CARIBBEAN EXAMINATIONS COUNCIL

CAPE® Electrical and Electronic Technology

SYLLABUS
SUBJECT REPORTS

Macmillan Education
4 Crinan Street, London, N1 9XW
A division of Macmillan Publishers Limited
Companies and representatives throughout the world

www.macmillan-caribbean.com

ISBN 978-0-230-48282-1 AER

First published 2014
This revised edition published November 2017

Designed by Macmillan Publishers Limited
Cover design by Macmillan Publishers Limited and Red Giraffe

CAPE® Electrical and Electronic Technology Free Resources

LIST OF CONTENTS

CAPE® Electrical and Electronic Technology Syllabus Extract 3

CAPE® Electrical and Electronic Technology Syllabus 5

CAPE® Electrical and Electronic Technology Subject Reports

May/June 2004 194

May/June 2005 199

May/June 2006 208

May/June 2007 219

May/June 2008 (Trinidad and Tobago) 230

May/June 2009 242

May/June 2010 255

May/June 2011 268

May/June 2012 282

May/June 2013 299

May/June 2014 319

May/June 2015 340

May/June 2016 357

SYLLABUS EXTRACT

Electrical and Electronic Technology

Electrical and Electronic Engineering Technology is a programme of study that offers knowledge and skills for work and lifelong learning in various engineering and technology fields. Electrical and electronics engineers manipulate electricity and use it to design and manufacture products that transmit power or process information. The syllabus, therefore, offers broad-based competencies in an appropriate combination of interdisciplinary processes, evidence-based delivery and assessment and employability skills in a world of school and work training environment.

The syllabus facilitates articulation with the field of study provided by post-secondary and tertiary institutions. It is appropriate for students aspiring to careers and employment as electrical and electronics technicians, electrical and electronic engineers, repair specialists, electronics tester, design and system engineers, inspectors, utility workers and service technicians. The competencies align with the philosophical foundation for education in the region and international best practices.

The syllabus consists of two Units, each containing three Modules.

UNIT 1: FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS

Module 1 – Occupational Safety, Health and Environmental Practices
Module 2 – Electrical and Electronic Related Studies
Module 3 – Introduction to Circuit Technology and Devices

UNIT 2: APPLIED THEORY IN ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

Unit 2, comprises **TWO** Options each consisting of three Modules. Students are required to choose **ONE** of the **TWO** Options in Unit 2.

OPTION A: ELECTRONIC ENGINEERING TECHNOLOGY

Module 1 – Communication Engineering

Module 2 – Analogue and Digital Electronics

Module 3 – Control Systems

OPTION B: ELECTRICAL ENGINEERING TECHNOLOGY

Module 1 – Power Machines and Systems

Module 2 – Introduction to Renewable Energy Systems

Module 3 – Power Generation Engineering

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination®

SYLLABUS

ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

CXC A12/U2/16

Effective for examinations from May–June 2017

CAPE®

Published in Jamaica by the Caribbean Examinations Council

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
Website: www.cxc.org

Contents

INTRODUCTION i

RATIONALE 1

AIMS 2

SKILLS AND ABILITIES TO BE ASSESSED 2

PREREQUISITES OF THE SYLLABUS 3

STRUCTURE OF THE SYLLABUS 3

APPROACHES TO TEACHING THE SYLLABUS 4

UNIT 1: FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS 5

MODULE 1: OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENTAL PRACTICES 5

MODULE 2: ELECTRICAL AND ELECTRONIC RELATED STUDIES 9

MODULE 3: INTRODUCTION TO CIRCUIT TECHNOLOGY AND DEVICES 20

UNIT 2: APPLIED THEORY IN ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY 27

OPTION A: ELECTRONIC ENGINEERING TECHNOLOGY 27

MODULE 1: COMMUNICATION ENGINEERING 27

MODULE 2: ANALOGUE AND DIGITAL ELECTRONICS 36

MODULE 3: CONTROL SYSTEMS 42

OPTION B: ELECTRICAL ENGINEERING TECHNOLOGY 45

MODULE 1: POWER MACHINES AND SYSTEMS 45

MODULE 2: INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 50

MODULE 3: POWER GENERATION ENGINEERING 54

OUTLINE OF ASSESSMENT 58

SUGGESTED LABORATORY EXERCISES FOR PROJECTS.......68

REGULATIONS FOR PRIVATE CANDIDATES.......71

REGULATIONS FOR RESIT CANDIDATES.......71

ASSESSMENT GRID.......72

GLOSSARY OF ACRONYMS/TERMS FOR ELECTRICAL AND
ELECTRONIC ENGINEERING TECHNOLOGY.......73

GLOSSARY OF EXAMINATION TERMS.......75

APPENDIX I: MINIMUM EQUIPMENT LIST FOR EVERY FIFTEEN STUDENTS.......77

APPENDIX II: SYMBOLS, ABBREVIATIONS, DEFINITIONS AND DIAGRAMATIC SYMBOLS.......78

This document CXC A12/U2/16 replaces CXC A12/U/05 issued in 2005.

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

First published in 1999
Revised in 2005, 2016

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

Introduction

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

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

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

Electrical and Electronic Engineering Technology Syllabus

♦ RATIONALE

The electrical and electronic revolution has had the greatest impact on the cultural and technological changes occurring in the twenty-first century. This has resulted in substantial growth of and dependence on a diversity of systems, gadgets, products and services that affect the lives of all people. The rapid growth and wide range of technologies, innovations and inventions in telecommunication, electronic and computer controlled systems worldwide, and the operating efficiency of these systems have created an overwhelming need for education and training to respond at equal intervals. The sustainable development of individuals with engineering and technology competencies to design, construct and maintain these gadgets, products, and services is an important imperative for education and training.

Electrical and Electronic Engineering Technology is a programme of study that offers knowledge and skills for work and lifelong learning in various engineering and technology fields. Electrical and electronic engineers manipulate electricity and use it to design and manufacture products that transmit power or process information. The syllabus, therefore, offers broad-based competencies in an appropriate combination of interdisciplinary processes, evidence-based delivery and assessment, and the development of twenty-first century and employability skills that are relevant to both the training and work environments.

The principles of Competency Based Education, Training and Assessment (CBETA) are integrated into the School-Based Assessment component, which requires that verifiable evidence is used to confirm the achievement of competence when measured against the performance standards which are determined by industry experts. This new approach to the School-Based Assessment component of the ***CAPE®*** *Electrical and Electronic Engineering Technology makes it possible, where applicable, for every student who attains acceptable performance in the examinations to exit with dual recognition.*

The syllabus facilitates articulation with the field of study provided by *post-secondary and tertiary institutions. It is appropriate for students aspiring to careers and employment as electrical and electronic technicians, electrical and electronic engineers, repair specialists, electronic testers, design and system engineers, inspectors, utility workers and service technicians. The syllabus will, therefore, contribute to the development of selected attributes of the Ideal Caribbean Person. This person is one who is respectful, emotionally intelligent, environmentally sensitive, democratically engaged and entrepreneurially capable (Caribbean Education Strategy, 2000). In addition, students pursuing this subject will benefit from competencies which align with selected UNESCO Pillars of Learning. These include learning to know, learning to do and learning to transform self and society.*

♦ AIMS

The syllabus aims to:

1. *develop an awareness of the fundamental knowledge, skills, ethical and professional standards appropriate for lifelong learning and careers in the field of electrical and electronic engineering technology;*

2. *develop the requisite competencies applying electrical and electronic theories, related studies, technology skills, codes and standards for the design and production of goods and services* pivotal *to national and regional sustainable development;*

3. *develop innovative minds equipped with critical thinking, problem solving and experimental skills in engineering, facilitated through laboratory work, field work and industry attachment; and,*

4. develop an awareness of the relevance of the competencies and teamwork skills for employment creation and entrepreneurship in the Region.

♦ SKILLS AND ABILITIES TO BE ASSESSED

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

(a) Knowledge;

(b) Use of Knowledge; and,

(c) Practical Ability.

Knowledge	The ability to recall and comprehend facts, principles, methods, procedures, theories and structures; interpolation and extrapolation.
Use of Knowledge	The ability to:
Application	use facts, concepts, principles and procedures in unfamiliar situations; transform data accurately and appropriately; use formulae accurately for computations;
Analysis and Interpretation	identify and recognise the component parts of a whole and interpret the relationship between those parts; identify causal factors and show how they interact with each other; infer, predict and draw conclusions; make necessary and accurate calculations and recognise the limitations and assumptions of data;
Synthesis	combine component parts to form a new meaningful whole; make predictions and solve problems; and,

Evaluation	make reasoned judgements and recommendations based on the value of ideas and information and their implications.
Practical Ability	The ability to use electrical and electronic equipment and tools to fabricate simple circuits, test and determine circuit parameters and gather and analyse data.

♦ PREREQUISITES OF THE SYLLABUS

It is expected that persons who have completed the **CSEC®** syllabuses in Physics, Chemistry, Mathematics or Electrical and Electronic Engineering Technology or their equivalent should be able to pursue this course successfully. *The success of the course of study will also depend on possession of good verbal and written communication skills.* **CSEC®** Mathematics or its equivalent would be a strong asset for those who wish to undertake this course.

♦ STRUCTURE OF THE SYLLABUS

The syllabus consists of two Units, each containing three Modules. Each Unit requires 150 hours distributed equally across the three Modules (50 hours each).

*Unit 1, the Fundamentals of Electricity and Electronics, consists of three Modules. It is designed to provide students with an all-rounded developmental experience in electricity and electronics. The knowledge and practical skills gained will enable students to focus on the essential prerequisites for optimal progression in the Options in Unit 2. Unit 2, Applied Theory in Electrical and Electronic Engineering Technology, comprises **TWO** Options each consisting of three Modules.* Students are required to choose **ONE** of the **TWO** Options in Unit 2.

UNIT 1: FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS

Module 1 - Occupational Safety, Health and Environmental Practices
Module 2 - Electrical and Electronic Related Studies
Module 3 - Introduction to Circuit Technology and Devices

UNIT 2: APPLIED THEORY IN ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

OPTION A: ELECTRONIC ENGINEERING TECHNOLOGY

Module 1 - Communication Engineering
Module 2 - Analogue and Digital Electronics
Module 3 - Control Systems

OPTION B: ELECTRICAL ENGINEERING TECHNOLOGY

Module 1 - Power Machines and Systems
Module 2 - Introduction to Renewable Energy Systems
Module 3 - Power Generation Engineering

♦ APPROACHES TO TEACHING THE SYLLABUS

The general and specific objectives indicate the scope of the content including practical work that should be covered. Teachers are encouraged to:

1. *use an interdisciplinary approach which caters to the different learning styles in the delivery and assessment of the syllabus. This approach will enable students to relate the content to their daily experiences;*

2. *actively engage students in the Engineering Design Process to ask, imagine, plan and create when designing and carrying out projects, as this will promote creativity, innovation and problem solving;*

3. *apply the principles of Science, Technology, Engineering and Mathematics (STEM) to all practical activities;*

4. *model the standards of the industry and ensure students engage in practical activities in a safe environment that is conducive to learning;*

5. *integrate and assess related Occupational Health Safety (OHS) practices and standards for all practical activities;*

6. *create a community of learning with teachers or facilitators, students and industry experts to facilitate the overall growth of students in the acquisition of knowledge, skills, attitudes and experience; share best practices and teaching methods; where possible share workshops or training laboratories, technologies; and network with colleagues and industry expert to maintain currency in the electrical and electronic field;*

7. *create opportunities for students to work in teams;*

8. *establish partnerships with industries or firms for support with resources (laboratories, personnel, materials, tools and equipment) and to create opportunities for students to participate in work experience, job shadowing and apprenticeship;*

9. *conduct at least one official group meeting to evaluate the completion of each project; and,*

10. *facilitate self and peer assessment throughout the syllabus.*

♦ UNIT 1: FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS
MODULE 1: OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENTAL PRACTICES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *develop an understanding of the potential dangers of electricity; and,*

2. *know the occupational, health, safety and environmental standards which must be practised, managed, reinforced and mastered within the industry.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *assess the effects of electricity on the body;*

2. *examine safety standards and regulations relating to electrical and electronic operations;*

3. *apply safety and maintenance standards when executing electrical and electronic operations;*

4. *render first aid assistance; and,*

5. *discuss environmental issues associated with electrical and electronic engineering technology.*

CONTENT

1. Effects of Electricity on the Body

(a) *Path of current through the body.*

(b) *Body impedance (resistance).*

(c) *Electrical shocks.*

(d) *Electrical burns.*

2. Health and Safety Standards

International, regional and local codes and standards to include British Standards (BS), International Electrotechnical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), International Standards Organisation (ISO) and Jamaica Standard 21 (JS 21) relevant for:

(a) workers and employers;

(b) buildings, materials, tools, equipment;

(c) electrical hazards (substances, materials, situations);

(d) electrical installation, wiring materials and equipment;

(e) electronic systems and equipment;

(f) high voltage and high current;

(g) earthing and insulation;

(h) isolation transformers;

(i) solar energy systems; and,

(j) power plants.

3. Safety and Maintenance Standards

Rules, procedures and standards for equipment, building, materials, tools and the external environment:

(a) Personal Protective Equipment (PPE);

(b) cleaning (pre-cleaning, ongoing cleaning, post-cleaning);

(c) maintenance plans;

(d) risk assessments; and,

(e) calibrating of basic equipment and systems.

4. Basic First Aid

(a) First Aid Station.

(b) Treating electrical injuries and accidents:

(i) electrical shock;

(ii) electrical burns;

(iii) *thermal burns;*

(iv) *electrocution; and,*

(v) *cuts and bruises.*

(c) *Mouth to Mouth Resuscitation.*

(d) *Recovery position.*

5. ***Environmental Issues and Concerns***

(a) *Environmental regulations.*

(b) *Types of electrical and electronic wastes.*

(c) *ISO Standards on electrical and electronic wastes.*

(d) *Management of electrical and electronic wastes.*

(e) *Electrical and electronic eco-friendly technology:*

(i) *materials;*

(ii) *energy; and,*

(iii) *tools, equipment and processes.*

Suggested Teaching and Learning Activities

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

1. *Engage resource personnel from electrical and electronic industries and associations to make presentations to students on developing trends in electrical and electronic engineering, and place students in groups to monitor the trends and make oral presentations on them throughout the Unit.*

2. *Establish a preventative maintenance team for the institution and have students get involved in housekeeping activities and carrying out minor repairs to the electrical workshop under your supervision. Have students develop a safety policy for the workshop/laboratory.*

3. *Engage the local first aid establishment or local health clinic for the demonstration of the practical aspects of basic first aid treatment. Have students develop a brochure and practise basic first aid treatment under supervision.*

RESOURCES

Jones, R. A, Jones, J.	*Electrical Safety in the Workplace*. Massachusetts: National Fire Protection Association, Quincy, 2000.
Miltolo, M.	*Educational Safety of Low-Voltage Systems*. New York: McGraw-Hill Education, 2009.
Watson, J.	*Practical Electricity and Electronics.* London: Macmillan Education, 1994.

UNIT 1
MODULE 2: ELECTRICAL AND ELECTRONIC RELATED STUDIES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *develop an understanding of the ethical, scientific and mathematical competencies which are foundational for studies in electrical and electronic engineering;*

2. *understand the technology of materials, their properties, processing and application;*

3. *develop an awareness of modern telecommunication systems; and,*

4. *appreciate the importance of entrepreneurship in electrical and electronic engineering technology.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *discuss the ethical and social responsibilities of an engineer;*

2. *examine the roles and responsibilities of an electronic engineer and an electrical engineer;*

3. *apply engineering mathematics concepts to solve problems relating to electrical and electronic circuits;*

4. *discuss the construction and working principles of measuring instruments;*

5. *outline the classification, structure and properties of electrical and electronic materials;*

6. *conduct simple experiments to analyse the properties of materials and their effects on the production of electrical and electronic goods and services;*

7. *analyse the principles of applied physics and chemistry in the electrical and electronic fields;*

8. *discuss the architecture and organisation of telecommunication systems;*

9. *design a simple microprocessor for a control operation;*

10. *explain the operating principles of robotics;*

11. *evaluate business opportunities in electrical and electronic engineering technology; and,*

12. *prepare a business plan for an electrical and electronic engineering technology enterprise.*

UNIT 1
MODULE 2: ELECTRICAL AND ELECTRONIC RELATED STUDIES

CONTENT

1. Ethics and social responsibilities

Social and ethical responsibilities of an engineer:

(a) laws and regulations; and,

(b) importance to businesses or organisations.

2. Roles and responsibilities

(a) Electrical engineer:

(i) research, design, develop and maintain electrical systems; and,

(ii) management and leadership functions.

(b) Electronic engineer:

(i) research, design, develop and test electronic systems and components; and,

(ii) management and leadership functions.

3. Engineering Mathematics

Solving problems relating to:

(a) number systems (binary, octal, decimal and hexadecimal);

(b) trigonometry (ratio of angles, properties of a triangle, sine and cosine rule with proof);

(c) differential equation and their application

(i) Theorems – Rolle's;

(ii) mean – value;

(iii) Taylor's;

(iv) Linear and non-linear; and,

(v) Vector algebra.

(d) *probability and statistics (correlation and regression analysis, conditional probability, mean, median, mode and standard deviation);*

(e) *algebra (matrix algebra, determinants and their properties, linear equation, homogenous systems, Eigen values and Eigen vectors);*

(f) *numerical methods (single and multi-step methods for differential equations, solutions for non-linear algebraic equations);*

(g) *calculus (multiple, integrals, vector identities, Fourier series);*

(h) *graph theory (structure of basic graphs, networks, graphic thematic problems, basic algorithms); and,*

(i) *transform theory (Fourier transform, Laplace transform, Z-transform).*

4. Measuring instruments

(a) *Construction and working principles of electrical measuring instruments:*

(i) *moving coil;*

(ii) *moving iron;*

(iii) *dynamometer types;*

(iv) *induction type instruments;*

(v) ammeters;

(vi) voltmeters;

(vii) oscilloscopes; and,

(viii) *potentiometric recorders.*

(b) *Construction and working principles of electronic measuring instruments:*

(i) multimeter;

(ii) *cathode ray oscilloscope (CRO);*

(iii) *digital voltmeter;*

(iv) *frequency counter;*

(v) *Q-meter;*

(vi) *spectrum-analyser;*

(vii) *distortion meter;*

(viii) transducers;

(ix) *tachometers; and,*

(x) *data acquisition systems.*

5. *Electrical* and electronic materials

(a) *Classification of materials:*

(i) *metals and alloys;*

(ii) *ceramics;*

(iii) *polymers; and,*

(iv) *composite and semiconductors.*

(b) *Atomic structure and chemical bonding in materials:*

(i) *structure-property relationship;*

(ii) *rules of alloying: phase diagrams; and,*

(iii) *diffusion in solids.*

(c) *Defects and imperfections in solids:*

(i) *classification (geometry and dimensions);*

(ii) *types of imperfections and defects; and,*

(iii) *impact on material properties.*

(d) *Elastic, plastic and viscoelastic behaviour of materials:*

(i) *stress-strain relationship;*

(ii) *relaxation; and,*

(iii) *creep strengthening mechanism.*

*6. **Properties of Materials***

(a) *Thermal properties of materials:*

- (i) *conductivity;*
- (ii) *conductance;*
- (iii) *mass;*
- (iv) *resistance; and,*
- (v) *diffusivity.*

(b) *Electrical properties:*

- (i) *electronic and ionic conduction;*
- (ii) *energy band structures in solids; and,*
- (iii) *electron mobility, temperature.*

(c) *Environmental degradation of materials:*

- (i) *oxidation;*
- (ii) *corrosion;*
- (iii) *thermal;*
- (iv) *photo; and,*
- (v) *chemical.*

(d) *Structure of solids:*

- (i) *crystalline and non-crystalline states;*
- (ii) *dielectric behaviour;*
- (iii) *capacitance;*
- (iv) *types of polarisation;*
- (v) *ferroelectricity and piezoelectricity in materials;*

(vi) *magnetic properties;*

(vii) *diamagnetic;*

(viii) *ferromagnetic;*

(ix) *antiferromagnetic and ferromagnetic behaviours of materials;*

(x) *soft and hard magnetic materials;*

(xi) *superconductivity;*

(xii) *optimal properties;*

(xiii) *light interaction with solids;*

(xiv) *absorption, transmission and reflection;*

(xv) *luminescence; and,*

(xvi) *photoconductivity.*

7. Principles of Applied Physics and Chemistry

(a) Electromagnetism:

(i) laws (Faraday's and Lenz's);

(ii) magnetic flux;

(iii) flux density;

(iv) using the relation $F = BIL\ Sin\ \vartheta$ to solve problems;

(v) calculating the *emf* generated in a conductor within a magnetic field;

(vi) electromagnetic induction;

(vii) concepts of permeability, magneto motive force, magnetising force and reluctance;

(viii) sketching and labelling a typical *B-H curve*; and,

(ix) applying *B-H curve* to calculate magnetic circuit characteristics for a simple toroid.

(b) *Computer simulation of electric circuits.*

(c) *Electrical resistance dependence factor.*

(d) *Interference of Light:*

  (i) *division of wave front;*

  (ii) *division of amplitude; and,*

  (iii) *interference.*

(e) *Principle of Superposition, Newton rings and Michelson interferometer.*

(f) *Diffraction:*

  (i) *Fresnel diffraction; and,*

  (ii) *diffraction at a straight edge.*

(g) *Polarisation.*

(h) *Laser.*

(i) *Fibre Optics.*

(j) *Theory of relativity.*

(k) *Formation of energy band in metals, semiconductors and insulators.*

(l) *Superconductivity.*

(m) *Electrochemistry:*

  (i) *electrochemical reactions;*

  (ii) *construction and working of electrochemical cell and electrolysis;*

  (iii) *Faraday's first and second laws of electrolysis; and,*

  (iv) *electrochemical cells and batteries.*

(n) *Production and properties of X-rays.*

(o) *Ultrasonic.*

8. ***Computer* design and architecture:**

(a) *history of computers;*

(b) *computer design and analysis;*

(c) *encoders and decoders;*

(d) *converters;*

(e) *concepts of programming; and,*

(f) *writing simple programs.*

9. ***Microprocessors***

(a) *Classification*

(b) *Modes*

(c) *Features*

(d) *Uses*

(e) *Drawing and labelling a simple block diagram for a microprocessor*

(f) *Designing a simple microprocessor*

(g) *Optical communication*

10. ***Robotics***

Working principles of robotics.

(a) *structure*;

(b) *sensors;*

(c) *systems;*

(d) *power supply;*

(e) *control systems; and,*

(f) *robotic laws.*

11. Business Opportunities

Entrepreneurship.

(a) *Definition.*

(b) *Characteristics of an Entrepreneur:*

- *(i)* *innovative;*
- *(ii)* *enthusiastic;*
- *(iii)* *success oriented;*
- *(iv)* *risk taker;*
- *(v)* *good human relation skills; and,*
- *(vi)* *good management and leadership skills.*

(c) *Types of business enterprise:*

- *(i)* *micro;*
- *(ii)* *small;*
- *(iii)* *medium; and,*
- *(iv)* *large.*

(d) *Opportunities for Entrepreneurship:*

- *(i)* *electrical engineer;*
- *(ii)* *electronic engineer;*
- *(iii)* *digital hardware design engineer;*
- *(iv)* *wire design and installation engineer;*
- *(v)* *automation specialist (logic controls and software);*
- *(vi)* *project engineer;*
- *(vii)* *engineering technician; and,*
- *(viii)* *control systems engineer.*

(e) *Requirements for establishing an enterprise:*

(i) *market research;*

(ii) *start-up capital;*

(iii) *operational costs;*

(iv) *advertisement and promotion; and,*

(v) *government regulations.*

12. Business Plan

(a) *Description of the product.*

(b) *Mission, objectives and legal structure.*

(c) *Market research, target market and competition.*

(d) *Operating schedule.*

(e) *Financial plan.*

Suggested Teaching and Learning Activities

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

1. *Have students create a database or journal to track the progress of their own learning and to reflect in writing on the lessons taught. Ensure that they log the relevant laboratory exercises provided in the syllabus.*

2. *Have students research the latest technological developments in engineering and apply relevant areas to their class projects.*

3. *Invite guest presenters with appropriate entrepreneurial background to help students learn through their experiences. Place students in groups to implement industry-focused projects employing the principles of entrepreneurship and employability skills they would have learnt through these presentations.*

UNIT 1
MODULE 2: ELECTRICAL AND ELECTRONIC RELATED STUDIES (cont'd)

RESOURCES

Duncan, T.	*Electronics for Today and Tomorrow, 2nd edition.* London: John Murray, 1997.
Maja, J.	*The Robotics Primer Mataric.* London: MIT Press, September 2007.
Barringer, B. R., Ireland, R. D.	*Entrepreneurship: Successfully Launching New Venture, 5th edition.* London: Pearson College Division, 2015.
Ministry of Industry, Investment and Commerce	*Micro, Small and Medium Enterprise (MSME) and Entrepreneurship Policy, 2013*

UNIT 1
MODULE 3: INTRODUCTION TO CIRCUIT TECHNOLOGY AND DEVICES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the basic laws and theorems of circuit theory and their application in circuit devices;*

2. *develop skills and proficiency in the techniques of direct current (DC) and alternating current (AC) circuit analysis;*

3. *appreciate the importance of passive components; and,*

4. *develop a working knowledge of the principles of semi-conductor materials and devices.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *apply the principles of direct current (DC) theory, network theorems and relationships in circuits and networks;*

2. *apply the operating principles of electromagnetism;*

3. *discuss the importance, construction and operating principles of passive components;*

4. *apply the principles of electrostatics;*

5. *apply the principles of operation of inductance; and,*

6. *apply the principles of alternating current (AC) theory, network theorems and relationships in circuits and networks.*

CONTENT

1. **Direct current (DC) theory *and network theorems:***

    (a) Ohm's Law:

    (i) equivalent resistance and resistance of resistors in series, parallel and series parallel;

    (ii) voltage and current divider and using it to solve problems;

(iii) the relationships $P = V^2 / R = I^2 R = I V$ to calculate the power dissipated by circuit elements; and,

(iv) temperature coefficient of resistance.

(b) Kirchoff's Law including the analysis of DC networks involving two meshes.

(c) *Network Theorems*

(i) Superposition.

(ii) Thevenin's.

(iii) Norton's.

(iv) Maximum Power Transfer.

(v) Utilisation of the theorems for a maximum of two independent sources and meshes in the solution of DC networks.

2. Electromagnetism

(a) Magnetic flux and magnetic flux density.

(b) Concept of lines of magnetic flux.

(c) Magnetic effect on a current carrying conductor.

(d) Problem solving using the relation $F = BIL \sin \vartheta$.

(e) Calculation of the *emf* generated in a conductor within a magnetic field.

(f) Electromagnetic induction.

(g) Concepts of permeability (free space, relative), magneto motive force, magnetising force (field intensity, field strength) and reluctance.

(h) *B-H curve* – sketch and label a typical B-H curve.

(i) Application of the *B-H curve* to calculate magnetic circuit characteristic for a simple toroid.

3. Passive Components

(a) Circuit protection:

(i) the relationship between continuous; and,

(ii) overload and fault currents.

(b) Fuses:

(i) function;

(ii) operation; and,

(iii) fuse rating.

(c) Relays:

(i) the thermal overload relay and its operations; and,

(ii) the inverse minimum time over-current relay and its operation.

(d) The inverse characteristics of the fuse, the thermal overload relay, and the inverse over-current relays.

(e) Under-voltage and over-voltage protection.

(f) Voltage surge protector:

(i) uses; and,

(ii) operations.

4. Electrostatics

(a) Terminologies:

(i) electric field strength;

(ii) electric flux density;

(iii) permittivity of free space; and,

(iv) relative permittivity.

(b) Principles of Electrostatics of capacitance.

(c) Formulae for capacitance in series and parallel circuits:

(i) relationship between capacitance and its dimensions;

(ii) determination of the capacitance for fixed and variable capacitors;

(iii) construction of fixed and variable capacitors;

(iv) capacitors (charging and discharging) – using time constant formulae, sketching curves for charging and discharging capacitors; and,

(v) application of the formulae for energy stored in a capacitor.

5. Inductance

(a) Concepts:

(i) self-inductance and mutual-inductance and their relationship;

(ii) coupling coefficient (coils inductively coupled in series); and,

(iii) additive and subtractive polarity.

(b) Functions of the core material in an iron-core inductor or choke.

(c) Physical factors governing inductance.

(d) Energy stored in an inductor.

(e) Total inductance for inductors in series, parallel, and combination.

(f) Helmholtz equation for simple RL circuits.

6. DC theory *and network theorems*

(a) Terminologies:

(i) frequency;

(ii) period;

(iii) amplitude;

(iv) instantaneous value;

(v) RMS; and,

(vi) average value (AC sinusoidal wave).

(b) Phasors:

(i) definition;

(ii) phasors (adding and subtracting);

(iii) diagrammatic representation of a phasor; and,

(iv) drawing and interpreting wave forms and phasor diagrams alternating currents and voltage in resistive, inductive and capacitive circuits.

(c) Power in AC circuits:

(i) non-inductive;

(ii) purely inductive;

(iii) apparent;

(iv) active;

(v) reactive;

(vi) calculating volt-ampere, apparent, active and reactive power for purely inductive and inductive resistive loads; and,

(vii) determining capacitor values to be applied in parallel for improving power factor.

(d) Impedance and reactance:

(i) complex numbers (addition, subtraction, multiplication, division); and,

(ii) calculating and determining impedance for series and parallel circuits – RL, and RLC networks (resistance and capacitance in series and parallel, resistance and Inductance in series and parallel, resistance, inductance and capacitance in series and parallel).

(e) RLC series circuits:

(i) determining resonant frequency;

(ii) phasor diagrams for RL, RC and RLC circuits; and,

(iii) resonance and Q-factor for RLC circuits.

(f) Filters:

(i) operations of low pass, high pass, band pass, band stop "π" and "T" sections;

(ii) drawing simple RLC circuits to implement low pass, high pass, band pass, band stop and notch filters;

(iii) calculating the cut-off frequency and designing impedance for high pass and low pass passive filters; and,

(iv) sketching and labelling the frequency response of the high pass and low pass filters.

