labelled X, Y and Z.



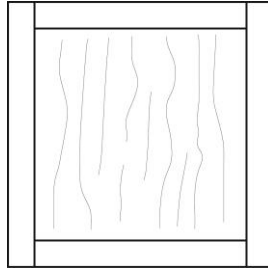
**Figure 4. Side view of surface planer**

- (a) Name EACH labelled part of the surface planer. **(3 marks)**
- (b) (i) List THREE factors which create the smoothness of a planed surface on the jointer. **(3 marks)**
- (ii) Explain, in sequence, with the aid of sketches, the cutting of a 6 mm deep by 15 mm wide rebate on the jointer. **(3 marks)**
- (c) Explain briefly, and with the aid of a sketch, the position of a worker's hands in relation to the surface planer or jointer when
- (i) starting a cut
- (ii) halfway through the cut
- (iii) completing the cut. **(3 marks)**
- (d) (i) List THREE operations other than rebating that can be carried out on the jointer. **(3 marks)**
- (ii) Give a possible cause for EACH of the following problems when using the jointer:
- a) The stock chips at the end of the operation
- b) The stock chips at the start of the operation
- c) The cutter not making contact with the stock

**(3 marks)**

**Total 18 marks**

5. Figure 5 shows a small panel door for a cupboard. The frame is 19 mm thick and is grooved to receive a plywood panel.



**Figure 5. Panel door**

- (a) (i) State the most appropriate joint that should be used to connect the rails and stiles of the door. **(1 mark)**
- (ii) Name **THREE** types of ironmongery necessary for the functioning of this door. **(3 marks)**
- (iii) State the purpose of any **TWO** of the types of ironmongery mentioned in (a) (ii). **(2 marks)**
- (b) Make a labelled isometric sketch of **EACH** of the following before cutting the joint:
- (i) The setting out of a rail **(6 marks)**
- (ii) The setting out of a stile
- (c) Describe, in sequence, the steps taken to form the part to be cut at the end of **ONE** rail. **(6 marks)**

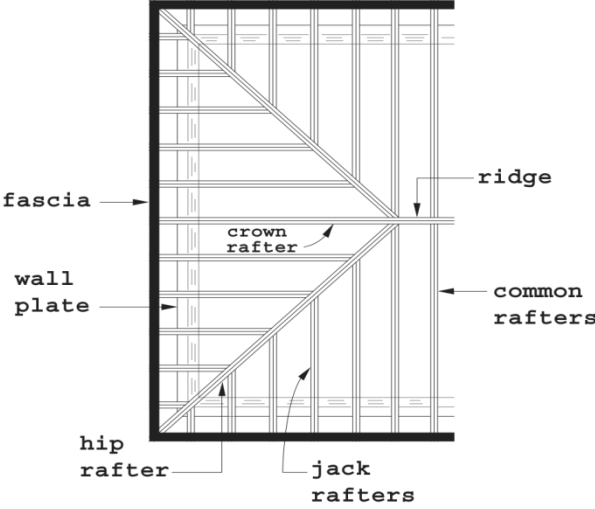
**Total 18 marks**

**END OF TEST**

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**INDUSTRIAL TECHNOLOGY  
OPTION C – BUILDING AND FURNITURE TECHNOLOGY  
PAPER 02 – TECHNICAL PROFICIENCY  
SOLUTION & MARK SCHEME 2015  
SPECIMEN PAPER**