Suggested Teaching and Learning Activities

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

1. *Place students in groups to conduct research, develop and execute projects that will allow them to develop basic managerial, administrative, entrepreneurial and teamwork skills.*

2. Have students conduct an analysis of model circuits to detect the actual problems given in theory, and carry out test on them to verify answers obtained from calculations.

3. Have students discuss the uses of Thevenin's and Norton's theorems after reading or watching case studies and/or presentations on the use and purpose of the theorems in the real world.

UNIT 1
MODULE 3: INTRODUCTION TO CIRCUIT TECHNOLOGY AND DEVICES (cont'd)

RESOURCES

Furbur, S.	*System-On-Chip Architecture,* 2nd edition. London: Pearson Education, 2001.
Hill, M. Turner, D.	*Instrumentation for Engineers and Scientists*. London: Oxford University Press, 1999.
Jones, I.	*Materials Science for Electrical and Electronic Engineer*. London: Oxford University Press, 2001.
Russel, G. K.	*Introductory Alternating Current Theory*. Australia: New South Wales University Press, 1990.
Ulaby, F.T.	*Electromagnetics for Engineers.* London: Pearson Education, Inc, 2008.

Website

www.orcad.com

♦ UNIT 2: APPLIED THEORY IN ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

OPTION A: ELECTRONIC ENGINEERING TECHNOLOGY
MODULE 1: COMMUNICATION ENGINEERING

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the theory, practice and operating principles of digital and analogue electronic data communication systems; and,*

2. *develop skills in designing, building, analysing and testing simple communication circuits and devices.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *discuss the elements of a communication system;*

2. *explain the functions of different communication devices;*

3. *compare analogue and digital communication systems;*

4. *discuss the terminologies, characteristics and operating principles of analogue communication systems;*

5. *demonstrate the application of analogue communication devices;*

6. *construct a simple analogue communication system;*

7. *discuss the terminologies, characteristics and operating principles of digital communication systems;*

8. *demonstrate the application of digital communication devices;*

9. *construct basic digital communication systems; and,*

10. *differentiate between wireless communication and multimedia communication.*

CONTENT

1. Elements of a communication system

(a) Source of information.

(b) Transmitter:

(i) *encoding; and,*

(ii) *modulation.*

(c) Channel:

(i) *distortion; and,*

(ii) *noise.*

(d) Receiver:

(i) *decoding; and,*

(ii) *demodulation.*

(e) Destination.

(f) Block diagram of the communication system.

2. Communication devices

Global network communication devices:

(a) television;

(b) radio;

(c) computer devices; and,

(d) mobile devices.

3. Analogue and Digital Communication Systems

(a) Terminologies.

(b) Signals.

(c) Principle of operation.

(d) Characteristics.

(e) Advantages.

(f) Disadvantages.

4. Analogue Communication Systems

(a) *Terminologies:*

(i) Amplitude Modulation (AM) index;

(ii) *Armstrong method;*

(iii) *bandwidth*;

(iv) *carrier wave;*

(v) *de-emphasis;*

(vi) double polarity;

(vii) *envelope detector;*

(viii) *frequency deviation;*

(ix) *frequency range;*

(x) *modulation carrier;*

(xi) *Frequency Modulation (FM) index;*

(xii) *noise frequency;*

(xiii) *phase deviation;*

(xiv) *pre-emphasis;*

(xv) *Pulse Width Modulation (PWM);*

(xvi) *Pulse Positive* Modulation (PPM);

(xvii) *radio detector;*

(xviii) *ring modulator;*

(xix) *single polarity;*

(xx) *Vestigal Sideband (VSB) system;*

(xxi) *wave; and,*

(xxii) *Wide band Frequency Modulation (WBFM).*

(b) *Noise:*

(i) *classification, sources, signal to noise ratio, mathematical representation of random noise and narrow band noise, calculation of noise ratio; and,*

(ii) *performance and transmission.*

(c) The electromagnetic spectrum:

(i) *propagation* of electromagnetic waves from an antenna;

(ii) distinguishing among ground waves, *sky waves*, space waves, *surface waves and tropospheric waves;*

(iii) ionospheric reflections;

(iv) major wavebands and their use; and,

(v) telephony communication.

(d) Modulation:

(i) *reasons for modulation;*

(ii) amplitude modulation – double sideband (DSB), single sideband (SSB) modulators and demodulators, narrowband and broadband AM;

(iii) angle modulation – frequency and phase modulation, spectrum of FM wave, modulation index and bandwidth of FM signal, AM and FM systems and signals; and,

(iv) AM and FM modulators and demodulators *methods* and operations.

(e) *Power distribution and application.*

(f) *Oscillator tracking and distribution characteristics.*

5. Analogue communication devices

Drawing block diagrams and explaining the operations of:

(a) the superheterodyne radio receiver;

(b) AM *and FM transmitters;*

(c) linear devices;

(d) *non-linear devices;*

(e) *filtering; and,*

(f) *performance metrics (complexity, performance, bandwidth efficiency).*

6. Building a simple analogue communication system

(a) *Design of a simple household or office system (for internal or external systems) using the engineering design process or steps.*

(b) *Circuit diagram and model system.*

(c) *Methods of testing the system.*

7. Digital communication systems

(a) *Terminologies:*

(i) amplitude;

(ii) attenuation;

(iii) bandwidth constraint;

(iv) baseband signal;

(v) digital network;

(vi) filtering;

(vii) integrated service;

(viii) multiplexing;

(ix) monotonicity;

(x) non-linearity;

(xi) offset error;

(xii) pass band transmission;

(xiii) phase-lock-loop;

(xiv) resolution;

(xv) sampling;

(xvi) scale error;

(xvii) speed limiting errors;

(xviii) settling times;

(xix) source coding; and,

(xx) transmission reliability.

(b) Characteristics:

(i) signals;

(ii) modulation;

(iii) demodulation;

(iv) encryption and comprehension;

(v) voice and data integration; and,

(vi) signal regeneration.

(c) *Operating Principles.*

8. Digital communication devices

(a) Memory circuits and converters:

(i) simple decoders and demultiplexers (binary adders, subtractors);

(ii) simple data selectors, multiplexers and encoders;

(iii) memory systems to include, read-only memory (ROM), random access memory (RAM), programmable read-only memory (PROM) and erasable programmable read-only memory (EPROM);

(iv) voltage to frequency, constant slope ramp and integrating analogue to digital (A/D) converters;

(v) successive approximation A/D converter; and,

(vi) calculating the digital output and resolution of digital-ramp A/D converters.

(b) Data Communication – basic concepts of bandwidth, channel capacity, signal to noise ratio, Shannon-Hartley law and information theory:

(i) source coding – Huffman, Shannon-Fano;

(ii) simplex and duplex data communications;

(iii) synchronous and asynchronous data communications;

(iv) regenerators and synchronisation in digital systems;

(v) concepts of mutual information and channel capacity;

(vi) Pulse code modulation (PCM) and frequency shift keying (FSK), phase shift keying (PSK) and differential phase shift keying (DPSK) digital modulation techniques;

(vii) error detection and correction, including cyclic redundancy check (CRC) and Hamming Codes;

(viii) intercomputer communications including universal asynchronous receiver or transmitter (UART) and universal synchronous asynchronous receiver or transmitter (USART);

(ix) demodulation techniques; and,

(x) ring, star and bus computer networking topologies.

9. Design and construct simple digital electronic systems (*using engineering design process or steps)*

(a) Safety standards.

(b) Building simple digital electronic devices using decoders and demultiplexers.

(c) Building simple digital electronic devices using data selectors, multiplexers and encoders.

(d) Building digital to analogue (D/A) – 4-8 bit D/A converters driven by digital counters, D/A converter with input code.

(e) Performing basic calculations with D/A converters using a summing op-amp.

(f) Building D/A converters using 2R-R resistor ladder networks.

10. *Multimedia and wireless communication systems*

(a) *Multimedia communication:*

(i) networks;

(ii) applications (texts, graphics, animation, video);

(iii) information representation (text, images, audio and video); and,

(iv) compression *techniques (texts, image, audio and video.*

(b) Wireless communication systems:

(i) types (radio, cellular, satellite, Wi-Fi);

(ii) designs, features and applications of cellular mobile and wireless communications system;

(iii) sine wave equation;

(iv) modulation;

(v) demodulation; and,

(vi) designing *a simple wireless communications system.*

UNIT 2A
MODULE 1: COMMUNICATION ENGINEERING (cont'd)

Suggested Teaching and Learning Activities

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

1. *Organise a mentoring programme with professional organisations and relevant companies to ensure the relevant resources to include a well-equipped computer lab with internet connectivity, simulations and virtual laboratories are accessible as the students conduct research and develop project ideas.*

2. *Place students in groups to design, build and test an analogue and digital communication system. Where possible obtain sponsorship from local business and industry to offset the cost of the students' projects.*

3. *Have students participate in work experience with relevant industries or firms and have both the students and the supervisor at the placement site or company submit a written report at the end of the exercise.*

RESOURCES

Hughes, E.	*Electrical and Electronic Technology*, 11th edition. London: Pearson Education, 2012.
Temes, L.	*Theory and Problems of Electronic Communication: Schaum's Outlines Series*. India: McGraw Hill Education, 2009.

UNIT 2A
MODULE 2: ANALOGUE AND DIGITAL ELECTRONICS

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the operations and applications of analogue and digital electronics in engineering;*

2. *develop* the skill to implement step-by-step procedures for designing, building, analysing and testing simple circuits and devices using analogue and digital electronic principles, practices and components; and,

3. demonstrate safety *and maintenance procedures in the manipulation of digital and analogue electronic components.*

SPECIFIC OBJECTIVES

Students should be able to:

1. discuss different types of operational amplifiers, their characteristics and operating principles;

2. solve problems related to operational amplifiers' using circuit diagrams, components, relationships and computations;

3. analyse the features and operations of the Wein Bridge RC and Hartley LC oscillators;

4. discuss the construction, properties and operation of different types of semiconductors;

5. construct semiconductor circuits;

6. show quantitatively the applications of a zener diode as a voltage regulator;

7. discuss the basic structure and operation of various types of transistors;

8. solve problems associated with transistors using drawings, circuit configuration and analysis;

9. discuss the construction and operations of different types of electronic switches;

10. discuss the features, design and operation of combination logic gates and truth tables; and,

11. build simple sequential logic *using basic data sheet*.

CONTENT

Analogue Electronics

1. **Operational amplifiers**

   Types and their characteristics:

   (a) *difference;*

   (b) inverting;

   (c) non-inverting; and,

   (d) *summing.*

2. **Problem solving – operational amplifiers**

   (a) Quantitative analysis of the operation of an operational amplifier:

   (i) used as a summing amplifier, a comparator, differentiator and an integrator circuit;

   (ii) definition of parameters and input/output quantities;

   (iii) transfer characteristics; and,

   (iv) negative feedback.

   (b) Deriving the relationship for the gain of the inverting and the non-inverting op-amp and solving problems.

3. **Wein Bridge RC and Hartley LC oscillators**

   Drawing circuit diagram for the Wein Bridge RC and Hartley LC oscillators and determine the frequency of oscillation:

   (a) operation of the Wein Bridge RC and Hartley LC oscillators; and,

   (b) frequency of operation of the Wein Bridge RC and Hartley LC oscillators.

4. Semiconductors

(a) Differences between n-type and p-type semiconductors.

(b) Current flow and conduction process in semiconductor materials.

5. Semi-conductor Circuits

(a) Engineering design process or steps.

(b) Doping: p-type and n-type semi-conductors.

(c) Current flow and conduction process.

(d) The p-n junction and depletion layer.

(e) Junction potential difference.

(f) The p-n junction under bias.

(g) Diode circuit models:

(i) the ideal model;

(ii) the constant voltage model; and,

(iii) the Shockley model.

(h) Avalanche multiplication.

6. Zener Diode

(a) Quantitatively applications of a Zener diode as a voltage regulator:

(i) circuit diagram;

(ii) regulation of input voltage;

(iii) maintaining output voltage; and,

(iv) values *and trends.*

(b) Rectification:

(i) half waves rectifier;

(ii) full wave rectifier (two and four diode); and,

(iii) verifying waveforms in circuits.

(c) Light-emitting diode (LED) application (illumination):

(i) lamps;

(ii) flashlights;

(iii) indoor; and,

(iv) outdoor lighting.

(d) Logic circuit applications:

(i) OR gates; and,

(ii) AND gates.

(e) Circuit limiters and clipping circuits.

7. Transistors

(a) Positive-negative-positive (PNP) and Negative-positive-negative (NPN) transistors.

(b) Terminal properties of a transistor.

(c) Operating regions of a transistor.

(d) Transistor characteristic curves.

(e) H-Parameter model of a transistor.

(f) Transistor applications.

(g) Load line analysis.

(h) Small signal amplifier circuits.

8. Problem solving associated with transistors

(a) Circuit configurations.

(b) Calculation.

(c) Forward bias and reverse bias.

(d) Solution.

Digital electronics

9. Electronic switches

(a) Construction.

(b) Characteristics.

(c) Operation and application of metal-oxide semiconductor field-effect transistor (MOSFET) and bipolar junction transistor (BJT).

10. Combinational logic and truth tables

(a) Drawing and identifying logic symbols.

(b) Producing truth tables and Karnaugh maps (Kmaps).

(c) Interpreting Kmaps.

(d) Implementing logic gates using single pole singles throw (SPST) and single pole double throw (SPDT) switches.

(e) Mathematical operations between various number systems – binary, octal, decimal and hexadecimal.

(f) Minimising logic expressions using Boolean algebra and Karnaugh maps utilising a maximum of four inputs.

(g) Relating truth tables to Kmaps and simplifying expressions using Kmaps.

(h) Implementing logic circuits from Boolean expressions.

(i) Designing, constructing and testing simple logic circuits from a verbal description of problem with maximum of four inputs.

(j) Designing a simple Binary Coded Decimal (BCD) to Gray code converter.

UNIT 2A
MODULE 2: ANALOGUE AND DIGITAL ELECTRONICS (cont'd)

11. Sequential logic

(a) Types of flip flops and their differences (SR, JK, D and T).

(b) Building a simple three stage shift register.

(c) Building an asynchronous counter (up to mod 10).

(d) Designing and constructing sequential logic using the engineering design process or steps:

(i) Designing and building monostable and bistable (quantitative analysis expected) multi-vibrators using a 555 timer.

(ii) Differences between binary adders and subtractors.

Suggested Teaching and Learning Activities

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

1. *Invite experts from engineering and related fields to make presentations and conduct demonstrations on selected topics and have students write reflective pieces on what they have learnt. Encourage students to cite information from other sources (textbooks, websites, journals, magazines) in their writing.*

2. *Have students perform experiments or practical exercises in one of the virtual laboratories that are available online and report the findings.*

3. *Direct students to relevant websites that offer practical guidance in the area, for example, www.howstuffworks.com and have them test the steps and critique the accuracy of the information presented.*

RESOURCES

Hughes, E.	*Electrical and Electronic Technology*, 11th edition. London: Pearson Education, 2012.
Temes, L.	*Theory and Problems of Electronic Communication: Schaum's Outlines Series*. India: McGraw Hill Education, 2009.

UNIT 2A
MODULE 3: CONTROL SYSTEMS

GENERAL OBJECTIVE

On completion of this Module, students should be able to understand the engineering principles, technology, design and safety standards of control systems and relate them to their operations.

SPECIFIC OBJECTIVES

Students should be able to:

1. demonstrate the operations of instruments and electrical systems;

2. demonstrate the operating principles for programmable logic control systems;

3. demonstrate the operating principles for supervisory control and data acquisition (SCADA) systems; and,

4. model safety standards.

CONTENT

1. **Instrument and Electrical System**

   (a) Drawing and explaining:

      (i) instrument control loop *diagrams; and,*

      (ii) Proportional-Integral-Derivative (PID) to control temperature, pressure, level and flow.

   (b) Conversion of signal (digital to analogue and analogue to digital) in relationship to industrial control loop.

   (c) Operations:

      (i) processes of feedback loop, feed forward loop and cascade loop in relationship to industrial processes;

      (ii) processes of electricity generation and water supply; and,

      (iii) distribution Control System (DCS).

   (d) Instrument and control safety standards.

2. Programmable logic control (PLC) systems

(a) Safety and specifications.

(b) Characteristics and functions of a PLC system.

(c) Drawing:

(i) symbols of PLC input and output devices; and,

(ii) simple PLC block diagram.

(d) Functions of the components in the PLC block diagram.

(e) Characteristics of PLC programmers.

(f) PLC programme.

(g) PLC controls.

3. Supervisory control and data acquisition (SCADA) systems

(a) Safety standards and specification.

(b) Importance of SCADA system as applied to electricity generation, transmission and the central control room.

(c) Comparing analogue and digital communication in relationship to communications as applied to power systems.

(d) Drawing a simple block diagram to represent a SCADA system and show the functions of each block.

(e) Using PLC in SCADA system.

(f) Methods of communications between the field and control rooms.

(g) Telemetering in SCADA systems.

(h) Roles of computers, PLC and distributive controls in SCADA systems.

(i) *Differences* between PLC and DCS.

UNIT 2A
MODULE 3: CONTROL SYSTEMS (cont'd)

Suggested Teaching and Learning Activities

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

1. *Invite experts from engineering and related fields to assist in the delivery and assessment of the Module and have students write reflective pieces on what they learnt. Encourage students to cite information from other sources (textbooks, websites, journals, magazines) in their writing.*

2. *Have students perform experiments or practical exercises in one of the virtual laboratories that are available online and report the findings.*

3. *Arrange for students to visit related industries and have them document the practices observed and make comparisons with the information taught in class or garnered through their own reading.*

RESOURCE

Global, M. *Control Systems*. India: Tata, McGraw Hill Education, 1997.

Varmah, K. R *Control Systems*. India: Tata, McGraw Hill Education, 2010.

UNIT 2: APPLIED THEORY IN ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

OPTION B: ELECTRICAL ENGINEERING TECHNOLOGY
MODULE 1: POWER MACHINES AND SYSTEMS

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the internal and external characteristics of various types of power machines;*

2. *understand the principles of operation and analysis of electrical power systems;*

3. develop proficiency in the use of related calculations and controllers in the management of power systems and machines; and,

4. develop the ability to construct, operate and test power systems and machines.

SPECIFIC OBJECTIVES

Students should be able to:

1. discuss the main types of power machines and the related safety requirements and regulations;

2. *analyse* the construction of power systems and machines;

3. apply the principle of operation of power systems and machines;

4. prepare sketches or drawings of the operating components of power systems and machines;

5. use calculations to solve power systems and machines operational problems;

6. construct, connect and test power systems and machines; and,

7. observe safety standards in the operations of power machines and systems.

CONTENT

1. Power Machines

(a) Uses, features, safety standards of DC Power:

(i) DC Generator:

- shunt;
- series; and,
- compound.

(ii) DC Motor:

- shunt;
- series; and,
- compound

(b) Uses, features, safety standards of AC Power:

(iii) AC Motors

- synchronous generators;
- synchronous motor:
- single-phase induction motor;
- three-phase induction motor; and,
- wound rotor induction motor.

2. Construction of Power Systems and Machines

(a) Characteristics of DC Machines

(b) Construction of a DC machine

(c) Wiring diagrams:

(i) shunt;

(ii) series; and,

(iii) compound.

(d) Meaning of armature reaction and commutation as applied to DC machines.

(e) Sketching:

(i) the open-circuit and no-load characteristics for various winding connections of the DC machine; and,

(ii) the torque speed characteristic of series, shunt and compound wound machines.

(f) Methods of varying the speed of a DC machine using the terminal voltage and excitation current:

(i) losses; and,

(ii) conditions for maximum efficiency.

(g) Induction Motor

(i) Differences between the squirrel cage and wound rotor and their uses.

(ii) Principle of operation of the induction motor.

(iii) Differences among rotor speed, slip, torque and losses.

(iv) Mathematical relationship between slip and torque.

(v) Characteristics of slip and torque.

(vi) Calculating the values of rotor speed, slip, torque and losses from given parameters.

(vii) Methods of speed control of the induction motor.

3. Operation of Power Systems and Machines

(a) Principle of operation and problem solving for a DC machine – in terms of the equation $T\omega = E_r I_a$, where T = torque, ω = angular velocity, E = emf, and I_a = armature current.

(b) Rotor Calculations:

(i) Slip Speed (ns=nr).

(ii) Rotor Speed (rpm).

(iii) Flemming right hand rule.

(iv) Flemming left hand rule.

(v) Frequency.

4. **Sketches or Drawings of the Operating Components**

   (a) Block diagram of control circuit

      (i) Direct Online Start.

      (ii) Forward Reverse Start.

      (iii) Jog Circuit.

   (b) Wiring diagram of control circuit

      (i) Direct Online Start.

      (ii) Forward Reverse Start; and,

      (iii) Jog Circuit.

5. **Use Calculations to Solve Problems**

   (a) Full load current.

   (b) Power Factor.

   (c) Line Current.

   (d) Line Voltage.

   (e) Output Power.

   (f) Input Power.

   (g) Impedance.

   (h) Inductive Reactance.

   (i) Capacitive Reactance.

6. **Construct, connect and test power systems and machines.**

   (a) Construct and connect:

      (i) three-phase induction motor on a Direct On Line (DOL);

      (ii) jog circuit; and,

      (iii) forward reverse circuit.

(b) Test:

(i) insulation resistance;

(ii) continuity;

(iii) voltage;

(iv) full load current; and,

(v) speed.

7. Safety Standards

Electrical Standards:

(a) International:

(i) National Electric Codes (NEC); and,

(ii) Institute of Electrical Engineers (IEE).

(b) National Electrical Standards

Suggested Teaching and Learning Activities

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

1. *Have students visit a motor rewind shop, where sections of motors and transformers can be used by employees for demonstration. At the end of the demonstrations have them compare their observations with the information presented in class.*

2. *Invite experts from engineering and related fields to conduct presentations and demonstrations on selected topics and have students write reflective pieces on what they learnt. Encourage students to cite information from other sources (textbooks, websites, journals, magazines) in their writing.*

3. *Have students perform experiments or practical exercises in one of the virtual laboratories that are available online and report the findings.*

4. *Direct students to relevant websites that offer practical guidance in the area, for example, www.howstuffworks.com and have them test the steps and critique the accuracy of the information presented.*

RESOURCE

Hughes, E. *Electrical and Electronic Technology*. 11th edition, London: Pearson Education, 2012.

UNIT 2B
MODULE 2: INTRODUCTION TO RENEWABLE ENERGY SYSTEMS

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand the importance of the concerns that are helping to drive increased interest in climate change, environmental degradation, and the need for clean energy;*

2. *understand the scientific and chemical conversion processes which are involved in renewable energy systems and their impact on energy efficiency; and,*

3. *appreciate renewal energy technologies and their environmental significance.*

SPECIFIC OBJECTIVES

Students should be able to:

1. *explain terminologies relating to climate change and sustainable development;*

2. *compare different sources of energy;*

3. *analyse the causes, impact and solutions of environmental pollution;*

4. *discuss the operations, uses and impact of various types of renewable technologies;*

5. *design a basic renewable energy system to power a small installation using wind or solar energy; and,*

6. *solve an energy wastage problem.*

CONTENT

1. *Terminologies*

(a) *Natural resources.*

(b) *Renewable resources.*

(c) *Non-renewable resources.*

(d) *Environmental degradation.*

(e) *Sustainable development.*

(f) *Solar energy.*

(g) *Converters.*

(h) *Wind energy.*

(i) *Photovoltaic.*

(j) *Geothermal energy.*

(k) *Nuclear power.*

(l) *Green energy.*

2. *Energy sources*

(a) *Conventional:*

(i) *fossil fuels; and,*

(ii) *nuclear energy.*

(b) *Renewable energy sources:*

(i) *solar;*

(ii) *biomass;*

(iii) *geothermal;*

(iv) *wind; and,*

(v) *hydropower.*

3. *Environmental pollution*

(a) *Fossil fuel (coal, oil, natural gas).*

(b) *Air pollution.*

(c) *Water pollution and damages:*

(i) *public health;*

(ii) *water and land use;*

(iii) *wildlife and habitat; and,*

(iv) *global warming emissions.*

4. ***Renewable technologies***

(a) *Uses and operations of:*

(i) *wind power;*

(ii) *solar energy; and,*

(iii) *geothermal energy.*

(b) *Impact:*

(i) *reduction of pollution;*

(ii) *slow global warming;*

(iii) *clean and healthy energy; and,*

(iv) *new industries and job creation.*

5. ***Renewable energy systems***

(a) *Construction and operating principles of:*

(i) *solar heat collecting system;*

(ii) *solar thermal system; and,*

(iii) *photovoltaic system.*

(b) *Designing a basic energy system:*

(i) *solar heat collecting system;*

(ii) *wind collecting system;*

(iii) *schematic diagrams; and,*

(iv) *regulations and safety requirements.*

6. ***Energy wastage***

   (a) *Energy wastage problem in the home, community or in the school.*

   (b) *Solution through the design of a conservation system.*

   (c) *Testing for efficiency.*

   (d) *Preparing and presenting the system.*

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

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

1. *Invite experts from engineering and related fields to conduct presentations and demonstrations on selected topics and have students write reflective pieces on what they learnt. Encourage students to cite information from other sources (textbooks, websites, journals, magazines) in their writing.*

2. *Have students perform experiments or practical exercises in one of the virtual laboratories that are available online and report the findings. Exercises may be done individually or in groups.*

3. *Direct students to relevant websites that offer practical guidance in the area, for example, www.howstuffworks.com and have them test the steps and critique the accuracy of the information presented.*

RESOURCES

Boyle, G.	*Renewable Energy*, 2nd edition. London: Oxford University Press, 2004.
Dunlop, J.P	*Photovoltaic Systems*, 3rd edition. Maryland: National Joint Apprenticeship and Training Committee (NJATC), 2012.

UNIT 2B
MODULE 3: POWER GENERATION ENGINEERING

GENERAL OBJECTIVE

On completion of the Module, students should demonstrate a working knowledge of the principles of the design, operation, analysis and maintenance of the network of systems used in the generation, transmission and distribution of electric power.

SPECIFIC OBJECTIVES

Students should be able to:

1. *discuss the sources of electrical energy;*

2. *discuss the design of a typical electrical power system used in the generation, transmission and distribution of electricity;*

3. *analyse various types of power plants and their operations;*

4. *discuss the factors associated with choosing the location of power plant;*

5. *interpret the schematic design for a power plant;*

6. *explain the layout and operations of a hydroelectric plant; and,*

7. *outline the transmission of electricity from the power plant to consumers.*

CONTENT

1. Electrical Energy

Fuels:

(a) *thermal (solid and liquid fuel, natural gas, nuclear, solar); and,*

(b) *non-thermal (hydropower, wind, direct solar conversion).*

2. Electrical Power System

(a) *Generating stations (bulk electric power).*

(b) *Division:*

(i) *source of mechanical energy (boiler, turbine); and,*

(ii) *electrical (alternators, transformers, protection apparatus, control system, and measuring and testing instruments).*

(c) *Transmission lines:*

(i) *overhead transmission lines; and,*

(ii) *underground cables.*

(d) *Distribution systems (connect all the individual loads to the transmission line).*

3. Types of Power Plants

(a) *Thermal (steam power, oil, coal or natural).*

(b) *Hydro-electric (sufficient water resources and head).*

(c) *Nuclear (nuclear fusion of uranium).*

(d) *Diesel (diesel engine).*

4. Criteria for choosing Power Plant

(a) *Economic.*

(b) *Technical.*

(c) *Environmental.*

(d) *Safety and restriction.*

(e) *Hydrology:*

(i) *flow duration curve;*

(ii) *mass curve; and,*

(iii) *types of power stations.*

5. Schematic Designs

(a) *A hydropower system.*

(b) *A steam power system.*

6. Hydroelectric Plants

Parts:

(a) *reservoir (store water);*

(b) *dam (provides a head of water to be utilised in the water turbine); and,*

(c) *penstocks (pipes of large diameter, taking water from the intake works to the power house turbine).*

7. Operations and Transmission of Electricity

(a) *Voltage of current produced.*

(b) *Transmission grids.*

(c) *Power distribution network.*

(d) *Transmission lines analysis.*

(e) *Fault studies (symmetrical and unsymmetrical).*

(f) *Power system protection.*

(g) *Distance protection for transmission lines.*

Suggested Teaching and Learning Activities

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

1. Organise power plant tours and workshops to develop and reinforce theoretical concepts and to familiarise students with power engineering skills and techniques. Have students write a reflective piece on what they learnt.

2. Invite experts from engineering and related fields to conduct presentations and demonstrations on selected topics and have students write reflective pieces on what they learnt. Encourage students to cite information from other sources (textbooks, websites, journals, magazines) in their writing.

3. Have students perform experiments or practical exercises in one of the virtual laboratories that *are available online and report the findings.*

4. *Direct students to relevant websites that offer practical guidance in the area, for example, www.howstuffworks.com and have them test the steps virtually and critique the accuracy of the information presented.*

RESOURCE

Kothari, D.P Nagrath, I. J	*Power System Engineering*, 2nd edition. New Delhi: Tata McGraw Hill Education, 2008.

Web

Electrical Circuit Lab

♦ OUTLINE OF ASSESSMENT

Each Unit of the syllabus will be independently assessed and graded separately. The same scheme of assessment will be applied to each Module in each Unit.

The scheme of assessment for each Unit will comprise two components: an external assessment component and a School-Based Assessment (SBA) component. The external component contributes 70 per cent and the School-Based Assessment component contributes 30 per cent towards the overall assessment for each Unit.

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

Written Papers

Paper 01	***<u>Unit 1</u>***	*30%*
(1 hour 30 Minutes)	*This paper will consist of 45 multiple-choice items, 15 items based on each of the three Modules in the Unit.*	
	<u>Unit 2</u>	
(1 hour 30 Minutes)	*Option A and Option B* *This paper will test options A and B separately and consists of 45 multiple choice items, 15 items based on each of the three Modules in the Unit.*	
Paper 02 *(2 hours 30 Minutes)*	***<u>Unit 1</u>*** *Six extended response questions arranged in three Sections A, B, and C.* *Sections A, B, and C each comprise two questions. Section A tests Module 1; Section B tests Module 2; Section C tests Module 3.* *Candidates will be required to answer ALL questions from Sections A and B and C.*	*40%*
	<u>Unit 2</u> *Option A and Option B* *For each Option: Six extended response questions arranged in three Sections: A, B and C.* *In both Options, Sections A, B and C each comprises two questions. Section A tests Module 1; Section B tests Module 2; and Section C tests Module 3.* *Candidates will be required to answer ALL questions from each Section.*	

School-Based Assessment

*The SBA for Unit 1 is derived from the composite marks of the entries in the School-Based Assessment portfolio and which may include evidence of having completed related **CVQ*** Units of Competency aligned to the content in the syllabus. Where applicable the candidates who successfully complete selected Units in the **CVQ*** Regional Occupational Standards will be awarded a Statement of Competence. Students are expected to produce electronic portfolios where ALL entries are digitised.*

*The SBA for Unit 2 is derived from the composite marks of the entries in the School-Based Assessment portfolio and which may include evidence of having completed related **CVQ*** Units of Competency aligned to the content in the syllabus. Where applicable the candidates who successfully complete selected Units in the **CVQ*** Regional Occupational Standards will be awarded a Statement of Competence. Students are expected to produce electronic portfolios where ALL entries are digitised.*

MODERATION OF SCHOOL-BASED ASSESSMENT

*Each year a School-Based Assessment Record Sheet will be sent to schools submitting candidates for the examination. All School-Based Assessment Record Sheets, sample assignments and records of units from the Regional Occupational Standards (ROS) that are completed, are to be submitted to the Local Registrar in time to reach **CXC®** by 31 May of the year of the examination. A sample of assignments will be requested by **CXC®** for moderation purposes.*

*These assignments will be assessed by **CXC®** Examiners to inform the moderation of scores submitted by the given teacher. Teachers' marks may be adjusted as a result of moderation. An Examiner's feedback report will be sent to each teacher.*

*Copies of students' assignments that are not included in the sample submitted to **CXC®** must be retained by the school until three months after the publication by **CXC®** of the examination results.*

ASSESSMENT DETAILS

Each Unit will be assessed as follows:

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

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

1. Composition of the Paper

<u>Unit 1</u>

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

(a) 15 items from Module 1;

(b) 15 items from Module 2, and,

(c) 15 items from Module 3.

All questions are compulsory.

Unit 2

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

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

2. Mark Allocation

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

3. Use of Calculators

Candidates may use silent, non-programmable calculators.

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

1. Composition of Paper

Unit 1

This paper consists of six questions in three sections, A, B, and C. Each section contains two questions.

(a) Section A tests Module 1;

(b) Section B tests Module 2; and,

(c) Section C tests Module 3.

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

Unit 2

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

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

2. Mark Allocation

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

3. ***Award of Marks***

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

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

4. ***Use of Calculators***

Candidates may use silent, non-programmable calculators.

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

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

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

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

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

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

The School-Based Assessment will consist of a Portfolio for each Unit consisting of a project and report encompassing the three Modules of the Unit outlined in the syllabus.

INTEGRATION OF CVQ® UNITS FOR THE SBA

The list presented below has 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:

Unit 1 – Fundamentals of Electricity and Electronics

Qualification – MEM31104 Industrial Electrical Maintenance

1. *MEMCOR0141A Follow principles of occupational health and safety (OH&S) in work environment;*

2. *MEMCOR0012A Plan a complete activity;*

3. *MEMCOR0022A Perform related computations;*

4. *MEMMRD0872A Install and maintain electrical equipment;*

5. *MEMMRD0892A Install and maintain electronic electrical equipment and distribution circuits; and,*

6. *MEMMRD0423A Diagnose and repair faults in electrical and electronic systems*

Unit 2 – Applied Theory in Electrical and Electronic Engineering Technology
Option A – Electronic Engineering Technology

Qualification – MEM31104 Industrial Electrical Maintenance

1. *MEMCOR0141A Follow principles of occupational health and safety (OH&S) in work environment; and,*

2. *MEMCOR0022A Perform related computations*

Qualification – MEM20802 Industrial Electronics

- *MEMMRD0642A Service and maintain power supplies*

Unit 2 – Applied Theory in Electrical and Electronic Engineering Technology
Option B – Electrical Engineering Technology

Qualification – MEM31104 Industrial Electrical Maintenance

1. *MEMCOR0141A Follow principles of occupational health and safety (OH&S) in work environment;*

2. *MEMMRD0652A Service and maintain electrical motor starting systems;*

3. *MEMMRD0882A Conduct generator electrical maintenance;*

4. *MEMMRD090A Service and repair electrical motors; and,*

5. *MEMMRD0642A Service and maintain power supplies*

Qualification - MEM20802 Industrial Electronics

- *MEMMRD0362A Locate and rectify faults in electrical equipment up to 1 kVac/1.5 Vdc*

SCHOOL-BASED ASSESSMENTS ASSIGNMENTS, CRITERIA AND MARK SCHEMES

1. Presentation of Project

The aims of the project are to:

(a) promote self-learning;

(b) provide opportunity for teachers to engage in the formative assessment of their students;

(c) provide opportunity for students to demonstrate their practical, experimental and investigative skills developed in the Unit; and,

(d) explore more fully, some areas of the Unit which may not be assessed adequately in an external examination.

2. Requirements

The reporting of results in **Caribbean Advanced Proficiency Examinations** is by Unit and Module and, as a result, each project must cover the three Modules for the particular Unit. It is the responsibility of the teacher to conceptualise the project to be done for the Unit. Using this conceptualised project, the student is then required to develop his/her individual project-idea with the teacher acting as advisor. It is strongly advised that students complete the project definition early in the coverage of a Unit and certainly before completing 50 per cent of the material in Module 2 of that Unit. In order to satisfy the objectives, *students will be required to produce a physical circuit of some utility and to demonstrate the practical, experimental and investigative skills developed in the Unit.*

Each project to be completed must be based on a single Unit, but should encompass knowledge, topics, concepts, skills and procedures contained in all Modules within the specific Unit.

3. Guidelines for Project Definition and Implementation

(a) There must be **ONE** project per Unit.

(b) Each project must be based solely on information delivered in that particular Unit.

(c) The project must use information from all three Modules of the particular Unit. The teacher must advise the students of the required project to be done at the start of Module 1.

(d) After discussion with the teacher, the project idea **MUST** be approved by the teacher for implementation by the student.

(e) The teacher is responsible for ensuring that the student’s project satisfies item (c) above and can be implemented in the time frame with the physical resources available.

(f) *A Project Activity Record Book to track the activities completed by the student **MUST** be maintained by the student as part of their portfolio.*

(g) Although the project is the responsibility of the student, it is essential that the teacher meets regularly (at least once a week) with the student so as to provide continual guidance. At the end of these student-teacher sessions, the teacher should sign the student's Project Activity Record Book electronically after noting what guidelines have been given to the student.

4. Project Planning and Implementation

Students should:

(a) prepare a written statement, clearly articulating the need, problem or purpose of the experiment;

(b) write the methodology or approach to satisfy the need, solve the problem or carry out the experiment;

(c) develop the project scope and functional specifications;

(d) maintain a *digitised* **Project Activity Record Book**, *in keeping with the e-portfolio concept. The Project Activity Record Book* should include a record of the following:

(i) the statement of need, problem definition or purpose of the experiment;

(ii) the approach or method statement;

(iii) sketches, diagrams and pictures;

(iv) design process, lab procedures and calculations;

(v) resources including tools, equipment and components used;

(vi) specifications;

(vii) problems, constraints, difficulties and limitations; and,

(viii) test and troubleshooting procedures and results.

(e) prepare a final report of the project which should include the:

(i) report purpose;

(ii) statement of need, problem definition or purpose of the experiment;

(iii) project scope and specifications;

(iv) methodology or approach;

(v) design and construction details;

(vi) summary of tests and troubleshooting procedures;

(vii) testing and troubleshooting results;

(viii) verification of scope and specifications;

(ix) constraints and difficulties;

(x) conclusion and recommendations; and,

(xi) project allocation form signed by the teacher.

Mark Allocation for the Project

Marks will be awarded for the project based on the following general criteria:

1.	*Management of the project*	-	*05*
2.	*Practical skills*	-	*20*
3.	*The written report*	-	*35*

MARK SCHEME FOR THE PROJECT

The mark scheme provided below is intended to assist teachers in awarding marks that are reliable assessments of the achievement of students on the project they select. **Candidates will be awarded a total of six marks for communicating information in a logical way using correct gramma**r.

Assessment Criteria			Range of Marks	Teacher's Mark	CXC's Mark
1.	**Management of Project**		**05**		
	(a)	Student required little or no supervision during the project.	4 - 5		
	(b)	Student required some supervision during the project.	2 - 3		
	(c)	Student required major supervision during the project.	0 - 1		
2.	**Practical skills**		**20**		
	(a)	Ability to correctly and safely use basic test instruments (for example. DMM, VOM, Oscilloscope) and other components.	0 - 2		
	(b)	Ability to correctly identify components and component values.	0 - 3		
	(c)	Ability to correctly and safely connect and wire basic circuits.	0 - 4		
	(d)	Ability to meet functional specifications.	0 - 8		
	(e)	Neatness.	0 - 3		
3.	**The Written Report**		**35**		
	Technical Content – 29 marks				
	(a)	Methodology	0 - 3		
	(b)	Design and construction details	0 - 4		
	(c)	Summary of tests and troubleshooting procedures	0 - 3		
	(d)	Results	0 - 4		
	(e)	Discussion and conclusion	0 - 8		
	(f)	Accuracy	0 - 4		
	(g)	Documentation	0 - 3		

	Communication of Information – 6 marks			
	(a) Communicates information in a logical way using correct grammar and appropriate jargon MOST of the time.	5 - 6		
	(b) Communicates information in a logical way using correct grammar and appropriate jargon SOME of the time.	3 - 4		
	(c) Communicates information in a logical way RARELY using correct grammar and appropriate jargon.	1 - 2		
	Total	**60**		

GENERAL GUIDELINES FOR TEACHERS

1. *The teacher is required to mark the project and report. The final marks **must** be recorded out of 60.*

2. *The school **must** retain all projects for at least three months after publication of the results since projects may be requested by **CXC**® for moderation purposes.*

3. *The reliability of the marks awarded is a significant factor in the School-Based Assessment, and has far reaching implications for the candidate's final grade. Teachers are therefore asked to note the following:*

   (a) *the marks awarded to the project **must** be carefully transferred to the **CXC**® School-Based Assessment forms;*

   (b) *the teacher **must** allocate one-third of the total score for the School-Based Assessment to each Module. **Fractional marks should not be awarded**. In cases where the mark is not divisible by three, then the allocation is as follows:*

      (i) *When the remainder is 1 mark, the mark is allocated to Module 3.*

      (ii) *When the remainder is 2, then a mark is allocated to Module 3 and the other mark to Module 2.*

      For example, 35 marks are allocated as follows:

      35 /3 = 11 remainder 2 so 11 marks to Module 1 and 12 marks to each of Modules 2 and 3.

      (iii) *The standard of marking should be consistent.*

4. *Candidates who do not fulfil the requirements of the School-Based Assessment will be considered absent from the whole examination.*

♦ SUGGESTED LABORATORY EXERCISES FOR PROJECTS

The students' practical competence will be enhanced by completing the following suggested laboratory exercises and any similar activities. To help guide students and teachers with respect to performance of practical skills, teachers are encouraged to use the following scoring guide to score these practice exercises and provide feedback to students:

	Practical Skills	***Mark***
(a)	*Ability to correctly and safely use basic test instruments (for example. DMM, VOM, Oscilloscope) and other components.*	*0 - 2*
(b)	*Ability to correctly identify components and component values.*	*0 - 3*
(c)	*Ability to correctly and safely connect and wire basic circuits.*	*0 - 4*
(d)	*Ability to meet functional specifications.*	*0 - 8*
(e)	*Ability to identify faults and provide solutions.*	*0 - 5*
(f)	*Neatness.*	*0 - 3*
	Total	*25*

UNIT 1: FUNDAMENTALS OF ELECTRICITY AND ELECTRONICS

PROJECT 1: Voltage Regulator Circuits

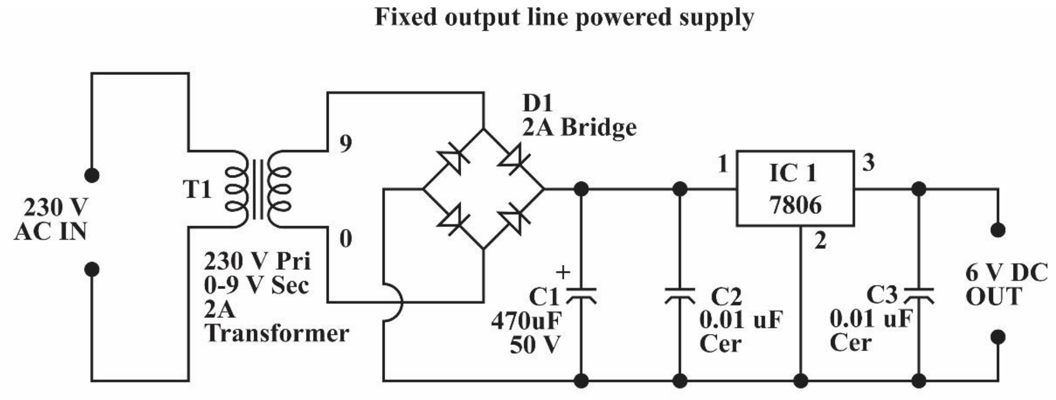


Figure I

Build your own DC power supply from an AC source. The circuit must have the following specifications (**Refer to Figure I above**)

PROJECT 2: **Current Balance**

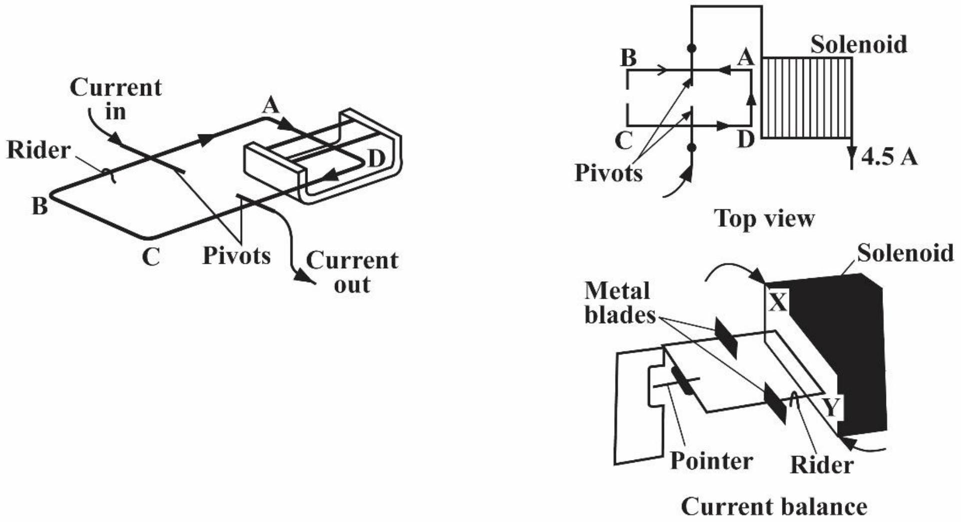


Figure II

Construct a current balance and use it to investigate the variation in magnetic flux density with distance using EITHER a bar magnet OR a current carrying wire**. Refer to Figure II** above.

UNIT 2A: ELECTRONIC ENGINEERING TECHNOLOGY

PROJECT 1: **Active Filter Circuit**

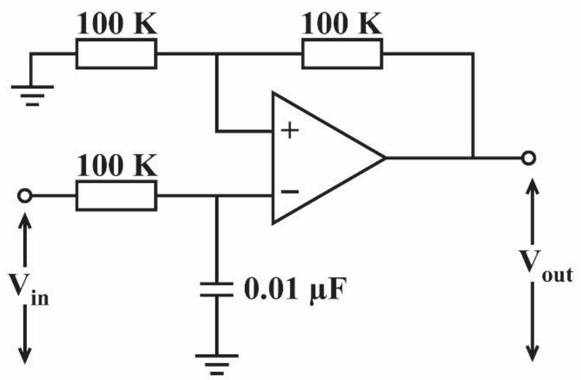


Figure III

Figure III above shows the circuit for an active filter (a filter and an amplifier). Modify the circuit to meet the following specifications:

(a) a high pass filter is required: cut-off frequency 1 kHz;

(b) gain of amplifier – 10 Db.

PROJECT 2: **6 – Digit Frequency Counter**

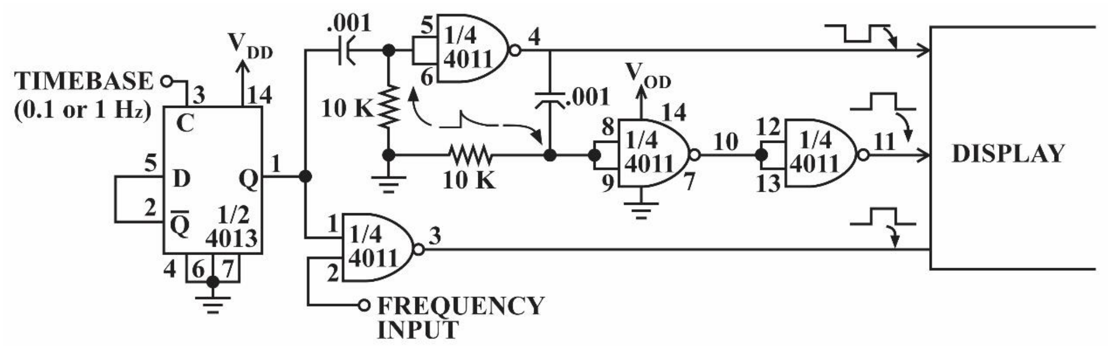


Figure IV

Construct a frequency counter/meter that will measure and display frequencies up to 999 Hz. **Refer to Figure IV** above.

PROJECT 3: **AM Receiver**

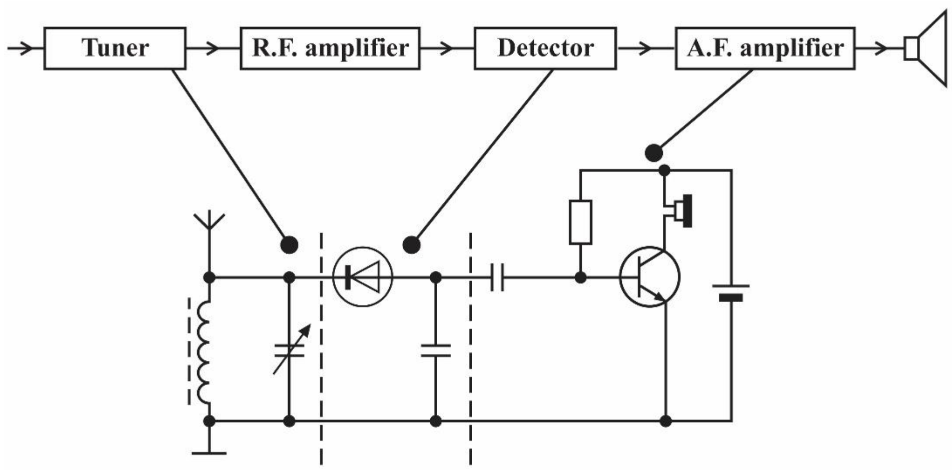


Figure V

Construct an A.M. receiver including tuning circuit, r.f. amplifier, diode detector, a.f. amplifier and speaker**. Refer to Figure V** above.

PROJECT 1: A Model Power Line

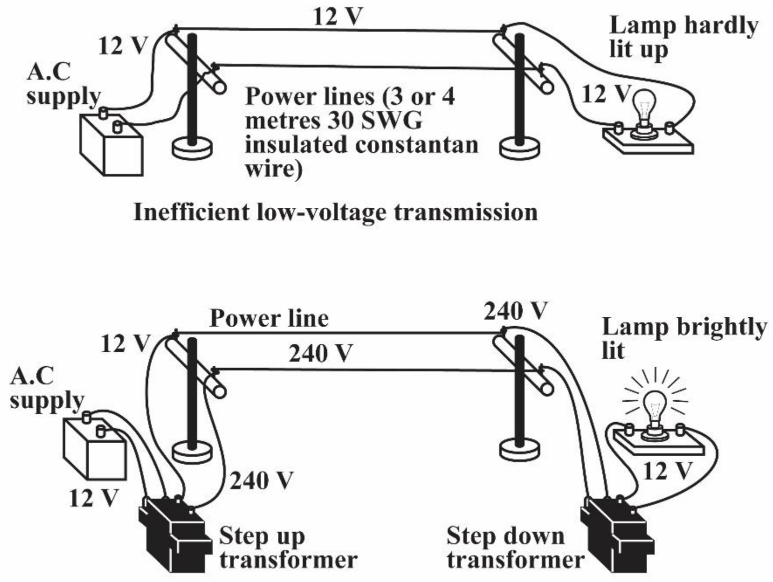


Figure VI

Construct a model power line using a 12 V power supply as the 'power station' and TWO 1m length of constantan wire as the power lines and a lamp as the house. Investigate the power losses with 12 V DC, and 12 V AC and then finally with TWO transformers. A lamp should be placed at the power station end and another at the house end. **Refer to Figure VI.**

♦ REGULATIONS FOR PRIVATE CANDIDATES

Private candidates will be required to sit all components of the examination. A private candidate must identify a teacher or tutor from a registered institution (school or technical institute or community college) who will assess and approve the candidate's submissions for the Internal Assessment component of the syllabus. The name, school, and territory of the identified teacher or tutor should be submitted to the Council on registration for the subject.

♦ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Paper 01 and 02 of the examination for the year for which they re-register. A candidate who rewrites the examination within two years may reuse the moderated School-Based Assessment score earned in the previous sitting within the preceding two years.

School-Based Assessment marks are NOT transferable across Units. A separate School-Based Assessment must be completed for each Unit.

Candidates are no longer required to earn a moderated score that is at least 50 per cent of the maximum possible score; any moderated score may be reused.

Candidates reusing SBA scores in this way must register as 'Resit candidates' and provide the previous candidate number. (In order to assist candidates in making decisions about whether or not to reuse a moderated SBA score, the Council will continue to indicate on the pre-slip if a candidate's moderated SBA score is less than 50 per cent).

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

♦ ASSESSMENT GRID

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

DISTRIBUTION OF MARKS FOR UNIT 1 AND UNIT 2

PAPERS	***MODULES***			***TOTAL (WEIGHTED)***	***(%)***
	Module 1	*Module 2*	*Module 3*		
External Assessment *Paper 01*	*15 (30)*	*15 (30)*	*15 (30)*	*45 (90)*	*(30)*
Paper 02	*40*	*40*	*40*	*120*	*(40)*
Unit 1 *School-Based Assessment* *Paper 031*	*20 (30)*	*20 (30)*	*20 (30)*	*60 (90)*	*(30)*
Unit 2 *School-Based Assessment* *Paper 031*	*20 (30)*	*20 (30)*	*20 (30)*	*60 (90)*	*(30)*
Total	*100*	*100*	*100*	*300*	*(100)*

♦ GLOSSARY OF ACRONYMS/TERMS FOR ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

ACRONYMS/TERMS	DEFINITIONS/MEANINGS
AC	Alternating Current
A/D converter	Analogue to Digital converter
AM	Amplitude Modulation
AND	Logical function which is TRUE if all inputs are TRUE
CRC	Cyclic Redundancy Check
DC	Direct Current
D/A converter	Digital to Analogue converter
DPSK	Differential Phase Shift Keying
Ex-OR (XOR)	Exclusive OR. Logical function which is TRUE, if and only if, exactly one input is TRUE. Frequently called XOR
Ex-NOR	Exclusive NOR. Logical function which is TRUE, if zero or an even number of inputs are TRUE
EPROM	Electrically Programmable Read Only Memory
Flip-Flop	Edge-triggered element with two stable states that are toggled on different events, depending on the type, namely: D-flip-flop; JK flip-flop; T-flip-flop; and RS Flip-Flop
FM	Frequency Modulation
FSK	Frequency Shift Keying
Gate	A circuit on a chip which implements a logical function
LED	Light Emitting Diode
NAND	Logical function which is FALSE, if and only if, all inputs are TRUE
NPN transistor	Negative Positive Negative transistor
NOR	Logical function which is TRUE, if and only if, all inputs are FALSE

ACRONYMS/TERMS	DEFINITIONS/MEANINGS
NOT	Logical function which is TRUE if the input is FALSE
PCM	Pulse Code Modulation
PNP transistor	Positive Negative Positive transistor
PROM	Programmable Read Only Memory
PSK	Phase Shift Keying
RAM	Random Access Memory
ROM	Read Only Memory
RLC circuits	Resistance Inductance Capacitance Circuits
SPDT switch	Single Pole Double Throw switch
SPST switch	Single Pole Single Throw switch
UART	Universal Asynchronous Receiver/Transmitter
USART	Universal Synchronous/Asynchronous Receiver/Transmitter

♦ GLOSSARY OF EXAMINATION TERMS

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

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

APPENDIX I

♦ MINIMUM EQUIPMENT LIST FOR EVERY FIFTEEN STUDENTS

NO.	EQUIPMENT	DESCRIPTION/SPECIFICATIONS	QUANTITY
1	Analog Multimeter	Volt/ohm/Current	3
2	Digital Multimeter	V/0/I/P/C/L	3
3	DC Power Supplies	5V/12V	3
4	Function Generators	Sinusoidol/square/triangular	3
5	Oscilloscope	20-100MHz Dual Trace	3
6	Bread Boards		15
7	Logic Probe	(At least TTL)	3
8	Logic Pulser	(At least TTL)	3
9	DC Motor	Small (0-24V); 2002-inch	1
10	Speed Encoder	Suitable for above (0-5V output)	1
11	Variac	0-240V; Single Phase	2
12	Single-Phase Transformer	110/240V Primary; 15-0-15; etc centre tap	3
13	Squirrel Cage Induction Motor	1 phase cut-away view	1
14	DC Generator	Cut-away view	1
15	Synchronous Generator	Cut-away view	1
16	Hook-up Wire		
17	Test leads, clips, probes etc.		
18	Resistance Boxes		5
19	Capacitance Boxes		5
20	Inductance Boxes		5

Note: The above list does not include electronic and other components that may be required.

APPENDIX II

♦ SYMBOLS, ABBREVIATIONS, DEFINITIONS AND DIAGRAMATIC SYMBOLS

Abbreviations for Multiples and Sub-multiples

T	tera	10^{12}
G	giga	10^{9}
M	mega or meg	10^{6}
k	kilo	10^{3}
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
P-	micro	10^{-6}
N	nano	10^{-9}
P	pico	10^{-12}

Units of length, volume, mass and time

Quantity	**Unit**	**Symbol**
Length	Metre, kilometre	M, km
Mass	Kilogram, megagram or tonne	kg, Mg, t
Volume	cubic metre, litre	m^3, l
Time	Second, minute, hour	S, min, h

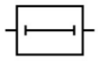
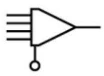
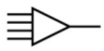
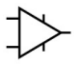
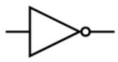
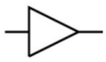
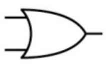
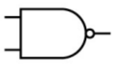
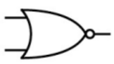
Units of length, volume, mass and time

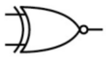
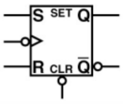
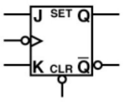
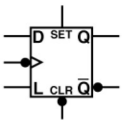
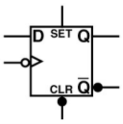
Quantity	Quantity Symbol	Unit	Unit Symbol
Admittance	Y	Siemens	*S*
Angular velocity	ω	radian per second	rad/s
Capacitance	*C*	Farad, microfarad, picofarad	F
Charge on Quantity of electricity	Q	coulomb	C
Conductance	G	Siemens	S
Conductivity	σ	Siemens per metre	S/m
Current Steady or r.m.s. value Instantaneous value Maximum	I i I,,,	Ampere, milliampere, microampere	A, mA, µ*A*
Current density	J	ampere per square metre	A/m^2
Difference of potential Steady or r.m.s. value Instantaneous value Maximum value	v v, V.	Volt, millivolt, kilovolt	V, mV, kV
Electric field strength	E	volt per metre	V/m
Electric flux	Q	coulomb	C
Electric flux density	D	coulomb per square metre	C/m^2
Electromotive force Steady or r.m.s. value Instantaneous value Maximum value	E, e, e.m.f	volt	V
Energy	W	Joule, kilojoule, megajoule watt hour, kilowatt hour, electronvolt	J, kJ, MJ Wh, kWh eV
Force	F	newton	N
Frequency	f	Hertz, kilohertz, Megahertz	Hz, kHz, Mhz
Impedance	Z	ohm	Ω
Inductance, self	L	henry (plural, henrys)	H
Inductance, mutual	M	henry (plural, henrys)	H

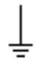
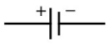
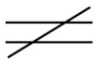
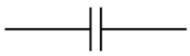
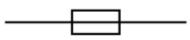
Units of length, volume, mass and time

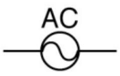
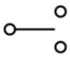
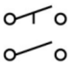
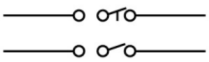
Quantity	Quantity Symbol	Unit	Unit Symbol
Magnetic field strength	H	Ampere turns per metre	At/m
Magnetic flux	Φ	Weber	Wb
Magnetic flux density	B	Tesla	T
Magnetic flux linkage	Φ	Weber	Wb
Magnetomotive force(mmf), magnetising force, magnetic potential	NI	Ampere-turns	At
Permeability of free space or Magnetic constant	μ_o	henry per metre	H/m
Permeability, relative	μ_r		
Permeability, absolute	μ	henry per metre	H/m
Permittivity of free space or Electric constant	ε_o	farad per metre	F/m
Permittivity, relative	ε_R		
Permittivity, absolute	ε	farad per metre	F/m
Power	P	Watt, kilowatt, Megawatt	W, kW, MW
Power, apparent	s	voltampere	VA
Power, reactive	Q	var	var
Reactance	X	ohm	Ω
Reactive voltampere	Q	var	var
Reluctance	$\Re$	ampere per weber	A/Wb
Resistance	R	ohm microhm megohm	Ω, $\mu\Omega$, MΩ
Resistivity	ρ	Ohm metre	Ωm
Speed, linear	u	metres per second	m/s
Speed, rotational	ω_o	radians per second	rad/s
Susceptance	B	Siemens	S
Torque	T	newton metre	Nm
Voltampere	-	Voltampere, kilovoltampere	VA, kVA
Wavelength	λ	Metre, micrometre	m ,μm

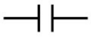
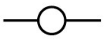
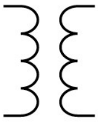
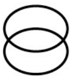
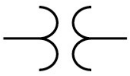
Graphical Symbols

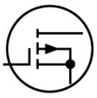
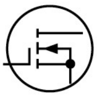
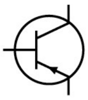
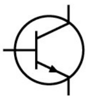
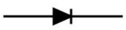
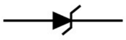
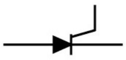
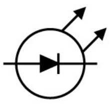
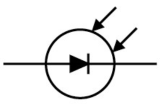
Analog and Digital Devices	
Symbol	***Devices***
	Crystal
	Delay Element
	Tri-State Buffer
	Integrator
	Summing Amplifier
	Operational Amplifier
	Inverter
	Buffer
	AND gate
	OR gate
	NAND gate
	NOR gate

Analog and Digital Devices (cont'd)	
Symbol	***Devices***
	XNOR
	RS Flip-flop
	JK Flip-flop
	Latch Flip-flop
	D Flip-flop

Fundamental Item	
Symbol	***Usage***
	Ground
	Common Ground
	Chassis
	Battery
	Resistor
	Resistor (Alternative)
	Variable Resistor
	Capacitor
	Variable Capacitor
	Circuit Breaker
	Fuse
	Inductor (Air core)
	Inductor (Magnetic core)

Fundamental Item (cont'd)	
Symbol	***Usage***
	Transducer
	Bell
	Microphone
	AC source
	DC source
	Speaker
	Lamp
	Motor
	Generator
	SPST switch
	SPDT switch
	DPST switch
	DPDT

Fundamental Item (cont'd)	
Symbol	***Usage***
	Pushbutton (break)
 N.O  N.C	Normal Open Normal Close — Relay contact
	Relay coils
	Transformer
	Transformer (Alternative)
	Current Transformer
	Potential Transformer

Semconductor Devices	
Symbol	***Devices***
	MOSFET (P-Type)
	MOSFET (N-Type)
	BJT (PNP)
	BJT (NPN)
	Rectifier Diode
	Zener Diode
	Thyristor (silicon Controlled Rectifier)
	Light emitting diode (LED)
	Photo-diode

Western Zone Office
June 2016

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination®
CAPE®

ELECTRICAL AND ELECTRONIC TECHNOLOGY

Specimen Papers and Mark Schemes/Keys

Specimen Papers:

Unit 1 Paper 01
Unit 1 Paper 02
Unit 2A Paper 01
Unit 2A Paper 02
Unit 2B Paper 01
Unit 2B Paper 02

Mark Schemes and Keys:

Unit 1 Paper 01
Unit 1 Paper 02
Unit 2A Paper 01
Unit 2A Paper 02
Unit 2B Paper 01
Unit 2B Paper 02

TEST CODE **TBD**

SPEC 2016/ TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL & ELECTRONIC TECHNOLOGY

SPECIMEN PAPER

Unit 1 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

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

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

3. Look at the sample item below.

   Sample Item

   The ampere is the unit of measurement for

   (A) voltage
   (B) resistance
   (C) electric power
   (D) electric current

   Sample Answer

   (A) (B) (C) ●

   The best answer to this item is "electric current" so (D) has been shaded.