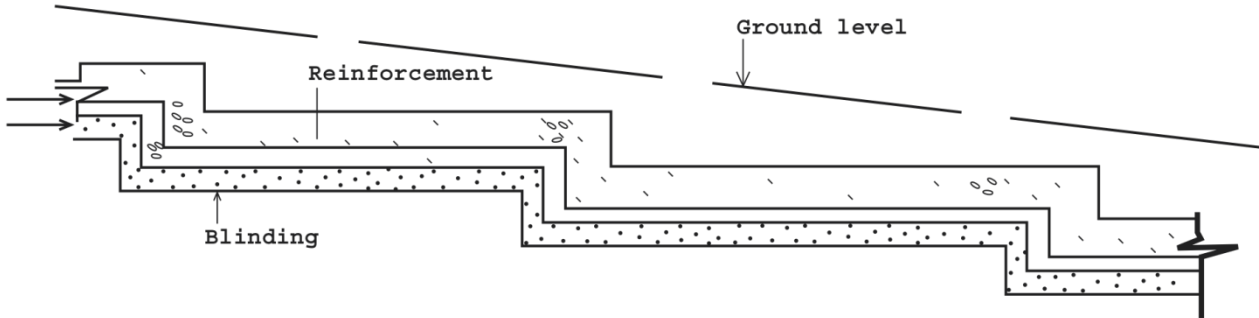
Industrial Technology  
Option C – Building and Furniture Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUESTION         | SOLUTION   | MARKS |    |          |          |
|------------------|--|-------|----|----------|----------|
|                  |  | KC    | UK | PA       | TOTAL    |
| 1 (a) (i)        | <p>PLAN VIEW OF HIP ROOF</p>  <p>Sketch: Hip rafters – 1<br/>Jack rafter – 1<br/>Crown rafter – 1<br/>Ridge – 1<br/>Common rafter – 1<br/>Labelling – 1</p> | -     | -  | <b>6</b> |          |
| <b>SUB TOTAL</b> |  | -     | -  | <b>6</b> | <b>6</b> |

Industrial Technology  
Option C – Building and Furniture Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUESTION  | SOLUTION   | MARKS    |          |          |           |
|-----------|--|----------|----------|----------|-----------|
|           |  | KC       | UK       | PA       | TOTAL     |
| 1 (b) (i) | <ul style="list-style-type: none"> <li>• Select correct method, tools, equipment.</li> <li>• Excavate trench</li> <li>• Timbering must be installed to prevent this side from caving in when digging the required depth</li> </ul> <p style="text-align: right;"><b>(First three in sequence - 3 marks)</b><br/><b>(First two in sequence - 2 marks)</b><br/><b>(First one in sequence - 1 mark)</b></p> | 3        |          |          |           |
| (b) (ii)  | <p>TOOLS AND EQUIPMENT</p> <p>Excavation work manually</p> <ul style="list-style-type: none"> <li>– Pick axe</li> <li>– Spade or shovel</li> <li>– Wheel barrow</li> </ul> <p style="text-align: right;"><b>(1 mark each)</b></p>  | 3        |          |          |           |
|           | <b>SUB TOTAL</b>   | <b>6</b> | <b>-</b> | <b>6</b> | <b>12</b> |

Industrial Technology  
 Option C – Building and Furniture Technology  
 Paper 02 – Technical Proficiency  
 Specimen Mark Scheme

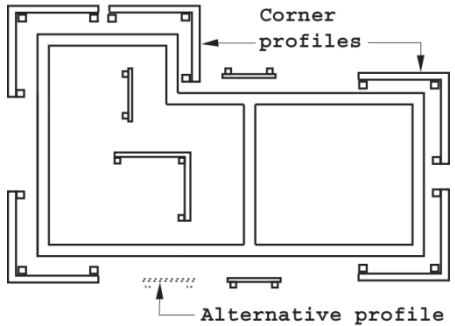
| QUESTION  | SOLUTION   | MARKS    |          |          |           |
|-----------|--|----------|----------|----------|-----------|
|           |  | KC       | UK       | PA       | TOTAL     |
| 1 (c) (i) | Step foundation (1 mark)<br>Reason – To reduce the amount of excavation and materials required to produce an adequate foundation (1 mark)  |          | 1<br>1   |          |           |
| (ii)      |  <p style="text-align: center;">Step Foundation on a Sloping Site</p> Step foundation – 2<br>Reinforcement – 2 |          | 4        |          |           |
|           | <b>TOTAL</b>   | <b>6</b> | <b>6</b> | <b>6</b> | <b>18</b> |