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

1. Which of the following types of fire extinguisher is used to put out electrical fires?

(A) Class A
(B) Class B
(C) Class C
(D) Class D

2. What is the maximum level of electrical current a human can withstand before succumbing to electric shock?

(A) 10-15 mA
(B) 15 A
(C) 1 mA
(D) 100-350 mA

3. A live conductor without insulation or guarding is said to be

(A) exposed
(B) open
(C) closed
(D) de-energized

4. A circuit breaker trips and de-energizes an electrical machine on a circuit. Which of the following is the appropriate action to take before restarting the machine?

(A) Install a new circuit breaker.
(B) Immediately lockout the machine.
(C) Manually re-set the circuit breaker and continue to use the machine.
(D) Determine that it is safe to re-energize the circuit before the circuit breaker can be re-set.

5. A barricaded area with limited entry and a posted electrical hazard warning sign indicates that

(A) a written permit allows any access
(B) you can use a buddy system to enter the area
(C) the area contains live exposed electrical components
(D) a non-qualified person needs a permit before they can work in the area

6. Which of the following will result in the lowest resistance and greater risk of injury when shocked?

(A) Dry skin
(B) Wet skin
(C) Dirty skin
(D) Thin skin

7. Which of the following should be done when a shocked victim is still in contact with an energized electrical circuit and one is immediately unable to shut off the electrical supply?

(A) Call an emergency response team.
(B) Pry the victim loose with a metal pole.
(C) Cut the live phase of the circuit with a pliers.
(D) Pry the victim loose with a dry wooden pole.

GO ON TO THE NEXT PAGE

8. The three-step safety model used by electrical workers to maintain a safe environment is

(A) evaluation of risk, proper tool management and hazard evaluation
(B) proper tool management, reduction of slips and falls and proper lighting
(C) evaluation of risk, proper tool management and proper lighting
(D) hazard evaluation, evaluation of risk and the management of hazards

9. Which of the following events is NOT one of the most common shock-related, non-fatal injuries?

(A) Electric burn
(B) Chemical burn
(C) Arc flash burn
(D) Thermal contact burn

10. Which of the following is the correct steps of procedure a first-aid responder should follow to perform CPR on a victim who has stopped breathing because of an electric shock?

I. Call emergency number.
II. Clear airway of the victim.
III. Place victim in the recovery position.
IV. Begin chest compression.
V. Administer mouth to mouth resuscitation.

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

11. Which of the following is the BEST procedure to follow when conducting voltage tests or measurements on an electrical system carrying 120 V or higher?

(A) Use one hand to manipulate the test leads across the system while using the other hand to brace for support.
(B) Use one hand to manipulate the test leads across the system while keeping the other hand behind your back or in your pocket.
(C) Use both hands to manipulate test leads across the system to obtain proper balance.
(D) Use both hands to manipulate test leads across the system while standing on a grounding mat.

12. Which of the following is NOT an environmental effect of electricity generation?

(A) Acid rain
(B) Renewable energy
(C) Greenhouse gases
(D) Waste disposal challenges

13. Which of the following makes circuit boards a valuable source of electronic waste?

(A) Contains metals of commercial value
(B) Contains non-toxic components
(C) Easy to work with
(D) Easily available

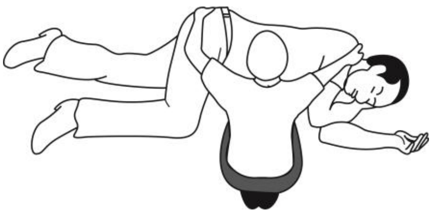
GO ON TO THE NEXT PAGE

14. Which of the following pieces of personal protective equipment are used in electrical work?

I. Safety shoes
II. Welding goggles
III. Insulating gloves with leather protectors

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

Item **15** refers to the following diagram of a worker who was found unconscious but breathing, being placed in a particular position.



15. Which of the following is the position?

(A) Recovery
(B) Injury
(C) Resting
(D) Prone

16. A DC wattmeter essentially consists of

(A) two ammeters
(B) two voltmeters
(C) a voltmeter and an ammeter
(D) a current and a potential transformer

17. The insulation resistance of a transformer winding can be easily measured with a

(A) megger
(B) voltmeter
(C) kelvin bridge
(D) wheatstone bridge

18. The effect of an air gap in a magnetic circuit is to

(A) divide the flux density
(B) reduce the magnetomotive force
(C) increase the reluctance and reduce the flux density
(D) increase the flux density and decrease the reluctance

19. The decibel is a unit of

(A) power
(B) impedance
(C) frequency
(D) power ratio

20. Which of the following categories of materials can be used as a dielectric?

(A) Insulator
(B) Conductor
(C) Semi-conductor
(D) Superconductor

21. An induced emf opposes the change of flux that induces the emf. This is known as

(A) Faraday’s law
(B) Kirchoff’s law
(C) Fleming’s law
(D) Lenz’s law

GO ON TO THE NEXT PAGE

22. On which of the following factors is the resistance of a conductor dependent?

I. Length
II. Cross sectional area
III. Temperature

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

23. Which of the following factors does NOT affect inductance?

(A) Resistance of the conductor
(B) Type of inductor core
(C) Current in the conductor
(D) Number of turns

24. Which of the following are TRUE about microprocessors?

I. Perform basic arithmetic and logic operations
II. Have areas called registers
III. Carryout instructions

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

25. Which of the following is NOT a classification of microprocessors?

(A) Digital source processors (DSP)
(B) Application specific processors (ASP)
(C) Application specific integrated circuit (ASIC)
(D) Application specific instruction set processors (ASIP)

26. The robotic controller that uses sensors to tell the controller the location or speed of the arm as it moves between programmed points is known as

(A) a closed loop Servo controller
(B) an open - loop servo controller
(C) an open - loop pneumatic controller
(D) a closed -loop pneumatic controller

27. Which of the following can programmed Servo robotics control?

I. Speed
II. Path trajectory
III. Acceleration

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

28. Which of the following BEST describes the function of a microprocessor?

(A) It is designed for single use on an automation network.
(B) It performs a dedicated task in a single integrated circuit.
(C) It interfaces with other components on the main assembly.
(D) It is a group of computers and devices connected to serve a region.

29. Which of the following are responsibilities of electronics engineers?

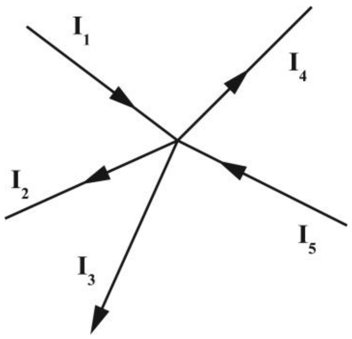
I. Writing specifications and technical reports.
II. Testing theoretical electronic systems.
III. Ensuring safety regulations are met.

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

30. Which of the following occurs when two dissimilar metals are in contact in the presence of an electrolyte?

(A) Electrolytic corrosion
(B) Pitting corrosion
(C) Metallic degradation
(D) Electrolysis

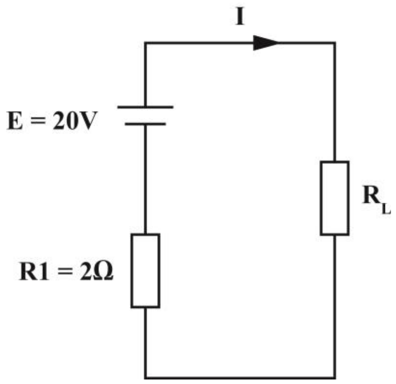
Item **31** refers to the following diagram which shows a current network.



31. The formula derived from this network is

(A) $I_5 - I_4 = I_3 - I_2 + I_1 = 0$
(B) $I_1 + I_2 + I_3 = I_4 + I_5 = 0$
(C) $I_2 + I_3 + I_5 = I_1 + I_4 = 0$
(D) $I_1 - I_2 - I_3 - I_4 + I_5 = 0$

Item **32** refers to the following circuit.



32. The maximum power transferred will be

(A) 5 W
(B) 40 W
(C) 50 W
(D) 200 W

33. The current flow in branches of a DC circuit may be determined by using

(A) Lenz's law
(B) Kirchoff's law
(C) Faraday's law
(D) Coulomb's law

34. An electrician needs to connect several light bulbs, rated at 100 W, to a 240 V supply fitted with a 13 A fuse. The number of lamps which can be safely connected to the circuit is

(A) 7
(B) 18
(C) 31
(D) 32

GO ON TO THE NEXT PAGE

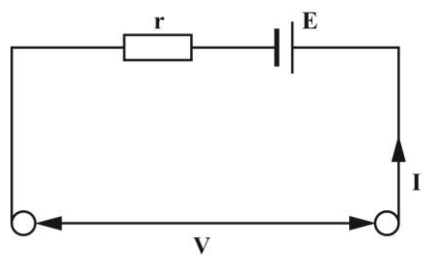
35. The symbolic unit representing temperature coefficient is

(A) Ω^0C
(B) Ω
(C) ^0C
(D) Ω/Ω^0C

36. When using the superposition theorem, the first step is to

(A) remove one voltage source
(B) remove all current sources
(C) remove all the voltage sources
(D) short circuit the loads in the circuit

Item **37** refers to the following circuit of a resistor in series with a cell.



37. The internal resistance **r** in the circuit will be given by

(A) I/ V-E
(B) V-E/I
(C) I/E-V
(D) E-V/I

38. The unit of flux density is the

(A) tesla
(B) weber
(C) weber per metre
(D) ampere turn metre

39. A conductor 15 cm long is moved at 20 m/s perpendicularly through a magnetic field of flux density 2T. The induced emf will be

(A) 62 mV
(B) 0.6 V
(C) 6 V
(D) 600 V

40. A force of attraction occurs between two current-carrying conductors when the current in them is

(A) the same magnitude
(B) in opposite directions
(C) in the same direction
(D) of different magnitude

41. Which of the following is used when calculating the appropriate fuse rating for an electric circuit?

(A) The peak value
(B) The average value
(C) The root mean square value
(D) The cable ohms per foot value

42. A fuse rated at 5 A blows when 9 A flows through it. Its fusing factor is

(A) 0.5
(B) 1.8
(C) 5
(D) 45

GO ON TO THE NEXT PAGE

43. The capacitance of a capacitor is the ratio of

(A) charge to potential difference between plates
(B) potential difference between plates to charge
(C) potential difference between the plate to plate spacing
(D) potential difference between plates to the thickness of the dielectric

44. A capacitor has a capacitance of a 10 pf and is connected to a voltage of 10 kv. The charge on this capacitor is

(A) 100 µF
(B) 0.1 C
(C) 0.1 µC
(D) 0.01 µC

45. A 10 µF capacitor is connected across a 500 V supply. The energy stored in this capacitor will be

(A) 1.25 mJ
(B) 1.25 J
(C) 1.25 C
(D) 0.025 µJ

	Syllabus Reference	Module	Key
1.	1.1.2	M1	C
2.	1.1.1	M1	A
3.	1.1.2	M1	C
4.	1.1.2	M1	D
5.	1.1.2	M1	C
6.	1.1.1	M1	B
7.	1.1.1	M1	D
8.	1.1.3	M1	D
9.	1.1.4	M1	B
10.	1.1.4	M1	A
11.	1.1.3	M1	B
12.	1.1.5	M1	B
13.	1.1.5	M1	A
14.	1.1.3	M1	B
15.	1.1.4	M1	A
16.	1.2.4	M2	C
17.	1.2.4	M2	A
18.	1.2.7	M2	C
19.	1.2.7	M2	D
20.	1.2.6	M2	A
21.	1.2.7	M2	D
22.	1.2.7	M2	D
23.	1.2.7	M2	A
24.	1.2.9	M2	D
25.	1.2.9	M2	A
26.	1.2.10	M2	A
27.	1.2.10	M2	D
28.	1.2.9	M2	C
29.	1.2.2	M2	D
30.	1.2.6	M2	A
31.	1.3.1	M3	D
32.	1.3.2	M3	C
33.	1.3.1	M3	B
34.	1.3.1	M3	C
35.	1.3.1	M3	D
36.	1.3.1	M3	A
37.	1.3.1.	M3	B
38.	1.3.2	M3	A
39.	1.3.2	M3	C
40.	1.3.2	M3	B
41.	1.3.3	M3	C
42.	1.3.3	M3	B
43.	1.3.4	M3	A
44.	1.3.4	M3	C
45.	1.3.4	M3	B

TEST CODE **TBD**

SPEC 2015/TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRIC TECHNOLOGY

SPECIMEN PAPER

Unit 1 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in THREE sections.
2. Answer ALL questions.
3. Write your answers in the spaces provided in this booklet.
4. DO NOT write in the margins.
5. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
6. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

MODULE 1

OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENTAL PRACTICES

1. In the field of electricity production, workers can be exposed to various dangers in their daily work.

(a) List FOUR dangers that workers in thermal power generating stations can encounter.

(4 marks)

(b) For EACH of the dangers identified in (a), explain the measures which can be taken to reduce exposure.

(16 marks)

[Total 20 marks]

GO ON TO THE NEXT PAGE

2. To ensure safe working environments for workers in the electrical and electronics fields, safety rules, procedures and standards have been developed and implemented.

(a) Explain the importance of maintenance plans to the safe operation of a power station.

(8 marks)

(b) Discuss how risk assessments in power plants are used to ensure an improved work environment.

(8 marks)

GO ON TO THE NEXT PAGE

(c) List FOUR types of personal protective equipment used by workers conducting work on power transmission lines.

(4 marks)

[Total 20 marks]

MODULE 2 – ELECTRICAL AND ELECTRONIC RELATED STUDIES

3. (a) State Lenz's Law.

[2 marks]

(b) State Faraday's Law.

[2 marks]

(c) Define EACH of the following terms and provide symbols and units for EACH:

(i) Relative permeability

[3 marks]

(ii) Reluctance

[3 marks]

(d) A mild steel ring has a circular cross section 7.2 cm in diameter and an inner circumference of 100 cm. The ring is uniformly wound with a coil of 800 turns.

Note: $\mu_0 = 4\pi \times 10^{-7}$ H/m

(i) Using the information in Figure 1, calculate the current in the coil required to produce a flux density of 1.1 T.

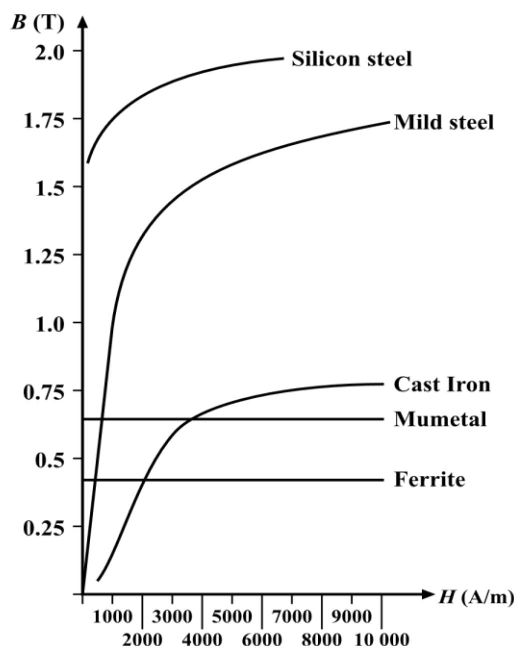


Figure 1. Magnetization characteristic of soft magnetic materials

[7 marks]

GO ON TO THE NEXT PAGE

(ii) A 2 mm air gap is now created in the ring. Calculate the reluctance of the air gap.

[3 marks]

Total 20 marks

4. (a) Define EACH of the following terms:

(i) Channel capacity

[2 marks]

(ii) Bandwidth

[2 marks]

(b) Give ONE possible reason why errors occur in the signal received in a data communication system, and state how they can be detected and corrected.

[3 marks]

(c) Figure 2 shows a block diagram of a UART.

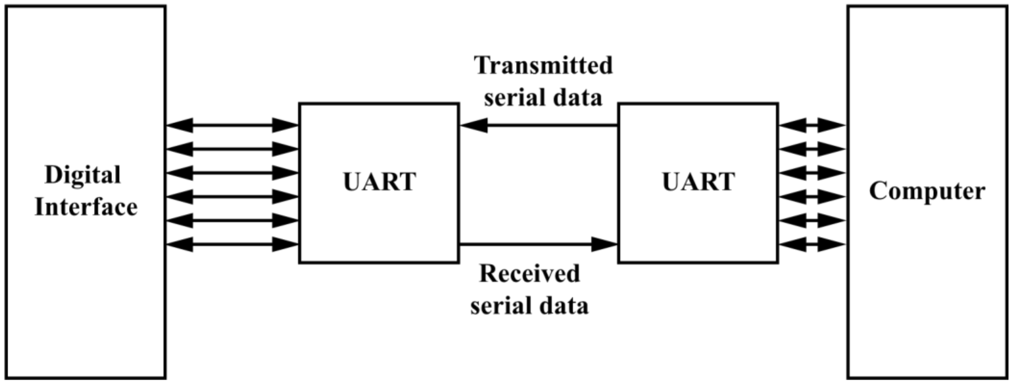


Figure 2. Block diagram of a UART

Use the block diagram in Figure 2 to explain the basic operation of a UART.

____

____

____

____

[4 marks]

(d) Identify TWO types of noise found in amplifiers that are used in communication systems, and state TWO sources of EACH type of noise identified.

____

____

____

____

____

____

[6 marks]

(e) Explain the term ‘differential phase shift keying’ as it relates to modulation techniques.

[3 marks]

Total 20 marks

MODULE 3 – INTRODUCTION TO CIRCUIT TECHNOLOGY AND DEVICES

5. (a) Figure 3 shows a DC network with two voltage sources.

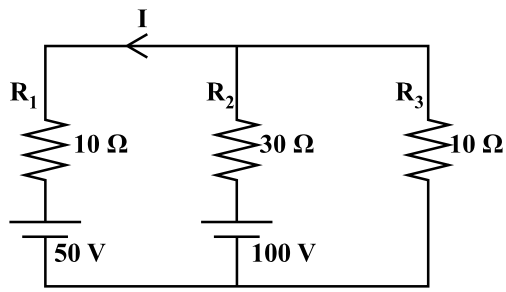


Figure 3. DC network with two voltage sources

(i) State the superposition theorem.

____

____

[2 marks]

(ii) Use the superposition theorem to determine the current I in the circuit in Figure 3.

____

____

____

____

____

____

[6 marks]

(iii) Calculate the power dissipated in R_1.

[2 marks]

(iv) If R_3 is made of copper, calculate its resistance when its temperature reaches 80 °C.
(Note: Temperature coefficient of copper $\alpha_{20} = 0.00392/°C$)

[3 marks]

(b) (i) State Kirchhoff's first and second laws.

[4 marks]

(iii) Figure 4 shows a mesh network with two voltage sources. The current in loop 2 is 3.5 A.

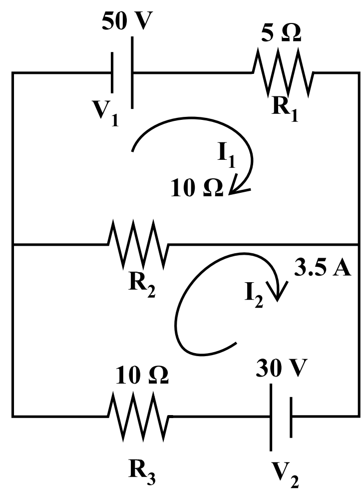


Figure 4. Mesh network with two voltage sources

Use a mesh equation to find the current I_1 flowing in loop 1.

____

____

____

[3 marks]

Total 20 marks

6. (a) (i) Define the term 'unit of inductance'.

____

____

[2 marks]

(ii) Consider a coil uniformly wound on a core of uniform cross section. List THREE ways to increase the inductance of the coil.

____

____

____

[3 marks]

(iii) A 0.32 H inductor consists of an iron ring of 5 cm mean diameter and 1 cm^2 cross-sectional area. If the permeability of the iron is 400 times that of free space, calculate the number of turns of wire for this inductor $\mu_0 = 1.26 \times 10^{-6}$ H/m.

____

____

____

____

[4 marks]

(c) Explain the term 'coupling coefficient' as it relates to inductors that are

(i) tightly coupled

____

____

[2 marks]

(ii) loosely coupled.

____

____

[2 marks]

(d) Three 0.5 H inductors are connected in series and the combination placed across a 3 V battery whose internal resistance is 1.5 Ω.

(i) Using the information given, draw a labelled circuit diagram.

____

____

[**2 marks]**

(ii) Calculate the circuit time constant.

____

____

[2 marks]

(iii) Calculate the final current in the circuit.

____

____

[2 marks]

(e) State where the energy is stored in an inductor.

____

[1 mark]

Total 20 marks

MS TBD/CAPE/KMS 2015 SPEC

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

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRONIC TECHNOLOGY

UNIT 1 — PAPER 02

MARK SCHEME

MAY/JUNE

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Question 1

(a) Dangers to which workers in thermal power plants are exposed:

1. High voltage, high current – arc flash
2. Poisonous gases – poor air quality
3. Exposure to toxic waste water/water pollution
4. High noise levels
5. Exposure to by-products of processing, e.g. coal ash, hot water release in rivers and sea
6. Boiler hazards
7. Chemical hazards

(1 mark for each, maximum 4 marks)

(b) Explanation of measures which can be taken to reduce exposure: Explanations should include actions specific to each danger. For example, in power plants that use coal, mention should be made of the use of wet scrubbers to reduce gases, heat and dust. The issue of personal protective equipment (PPE) to workers should also be included. Mention of the use specific legislation to which power companies are expected to conform to protect workers is also expected.

(4 marks for EACH full explanation)

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Question 2

(a) Explanation of the importance of maintenance plans to include:

- Detection of problems
- Diagnosis of problems
- Repair/replacement
- Checking of emergency failure
- Setting up and performing scheduled periodic preventive inspections, replacement and repairs
- Repair activities in a central facility
- Extending the service life of machinery
- Availability and readiness of machinery when needed
- Ensure the safety of personnel

(8 marks for full explanation containing at least six of the above points)

(b) Discussion on risk assessments in power plants should include identification of stages of risk –
Hazard identification – being aware of potential hazards associated with dangerous goods to be processed, used and handled at a power station and the impact on workers.

Consequence and effect analysis – the consequences of identified hazards are assessed using current techniques for risk assessment.

Frequency analysis – assessment of the frequency of incidents based on historical data.

Quantitative risk analysis – the probability of an incident occurring, combined with the frequency of an event would give the risk from the event.

Risk reduction – based on the foregoing, risk reduction measures are identified and recommendations made to improve the work environment.

(8 marks for full explanation containing all stages of risk assessment)

Question 2 cont'd

(c) Types of protective equipment (PE) used by workers on power transmission lines:

- Body belt and pole strap
- Body harness
- Ariel lift
- Safety glasses
- Face shield
- Hard hat
- Safety shoes
- Insulating rubber gloves
- Insulating sleeves
- Flame-retardant clothing
- Respirators

(1 mark EACH, any four protective equipment)

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Question 3

(a) Lenz's Law: the direction of an induced emf **(1 mark)** is always such that it tends to set up a current opposing the motion of the charge of flux **(1 mark)**

[2 marks]

(b) Faraday's Law: the magnitude of the induced emf **(1 mark)** is proportional to the rate of change of magnetic flux linkage $e = \frac{Nd\Phi}{dt}$ **(1 mark)**

[2 marks]

(c) (i) Relative permeability is the ratio of flux density produced in a material to the flux density produced in a vacuum (or in a non-magnetic core) by the same magnetic field strength **(1 mark)**

Symbol: μr **(1 mark)**

Units: No units **(1 mark)**

(ii) Reluctance is the resistance of a magnetic circuit **(1 mark)**

Symbol: S **(1 mark)**

Unit: A/Wb or At/wb **(1 mark)**

[6 marks]

(d) (i) From graph with mild steel plot
(a) 1.17 for mild steel H = 1000 A/M **(1 mark)**

Question 3 cont'd

MMf, $F = Hl = NI$

l = mean circumference = π × mean diameter

(1 mark)

$= \left(\frac{100}{\pi} + 7.2\right)\pi = 122.62$ cm **(1 mark)**

$F = Hl$

$= (1000)\ (1.226)$ **(1 mark)**

$= 1226$ A **(1 mark)**

$F = NI$

$I = \frac{1226}{800}$ **(1 mark)**

$= 1.53$ A **(1 mark)**

[7 marks]

(ii) $R = \frac{l}{\mu_o A}$ **(1 mark)**

$= \frac{2 \times 10^{-3}}{\left(4\pi \times 10^{-7}\right)\left(\frac{0.072}{2}\right)^{2\pi}}$ **(1 mark)**

$= 3.91 \times 10^{5}$ A/wb **(1 mark)**

[3 marks]

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Question 4

(a) (i) Channel capacity — is the upper limit **(1 mark)** of the amount of data that can be passed through a communication channel

(1 mark) in a given time. **(1 mark)**

[2 marks]

(ii) Bandwidth — is the range of frequencies that are available for use **(1 mark)** in a communication channel. **(1 mark)**

[2 marks]

(b) Error occurrences detection and correction — if the channel is noisy, the received data will have errors. **(1 mark)** Detection and if possible correction of errors have to be done at the receiving end. **(1 mark)** This is done through a mechanism called channel coding. **(1 mark)**

[3 marks]

(c) The UART receives data in serial form then converts it to parallel form. **(1 mark)** The parallel form of information is then put into the computer, where the digital information is to be stored or processed. **(1 mark)** The UART transmits data in serial form. **(1 mark)** It takes the information from the computer in its parallel form and converts it into serial form for transmission. **(1 mark)**

[4 marks]

(d) Types of noise

- Natural — external noise
- Manufactured
- Internal

Any two — 1 mark each

[2 marks]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Type of Noise	**Source**
Natural	– Weather conditions – Energy from the sun (sun spots) – Radiation from space
Manufactured	– Vehicles – Other communication equipment – Industry
Internal	– Passive components, resistor, capacitors – Active components, transistors FETS

Any two sources — 1 mark each

[4 marks]

(e) Differential Phase Shift Keying — this modulating technique effectively transmits a synchronizing pulse along with the digital data. **(1 mark)** If the phase is a mark, the phase of the signal is shifted +90°. **(1 mark)** If there is a space, the phase signal is shifted -90°, these phase shifts are periodic. **(1 mark)**

[3 marks]

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

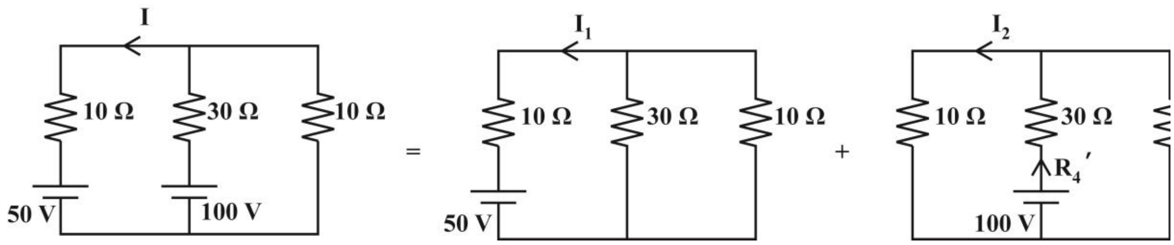
KEY AND MARK SCHEME

Question 5

(a) (i) The superposition theorem states that in any network containing more than one source, **(1 mark)** the current in, or the pd across, any brand can be found by considering each source separately and adding their effects
(1 mark)

[2 marks]

(ii)



Circuit 1 **Circuit 2**

Circuit 1

$I_1 = \dfrac{50}{10 + 30//10}$ **(1 mark)**

$= \dfrac{50}{10 + 7.5} = 2.86\ A$

$I_1 = 2.86\ A$ **(1 mark)**

Circuit 2

$I_2^1 = \dfrac{100}{30 + 10//10}$

$= \dfrac{100}{30 + 15} = 2.86\ A$ **(1 mark)**

$I_2 = \dfrac{10}{10 + 10} \times 2.86\ A$ **(1 mark)**

$= 1.43\ A$ **(1 mark)**

$I = I_1 + I_2$ **(1 mark)** **(negative sign denotes opposite direction)**

$= - 2.86 + 1.43$

$= -1.43\ A$ **(1 mark)**

[6 marks]

Question **5** cont'd

(iii) Power in R_1

$P = I^2 R_1$ **(1 mark)**

$= (-1.43)^2 (10)$

$= 20.4$ W **(1 mark)**

[2 marks]

(iv) $R\theta = R0(1 + \propto \theta)$

(1 mark)

$R_{60} = 10(1 = 0.00392(80 - 20))$ **(1 mark)**

(1 mark)

$= 12.4\ \Omega$

[3 marks]

(b) (i) Kirchhoff's Laws

- First (current) law – At any instant the algebraic sum of the currents at a junction in a network is zero. **(1 mark)**
- Second (voltage) law – at any instant in a closed loop **(1 mark)** the algebraic sum of the emfs acting round the loop **(1 mark)** is equal to the algebraic sum of the pds round the loop **(1 mark)**

[4 marks]

(ii) $50 = 5I_1 + 10(I_1 - I_2)$

$50 = 15I_1 - 10 I_2$

$5 = 3I_1 - 2 I_2$

$5 = 3I_1 - 2 I_2$ **(1 mark)**

Subst $I_2 = 3.5$ A

$I_1 = \frac{5 + 2(3.5)}{3} = \frac{12}{3}$ **(1 mark)**

(1 mark)

$I_1 = 4$ A

[3 marks]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 1 - PAPER 02

KEY AND MARK SCHEME

Question 6

(a) (i) A circuit has an inductance of 1 Henry if an emf of 1 volt is induced in the circuit **(1 mark)** when the current varies uniformly at the rate of 1 ampere per second **(1 mark)**

OR

A coil possesses an inductance of 1 Henry if a current of 1 ampere through the coil **(1 mark)** produces a flux-linkage of 1 weber-turn **(1 mark)**

[2 marks]

(ii) Increase inductance

- increase number of turns
- increase cross-sectional area
- reduce length of magnetic circuit
- use a ferromagnetic core

(Any three — 1 mark each) [3 marks]

(iii)

$$L = \frac{\mu_0 \, \mu r \, N^2 A}{l}$$ **(1 mark)**

$$N = \sqrt{\frac{(0.32)(\pi \times 0.05)}{(1.26 \times 10^{-6})(400)(1 \times 10^{-4})}}$$ **(1 mark)**

$$N = \sqrt{\frac{5.027 \times 10^{-2}}{5.04 \times 10^{-8}}}$$ **(1 mark)**

N = 999 turns **(1 mark)**

[4 marks]

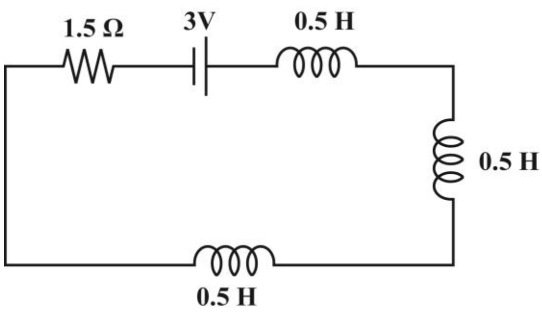
(b) (i) An inductor is tightly coupled if the two coils are close together **(1 mark)**. Most of the flux produced by the current in one coil passes through or links the other **(1 mark)**. **(2 marks)**

Question 6 cont'd

(ii) An inductor is loosely coupled if the coils are well apart **(1 mark)**. Only a small fraction of the flux produced by the current in one coil passes through or links the other **(1 mark)**. **(2 marks)**

[4 marks]

(c) (i)



(2 marks)

(ii) $T = \frac{L}{R}$ **(1 mark)**

$= \frac{1.5\ H}{1.5\ \Omega} = 1$ Sec **(1 mark)**

(iii) Current $I = \frac{V}{R}$ **(1 mark)**

$= \frac{3}{1.5} = 2$ A **(1 mark)**

(d) Stored in the magnetic field **(1 mark)**

[7marks]

Total 20 marks

TEST CODE **TBD**

SPEC 2016/ TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL & ELECTRONIC TECHNOLOGY

SPECIMEN PAPER

Unit 2A – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

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

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

3. Look at the sample item below.

   Sample Item

   A collection of electronic circuits that are designed to convert information into a signal suitable for sending over a given communication medium is a

   Sample Answer

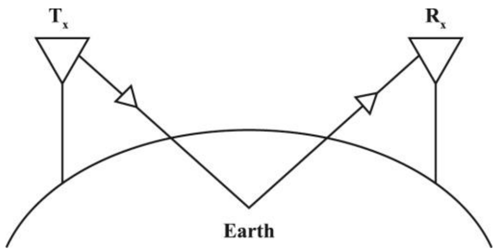
   (A) channel
   (B) detector
   (C) receiver
   (D) transmitter

   Ⓐ Ⓑ Ⓒ ●

   The best answer to this item is "transmitter" so (D) has been shaded.

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

<u>Item **1**</u> refers to the following diagram which shows a propagated wave reflected from the earth's surface.



1. What type of wave is it classified as?

(A) Sky
(B) Space
(C) Ground
(D) Surface

2. Which of the following is the type of modulation that causes the frequency of the carrier signal to change?

(A) AM
(B) FM
(C) PAM
(D) PCM

3. A/D conversion is the process of converting

(A) analog quantity into digital quantity
(B) analog quantity into digital quality
(C) analog quality into digital quantity
(D) analog quality into digital quality

4. Which of the following is the type of propagation where the wave travels along the surface of the earth?

(A) Sky wave
(B) Line of sight
(C) Space wave
(D) Ground wave

5. The high frequency bandwidth of a carrier wave is

(A) 30 KHz – 300 KHz
(B) 3 MHz – 30 MHz
(C) 30 MHz – 300 MHz
(D) 300 MHz – 3 GHz

6. In a superheterodyne receiver, the circuit that keeps the receiver bandwidth constant is the

(A) mixer
(B) detector
(C) RF amplifier
(D) IF amplifier

7. A multiplexer is a device which

(A) accepts data from a number of sources
(B) accepts data from a single source
(C) has three select variables
(D) has four select variables

8. Which of the following is the type of modulation that causes the phase of the carrier to change?

(A) PM
(B) FM
(C) PPM
(D) PTM

GO ON TO THE NEXT PAGE

9. The stage of a frequency modulated (FM) receiver that prevents the local oscillator frequency from drifting is the

(A) IF amplifier
(B) RF amplifier
(C) Limiter
(D) AFC

10. The three states of a phase lock loop are

(A) AC output voltage, voltage, phase locked
(B) DC output voltage, free running, phase locked
(C) high pass filter, voltage controlled, phase locked
(D) capture, voltage controlled oscillator, phase locked

11. The contents of the memory system EPROM

(A) cannot be reprogrammed
(B) are unalterable once programmed
(C) can be reprogrammed quite readily
(D) can be programmed with ultraviolet light

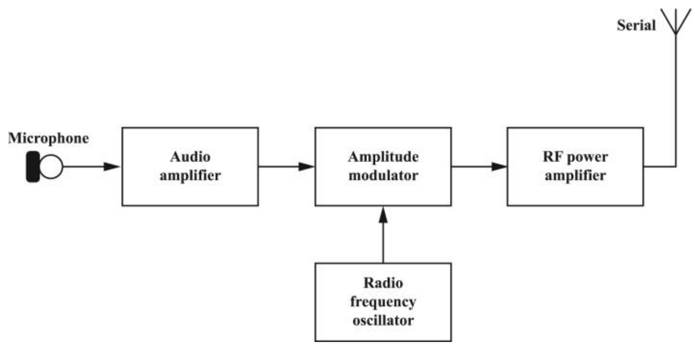
12. The half-duplex mode of data communication allows

(A) one-way communication in one direction only
(B) two-way communication at the same time
(C) two-way communication but not at the same time
(D) two-communication using different frequencies

13. In digital communication sampling, which of the following is observed in a circuit?

(A) A signal at one point.
(B) A signal at various points.
(C) Multiple signals at one point.
(D) Multiple signals at various points.

Item **14** refers to the following block diagram.

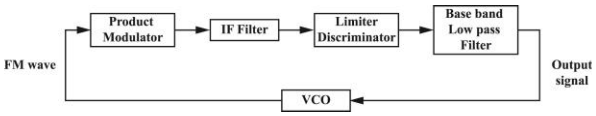


14. The block diagram above is an example of an

(A) AM transmitter
(B) FM transmitter
(C) AM receiver
(D) FM receiver

GO ON TO THE NEXT PAGE

Item **15** refers to the following block diagram.



15. The block diagram above represents a

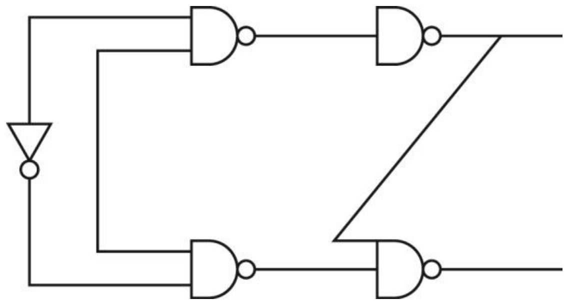
(A) tuner
(B) detector
(C) modulator
(D) demodulator

16. Which of the following functions is performed by combinational logic?

I. Decode
II. Encode
III. Count

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

Item **17** refers to the following circuit diagram of a flip-flop.



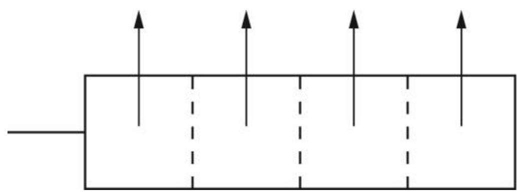
17. Which of the following flip-flops is represented in the diagram above?

(A) SR
(B) JK
(C) T
(D) D

18. An NPN transistor is connected in the common emitter configuration with a collector current I_c = 90 mA and a base current I_B = 400 μA. What is the emitter current I_E?

(A) 86 mA
(B) 90.004 mA
(C) 90.04 mA
(D) 90.4 mA

Item **19** refers to the following diagram of a shift register.



19. Which type of shift register is shown above?

(A) PISO
(B) SIPO
(C) PIPO
(D) SISO

20. In a counter, there are six cascaded J-K flip flops. How far can this counter count?

(A) 12
(B) 15
(C) 63
(D) 64

21. Which of the following is a characteristic of a differential amplifier?

(A) Finite gain
(B) Infinite gain
(C) Infinite bandwidth
(D) Finite input impedance

22. An ideal operational amplifier has

(A) a finite input resistance
(B) an infinite output resistance
(C) a finite open lop voltage gain
(D) an infinite open loop voltage gain

23. Which of the following types of amplifier is widely used as the input stage of an operational amplifier?

(A) Class A
(B) Class B
(C) Summing
(D) Differential

24. The power bandwidth of an operational amplifier is

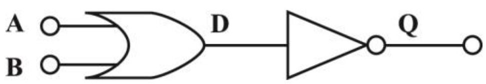
(A) the highest frequency the amplifier can handle without slow rate distortion
(B) the highest frequency the amplifier can handle without slow rate distortion
(C) that frequency where the open loop gain is unity
(D) that frequency that equals the gain product

25. The average value of the load current I_l of a single-phase half-wave rectifier is

(A) 0.159 I_m
(B) 0.318 I_m
(C) 0.637 I_m
(D) 0.707 I_m

GO ON TO THE NEXT PAGE

Item **26** refers to the following diagram of a logic gate symbol.



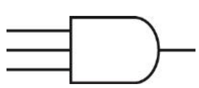
26. Which logic gate is shown in the diagram?

(A) NOR
(B) OR
(C) XOR
(D) AND

27. A Hartley oscillator uses

(A) a lead-lag network to maintain a stable output
(B) a transformer to feed back the output signal to the input
(C) an inductive voltage divider
(D) a capacitive voltage divider

Item **28** refers to the following diagram of a logic gate.



28. The Boolean expression for the logic gate is

(A) F = A + B + C
(B) F = A – B – C
(C) F = A . B . C
(D) F = A . B . C

29. Which of the following is an operational feature of an enhancement mode MOSFET?

(A) High power consumption
(B) Low power consumption
(C) Low input resistance
(D) High input resistance

30. A monostable multivibrator has

(A) one quasi-stable operating state
(B) two quasi-stable operating states
(C) one stable operating state and one quasi-stable state
(D) two stable operating states and one quasi-stable state

31. A distributed control system (DCS)

(A) supports string data
(B) cannot be used in process industries
(C) adds up control tasks among multiple systems
(D) cannot be connected directly to physical equipment

32. The controller of a basic control system

(A) compares the input and output signals
(B) causes the required activity to happen
(C) sets the intended condition
(D) provides the reference signal

33. Which of the following is the memory forms in which programmable logic controller (PLC) programmes are held?

(A) RAM, ROM, EEPROM
(B) RAM, ROM, EPROM
(C) RAM, ROM, PROM
(D) RAM, PROM, EPROM

GO ON TO THE NEXT PAGE

34. The rack-type construction of a programmable logic controller (PLC)

(A) is used for small controllers
(B) is used for large controllers
(C) has a shallow mounting depth
(D) allows a degree of flexibility in the choice of racks

35. Which of the following are functions of programmable logic controllers?

I. Interlocking
II. Counting
III. Sequencing

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

36. The human interface subsystem of SCADA

(A) presents process data to a human operator
(B) converts sensor signals to digital signals
(C) sends commands to a human operator
(D) connect the sensors in the terminal unit

37. Which of the following is an advantage of digital communication over analogue communication?

(A) Utilization of a small bandwidth
(B) No sampling error is experienced
(C) Synchronization of communication system
(D) Ease of developing a secure communication system

38. Which of the following are functions of telemetering?

I. Combining all measurements into a common stream.
II. Combining selected measurements into a form for analysis.
III. Storing selected measurements for future analysis.

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

39. Which of the following are advantages of programmable logic controllers?

I. Physically secure access points.
II. Economical transmission over short distances.
III. Power lines are not usually required for communication links.

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

40. A SCADA system concentrates MAINLY on

(A) process trends
(B) open loop control
(C) quality of data shown to operators
(D) each section having its own control

GO ON TO THE NEXT PAGE

41. A distributed control system is principally concerned with

(A) process events
(B) open loop control
(C) a centrally located device to control machines
(D) input and output protocols to control machines

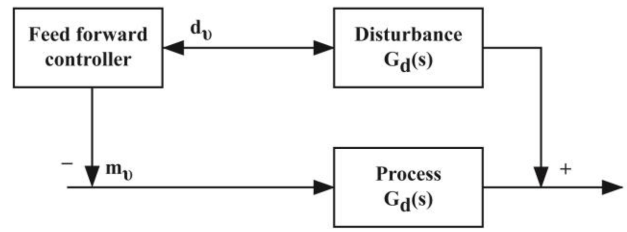
42. Which of the following is a characteristic of the supervisory subsystem of SCADA?

(A) Data security
(B) Data reliability
(C) Data gathering
(D) Data processing control

43. Which of the following is a function of PLC systems?

(A) Showing visual output and feedback
(B) Monitoring and controlling a process
(C) Controlling devices such as motors and sensors
(D) Monitoring and controlling an entire site or complex

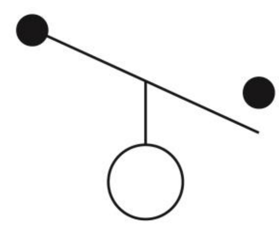
<u>Item **44**</u> refers to the following block diagram of a feed forward control.



44. The $G_d{}^{(s)}$ in the feed forward control provides

(A) temperature measurement
(B) mathematical relationship
(C) impact on the output
(D) process dynamics

<u>Item **45**</u> refers to the following diagram of a component used in a programmable logic controller.



45. The component shown is a

(A) selector switch
(B) float control
(C) push button
(D) thermostat

	Syllabus Reference	Module	Key
1.	2A.1.4	M1	B
2.	2A.1.1	M1	B
3.	2A.1.3	M1	A
4.	2A.1.4	M1	D
5.	2A.1.4	M1	B
6.	2A.1.5	M1	C
7.	2A.1.7	M1	A
8.	2A.1.7	M1	A
9.	2A.1.4	M1	D
10.	2A.1.7	M1	D
11.	2A.1.8	M1	C
12.	2A.1.8	M1	C
13.	2A.1.7	M1	B
14.	2A.1.5	M1	A
15.	2A.1.1	M1	D
16.	2A.2.10	M2	A
17.	2A.2.11	M2	D
18.	2A.2.8	M2	D
19.	2A.2.11	M2	B
20.	2A.2.11	M2	C
21.	2A.2.1	M2	B
22.	2A.2.2	M2	C
23.	2A.2.1	M2	D
24.	2A.2.2	M2	A
25.	2A.2.6	M2	B
26.	2A.2.6	M2	A
27.	2A.2.3	M2	C
28.	2A.2.6	M2	C
29.	2A.2.9	M2	B
30.	2A.2.11	M2	C
31.	2A.3.1	M3	D
32.	2A.3.1	M3	B
33.	2A.3.2	M3	A
34.	2A.3.2	M3	C
35.	2A.3.2	M3	D
36.	2A.3.3	M3	A
37.	2A.3.3	M3	D
38.	2A.3.3	M3	A
39.	2A.3.3	M3	A
40.	2A.3.3	M3	C
41.	2A.3.1	M3	D
42.	2A.3.3	M3	C
43.	2A.3.2	M3	C
44.	2A.3.1	M3	B
45.	2A.3.2	M3	B

TEST CODE **TBD**

SPEC 2015/TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRIC TECHNOLOGY

SPECIMEN PAPER

Unit 2A – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in THREE sections.
2. Answer ALL questions.
3. Write your answers in the spaces provided in this booklet.
4. DO NOT write in the margins.
5. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
6. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

MODULE 1 – COMMUNICATION ENGINEERING

1. (a) State the formula used to calculate the modulation factor of an amplitude modulated waveform and indicate what EACH of its symbols represents.

[4 marks]

(b) Figure 1 shows a block diagram of an AM superheterodyne receiver.

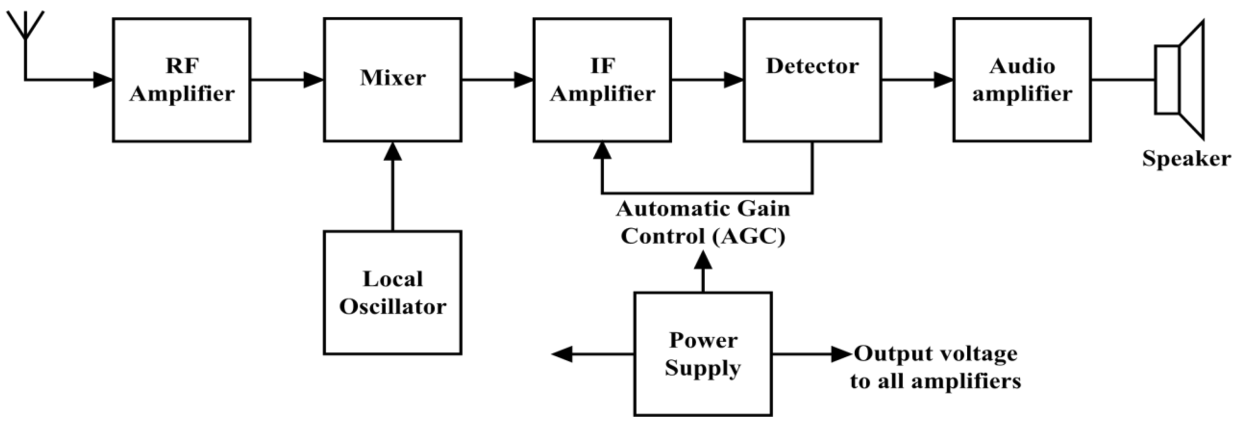


Figure 1. Block diagram of an AM superheterodyne receiver

(i) Calculate the frequency of the local oscillator if the IF amplifier is tuned to 450 kHz and the radio signal is 760 kHz.

[2 marks]

(ii) State the function of the

a) detector

[2 marks]

b) automatic gain control

[2 marks]

(c) State the function of the following stages of an FM receiver:

(i) Limiter

(ii) IF amplifier

(iii) DC emphasis network

[6 marks]

(d) Noise causes changes in the amplitude of both AM and FM waveforms. State the effects of both AM and FM changes in amplitude at the receiver.

[4 marks]

Total 20 marks

2. (a) Explain how a transistor must be biased for normal operation.

____

____

[2 marks]

(b) State the formula used to calculate the DC current gain of a transistor in the common emitter configuration.

____

____

[2 marks]

(c) Figure 2 shows a common emitter transistor circuit.

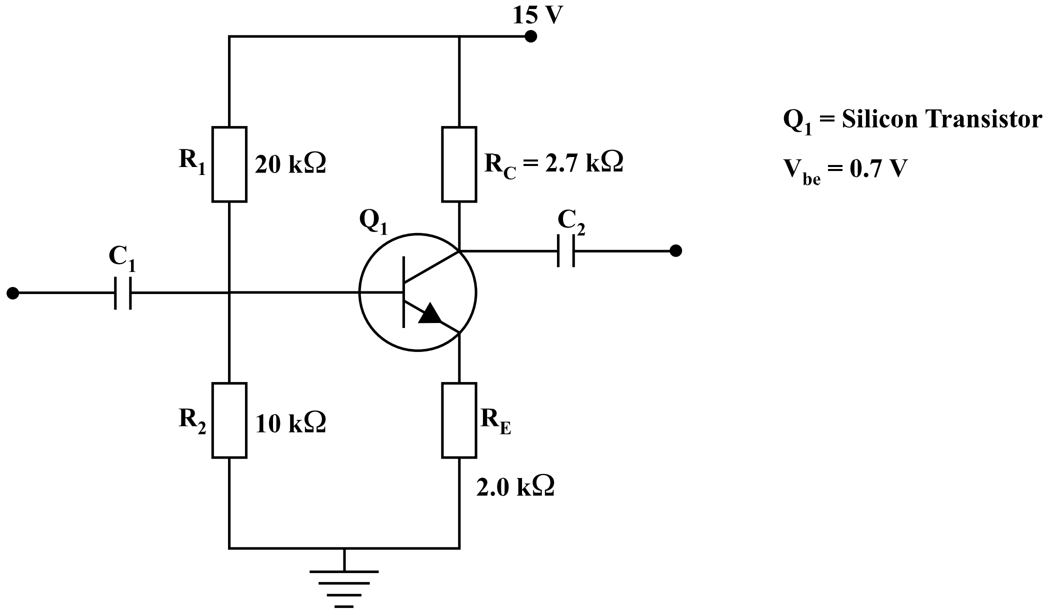


Figure 2. Common emitter transistor circuit

Calculate the

(i) DC base voltage

[3 marks]

(ii) emitter and collector currents

[4 marks]

(iii) collector to emitter voltage.

[3 marks]

GO ON TO THE NEXT PAGE

(d) Explain what is meant by the term ‘thermal runaway’ as applied to a transistor connected in the common emitter configuration.

[6 marks]
Total 20 marks

MODULE 2 – ANALOGUE AND DIGITAL ELECTRONICS

3. (a) State what is meant by the term ‘depletion layer’ when a PN junction is formed.

[2 marks]

(b) State what is meant by the term ‘barrier potential’ of a semiconductor diode and give its value at room temperature for a silicon diode.

[2 marks]

(c) With the aid of a block diagram, explain current flow in a PN junction diode.

[8 marks]

GO ON TO THE NEXT PAGE

(d) Figure 3 shows a full wave bridge rectifier.

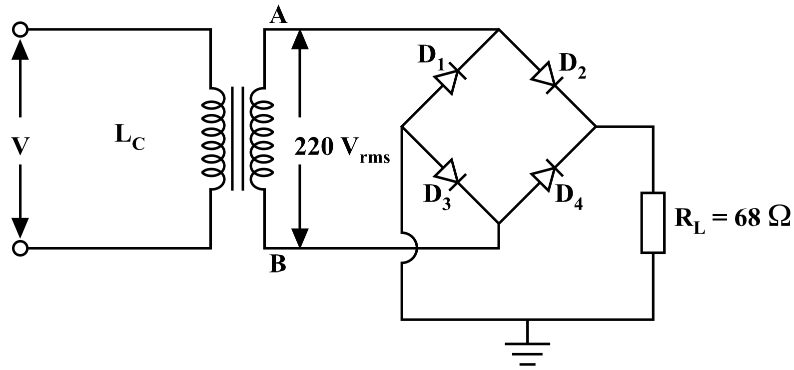


Figure 3. Full wave bridge rectifier

(i) Explain how the circuit operates in the rectifier.

[5 marks]

(ii) Draw the circuit diagram of a typical resistive filter that can be used with the rectifier.

[3 marks]

Total 20 marks

4. (a) Define the term 'truth table' as it relates to logic gates.

____

[1 mark]

(b) List THREE applications of logic gates.

____

____

____

[3 marks]

(c) Explain Karnaugh maps in relation to combination logic.

____

____

____

____

____

____

[6 marks]

(d) Figure 4 shows a logic gate circuit.

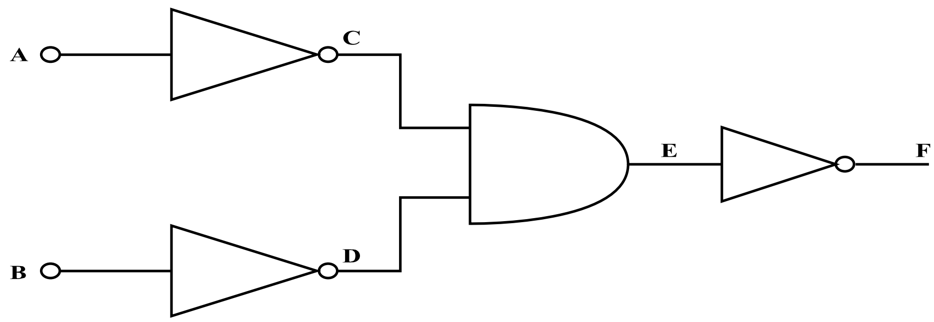


Figure 4. Logic gate circuit

Prepare the truth table for the circuit shown in Figure 4 and state the type of logic gate it represents.

____

____

____

____

____

[5 marks]

(e) Draw TWO of the symbols used to represent a three-input AND gate. State the Boolean expression for the AND gate.

____

____

____

[3 marks]

(f) Determine the decimal numbers that are represented by EACH of the following binary numbers:

(i) 1011_2

____

[1 mark]

(ii) 0111_2

____

[1 mark]

Total 20 marks

GO ON TO THE NEXT PAGE

MODULE 3 – CONTROL SYSTEMS

5. (a) (i) Explain the SCADA system.

____

____

____

[3 marks]

(iii) Identify the main components of a SCADA system.

____

____

____

[3 marks]

(b) Describe how SCADA system data is transmitted.

____

____

____

____

____

[5 marks]

(c) State TWO advantages and TWO disadvantages of digital communications.

____

____

____

____

[4 marks]

(d) (i) Explain the term ‘duplex data communication’.

____

____

____

[3 marks]

(iii) Give TWO suitable examples of duplex data communication.

[2 marks]

Total 20 marks

6. (a) Explain the basic difference between the simplex, half duplex and full duplex modes of operation as they relate to the transmission of digital information.

[6 marks]

(b) Explain the purpose of a universal asynchronous receiver transmitter (UART).

[4 marks]

(c) State TWO **main** advantages and TWO disadvantages of star topology.

[4 marks]

(d) A receiver has an input signal of 85 µV with internal noise at the input being 8 µV. The Signal at the output, after amplification, is 5 volts and the noise at the output is 0.6 volt.
Calculate the noise factor (NF).

[3 marks]

(e) Explain the differential phase shift keying (DPSK) modulation technique and state its advantage over phase modulation.

[3 marks]

Total 20 marks

MS TBD/CAPE/KMS 2015 SPEC

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

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRONIC TECHNOLOGY

UNIT 2A — PAPER 02

MARK SCHEME

MAY/JUNE

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 1

(a) Formula $m = \frac{B}{A}$ **(1 mark)**

Where M = modulation factor (no units) **(1 mark)**
B = peak value of the modulating signal **(1 mark)**
A = peak value of the unmodulated signal **(1 mark)**

[4 marks]

(b) (i) Frequency of local oscillator

(1 mark) **(1 mark)**
IF + RF = oscillator frequency = 760 + 450 KH_z = 1210 KH_z

[2 marks]

(ii) a) The Detector is used to restore the audio **(1 mark)** and bypass **(1 mark)** the R_F. **[2 marks]**

b) Automatic gain control is the method used in the superheterodyne to help keep the output of the receiver constant **(1 mark)** as stations of different signal strengths are received **(1 mark)**

[2 marks]

(c) (i) The limiter — clips the peaks of the FM waveform **(1 mark)** eliminating the amplitude changes caused by the noise **(1 mark)**

[2 marks]

(ii) The IF amplifier — amplifies the difference frequency **(1 mark)**. In commercial FM receivers, the IF is tuned to 10.7 MH_Z **(1 mark)**.