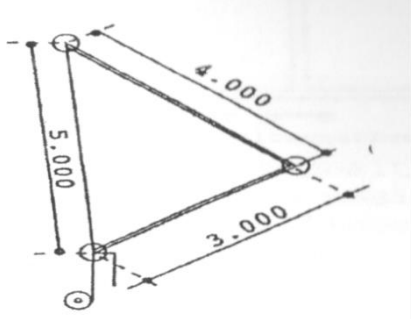
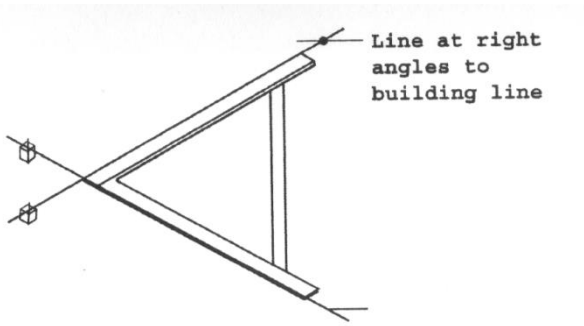
Industrial Technology  
Option C – Building and Furniture Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUESTION | SOLUTION   | MARKS    |    |    |          |
|----------|--|----------|----|----|----------|
|          |  | KC       | UK | PA | TOTAL    |
| 2        | <p>(a) Reasons for Stripping a Building Site</p> <ul style="list-style-type: none"> <li>• To remove vegetation such as bushes and shrubs</li> <li>• To remove rocks and boulders in the area where the building is to be set out</li> <li>• To clear trees and bushes</li> <li>• To remove termite nests</li> </ul> <p style="text-align: right;"><b>(1 mark each for any TWO)</b></p> | 2        |    |    |          |
|          | <p>(b) Temporary Services</p> <ul style="list-style-type: none"> <li>• A supply of fresh water</li> <li>• A toilet</li> <li>• An electrical supply</li> <li>• A telephone</li> </ul> <p style="text-align: right;"><b>(1 mark each for any TWO)</b></p>  | 2        |    |    |          |
|          | <p>(c) Functions of External Walls of a Building</p> <ul style="list-style-type: none"> <li>• Enclose the building</li> <li>• Protect the inside of the building from the elements</li> <li>• Support the roof and upper floors</li> </ul> <p style="text-align: right;"><b>(1 mark each for any TWO)</b></p>  | 2        |    |    |          |
|          | <b>SUB TOTAL</b>   | <b>6</b> | -  | -  | <b>6</b> |

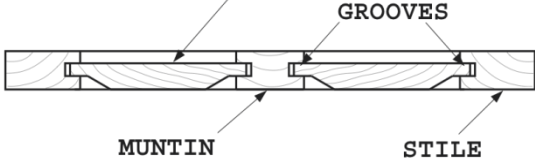
Industrial Technology  
Option C – Building and Furniture Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUESTION  | SOLUTION  | MARKS    |          |    |           |
|-----------|---|----------|----------|----|-----------|
|           |   | KC       | UK       | PA | TOTAL     |
| 2 (d) (i) | <p>Position of Corner Profile Boards When Setting Out</p>  <p style="text-align: center;">Corner profiles</p> <p style="text-align: center;">Alternative profile</p> <ul style="list-style-type: none"> <li>• Locate the position. (1 mark)</li> <li>• Measure the position on the ground and place peg to mark. (1 mark)</li> <li>• Check that lines are at right angles to the proposed wall position. (1 mark)</li> <li>• Run lines from the centre to the pegs. (1 mark)</li> </ul> <p style="text-align: right;"><b>SUB-TOTAL</b></p> |          | 4        |    |           |
|           |   | <b>6</b> | <b>4</b> |    | <b>10</b> |

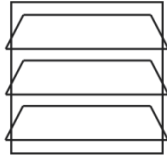
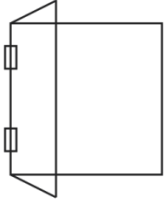
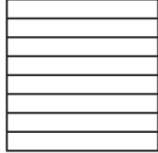
Industrial Technology  
 Option C – Building and Furniture Technology  
 Paper 02 – Technical Proficiency  
 Specimen Mark Scheme

| QUESTION  | SOLUTION  | MARKS        |          |          |          |
|---|---|--------------|----------|----------|----------|
|   |   | KC           | UK       | PA       | TOTAL    |
| <p><b>2 (d) (ii)</b></p> <p>Method of Squaring a Small Building During Setting Out</p> <p>(1) Method – 3 : 4 : 5<br/>                     (2) Method – Builders’ Square</p>  <p>Builder’s square</p>  | <p>(2 marks for sketch and label of any method)</p> |              | 2        |          |          |
|   |   | <b>TOTAL</b> | <b>6</b> | <b>6</b> | <b>2</b> |

Industrial Technology  
Option C – Building and Furniture Technology  
Paper 02 – Technical Proficiency  
Specimen Mark Scheme

| QUESTION           | SOLUTION   | MARKS    |          |          |           |        |     |         |     |                    |     |  |  |          |  |
|--------------------|--|----------|----------|----------|-----------|--------|-----|---------|-----|--------------------|-----|--|--|----------|--|
|                    |  | KC       | UK       | PA       | TOTAL     |        |     |         |     |                    |     |  |  |          |  |
| 2 (e)              | <p><b>RAISED &amp; FIELD PANEL</b></p>  <p>Section X-X of Panelled Door</p> <p>Sketch:</p> <table style="margin-left: 20px;"> <tr><td>Stile</td><td style="text-align: right;">– 1</td></tr> <tr><td>Muntin</td><td style="text-align: right;">– 1</td></tr> <tr><td>Panels</td><td style="text-align: right;">– 1</td></tr> <tr><td>Grooves</td><td style="text-align: right;">– 1</td></tr> <tr><td>Horizontal Section</td><td style="text-align: right;">– 1</td></tr> </table> <p style="text-align: right; margin-right: 100px;"><b>1 mark each for any FOUR (4 marks)</b></p> | Stile    | – 1      | Muntin   | – 1       | Panels | – 1 | Grooves | – 1 | Horizontal Section | – 1 |  |  | <b>4</b> |  |
| Stile              | – 1  |          |          |          |           |        |     |         |     |                    |     |  |  |          |  |
| Muntin             | – 1  |          |          |          |           |        |     |         |     |                    |     |  |  |          |  |
| Panels             | – 1  |          |          |          |           |        |     |         |     |                    |     |  |  |          |  |
| Grooves            | – 1  |          |          |          |           |        |     |         |     |                    |     |  |  |          |  |
| Horizontal Section | – 1  |          |          |          |           |        |     |         |     |                    |     |  |  |          |  |
|                    | <b>TOTAL</b>   | <b>6</b> | <b>6</b> | <b>6</b> | <b>18</b> |        |     |         |     |                    |     |  |  |          |  |

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Paper 02 – Technical Proficiency  
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| QUESTION     | SOLUTION   | MARKS    |          |          |           |
|--------------|--|----------|----------|----------|-----------|
|              |  | KC       | UK       | PA       | TOTAL     |
| <b>3 (a)</b> | Function of Windows <ul style="list-style-type: none"> <li>- Through vision/privacy</li> <li>- Ventilation</li> <li>- Outside view</li> <li>- Lighting (natural)</li> <li>- Decoration</li> </ul> <p style="text-align: right;"><b>(1 mark EACH – maximum 4 marks)</b></p>   | <b>4</b> |          |          |           |
| <b>(b)</b>   | Single Sketches of Windows <div style="text-align: center; margin: 10px 0;">  <p>AWNING WINDOW</p> </div> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center; margin: 10px 0;">  <p>CASEMENT WINDOW</p> </div> <div style="text-align: center; margin: 10px 0;">  <p>LOUVRE WINDOW</p> </div> </div> <p style="text-align: right;"><b>(2 marks each)<br/>(6 marks)</b></p> |          |          | <b>6</b> |           |
|              | <b>SUB TOTAL</b>   | <b>4</b> | <b>-</b> | <b>6</b> | <b>10</b> |