[2 marks]

(iii) The DC-emphasis network — compensates for the effect of the pre-emphasis network at the FM transmitter **(1 mark)**. Reduces the higher frequency audio signal **(1 mark)**.

[2 marks]

(d) In AM the changes in amplitude cannot be removed **(1 mark)**, doing so would also remove the original signal **(1 mark)**.

[2 marks]

In FM the changes in amplitude do not represent intentional information **(1 mark)**. A circuit called a limiter is used to remove any changes in amplitude of the received FM. **(1 mark)**

[2 marks]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 2

(a) For normal operation, the emitter-base junction must be forward biased **(1 mark)** and the collector-base reversed bias **(1 mark)**.

[2 marks]

(b) **(1 mark)** **(1 mark)**

$$\beta_{dc} = \frac{I_C}{I_B} \text{ for a given value of } V_{CE}$$

[2 marks]

(c) (i) **(1 mark)** **(1 mark)** **(1 mark)**

$$V_b = \frac{R_2 \times V_{CC}}{R_1 + R_2} = \frac{10\ K\Omega \times 15\ V}{20\ K\Omega + 10\ K\Omega} = \frac{10}{30} \times 15 = 5.0\ V$$

(ii) **(1 mark)** **(1 mark)** **(1 mark)**

$$I_E = \frac{V_b - V_{bc}}{R_e} = \frac{5.0\ V - 0.7\ V}{2\ K\Omega} = 2.15\ mA$$

I_C approximately equal to I_E = 2.15 mA **(1 mark)**

(iii) **(1 mark)**

$V_{CE} = V_{CC} - (I_E)(R_c + R_E)$

(1 mark)

$V_{CEQ} = 15 - (2.15\ mA) \times (2.7\ K\Omega + 2K)$

(1 mark)

$= 15 - (2.15 \times 4.7) = 4.89\ V$

[10 marks]

(d) A rise in ambient temperature results in thermal generation of electron hole pairs within the transistor **(1 mark)**, which has an equivalent effect to a rise in external base drive **(1 mark)**. This results in an increase in collector current and a reduced collector voltage **(1 mark)**. The quiescent point thus moves along the load line with change in temperature **(1 mark)**. This leads to an increase in internal power dissipation which can result in a further increase in junction temperature **(1 mark)**. If the heat generated rises at a greater rate than it can be dissipated, the effect becomes cumulative leading to thermal runaway **(1 mark)**.

[6 marks]

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 3

(a) The recombination of free electrons and holes near the junction **(1 mark)** produces a region of negative and positive ions called the depletion layer **(1 mark)**

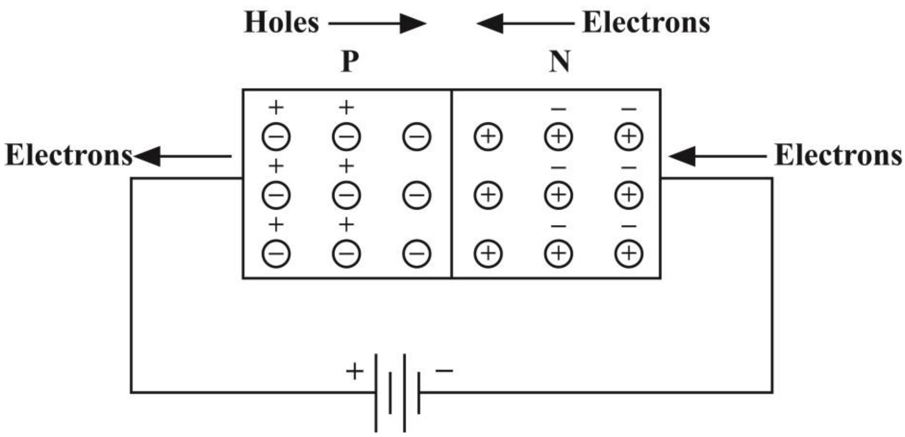
[2 marks]

(b) The difference of potential produced by the negative and positive ions is called the barrier potential **(1 mark)**

At room temperature the barrier potential is approximately 0.7 volt for a silicon diode **(1 mark)**.

[2 marks]

(c)



Correct placement of battery — 1 mark
Correct drawing of PN junction — 1 mark
Electron flow - 1 mark **(3 marks)**

Forward bias causes the free electrons on the N side to move towards the junction. This leaves positive ions at the right end of the crystal **(1 mark)**. The positive ions then attract free electrons from the battery. These free electrons flow from the negative battery terminal through the wire into the right end of the crystal **(1 mark)**. Since the positive battery terminal is connected to the P side, all of the holes in the P region are repelled towards the junction **(1 mark)**. As the holes move towards the right, they leave negative ions at the left end of the crystal **(1 mark)**. Valence electrons then flow from these negative ions into the wire connected to the positive battery terminal, As those valence electrons leave, new holes are created at the left end of the crystal **(1 mark)**.

(5 marks)

[8 marks]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

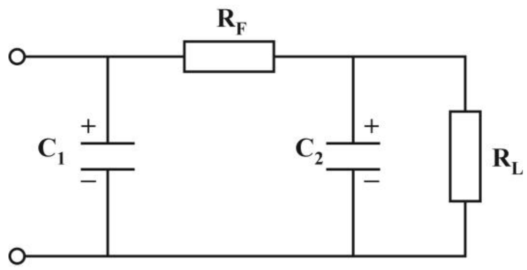
KEY AND MARK SCHEME

(d) (i) During the positive half cycle of secondary voltage when A is positive with respect to B, diodes D_2 and D_3 are forward biased and current flows through the load R_L **(1 mark).** When A is positive with respect B, Diodes D_1 and D_4 are reversed biased **(1 mark).**

When B is positive with respect to A, Diodes D_1 and D_4 are forward biased and current flows through the load R_L **(1 mark),** At the same time Diodes D_2 and D_3 are reversed biased. Thus a full wave type of output is produced **(1 mark).** The current in the load is in the same direction when the respective diodes are forward biased **(1 mark).**

[5 marks]

(ii)



Resistive filter

Correct placement R_F C_1 C_2 — 1 mark each

[3 marks]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 4

(a) A truth table for a logic circuit indicates all possible conditions of the inputs and what effects the input has on the output. **(1 mark)**

OR

A truth table is a very convenient way of summarizing the behavior of a logic gate. **(1 mark)** **[1 mark]**

(b) Three applications where logic circuits are used are:-

- Computers
- Calculators
- Railway signalling
- Control and test equipment
- Elevator controls

Any three 1 mark each **[3 marks]**

(c) Karnaugh maps are graphical methods to simplify logic expressions that will always give the simplest sum of products form. **(1 mark)** They allow expressions up to four variables to be handled in a straightforward manner **(1 mark)** and can be used with expressions up to six variables. **(1 mark)** It is a way of rearranging a truth table so that terms could be grouped together. **(1 mark)** Each cell in the Karnaugh map corresponds to one line in the truth table. **(1 mark)** The map is essentially nothing more than the truth table redrawn. **(1 mark)** **[6 marks]**

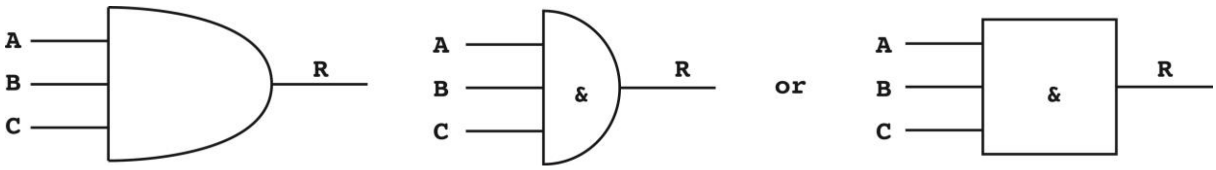
(d) Truth table

B	A	C	D	E	F
0	0	1	1	1	0
0	1	0	1	0	1
1	0	1	0	0	1
1	1	0	0	0	1

One mark for each correct result - (4 marks)

It represents an ''OR'' gate **(1 mark)** **[5 marks]**

(e)



Any two, 1 mark each **(2 marks)**

Boolean expression R = A.B.C **(1 mark)** **(3 marks)**

(f) (i) Place value: 8421
Given number: 1011
Adding the full cups: 8 + 0 + 2 + 1 = 11 **(1 mark)**

(ii) Place value: 8421
Given number: 0111
Adding the full cups: 0 + 4 + 2 + 1 = 7 **(1 mark)** **(2 marks)**

Total 20 marks

<u>Question 5</u>

(a) (i) SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations **(1)** and then sends these data to a central computer **(1)** which manages and controls the data. **(1)** **[3 marks]**

(ii) Main SCADA system components are the

- Signal hardware (input and out) **(1)**
- Controllers, networks, user interface **(1)**
- Communication equipment and software **(1)** **[3 marks]**

(b) Signals from the computer at the remote station are modulated by the modem **(1)** and fed to a communication link. **(1)** These signals are then impressed on the power line **(1)** which transmit the signals to the master station **(1)** via a communication link where they are demodulated and stored/used. **(1)** **[5 marks]**

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

(c) Advantages

- Comparatively immune to noise **(1)**
- More reliable transmission because only discrimination between zeros and ones required **(1)**
- Becoming cheaper to implement as digital logic chips are advanced **(1)**
- Ease of combining various types of signals (voice, video etc) **(1)**
- Ease of developing secure communication systems **(1)**

Any two — 1 mark each

Disadvantages

- Sampling error **(1)**
- Digital communications require greater bandwidth **(1)** than analogue to transmit the same information
- Digital signal detection requires communication **(1)** systems to be synchronized.

Any two — 1 mark each **[4 marks]**

(d) (i) A duplex system provides two-way communication. **(1)** There are two types; half duplex and full duplex. Half duplex facilitates sending and receiving but not at the same time. **(1)** for example, parallel interface on PC, walkie-talkie. **(1)** **[3 marks]**

(ii) Full duplex facilitates transmission in both directions simultaneously for example, RS232, **(1)** telephone **(1)** **[2 marks]**

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question 6

(a)

- Simplex mode - data flow in only one direction **(1)** from the transmitting device to the receiving device. **(1)**

- Half-duplex mode - allows for two-way communication between two digital systems. **(1)** However, the two-way communication cannot occur at the same time. **(1)**

- Full-duplex mode - can be achieved by using FDM (Frequency Division Multiplexing) **(1)** where both systems may transmit and receive at the same time using different transmission frequencies. **(1)** **[6 marks]**

(b) Computers process information in parallel, where groups of bits represent words, numbers and other useful information. **(1)** Since the practical transmission of digital information over wires requires that this information be transmitted serially **(1)** a device at the computer is required to convert parallel information into serial form for transmission. **(1)** This same device must be capable of converting a received signal transmission into parallel digital information. **(1)** Such a device is called a UART. **[4 marks]**

(c) Main Advantages

- A communication breakdown between any computer and the hub does not affect any other mode on the network. **(1)**

- Data must travel through the hub during transmission which enables the network administrator to monitor the status of all connected nodes. **(1)**

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Disadvantages

- The largest number of hubs from any source computer to the destination is only two.
- The whole network goes down if the hub breaks.
- Source to source computers not permitted direct.

(Any two — 1 mark each) **[4 marks]**

(d) $$\text{Noise factor} = \frac{S_{in}/N_{iN}}{S_{out}/N_{out}}$$ **(1)**

$$NF = \frac{85\ \mu V/8\ \mu V}{5V\ /0.6V}$$ **(1)**

[3 marks]

$$NF = \frac{10.6}{8.3}$$ **(1)**

$$= 1.28$$

(e) Differential Phase Shift Keying modulation — This modulation technique effectively transmits a synchronizing pulse along with the digital data. **(1)** If there is a mark, the phase of the signal is shifted +90°. If there is a space, the phase of the signal is shifted 90°. The phase shifts are periodic and can be used to derive the received clock signal in synchronous modems. **(1)** This method is advantageous over pure phase modulation in that the phase shift must occur at the end of each bit internal - even if the state of the information is not changing (i.e. two consecutive marks). **(1)**

[3 marks]

Total 20 marks

SPEC 2016/ TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL & ELECTRONIC TECHNOLOGY

SPECIMEN PAPER

Unit 2B – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

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

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

3. Look at the sample item below.

   <u>Sample Item</u>

   Which of the following is NOT an advantage of using fossil fuel thermal methods for electricity power generation?

   <u>Sample Answer</u>

   (A) Fuel cost is relatively low
   (B) Produces high levels of CO_2
   (C) Requires relatively small space for the plant
   (D) Can be produced almost anywhere in the world

   (A) ● (C) (D)

   The best answer to this item is "Produces high levels of CO_2" so (B) has been shaded.

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

1. A six-pole synchronous generator is driven at a speed of 1200 revolutions per minute. What is the frequency of the generated emf?

(A) 60 Hz
(B) 120 Hz
(C) 200 Hz
(D) 400 Hz

2. The power supplied to a three-phase induction motor is 40 Kw. If the stator losses are 2000 w and the slip is 25%, what is the rotor copper loss?

(A) 0.1 Kw
(B) 1.9 Kw
(C) 2.0 Kw
(D) 2.1 Kw

3. The stator of a 3-phase 8-pole induction motor is connected to a 50 Hz supply. What is the slip at full load if the rotor travels at a speed of 690 rpm?

(A) 8%
(B) 8.7%
(C) 45.65%
(D) 84%

4. Which of the following is the shunt resistance component equivalent circuit obtained by no load test of an induction motor representative of?

(A) Copper loss
(B) Core loss
(C) Windage loss
(D) Friction loss

5. An 8-pole, 50 Hz single-phase induction motor is running at 690 rpm. The resulting slip is

(A) 0.08
(B) -0.08
(C) 1.92
(D) -1.92

6. A 3-phase, 50 Hz, 4-pole induction motor is running at 1440 rpm and the rotor input power is 2 KW. Which of the following is the resulting rotor copper loss?

(A) 40 W
(B) 60 W
(C) 80 W
(D) 100 W

7. Which of the following is/are reason(s) for squirrel cage induction motors being provided with blades?

I. Eliminate noise
II. Balance the rotor
III. Allow for cooling

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

8. Which DC motor will have the least percentage increase of input current, for the same percentage increase in torque?

(A) Shunt
(B) Series
(C) Excited
(D) Compound

9. If a DC motor is connected across the AC supply it will

(A) burn
(B) not run
(C) run at lower speed
(D) run at normal speed

10. The direction of rotation of a DC motor can be determined by

(A) Lenz's law
(B) Ampere's law
(C) Fleming's left hand rule
(D) Fleming's right hand rule

11. A 440 V, 3-phase, 10-pole and 50 Hz synchronous motor delivering a torque of 50/n N-m, delivers a power of

(A) 100 W
(B) 500 W
(C) 1000 W
(D) 3000 W

12. The emf induced in a DC generator armature winding is

I. AC
II. DC
III. AC and DC

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

13. Which of the following are parts of the stator of the three-phase induction motor?

I. Frame
II. Core
III. Field winding

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

14. The basic function of a transformer is to change the

(A) power level
(B) power factor
(C) frequency
(D) level of the voltage

15. The core flux in a transformer depends MAINLY on the supply

(A) voltage
(B) voltage and load
(C) voltage and frequency
(D) voltage, frequency and load

16. Which of the following forms of energy is a renewable source?

(A) Synthetic oil
(B) Natural gas
(C) Oil shale
(D) Biomass

GO ON TO THE NEXT PAGE

17. Which of the following energy sources has the LOWEST average generating cost?

(A) Nuclear
(B) Geothermal
(C) Solar photovoltaics
(D) Hydroelectric plants

18. The FASTEST growing renewable energy resource today is

(A) wind
(B) nuclear energy
(C) hydroelectric plants
(D) geothermal energy

19. Which of the following is the LEAST efficient energy conversion device?

(A) Fuel cell
(B) Fluorescent light
(C) Incandescent light
(D) Internal combustion engine

20. Which of the following is the percentage of the world's energy needs derived from fossil fuels?

(A) 12%
(B) 50%
(C) 85%
(D) 93%

21. Using biomass as a source of energy for cooking means you might be cooking with

(A) coal
(B) natural gas
(C) petroleum
(D) a wood stove

22. Which of the following is an air pollutant?

(A) Oxygen
(B) Nitrogen
(C) Carbon dioxide
(D) Carbon monoxide

23. Air pollution from automobiles in some countries has reached epidemic proportions. What device can be fitted to vehicles to control air pollution?

(A) Bag filter
(B) Wet scrubber
(C) Catalytic converter
(D) Electrostatic precipitator

24. Which of the following is NOT a marine pollutant?

(A) Oil
(B) Plastics
(C) Raw sewage
(D) Dissolved oxygen

25. Which of the following can be used to describe a geothermal energy source?

I. Alternative energy source
II. An inexhaustible energy source
III. A renewable energy resource

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

GO ON TO THE NEXT PAGE

26. Which of the following areas is preferred for solar thermal electric plants?

(A) Hill tops
(B) Hot arid zones
(C) Coastal areas
(D) High rainfall areas

27. Which of the following is a disadvantage of most renewable energy sources?

(A) High polluting
(B) Unreliable supply
(C) High operating cost
(D) High waste disposal costs

28. Photovoltaic energy is the conversion of sunlight into

(A) biogas
(B) electricity
(C) chemical energy
(D) geothermal energy

29. Alcohols, ethers, and other chemicals made from raw biological material such as herbaceous and woody plants are collectively known as

(A) biofuels
(B) fossil fuels
(C) natural fuels
(D) biodegradables

30. Using less energy to perform the same function at the same level of quality is BEST known as

(A) electric energy
(B) energy efficiency
(C) energy conservation
(D) energy development

31. A 1200 V/200 V single-phase transformer takes a load current of 600 mA. If the core loss is 0.5 Kw, what is the value of the magnetizing current?

(A) 0.183 A
(B) 0.417 A
(C) 0.432 A
(D) 3.6 A

32. A 100 KVA 4000 V/200 V, 50 Hz single-phase transformer has 100 secondary turns. Assuming no losses, what is the maximum value of the flux?

(A) 4.5 mWb
(B) 9.01 mWb
(C) 0.18 Wb
(D) 111 Wb

33. Which of the following statements are TRUE for synchronous generators?

I. A DC power source supplies its magnetic field current.
II. A salient pole rotor is normally used for rotors with four or more poles.
III. A non-salient pole is a magnetic pole that sticks out from the rotor's surface.

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

GO ON TO THE NEXT PAGE

34. Which of the following is NOT a thermal fuel source for electrical energy?

(A) Solar
(B) Nuclear
(C) Natural gas
(D) Hydropower

35. The standard frequency for electricity supply is

(A) 50 Hz
(B) 60 Hz
(C) 70 Hz
(D) 80 Hz

36. In a steam turbine cycle, the lowest pressure occurs in

(A) boiler
(B) turbine inlet
(C) condenser
(D) super heater

37. Which of the following are advantages of higher transmission voltage?

I. Transmission line losses are reduced.
II. Power transfer capability of the transmission line is increased.
III. Area of cross section and volume of the conductor is reduced.

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

38. Aluminium is now the most commonly employed conductor material in transmission lines than copper because

(A) it is costlier
(B) it is more conductive
(C) it is cheaper and lighter
(D) its tensile strength is greater

39. If the length of a transmission line is increased, the charging current

(A) increases
(B) decreases
(C) remains unaffected
(D) continues to flow

40. Which of the following is the reason for suspending high voltage transmission lines from towers?

(A) To reduce wind loads.
(B) To reduce clearance from the ground.
(C) To increase clearance from the ground.
(D) To account for extension in length during summer.

41. Power plants that utilize fossil fuels are generally classified as

(A) tidal
(B) nuclear
(C) thermal
(D) hydro-electric

42. Geo-thermal power plants get their energy from

(A) the sun
(B) fossil fuels
(C) wind sources
(D) the earth’s crust

GO ON TO THE NEXT PAGE

43. Which of the following is NOT a protective device in a power system?

(A) Relay
(B) Regulator
(C) Circuit breaker
(D) Voltage transformer

44. Electrical power generated by forcing water through a penstock to turn turbines is known as

(A) solar power
(B) wind energy
(C) hydroelectricity
(D) chemical energy

45. Transmission lines are used to link

(A) service points to consumer premises
(B) generating station to receiving end station
(C) distribution transformer to consumer premises
(D) receiving end station to distribution transformer

	Syllabus Reference	Module	Key
1.	2B.1.1	M1	A
2.	2B.1.1	M1	B
3.	2B.1.1	M1	A
4.	2B.1.1	M1	B
5.	2B.1.2	M1	A
6.	2B.1.2	M1	C
7.	2B.1.2	M1	B
8.	2B.1.1	M1	A
9.	2B.1.1	M1	A
10.	2B.1.3	M1	C
11.	2B.1.5	M1	C
12.	2B.1.3	M1	A
13.	2B.1.2	M1	D
14.	2B. 1.2	M1	D
15.	2B.1.2	M1	C
16.	2B.2.2	M2	D
17.	2B.2.2	M2	D
18.	2B.2.2	M2	A
19.	2B.2.2	M2	D
20.	2B.2.2	M2	C
21.	2B.2.2	M2	D
22.	2B.2.3	M2	D
23.	2B.2.3	M2	C
24.	2B.2.3	M2	D
25.	2B.2.4	M2	D

	Syllabus Reference	Module	Key
26.	2B.2.4	M2	B
27.	2B.2.4	M2	B
28.	2B.2.4	M2	C
29.	2B.2.1	M2	A
30.	2B.2.1	M2	B
31.	2B.3.2	M3	C
32.	2B.3.2	M3	B
33.	2B.3.2	M3	A
34.	2B.3.1	M3	D
35.	2B.3.1	M3	A
36.	2B.3.1	M3	C
37.	2B.3.2	M3	D
38.	2B.3.2	M3	C
39.	2B.3.2	M3	B
40.	2B.3.2	M3	C
41.	2B.3.4	M3	C
42.	2B.3.4	M3	D
43.	2B.3.7	M3	B
44.	2B.3.6	M3	C
45.	2B.3.7	M3	B

TEST CODE **TBD**

SPEC 2015/TBD

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

CARRIBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRIC TECHNOLOGY

SPECIMEN PAPER

Unit 2B – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in THREE sections.
2. Answer ALL questions.
3. Write your answers in the spaces provided in this booklet.
4. DO NOT write in the margins.
5. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
6. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

MODULE 1 – POWER MACHINES AND SYSTEMS

1. (a) What is an induction motor?

[2 marks]

(b) State THREE advantages of EACH of the following types of induction motors:

(i) Squirrel cage

(ii) Wound rotor

[6 marks]

(c) An induction motor which is wound on 8 poles is supplied from a 60 Hz system. Calculate the

(i) synchronous speed

[3 marks]

(ii) rotor speed when the slip is 6 per cent

[5 marks]

(iii) rotor frequency when the speed of the rotor is 650 rev/mim.

[2 marks]

(d) State the meaning of the term ‘plugging’ as it relates to an induction motor.

[2 marks]

Total 20 marks

2. (a) Explain, with the use of a suitable diagram, the principle of mutual induction.

[4 marks]

(b) Sketch and label a typical B-H curve for a ferromagnetic material.

[3 marks]

(c) A current carrying coil of 1 780 turns yields a magnetic flux of 3.53 mWb. Given that the direction of current flow is reversed within 100 ms, determine the average value of the emf induced in the coil.

[4 marks]

(d) Explain the following terms, and state their symbols and units:

(i) Relative permeability

____

____

____

[3 marks]

(ii) Reluctance

____

____

____

[3 marks]

(iii) Magnetomotive force

____

____

____

[3 marks]

Total 20 marks

MODULE 2 – INTRODUCTION TO RENEWABLE ENERGY SYSTEMS

3. (a) Explain the main reason for climate change.

[4 marks]

(b) Discuss FOUR major impacts of climate change that have occurred within this century.

[16 marks]

Total 20 marks

4. (a) Define the term 'sustainable development' in the context of the Brundtland Report.

[2 marks]

(b) Using FIVE major points, develop a strategy of how you would implement a sustainable energy framework in your country.

[15 marks]

(c) List THREE benefits of converting waste to energy.

[3 marks]

Total 20 marks

MODULE 3 – POWER GENERATION ENGINEERING

5. (a) State TWO advantages and TWO disadvantages EACH of using thermal and nuclear methods of power generation.

[8 marks]

(a) Explain, with the use of a suitable diagram, the operation of a hydroelectric power generating plant. Your diagram must include water storage and release, the powerhouse details and transmission lines.

[12 marks]

Total 20 marks

6. (a) Outline the difference between thermal energy produced in a power plant using fossil fuels and non-thermal sources of electrical energy.

[4 marks]

(b) Explain, briefly, with the use of suitable diagrams, how TWO of the following electricity generating systems work.

(i) Wind turbine

(ii) Solar panel

(iii) Nuclear

[16 marks]

Total 20 marks

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

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ELECTRICAL AND ELECTRONIC TECHNOLOGY

UNIT 2B — PAPER 02

MARK SCHEME

MAY/JUNE

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **1**

(a) An induction motor is a type of asynchronous a.c. motor **(1)** where power is supplied to the rotating device by means of electromagnetic induction. **(1)** **[2 marks]**

(b) (i) Squirrel cage

- Cheaper and more robust
- Slightly higher efficiency and power factor
- Less noisy
- Explosion proof since the absence of slip rings and brushes eliminate work of sparking

(Any three — 1 mark each)

(ii) Wound Rotor

- Starting torque much higher **(1)**
- Starting current much lower **(1)**
- Speed can be altered by external means (resistors, solid state switching) **(1)**

[6 marks]

(c) (i)

$$\text{Synchronous speed} = \frac{60F}{P}\ \textbf{(1)} = \frac{60 \times 60}{P} \text{ rev/min} \quad \textbf{(1)}$$

$$= \frac{3600}{4} = 900 \text{ rev/min} \quad \textbf{(1)}$$

[3 marks]

(ii)

$$\text{Per unit slip} = \frac{\text{slip in r/min}}{\text{syn speed in r/min}}$$

$$= \frac{\text{Syn speed - Rotor speed}}{\text{Syn Speed}} \quad \textbf{(1)}$$

$$0.06 = \frac{900 - \text{Rotor Speed}}{900} \quad \textbf{(1)}$$

$$900 \times 0.06 = 900 - \text{Rotor Speed} \quad \textbf{(1)}$$

Question **1** cont'd

54 = 900 - Rotor Speed **(1)**

Rotor speed = 900 - 54 = 846 r/m **(1)**

[5 marks]

(iii) Per unit slip = $\frac{900 - 650}{900}$ = 0.27 **(1)**

Rotor frequency = per unit slip x freq

= 0.27 x 60 = 16.2 Hz **(1)**

[2 marks]

(d) Plugging is where the induction motor is used to break the load **(1)**, by reversing the phase of the windings. **(1)** **[2 marks]**

Total 20 marks

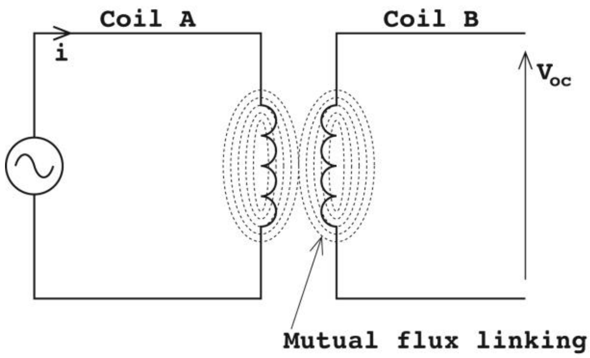
ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **2**

(a) Mutual Induction

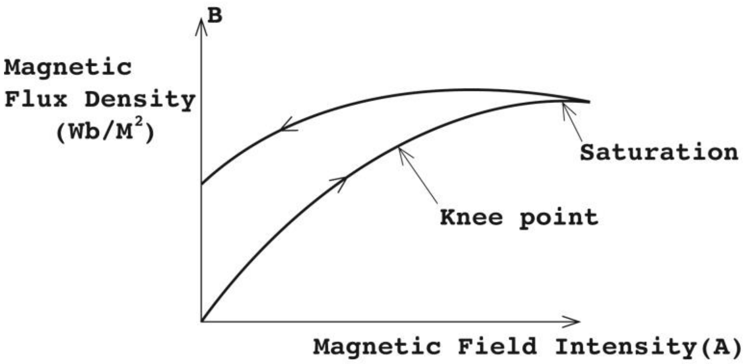


(1)

Diagrams — 1 mark

If a coil, A, is connected to an ac supply an alternating flux would be produced across it. **(1)** If another coil, B, is brought close to coil A (not touching) the alternating flux in coil A will link the other coil B and induce a voltage in it. **(1)** **[4 marks]**

(b)



Axes — 1 mark

Saturation and Knee point — 1 mark

Curve shape — 1 mark **[3 marks]**

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **2** cont'd

(c) $E = -N\frac{d\Phi}{dt}$ **(1)**

Current reversed flux polarity changes

$\Delta\Phi = 2(3.53 \times 10^{-3})$ **(1)**

$\Delta t = 100 \times 10^{-3}$

$E = \frac{(1780)(2)(3.53 \times 10^{-3})}{100 \times 10^{-3}}$ **(1)**

$= 125.67V$ **(1)** **[4 marks]**

(d) (i) Relative permeability is the ratio of flux density produced in a material to the flux density produced in a vacuum (or in a non-magnetic core) by the same magnetic field strength. **(1)**

Symbol: μr **(1)**

Unit: no units (dimension less) **(1)** **[3 marks]**

(ii) Reluctance is the resistance of a magnetic circuit. It is the ratio of mmf to flux. **(1)**

Symbol: S **(1)**

Unit: A/wb **(1)** **[3 marks]**

(iii) Magnetomotive force is the driving force that sustains the existence of magnetic flux caused by a current flowing through one or more turns. **(1)**

Symbol: F **(1)**

Unit: A **(1)**

[3 marks]

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **3**

(a) The main reason/reasons for climate change is the human influence **(1)** through the burning of fossil fuels **(1)**. When fuels such as coal, oil and natural gas are burnt carbon dioxide is released into the atmosphere, thus increasing the concentration of this greenhouse gas which in turn is making the earth warmer **(1)**. In addition, the high output of methane gas from agricultural practices has also contributed to the greenhouse effect **(1)**.