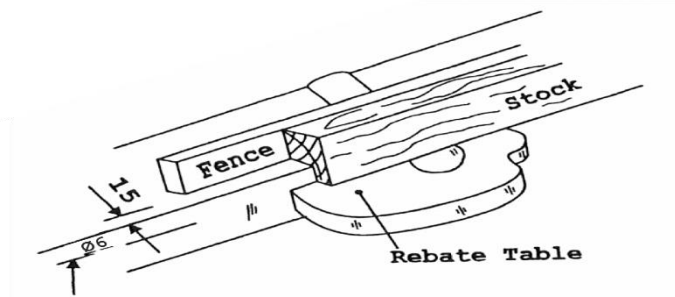
Industrial Technology  
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Paper 02 – Technical Proficiency  
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| QUESTION       | SOLUTION  | MARKS    |          |          |           |
|----------------|---|----------|----------|----------|-----------|
|                |   | KC       | UK       | PA       | TOTAL     |
| <b>3 (c)</b>   | Names of Doors<br><br>(A) - Ledged, braced and battened (match boarded)<br>(B) - Flush door<br><br><p style="text-align: right;"><b>(1 mark each – 2 marks)</b></p>           |          |          |          |           |
| <b>(d) (i)</b> | Total number of risers equal $2.600/200 = 13$ risers<br><br><p style="text-align: right;">(2 marks)</p>   |          |          |          |           |
| <b>(ii)</b>    | Since there is going to be one tread less than the number of risers,<br>total number of treads equal $13 - 1 = 12$ treads.<br><br><p style="text-align: right;">(2 marks)</p> |          |          |          |           |
| <b>(iii)</b>   | Total going = $12 \times 250 = 3.000$ m.<br><br><p style="text-align: right;">(2 marks)</p>   |          |          |          |           |
|                | <b>TOTAL</b>  | <b>6</b> | <b>6</b> | <b>6</b> | <b>18</b> |

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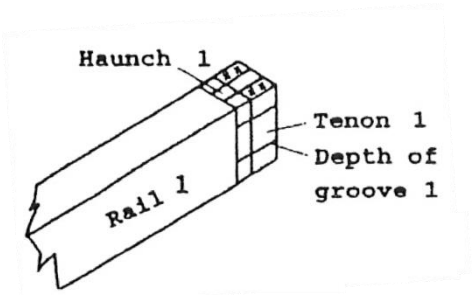
| QUESTION        | SOLUTION   | MARKS    |          |          |       |
|-----------------|--|----------|----------|----------|-------|
|                 |  | KC       | UK       | PA       | TOTAL |
| <b>4. (a)</b>   | Parts of Planer/Joiner<br><br>X – REAR (outfeed) Table<br>Y – FENCE<br>Z – FRONT (infeed) Table<br><br><div style="text-align: right;"><b>(1 mark each)</b></div>  | <b>3</b> |          |          |       |
| <b>(b) (i)</b>  | Factors that determine smoothness of a planed surface<br><br>- Diameter of cutter lead<br>- Number of knives<br>- Number of revolutions per minute<br>- Feed speed<br><br><div style="text-align: right;"><b>(1 mark each for any THREE)</b></div> | <b>3</b> |          |          |       |
| <b>(b) (ii)</b> | Procedure for cutting a rebate<br><br>- Adjust the power 15 mm from the edge of the knife<br>- Adjust the front infeed table 6 mm down   |          |          | <b>3</b> |       |
|                 | <b>SUBTOTAL</b>  | <b>6</b> | <b>-</b> | <b>3</b> |       |

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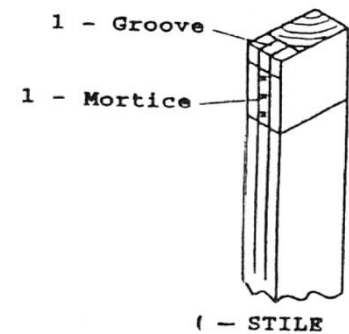
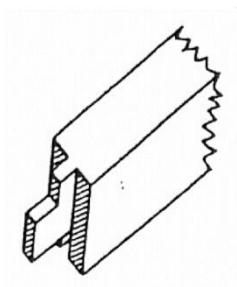
| QUESTION | SOLUTION  | MARKS    |          |          |           |
|----------|---|----------|----------|----------|-----------|
|          |   | KC       | UK       | PA       | TOTAL     |
| (c)      | <p><b>Sketch</b></p>  <p>(i) Both hands pressing stock on from table<br/>(ii) Left hand moved over on rear table pressing stock down<br/>(iii) Right hand with push stick/block to finish</p> |          |          | 3        |           |
| (d) (i)  | <p>Bevel<br/>Clamper<br/>Tongues<br/>Taper</p> <p style="text-align: right;">(1 mark each for any THREE)</p>  |          | 3        |          |           |
| (d) (ii) | <p>a) Outfeed table too high<br/>b) Outfeed table too low<br/>c) Both tables too high</p> <p style="text-align: right;">(1 mark each)</p>   |          | 3        |          |           |
|          | <b>TOTAL</b>  | <b>6</b> | <b>6</b> | <b>6</b> | <b>18</b> |



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| QUESTION  | SOLUTION   | MARKS    |    |          |       |
|-----------|--|----------|----|----------|-------|
|           |  | KC       | UK | PA       | TOTAL |
| 5 (a) (i) | Joint<br>Haunched Mortice & Tenon Joint  | 1        |    |          |       |
| (ii)      | Ironmongery<br>Hinge<br>Straight Lock (cupboard lock)<br>Catches<br>Knob (Handle)                            |          |    |          |       |
|           | (1 mark each for any THREE)  | 3        |    |          |       |
| (iii)     | Purpose<br>Hanging the door<br>Locking the door<br>Keeping the door closed<br>Operating and closing the door |          |    |          |       |
|           | (1 mark each for any TWO)  | 2        |    |          |       |
| 5 b (i)   | Setting out of a rail  |          |    |          |       |
|           |                           |          |    |          |       |
|           | (2 marks for sketch)<br>(1 mark for any TWO labels)  |          |    | 3        |       |
|           | <b>SUB TOTAL</b>   | <b>6</b> |    | <b>3</b> |       |

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| QUESTION   | SOLUTION  | MARKS     |          |          |           |       |   |        |   |            |   |  |   |  |  |
|------------|---|-----------|----------|----------|-----------|-------|---|--------|---|------------|---|--|---|--|--|
|            |   | KC        | UK       | PA       | TOTAL     |       |   |        |   |            |   |  |   |  |  |
| 5 b (ii)   | Setting out the stile<br><br>  |           |          | 3        |           |       |   |        |   |            |   |  |   |  |  |
| 5 (c)      |  <div style="text-align: right; margin-top: 20px;"> <p>(2 marks for sketch)<br/>(1 mark for any TWO labels)</p> <table style="margin-left: auto; margin-right: 0;"> <tr><td>Pictorial</td><td style="text-align: right;">2</td></tr> <tr><td>Haunch</td><td style="text-align: right;">1</td></tr> <tr><td>Tenon</td><td style="text-align: right;">1</td></tr> <tr><td>Groove</td><td style="text-align: right;">1</td></tr> <tr><td>Proportion</td><td style="text-align: right;">1</td></tr> </table> </div> | Pictorial | 2        | Haunch   | 1         | Tenon | 1 | Groove | 1 | Proportion | 1 |  | 6 |  |  |
| Pictorial  | 2   |           |          |          |           |       |   |        |   |            |   |  |   |  |  |
| Haunch     | 1   |           |          |          |           |       |   |        |   |            |   |  |   |  |  |
| Tenon      | 1   |           |          |          |           |       |   |        |   |            |   |  |   |  |  |
| Groove     | 1   |           |          |          |           |       |   |        |   |            |   |  |   |  |  |
| Proportion | 1   |           |          |          |           |       |   |        |   |            |   |  |   |  |  |
|            | <b>TOTAL</b>  | <b>6</b>  | <b>6</b> | <b>6</b> | <b>18</b> |       |   |        |   |            |   |  |   |  |  |



Caribbean Examinations Council  
Prince Road, Pine Plantation Road,  
St Michael BB11091  
Tel: (246) 227 1700  
Email: [cxcezo@cxc.org](mailto:cxcezo@cxc.org)