[4 marks]

(b) **Health impacts**- weather related mortality, infectious diseases, poor air quality (increase in toxic air pollutants) and respiratory diseases, especially in vulnerable populations such as children and the elderly. The increase and severity of respiratory diseases due to poor air quality (such as asthma and upper respiratory tract infections). Other health impacts include cardiovascular disease, heat-related mortality, foodborne diseases, vectorborne diseases, and mental health and stress related disorders.

Agricultural impacts – climate change affects agriculture in a number of ways, including through changes in pests and diseases; changes in atmospheric carbon dioxide and ozone concentrations; changes in the nutritional quality of some foods. Furthermore, agriculture contributes to climate change through the emission of greenhouse gases (mainly methane), and the conversion of forested lands into agricultural fields.

Ecosystems impact – forest composition, the extent of forests, forest health and increased production of timber have had detrimental effects. Forest are an important part of ecosystems and climate has an important influence on ecosystems. Therefore, climate changes affect ecosystems in numerous ways. Global warming forces species to migrate to other regions which are more conducive to their survival. Rise is sea water levels can result in the deposit of salt water into freshwater systems which can cause species to relocate or die. Logged forested areas can become vulnerable to erosion if climate change leads to increases in heavy rainfall.

Water resource impact – Water supply, water quality and competition for water are all affected. As temperatures begin to rise, there can be significant impact on the fresh water supplies. As temperatures increase so too does evaporation, sometimes resulting in drought. Temperature rise is also melting glaciers at alarming rates. These are sources of fresh water worldwide. Once the glaciers have melted they cannot be replaced.

Areas that depended on glaciers for fresh water would have to seek other sources for their freshwater supply.

[Four marks for EACH point discussed]
Total 20 marks

Question **4**

(a) *Sustainable development is development that meets the needs of the present **(1)** without compromising the ability of future generations to meet their own needs **(1)**.*

[2 marks]

(b) A strategy for implementing a sustainable energy framework should include:

- Develop a policy framework to guide the strategy
- Introduce renewable energy generation such as photovoltaic, wind, biomass or thermal energy systems
- Reduce greenhouse gas emissions using realistic time-lines
- Promote the use of energy efficient appliances and equipment and the introduction of renewable energy technology in buildings
- Educate and sensitize the population as it relates to effects of greenhouse gas emissions
- Educate population on strategies for implementing renewable energy uses and benefits

[3 marks for EACH major point developed. Total 15 marks]

(c) Benefits of converting waste to energy include:

- Production and use of energy
- Reduction is waste going to landfills
- Use of by-products as fertilizers
- Reduced methane emissions from landfills
- Avoidance of disposal costs
- Reduction in carbon emitted
- Domestic production of electricity
- Creation of jobs

[1 mark EACH, Any THREE]

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **5**

(a) Advantages of thermal methods of power generation:

- Fuel cost is relatively low
- Can be produced almost anywhere in the world
- Overall cost is effective
- Easier maintenance of power station
- Requires relatively small space
- Heat generated could be reused

Disadvantages of thermal methods of power generation:

- Production of high levels of CO_2
- Low overall efficiency
- Gases that are produced harm the atmosphere
- Large amounts of water required for cooling
- Fuel sources are non-renewable
- Contributes to acid rain

(1 mark for EACH advantage and 1 mark for EACH disadvantage = 4 marks)

Advantages of nuclear methods of power generation:

- Do not require a lot of space
- Does not contribute to global warming because there are no carbon emissions
- Does not contribute to acid rain by producing smoke particulates
- High levels of energy are produced from a small mass of fuel
- It is reliable
- Output can be controlled to suit needs

Disadvantages of nuclear methods of power generation:

- Fuel sources are non-renewable
- Large amounts of radioactive material can be released into the environment if there is an accident
- Nuclear waste remains radioactive for thousands of years
- Acutely hazardous to health
- Requires large quantities of water for cooling
- Disposal of waste is problematic because of its radioactive nature

(1 mark for EACH advantage and 1 mark for EACH disadvantage = 4 marks)

[8 marks]

Question **5** cont'd

(b) The operation of hydroelectric power generating plant: Hydroelectric power plants capture the energy produced from falling water to generate electricity. The water is controlled to strike a turbine, thus converting the kinetic energy of the falling water into mechanical energy. The farther the water falls and the greater the volume of water striking the turbine, the more power can be produced. Thus, location of the plant is critical to energy efficiency. A generator then converts the mechanical energy from the turbine into electrical energy. This energy in turn is distributed to customers using transformers and transmission and distribution lines.

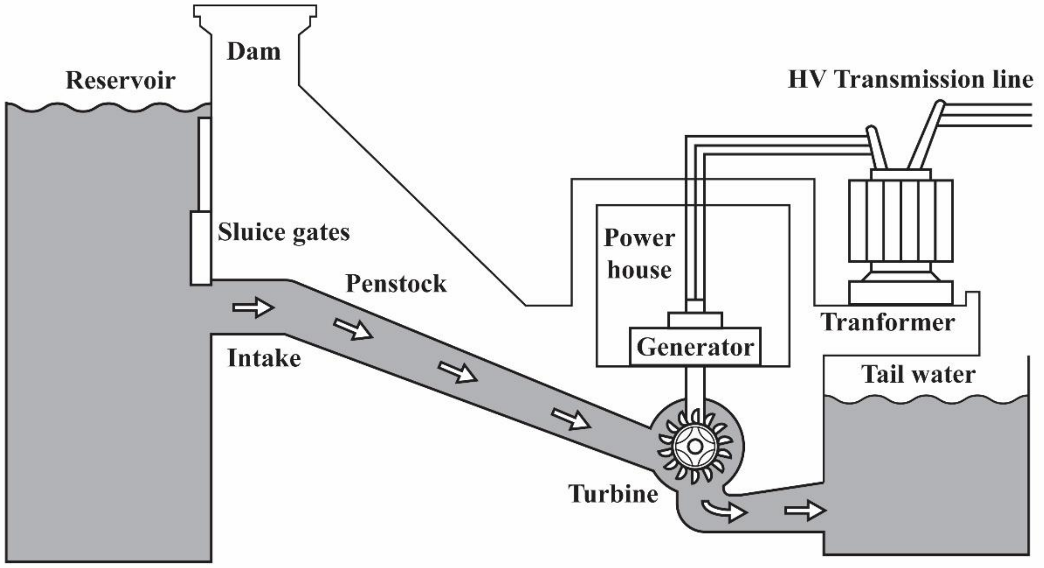
To generate hydroelectric power the following are required:

- a water source with the capacity to dam the water and release it in a controlled manner
- a turbine whose blades are turned by the force of the water, thus converting kinetic energy of the falling water into mechanical energy
- a generator connected to the turbine in such a way as to allow it to spin when the turbine spins, thus producing electricity
- transformers and transmission and distribution lines to carry the electricity to customers

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME



(2 marks for explaining each of the four components that contribute to the generation of power in a hydroelectric plant = 8 marks)

(4 marks for diagram of hydroelectric power generating plant showing dam, turbine, generator and transmission lines)

[12 marks]

Total 20 marks

ELECTRICAL & ELECTRONIC TECHNOLOGY

UNIT 2 - PAPER 02

KEY AND MARK SCHEME

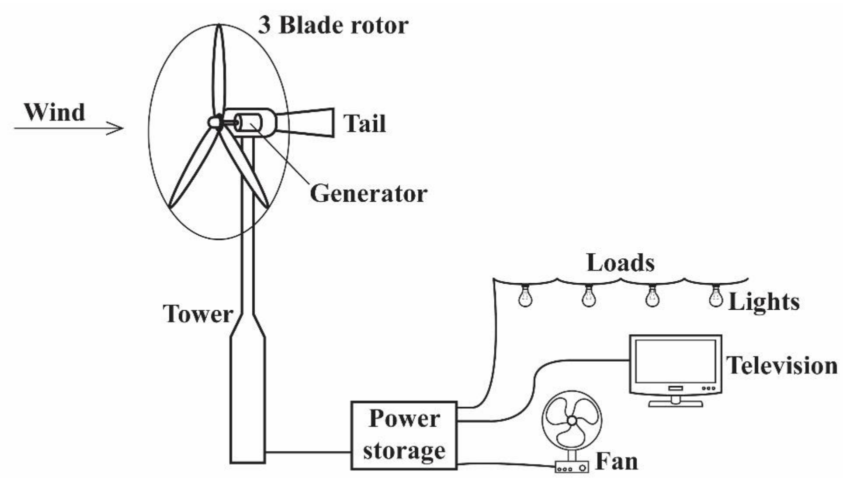
Question **6**

(a) In thermal sources of energy, heat energy is converted to electric power **(1)**. In most thermal power plants, water is heated, it turns to steam which in turn spins a steam turbine that drives an electric generator **(1)**. The generator produces electricity. In other types of power plants fossil fuels such as coal and natural gas are burnt to produce heat which turns a generator thus producing electricity.

Non-thermal sources of electricity production utilize energy from various sources. These types of plants do not burn any fuels **(1)**. They rely on energy from the sun, wind or water (hydroelectric power and wave energy) to generate electricity **(1)**.

[4 marks]

(b) (i) Wind turbine – these are placed on towers of at least 30 metres to take advantage of the faster, uninterrupted winds. The energy from the wind turns the two or three propeller blades around a rotor. The rotor is connected to the main shaft which spins a generator to produce electricity. Wind turbines can be used in clusters to produce electricity for a community.



ELECTRICAL & ELECTRONIC TECHNOLOGY

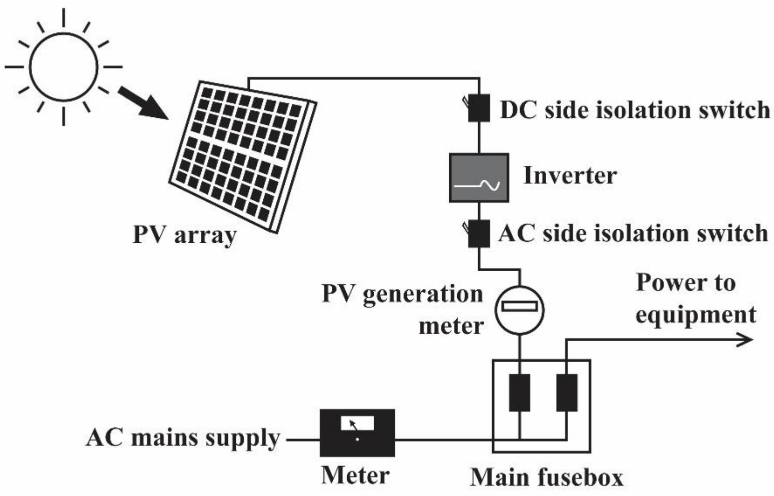
UNIT 2 - PAPER 02

KEY AND MARK SCHEME

Question **6** cont'd

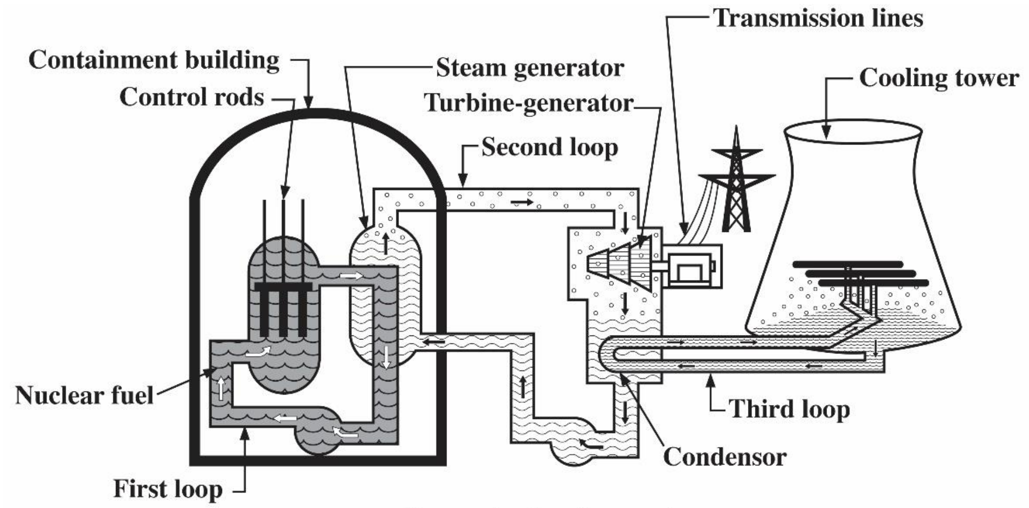
(ii) solar panels work by allowing photons, or particles of light, to free electrons from atoms, thus generating a flow of electricity. The panels comprise many smaller units called photovoltaic (PV) cells which can convert sunlight to electricity. They consist of one or two layers of silicon-based conductor wafers. Several of the PV cells are packaged together into solar modules, which in turn are packaged into solar panels.

These panels are mounted on rooftops and in large unobstructed open areas and are arranged to maximize the hours of exposure to direct sunlight. The electricity produced in direct current, thus it is passed through an inverter to transform it into alternating current, suitable for use with appliances.



(iii) At nuclear power plants, heat is produced from splitting uranium atoms (fission). There is no combustion. Pressurized water reactors keeps water under pressure so that it heats. The heated water is circulated through tubes in steam generators, allowing water in the steam generators to turn to steam which then turns the turbine generator.

Question **6** cont'd



Pressurized water reactor

(4 marks each explanation and 4 marks each diagram)

[16 marks]

Total 20 marks

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2004

ELECTRICAL AND ELECTRONIC TECHNOLOGY

ELECTRICAL AND ELECTRONIC TECHNOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2004

GENERAL COMMENTS

When compared with 2003, there has been a significant increase in the number of candidates for this examination. It is evident also that there has been improvement in the performance of candidates even though their improved performance appeared to be skewed to the electronics areas. Most candidates appear to be comfortable with the electronics related topics. It is evident that there is lack of understanding of some basic electrical and electronics concepts which affect the candidates' performance.

Fifty four candidates registered for this examination. Of this number, only thirty eight sets of scripts were received for marking.

The examination offered a wide coverage of the syllabus, in fact, the two papers when combined, covered all units in the syllabus.

It is quite evident that the schools are doing a better job of preparing students for this subject. However, more work is needed to get candidates to perform at the standard required for this level examination. Of the candidates who entered, a significant number of them have attempted more questions in the examination than in the past examinations.

The overall performance of candidates in this examination declined when compared with the performance of those who wrote the examination in 2003. In 2004, 68 per cent of the candidates achieved Grades II – V, compared with 86 per cent in 2003. No candidate achieved Grade I. This decline in performance was consistent across Modules 2 and 3, Analogue and Digital Electronics and Electrical Energy Systems respectively. Module 1 - Circuit Theory, continues to experience the best performance by candidates.

Only a few candidates have demonstrated competency in electronics as well as electrical energy systems. Most seem to be well prepared in topics on circuit theories and electronics. Candidates would be well advised to spend more time on both specializations electrical and electronics.

DETAILED COMMENTS

PAPER 01

Module 1 – Circuit Theory

Questions 1 – 10

Candidates were required to use fundamental laws to solve simple electrical/electronics circuits. More than 50 per cent of the candidates scored above 50 per cent in Module 1. From a possible 30 marks, six candidates scored in the 20 – 25 range, 16 scored in the 15 – 19 range, six scored in the 10 – 14 range and the remaining 10 candidates scores below 10 points.

Module 2 – Analogue and Digital Electronics

Questions 11 – 20

Basic analogue and digital electronic concepts were covered in this module. This module proved to be somewhat challenging. Of the 38 candidates, three candidates scored zero and only three above 20 points. Another three scored in the 15 – 19 range. Seven scored in the 10 – 14 range and the remaining 25 scored below 10 points.

Module 3 – Electric Energy Systems

Questions 21 – 30

This was the most challenging module. None of the candidates scored above 12 points and four scored zero. Twenty-three scored in the 1 – 5 range and the remaining 12 scored in the 6 – 12 range. This reveals that most candidates were ill prepared for this module.

PAPER 02

Candidates were required to do all six questions in this paper.

Module 1 – Circuit Theory

Questions 1 and 2

Candidates were required to state and use the Superposition Theorem to solve simple problems in Question 1 and solve problems in inductance in Question 2. Only two candidates scored in the 20 – 25 range for Question 1 and two in that range for Question 2. Eight candidates scored in the 10 – 20 range for Question 1 and 19 for Question 2. Twenty-seven candidates scored below 10 for Question 1 and 17 for Question 2.

Module 2 – Analogue and Digital Electronics

Questions 3 and 4

Question 3 concentrated on operational amplifiers, whereas Question 4 concentrated on logic circuits. Two candidates scored above 20 in both questions. Four candidates scored in the 10 – 20 range in Question 3 whereas 11 scored in this range for Question 4. Thirty-two scored 10 and below (seven zeros) in Question 3 and 25 (two zeros) in Question 4.

Module 3 – Electrical Energy Systems

Questions 5 and 6

These question were the most challenging and concentrated on several types of motors and transformers. No candidate scored above 15 marks in either question. Three candidates scored in the 10 – 15 range for question 5 and seven scored in this range for Question 6. The remaining 35 and 31 candidates scored below 10 for Questions 5 and 6 consecutively. Seventeen candidates scored zero for Question 5 and four scored zero for Questions 6.

INTERNAL ASSESSMENT

Only written reports for School Based Assessment were submitted for moderation. For the most part, the reports were poorly written. It appears that candidates are not encouraged to prepare their reports on projects in a timely manner. Consequently they are rushed when due by CXC.

RECOMMENDATIONS

1. Candidates need to spend more time on the electrical and electronics specializations. Only few candidates have demonstrated competency in electronics and few in electrical energy systems. Most seem to be quite knowledgeable about circuit theories and electronics.

2. Practical exercises should be more closely monitored. It appears that candidates are focussing primarily on electronics at the expense of the electrical areas.

3. Sample projects should be made available in order to effectively moderate grades assigned by teachers.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2005

ELECTRICAL & ELECTRONIC TECHNOLOGY

ELECTRICAL & ELECTRONICS TECHNOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2005

GENERAL COMMENTS

This year represents a record setting year for the Electrical and Electronics Technology examination. There has been a significant increase in the number of candidates as 74 candidates wrote the examination compared with 30 in 2004. There has been significant improvement in the performance of candidates even though their improved performance appeared to be skewed to the electronics area.

Most candidates appear to be comfortable with the electronics related topic consequently, the scores obtained for Unit 1 and 2 were quite impressive. Like previous years it is evident that there is lack of understanding of some basic electrical and electronics concepts which affects the candidates' performance especially in the electrical related units.

Time seemed to be a function as most students had difficulty completing all questions on the exam. Good responses were received for Module 1 while candidates did not perform well on Module 3. It appeared that candidates ran out of time.

It is quite evident that the schools are doing a better job of preparing students for this subject. The standard of the answers continues to improve, with increase in number of candidates sitting the examination. However, more work is needed to get candidates to perform at the standard required for this level examination. Of the candidates who entered, a significant number of them have attempted more questions in the examination than in the past examination.

The examination offered a wide coverage of the syllabus, in fact, the two papers when combined, covered all Units in the syllabus.

PAPER 01 — SHORT ANSWERS

MODULE 1

Circuit Theory (Questions 1-10):

Candidates were required to use fundamental laws to solve electrical/electronics circuits. Less than fifty percent of the candidates scored above fifty per cent in Module 1. From a possible 30 marks, 16 candidates scored in the 21-30 range, 17 scored in the 16-20 range, 18 scored in the 10-15 range and the remaining 20 candidates scored below 10 points.

Comments:

Question 1

The most common error was that of ignoring the polarity of the cells in the circuit which led to an inaccurate calculation of the current.

Question 2

Candidates did not realize that the bigger current flowed through the smaller resistor.

Question 3

Some candidate ignored the units in the calculation and failed to perform the calculation correctly.

Question 4

Most candidates were able to state the Maximum Power Transfer theorem correctly.

Question 5

This question was fairly well done. The most common error was stating the units incorrectly.

Question 6

This question was fairly well done. The most common error was that the units were not stated.

Question 7

Candidates tended to explain the concepts of electromagnetic induction rather than stating the law in a concise fashion.

Question 8

This question was fairly well done. Candidates generally knew the formulae needed to calculate time-constant and the current in the circuit.

Question 9

The relationship for calculating impedance were generally well known. The response to this question was fairly good.

Question 10

This open-ended question produced al large variety of correct answers.

MODULE 2

Analogue & Digital Electronics (Questions 11-20):

Basic analogue and digital electronics concepts were covered in this module. This module proved to be somewhat challenging. Of the 71 candidates, only five scored above 20 points. Seventeen scored in the 16-20 range. Twenty-six scored in the 10-15 range and the remaining 23 scored below 10 points.

Comments:

Question 11

The most common error was that the diodes were not oriented in a proper manner. Some candidates also placed the filter capacitor in series with the load resistor.

Question 12

Most candidates were able to calculate I_c correctly but calculation of V_{ce} was beyond their capability.

Question 13

Many candidates were unable to identify the circuit and thus were unable to state the relationship between input and output.

Question 14

Candidates produced good responses to this question.

Question 15

While many candidates understood the commutation process, most could not recall the principle of forced and natural commutation.

Question 16

This question was fairly well done. Most candidates were able to convert between bases.

Question 17

Many candidates were able to produce the Boolean expression for the output. The primary weakness was that candidates did not show how they arrived at the answer.

Question 18

More than 50 per cent of the candidates did not know how to fill in the table.

Question 19

Most candidates were confused by this question. They described different types of electromagnetic waves.

Question 20

Most candidates drew the AM and FM waves but offered no explanation.

MODULE 3

Electric Energy Systems (Questions 21-30):

This was the most challenging module. None of the candidates scored above 13 points and 16 scored zero. Fifty-three scored in the 1-9 range and the remaining two scored in the 10-15 range. This reveals that most candidates were not prepared for this module.

Comments:

Question 21

This question was misinterpreted by candidates. A common response was friction as opposed to brush size.

Question 22

Most candidates defined mutual inductance instead of the unit of mutual inductance.

Question 23

This question was answered satisfactorily by most candidates.

Question 24

Most candidates were unfamiliar with the synchronous motor and thus were unable to give advantages of this motor.

Question 25

Many candidates were unfamiliar with the shaded pole motor and thus were unable to describe its operation.

Question 26

Most candidates were unsure of which type of relay to sketch. Sketches of many different types of relays were produced.

Question 27

Many candidates knew that the SCADA system was used to transmit data but were unable to describe how the system works.

Question 28

Candidates were unable to differentiate between the various types of motors. They also appeared to be confused about labelling the devices.

Question 29

Most candidates answered part (a) satisfactorily, however, answers to part (b) were usually incorrect.

Question 30

Many candidates were unable to distinguish between slip speed and percentage slip.

PAPER 02 — ESSAY QUESTIONS

Candidates were required to do all six questions in this Paper which accounts for 150 marks. The standard achieved by candidates was higher than previous years. Most candidates attempted all sections, however, it appears at if Module 3 was the most challenging. The range of the marks obtained was zero to seventy-one. Ten candidates scored in the 50-71 range, twenty-four scored in the 30-49 range, thirty nine scored in the 10-29 range and nine scored below ten.

MODULE 1

Circuit Theory (Questions 1 & 2):

Candidates were required to determine currents in a two window mesh, define capacitance and determine charge stored in a capacitor. In Question 2, candidates were required to solve RC series circuit and determine frequency, period and RMS current. Only two candidates scored in the 20-25 range for Question 1 and one in that range for Question 2. Nineteen candidates scored in the 10-19 range for Question 1 and three for Question 2. Sixty candidates scored below 10 marks for Question 1, of this 60, 10 either scored zero or did not respond to the question. Seventy-nine candidates scored below 10 marks for Question 2. Of this number, 37 scored zero or did not respond to the question.

Comments:

Question 1 (a)

Most candidates attempted this question and it was generally well done. Some candidates used superposition but encountered problems determining the currents due to confusion with the polarity of the current. Many of those who attempted the loop equations were able to obtain correct answers. Candidates did not use correct units I writing their answers. They also experienced problems with using the correct sign and ended up subtracting currents where addition was necessary.

Question 1 (b)

Candidates did not give a definition. Instead they gave a description. The definition includes the explicit relationship between the relevant qualities. Parts II and III were very poorly done. Decay equations were not known and in cases where the equations were known, they were incorrectly applied to the problem.

Question 2 (a)

Most candidates attempted this question but it was poorly done. Candidates were unable to find the frequency and therefore assumed a frequency to do part II of the problem. Few candidates were able to calculate the phase angle. It appears that the formula was not known.

Question 2 (b)

This section appeared to be beyond the scope of the candidates.

MODULE 2

Analogue and Digital Electronics (Questions 3 & 4):

Question 3 concentrated on the Common Emitter amplifier and digital circuitry, whereas, Question 4 concentrated on the operational amplifier and flip-flops. Only one candidate scored above 15 in Question three and four in Question 4. Twenty-seven candidates scored in the 10-15 range in Question 3, whereas, 21 scored in this range for Question 4. Fifty-four scored 10 and below (15 zeros) in Question 3 and 57 (five zeros) in Question 4.

Comments:

Question 3 (a)

Most candidates were not prepared to answer this relatively straight-forward question. Only few candidates were able to identify the purpose of the capacitors. All but one could determine the input impedance.

Question 3 (b)

The response to this section was generally quite good. Most candidates could draw the truth table, but many had difficulty simplifying the Boolean expression obtained. Most candidates could draw the circuit from the minimized expression.

Question 4 (a)

Many candidates could not identify the summing amplifier even though the input-output relationship was known. None of the candidates could derive the relationship.

Question 4 (b)

This response to this section was generally quite good. However, the explanations given by most candidates were inadequate.

MODULE 3

Electrical Energy Systems (Questions 5 & 6):

These questions were the most challenging and concentrated on several types of motors and transformers. No candidate scored above 10 marks in Question 5 and none above 14 marks in Question 6. One candidate scored in the 10-15 mark range for Question 5 and ten scored in this range for Question 6. Eighty candidates scored below 10 for Question 5 and seventy-one for Question 6. Thirty-four candidates scored zero for Question 5 and eleven scored zero for Question 6.

Comments:

Question 5

Very few candidates made an attempt to answer this question. It seems that very little is known about the synchronous motor.

Question 6

Many candidates experienced difficulty explaining self-inductance. The numerical parts of the question were poorly done.

School Based Assessment

Some centres submitted both samples of projects as well as written reports whereas, others submitted only written reports. The SBAs were moderate based on the written samples submitted. In some instances experiments were conducted, however, the results were not properly documented. Candidates failed to discuss the findings of the experiment or outcome of the project. Again, it appears that candidates are not encouraged to prepare their reports on projects in a timely manner.

Recommendations

1 Candidates need to spend more time on the electrical and electronics specialization. Only few candidates have demonstrated competency in electronics and few in electrical energy systems. Most candidates seem to be quite knowledgeable about circuit theories and electronics.

2 Practical exercises should be more closely monitored. It appears that candidates are focusing primarily on electronics at the expense of the electrical areas.

3 Sample projects should be made available in order to effectively moderate grades assigned by teachers.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2006

ELECTRICAL & ELECTRONIC TECHNOLOGY

ELECTRICAL & ELECTRONICS TECHNOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2006

GENERAL COMMENTS

One hundred and thirteen candidates registered for Unit 1 and 11 candidates registered for Unit 2 in this examination. All candidates who registered for Unit 1 sat Paper 1, whereas 112 sat Paper 2. All eleven candidates who registered for Unit 2 sat both Papers 1 and 2.

The revised syllabus is being tested for the first time with candidates sitting two papers in Units 1 and 2. There has been a significant increase in the number of candidates when compared to last year. There was also incremental improvement in the performance of candidates when compared with the previous year, however, performance is still poor.

UNIT 1

PAPER 1 – SHORT ANSWERS

<u>Module 1 – DC Circuit Theory (Questions 1 – 5)</u>

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. Approximately 31 per cent, 35 candidates scored 50 per cent or above in Module 1. From a possible 30 marks, 15 candidates scored in the 21 – 30 range, 20 scored in the 15 – 19 range, 37 scored in the 10 – 14 range and the remaining 41 candidates scored below 10 marks.

COMMENTS

<u>Question 1</u>

Most candidates were able to find the total capacitance but many were unable to find the energy stored by the 20 microfarad capacitor because they did not calculate the voltage across the capacitor. Instead they used the 20V which led to erroneous results.

<u>Question 2</u>

This question was generally well done. Most candidates used the general formula to find the total resistance. Candidates who tried to use the current divider rule ran into difficulty as the rule only applies to two resistors.

<u>Question 3</u>

Many candidates ignored the current directions and polarity of the cell and this led to incorrect results.

<u>Question 4</u>

Most candidates were able to find the total inductance but failed to write down or use the Helmholtz equation.

Question 5

Many candidates were unable to convert from Kilowatts to Watts, therefore, yielding an incorrect answer for the current. Most candidates either did not write the equation for the temperature coefficient of resistance or exhibited poor mathematical skills in calculating the temperature.

Module 2 – Analogue Electronics & Communications (Questions 6 – 10)

Basic analogue and electronics and communications concepts were covered in this module questions were challenging for most candidates. Of the 113 candidates, only two scored 20 marks or above. Five scored in the 15 – 19 range. Twenty-two scored in the 10 – 14 range and the remaining 84 scored below 10 marks.

Question 6

Many candidates were unable to draw the circuit for the full-wave rectifier. The circuit diagrams produced indicated that the caandidates were unable to place the smoothing capacitor. The diodes were usually oriented incorrectly. Some candidates used the center-tapped transformer with two diodes but the circuits were usually incorrect. The majority of candidates who attempted Part (b) recognized that the clipping circuit would remove the lower half of the wave.

Question 7

Most candidates were unable to find the base current as they were unable to analyze the transistor circuit. Finding the collector current was also a major challenge for most candidates.

Question 8

Most candidates were unable to identify the operational amplifier configuration as an inverting amplifier, thus they were unable to complete the question.

Question 9

Most candidates failed to answer this question correctly as they were unable to identify the electromagnet spectrum. They were not able to give an application of each part.

Question 10

Many candidates were able to explain amplitude modulation but were unable to explain frequency modulation.

Module 3 – Introduction to Power Systems: (Questions 11 – 15)

This was the most challenging module. Only one of the candidates scored above 15 marks and 14 scored zero. Three scored in the 15 – 19 range. Eleven scored in the 10 – 14 range and the remaining 98 scored below 10 marks. Most candidates were ill prepared for this module.

Question 11

Some candidates were able to draw and label the cross-section of the d.c. but majority were unable to sketch or explain the speed – load characteristics for the motor.

Question 12

The question asked for an illustration of Faraday’s Laws but most candidates just stated the law. Most candidates had difficulty calculating the e.m.f as they could not recall the formula.

Question 13

Most candidates were able to explain the operation of the fuse but were not able to sketch the inverse characteristic curve of the fuse.

Question 14

Most candidates were able to give advantages of digital communication but some went on to give very elaborate diagrams for Part (b) which was much more than required.

Question 15

Most candidates produced incorrect responses for Part (a) as the torque – slip relationship was not known. Part (b) produced better responses but many candidates had difficulty explaining the concepts.

UNIT 1

PAPER 2 – LONG ANSWERS

Candidates were required to do six questions from this paper which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and carried 30 marks each. Candidates were required to select one of the remaining two questions in each module which carried 20 marks each. Most candidates attempted the required two questions from each module.

The range of the marks obtained was three to 113. One candidate scored above 100, whereas eight scored in the 70 – 100 range. 18 candidates scored in the 50 – 69 range, 38 scored in the 30 – 49 range, 47 scored in the 10 – 29 range.

Module 1 – DC Circuit Theory (Questions 1 – 3)

Candidates were required to do Question 1 and one other from this section. For Question 1, eight candidates scored in the 20 – 30 range, 31 scored in the 10 – 19 range, 54 scored in the 1 – 9 range, whereas 18 scored zero.

Seventy-three candidates attempted Question 2. Of this number, 21 scored zero, two candidates scored in the 10 – 15 range and the remaining 53 candidates scored between one and nine marks.

Thirty-five candidates attempted Question 3. Of this number, three candidates scored zero, three scored in the 10 – 15 range and the remaining 19 candidates scored between one and nine marks.

Question 1a

The answer produced by most candidates was fair. In general, candidates were able to state Thevenin’s and Norton’s Theorem.

Question 1b

Many candidates experienced difficulties completing this question. They used the wrong orientation to find the Thevenin's resistance.

Question 1c

This section of the question was fairly well done. The main problem observed is that candidates ignored the polarity of the cells and thus ended up with incorrect responses.

Question 1d

This section of the question provided challenge for most candidates. Many did not recognize that they should calculate the voltage drop across the device. Instead, they used the 27 Volts in their calculations.

Question 2a

Definitions for capacitance were not given. A definition should state how the quantity being defined is calculated.

Question 2b

Most candidates were unable to state or use charging or discharging formulae. Very few candidates made progress with this question.

Question 2c

Many candidates were able to score reasonable marks for this question.

Question 3

Many candidates experienced difficulties completing this question. Part (f) of the question was fairly well done.

Module 2 – Analogue Electronics & Communications (Questions 4 – 6)

Candidates were required to do Question 4 and one other from this section. For Question 4, six candidates scored in the 25 – 30 range, seven scored in the 20 – 24 range, 45 scored in the 10 – 19 range, whereas 50 scored below 10 including eight who scored zero.

Thirty-nine candidates attempted Question 5. Of this number 16 either scored zero or did not respond to the question, four candidates scored above 10 and the remaining 19 candidates scored between 1 and 9 marks.

Sixty candidates attempted Question 6. Of this number, 16 candidates either scored zero or did not respond to the question, two scored above 10 and the remaining 42 candidates scored between one and nine marks.

Question 4

Several candidates provided good responses to this question and scored 50 per cent or more of the available marks. Weaker candidates had difficulty identifying the circuit.

Question 5

Forty candidates attempted this question. Of this number, 15 either made no response or scored zero, six scored between 10 and 13 marks while the remaining 19 scored below 10 marks from a possible 20 marks. The candidates who attempted this question were unable to make progress as the relationship and equivalent circuits were not known.

Question 6

Sixty candidates attempted this question. Of this number, 16 either made no response or scored zero, two scored above 14 marks while the remaining 42 candidates scored below 10 marks from a possible 20 marks. Most candidates could not calculate the output voltage of the summing amplifier and knew very little about the Wein Bridge Oscillator.

Module 3 – Introduction to Electrical Power Systems: (Questions 7 – 9)

Candidates were required to do Question 7 and one other from this section. For Question 7, no candidate scored in the 25 – 30 range, one scored in the 20 – 24 range, 38 scored in the 10 – 19 range, whereas 70 scored below 10 including two candidates who scored zero.

Eighty-six candidates attempted Question 8. Of this number 14 either scored zero or did not respond to the question, five candidates scored above 10 and the remaining 67 candidates scored between one and nine marks.

Twenty-four candidates attempted Question 9. Three candidates either scored zero or did not respond to the question, four scored above 10 and the remaining 17 candidates scored between one and nine marks.

For Question 6, 80 candidates scored below 10 for Question 5 and 71 for Question 6. Thirty-four candidates scored zero for Question 5 and 11 scored zero for Question 6.

Question 7

This response to this question was generally poor. Only six candidates scored 15 marks and above from a possible 30 marks. Four candidates scored zero or did not attempt the question and 68 scored below 10 marks.

Question 8

Eighty-six candidates attempted this question. Of this number, 14 either made no response or scored zero, five scored 10 or above marks while the remaining 67 candidates scored below 10 marks from a possible 20 marks. Most candidates were unfamiliar with Lenz’s Law and could not calculate variables for the DC generator.

Question 9

The response to this question was extremely poor. Only 23 candidates attempted this question. Of this number, three either made no response or scored zero, four scored 10 and above marks while the remaining 16 candidates scored below 10 marks from a possible 20 marks.

UNIT 2

PAPER 1 – SHORT ANSWERS

Module 1 – AC Circuit Theory (Questions 1 – 5)

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits.

One candidate scored above 50 per cent in this module. Two scored in the 10 – 15 range. Seven scored in the 1 – 9 range and one scored zero.

Question 1

Two candidates scored four of six marks. Most candidates were capable of drawing a sine wave, but were unable to calculate the rms value of the wave.

Question 2

Although two candidates scored relatively high marks, all the others had difficulty with this question (more than 50 per cent scored zero). While some candidates could recall the relationship for phase angle and power factor, they could not carry out the required algebraic manipulation.

Question 3

Two candidates scored five marks for this question, six scored zero while the other four candidates scored either one or two marks. While many candidates correctly noted that $X_L = X_C$ at resonance, they were unable to calculate the cut-off frequency. Neither could they calculate the Q factor.

Question 4

Most candidates were unable to answer this question. Six candidates scored zero while three scored one mark only. The other two candidates scored three and four marks respectively. Most of the candidates did not recognize that the circuit was a parallel circuit and they used the series formula find the total inductance.

Question 5

Only two candidates provided relatively good responses. All others scored zero or one point. Most candidates correctly identified the filter as a low pass filter, many could not recall the cut off frequency formula. A variety of incorrect sketches of the frequency responses were seen.

Module 2 – Digital Electronics & Data Communications (Questions 6 – 10)

Basic analogue and electronics and communications concepts were covered in this module. This module proved to be somewhat challenging.

One candidate scored above 50 per cent (15 marks) in this module. One scored in the 10 – 15 range and the remaining nine candidates scored in the 1 – 9 range.

Question 6

This question tested the candidates understanding of the transistor when it was used as a switch. None of the candidates was able to produce an accurate response.

Question 7

Three candidates provided good responses, four scored zero for this question. Most candidates were able to construct the truth table for the circuit. Some candidates were confused about the method by which they should proceed to construct the truth table.

Question 8

Fifty per cent of the candidates responded well to this question. Some did not seem to know what a flip flop was and so were unable to proceed with the question.

Questions 9 & 10

Only four candidates attempted these questions. In particular most candidates had difficulty explaining the ring and star networks.

Module 3 – Introduction to AC Machines: (Questions 11 – 15)

For this module none of the candidates scored above 15 marks. Four scored in the 10 – 14 range and the remaining seven scored below 10 marks.

Question 11

All candidates attempted this question. However, the scores were relatively low. The majority had no difficulty defining primary and secondary windings could not carry out calculations for efficiency. Algebraic manipulation continues to be a serious weakness of many candidates.

Question 12

Only four candidates got marks for this question. The marks were relatively low (either one or two). Very few candidates were able to make a sketch and label the motor. Most candidates were unable to define slip

Question 13

Five candidates provided no responses to this question. Others scored between one and four marks.

Question 14

All candidates except one attempted this question, however only one managed to score four points. Others scored either one or two marks.

Question 15

All candidates except one attempted this question, two scored three marks whereas others scored between zero and two marks. Most candidates were able to identify uses of the induction motor but were unable to sketch the slip versus torque characteristics of the motor.

UNIT 2

PAPER 2 – LONG ANSWERS

Candidates were required to do six questions from this paper which accounted for 150 marks. Questions 1, 4 and 7 are compulsory and carried 30 marks each. Candidates are required to select one of the remaining two questions in each module for 20 marks each. All candidates attempted the required two questions from each module.

The marks obtained by candidates ranged from 21 to 101. One candidate scored above 100, whereas two scored in the 70 – 100 range. One candidate scored in the 50 – 69 range, four scored in the 30 – 49 range, and the remaining three candidates scored in the 20 – 29 range.

Module 1 – AC Circuit Theory (Questions 1 – 3)

Candidates were required to do Question 1 and one other from this section. For Question 1, one candidate scored in the 25 – 30 range, one scored in the 20 – 24 range, one scored in the 10 – 19 range, whereas the remaining seven candidates scored below 10 marks.

Seven candidates attempted Question 2. Of this number, two candidates scored in the 15 – 20 range and the remaining five candidates scored below six marks.

Four candidates attempted Question 3. Of this number one candidate scored zero, two scored below 10 marks and one candidate scored 20 marks.

Question 1

This question which tested knowledge of Q factor was poorly done by most candidates. It seems the relationship for Q factor was not well understood. They were also at a loss when it came to calculations of power factor.

Question 2

Seven candidates attempted this question but it was poorly done by five candidates. Those candidates who attempted it were able to state the resonance relation but were unable to perform the necessary calculations. Algebraic manipulation was a major weakness of those who attempted the question.

Question 3

Four candidates attempted this question. One candidate provided a relatively good response. Weaker candidates could only draw one type of filter, usually the low pass filter. The major weakness was the inability of most candidates to sketch the frequency response for the filters. Calculation of the cut off frequency proved to be a problem as most candidates quoted the formula f =1/2ðRC and were unable to proceed as there was no capacitor in the circuit.

Module 2 – Digital Electronics & Data Communications (Questions 4 – 6)

Candidates were required to do Question 4 and one other from this section. For Question 4, no candidate scored in the 25 – 30 and the 20 – 24 ranges, three candidates scored in the 10 – 19 range, whereas seven scored below 10 marks.

Three candidates attempted Question 5. One scored 16 marks and the remaining two scored five and six marks each.

Eight candidates attempted Question 6. Two scored in the 10 – 15 range and six candidates scored below ten marks.

Question 4

The majority of the responses to this question were poor. Analysis of transistor circuits was the major weakness of candidates.

Only part (f) of the question produced a response from the candidates. The major weakness with part (f) was that candidates tended to draw counter configurations for the shift register.

Question 5

This question was unpopular. Only three candidates attempted it. Of this number, one scored 16 marks and the other two scored five and six marks respectively.

Question 6a

This question was attempted by eight candidates. However, the responses were poor. One candidate scored 14 marks, whereas all others scored below 10 marks. Many were able to complete the truth table but then were at a loss when writing down the Boolean expression and had difficulty when asked to draw the circuit.

Question 6b

The candidates who attempted this part of the question produced circuits which were incorrect. The right type of flip flops were used but candidates did not know how to connect them to produce a correct circuit.

Module 3 – Introduction to AC Machines: (Questions 7 – 9)

Candidates were required to do Question 7 and one other from this section. For Question 7, no candidate scored in the 25 – 30 range, one scored in the 20 – 24 range, seven scored in the 10 – 19 range, whereas the remaining three candidates scored below 10 marks.

Three candidates attempted Question 8, and seven candidates attempted Question 9 candidates scored below 10 marks.

Question 7

All candidates attempted this question and the responses were impressive. Six candidates scored in excess of 15 marks and the remaining five candidates scored between five and 11 marks.

Question 8

Three candidates attempted this question. The responses were poor. Attempts were made at sketching the dynamo but the sketches produced were poor, and candidates were not able to do the calculations

Question 9

Seven candidates attempted this question but all scored below 10 marks.

INTERNAL ASSESSMENT

Some centres submitted samples of candidates’ projects as well as written reports whereas others submitted only written reports. The Internal Assessment moderated based on the written samples submitted. For the most part, the reports were properly written. Candidates failed to discuss the findings of the experiment or outcome of the project.

RECOMMENDATIONS

1. All teachers should use the same report forms. Some teachers used the old forms.

2. Candidates could benefit from closer supervision in carrying out Internal Assessment.

3. Teachers are reminded to follow the Procedures for the selection of Internal Assessment samples. (SEE INTERNAL ASSESSMENT MANUAL FOR PRINCIPALS).

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2007

ELECTRICAL & ELECTRONIC TECHNOLOGY

ELECTRICAL & ELECTRONICS TECHNOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2007

GENERAL COMMENTS

Sixty-one candidates registered for Unit 1 and 61 candidates registered for Unit 2 in this examination. All candidates who registered for Unit 1 sat Paper 02, whereas 59 sat Paper 01. All 61 candidates who registered for Unit 2 sat both Papers 01 and 02.

This is the second time which the revised syllabus is being tested with candidates sitting two papers in Units 1 & 2. Approximately the same number of candidates sat the examination when compared to last year; however the numbers were evenly spread across the units. As in previous years, the performance is quite poor.

The examiners are of the opinion that performance would be improved if candidates were given a booklet of formulae to be used in the examination. Providing formula booklets for candidates will not compromise the quality of examination since the paper setting exercise would take this into consideration when setting papers.

DETAILED COMMENTS

UNIT 1

PAPER 01

This paper in which all questions were compulsory, accounted for a total of 90 marks. The range of marks scored by candidates was 0 – 56. One candidate scored above 50 per cent, whereas six candidates (10 per cent) scored in the 40 – 50 per cent range. Thirty-four candidates (58 per cent) scored in the 20 – 39 range. The remaining 18 candidates (31 per cent) scored below 20 marks.

MODULE 1

DC Circuit Theory

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. From a possible 30 marks, the highest score was 26 and three candidates scored zero. Approximately 25 per cent of the candidates scored 50 per cent or above on Module 1. Six candidates scored in the 21 – 30 range, nine scored in the 15 -20 range, fourteen (16 per cent) scored in the 10 – 14 range and the remaining 28 candidates scored below 10 marks.

Question 1

Twenty-two per cent of the candidates were able to provide perfect responses (5 – 6 marks) whereas 50 per cent scored in the 0 – 2 marks range from a possible six marks. Candidates experienced difficulties in calculating mesh currents.

Question 2

Sixteen per cent of the candidates were able to provide perfect responses whereas 46 per cent scored between 0 and 2 marks from a possible six marks. Most candidates experienced difficulties with the second section of the question where they were asked to calculate voltage across a capacitor.

Question 3

Fourteen per cent of the candidates were able to provide perfect responses whereas 66 percent scored between 0 and 2 marks from a possible six marks. Most candidates experienced difficulties with the second section of the question where they were asked to calculate time constant.

Question 4

Thirty three per cent of the candidates were able to provide perfect responses whereas 20 per cent scored between 0 and 2 marks from a possible six marks. Few candidates had difficulties with this question.

Question 5

Three per cent of the candidates were able to provide perfect responses whereas 88 per cent scored between 0 and 2 marks from a possible six marks. Most candidates experienced difficulties with this question. They were unable to manipulate the temperature coefficient formula.

MODULE 2

Analogue Electronics & Communications

Basic analogue and electronics and communications concepts were covered in this Module. This Module proved to be somewhat challenging. The highest score was 20 and five candidates scored zero from a possible 30 marks. Of the 59 candidates, none scored in the 21 and above range. Six scored in the 15 – 20 range, 12 scored in the 10 – 14 range and the remaining 41 scored below 10 points.

Question 6

Five per cent of the candidates were able to provide perfect responses whereas 89 per cent scored between 0 and 2 marks from a possible six marks. Most candidates experienced difficulties with all parts of the question. They do not understand semiconductor doping.

Question 7

None of the candidates were able to provide perfect responses, five per cent scored between 1 and 2 marks while 66 per cent either did not attempt the question or scored zero from a possible six marks. A few candidates were able to explain how the clipper works but were unable to sketch the out put wave.

Question 8

Thirteen per cent of the candidates were able to provide perfect responses, 33 per cent scored between 1 and 2 marks while 33 per cent either did not attempt the question or scored zero from a possible six marks. It appears that candidates were not familiar with the characteristics curves of the transistor.

Question 9

Twenty-one per cent of the candidates were able to provide perfect responses, 23 per cent scored between 1 and 2 marks while 23 per cent either did not attempt the question or scored zero from a possible six mark. The diagram of the summing circuit was widely known, however most candidates were unable to provide and use the formula to determine the output.

Question 10

None of the candidates were able to provide perfect responses, 15 per cent scored between 1 and 2 marks while 62 per cent either did not attempt the question or scored zero from a possible six marks. Candidates were not familiar with ground wave propagation.

MODULE 3

Introduction to Power Systems

This was the most challenging of the three Modules. The highest score was 17 and seven candidates scored zero from a possible 30 marks. Of the 59 candidates, five 5 scored in the 15 – 20 range, 12 scored in the 10 – 14 range and the remaining 42 scored below 10 marks. Most candidates were ill prepared for this Module.

Question 11

Only three candidates (5 per cent) were able to provide near perfect responses, 33 per cent scored between 1 and 2 marks while 50 per cent either did not attempt the question or scored zero from a possible six marks. Candidates were unable to define magnetomotive and magnetizing force.

Question 12

None of the candidates were able to provide perfect responses, 25 per cent scored between 1 and 2 marks while 66 per cent either did not attempt the question or scored zero from a possible six marks. Most candidates were not familiar with DC machines and magnetization curves.

Question 13

Only one candidate was able to provide a near perfect response, 33 per cent scored between 1 and 2 marks while 26 per cent either did not attempt the question or scored zero from a possible six marks. Only a few candidates were able to identify where fuses and circuit breakers are located in a typical electrical system.

Question 14

Only one candidate was able to provide a perfect response, 44 per cent scored between 1 and 2 marks while 41 per cent either did not attempt the question or scored zero from a possible six marks. Only a few candidates were able to identify where fuses and circuit breakers are located in a typical electrical system.

Question 15

Twenty-five per cent of the candidates were able to provide prefect responses, 33 per cent scored between 1 and 2 marks while 26 per cent either did not attempt the question or scored zero from a possible six marks. Most candidates were able to identify parts of the motor but were unable to explain their functions.

PAPER 02

Sixty-one candidates sat this paper. They were required to do six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates were required to select one of the remaining two questions in each Module for a value of 20 marks each. Most candidates attempted the required two questions from each Module.

The range of the marks obtained was 0 -78. Only Three candidates (5 per cent) scored in the 70 – 100 range. Nine candidates (15 per cent) scored in the 50 -69 range. Eighteen (18) candidates (30 per cent) scored in the 30 – 49 range, twenty three (38 per cent) scored in the 10 – 29 range. Only six candidates (10 per cent) scored below 10 marks.

MODULE 1

DC Circuit Theory

Candidates were required to do Question 1 and one other from this section. From a possible score of 50 from this module, the highest score was 40. Six candidates scored in the 31 – 50 range, seven candidates scored in the 20 – 30 range, 22 scored in the 10 – 19 range, 26 scored in the 1- 9 range and one candidate scored zero.

Question 1

Eleven per cent of the candidates were able to provide reasonable (16 – 20 marks), 25 per cent scored between 6 and 16 marks, 44 per cent scored between 1 and 5 marks, while 20 per cent either did not attempt the question or scored zero from a possible 30 marks. Generally, candidates understood Thevenin’s circuit but were unable to calculate maximum power transfer.

Question 2

Seventy-three per cent of the candidates (45) chose this question. Of this number 6 per cent were able to provide excellent responses (16 – 20 marks), 31 per cent provided reasonable responses (10 – 15 marks), 47 per cent scored 5 – 9 marks, and 13 per cent scored between 1 and 4 marks. The remaining candidates (2 per cent) scored zero from a possible 20 marks. Many candidates were unable to calculate capacitance and the charge stored by the capacitor.

Question 3

Only 23 per cent of the candidates (15) chose this question. Of this number, one scored 11 and a second scored 6 marks. All others scored in the 1 – 5 mark range. In general, this question was not well done by candidates. Candidates have difficulties with inductance.

MODULE 2

Analogue Electronics & Communications

Candidates were required to do Question 4 and one other from this section. From a possible score of 50 from this Module, the highest score was 27. Four candidates scored in the 20 – 30 range, 21 scored in the 10 – 19 range, 26 scored in the 1 – 9 range and ten candidates scored zero.

Question 4

This question, though compulsory was attempted by 43 per cent of the candidates. The highest score was 18. Only two candidates were able to provide reasonable responses (16 – 20 marks), 23 per cent scored between 6 and 16 marks, another 23 per cent scored between 1 and 5 marks from a possible 30 marks. Fifteen candidates scored zero and 12 did not respond to the question. Candidates do not understand hybrid parameters.

Question 5

Fifty per cent of the candidates (30) chose this question and scored a high of 16 from a possible 20 marks. One candidate scored in the 16 – 20 mark range whereas 23 per cent provided reasonable responses (10 – 15 marks), 33 per cent scored 5 – 9 marks, and 33 per cent scored between 1 and 4 marks. The remaining candidates (5 per cent) scored 0 from a possible 20 marks. Parts (b) and (c) were widely known, however part (d) which questioned sensitivity of the superhetrodyne receiver, presented much difficulty for candidates.

Question 6

Twenty three candidates attempted this question and scored a high of 15 marks. Four candidates scored in the 10 – 15 range whereas 14 scored in the 1 – 9 range and five candidates scored zero. Most candidates were unable to draw a diagram of the Wein Bridge Oscillator and explain how it works.

MODULE 3

Introduction to Electrical Power Systems

Candidates were required to do Question 7 and one other from this section. From a possible score of 50 from this module, the highest score was 24. Seven candidates scored in the 20 – 30 range, 26 scored in the 10 – 19 range, 25 scored in the 1 – 9 range and three candidates scored zero.

Question 7

The response to this question was generally poor. The highest score was 12 marks. Only eight candidates (13 per cent) scored in the 10 – 15 range from a possible 30 marks. Thirty-eight scored below 10 marks and 14 candidates (23 per cent) scored zero or did not attempt the question. Candidates experienced difficulties in sketching the characteristics curves for various DC generator configurations.

Question 8

Thirty-seven candidates (61 per cent) attempted this question with the highest score being 12 from a possible 20 marks. Of this number, three scored zero, while 13 scored 10 or above marks. The remaining 23 candidates scored below 10 marks. It was evident that candidates were unfamiliar with the GPS and how it relates to SCADA.

Question 9

Twenty candidates (33 per cent) attempted this question. Of this number two scored zero. Only one candidate scored above 10 marks. Faraday’s Law of magnetic induction was generally not known to the candidates.

UNIT 2

PAPER 01

Candidates were required to do all questions from this paper which accounts for 90 marks. The range of the marks scored by candidates was from a low six to a high of 67, of the 61 candidates, thirteen candidates scored in the 50 – 70 range, thirty six scored in the 30 – 49 range. Five (5) candidates scored in the 20 – 29 range. The remaining seven candidates scored below 20 marks.

MODULE 1

AC Circuit Theory

Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. From a possible 30 marks, the highest score was 30 and the lowest 2 marks. Approximately sixty four per cent of the candidates (39) scored 50 per cent or above in this module. Sixteen candidates scored in the 21 – 30 range, 23 scored in the 15 – 20 range, nine scored in the 10 – 14 range and the remaining 13 candidates scored below 10 marks.

Question 1

Most candidates provided excellent responses to this question (35 scored in the 5 – 6 range from a possible 6 marks). Nine candidates either did not attempt or provide adequate responses for this question. Most candidates understood how to calculate the rms voltage and the frequency for an alternating voltage. A few candidates experienced difficulty labeling the graph (wave).

Question 2

Most candidates were able to provide good responses to this question (43 scored in the 5 – 6 range from a possible 6 marks). Only 11 candidates scored in the 0 – 2 mark range. Most candidates were able to determine the impedance of the circuit.

Question 3

Fourteen candidates provided adequate responses for this question (14 scored in the 5 – 6 range from a possible 6 marks). Sixty-six per cent of the candidates scored in the 0 – 2 range of which half of this number either scored zero or did not attempt the question. Most candidates were unable to convert the impedance to polar form.

Question 4

All candidates responded to this question of which 35 per cent of them were able to provide reasonable responses (9 scored in the 5 – 6 range from a possible 6 marks). Thirty-nine candidates scored in the 0 – 2 range. This number includes 11 who scored zero. Most candidates experienced difficulties in calculating the cut-off frequency of the filter.

Question 5

Although all candidates attempted this question, only 11 scored in the 5 – 6 range. Forty seven did not provide adequate responses. They scored in the 0 – 2 range which include nine who scored zero. Candidates experienced difficulties in calculating impedance of the circuit.

MODULE 2

Digital Electronics & Data Communications

Basic analogue electronics and communications concepts were covered in this module. This module proved to be somewhat challenging.

Fourteen candidates scored above 50 per cent (15 marks) in this module. Six candidates scored in the 21 – 30 range, eight candidates scored in the 15 – 20 range, twenty-four scored in the 10 – 14 range and the remaining 23 candidates scored below 10 marks.

Question 6

This question tested the candidates understanding of Boolean algebra. All except two candidates responded to this question. Twenty-five per cent of the candidates (16) were able to provide excellent responses (scored in the 5 – 6 range from a possible 6 marks). Thirty- three candidates scored in the 0 – 2 range. This number includes 17 who scored zero.

Question 7

Only four candidates provided reasonable responses to this question (scored in the 4 – 5 range from a possible 6 marks). Thirty four (56 per cent) candidates either did not attempt or scored zero. It was evident that most candidate do not understand counter circuits.

Question 8

All except three candidates responded to this question. Twenty three per cent of the candidates (14) were able to provide excellent responses (scored in the 5 – 6 range from a possible 6 marks). Twenty-eight candidates scored in the 0 – 2 range. This number includes nine candidates who scored zero. Many candidates experienced difficulties with assigning parity bits.

Question 9

This question tested the understanding of Logic gates. It is evident that most candidates did not understand truth tables. All except two candidates responded to this question. Forty-one per cent of the candidates (25) were able to provide excellent responses (scored in the 5 – 6 range from a possible 6 marks). Seventeen candidates scored in the 0 – 2 range. This number includes five candidates who scored zero.

Question 10

This question tested the understanding of digital to analogue converters. It is evident that most candidates were not familiar with this topic. Only five candidates provided excellent responses to this question (scored in the 5 – 6 range from a possible 6 marks). Thirty-five candidates (57 per cent) either did not attempt or scored zero, while eight candidates scored in the 1 – 2 mark range.

MODULE 3

Introduction to AC Machines

This module posed significant challenges to candidates. Only eight candidates scored above 50 per cent (15 marks) in this module. Another eight candidates scored in the 15 – 20 range, twenty five scored in the 10 – 14 range and the remaining 28 candidates scored below 10 marks.

Question 11

All candidates attempted this question.. Twenty-one per cent of the candidates (13) were able to provide excellent responses (scored in the 5 – 6 range from a possible 6 marks). Nineteen candidates scored in the 0 – 2 range. This number includes 11 candidates who scored zero. The majority of the candidates did not have a knowledge of or even understood autotransformers.

Question 12

This question tested the candidates’ knowledge of AC machines. Candidates lacked knowledge and understanding of the concepts related to this topic. Only 13 candidates scored points and nine did not attempt to answer this question. Two candidates scored 4 marks where as 11 scored in the 1 – 2 range.

Question 13

All except three candidates responded to this question. Sixteen candidates (25 per cent) provided reasonable responses (scored in the 4 – 5 range from a possible 6 marks). Twenty nine candidates (48 per cent) scored in the 0 – 2 range of which 3 candidates scored zero for this question. Few candidates have knowledge of the slip vs torque characteristics of the induction motor.

Question 14

All except five candidates responded to this question of which only four candidates provided reasonable responses (scored in the 4 – 5 range from a possible 6 marks). Fifty-two candidates (85 per cent) scored in the 0 – 2 range, half of this number (26) scored zero for this question. Most candidates were unable to explain the function of the windings of the wound rotor induction motor.

Question 15

All except five candidates responded to this question. Seventeen candidates provided excellent responses (scored in the 5 – 6 range from a possible 6 marks). Nineteen candidates (31 per cent) scored in the 0 – 2 range of which three scored zero. Many candidates were unable to complete the equivalent circuit as required.

PAPER 02

Candidates were required to do six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates are required to select on of the remaining two questions in each module for a value of 20 marks each. Most candidates attempted the required two questions from each module.

The marks obtained by candidates ranged from 11 – 82. Six candidates scored in the 70 – 100 range. Sixteen candidates scored in the 50 – 69 range, twenty-five scored in the 30 – 49 range, and the remaining thirteen candidates scored in the 0 – 29 range.

MODULE 1

AC Circuit Theory (Question 1 – 3)

Candidates were required to do question one and one other from this section. From a possible score of 50 from this module, the highest scored was thirty nine (39) and the lowest was two (2) marks. Three (3) candidates scored in the 31 – 50 range, Eleven (11) candidates scored in the 20 – 30 range, 31 scored in the 10 – 19 range, 16 scored in the 1 – 9 range.

Question 1

This question tested candidates' knowledge of RLC circuits. Most could explain the terms apparent, active and reactive power. All candidates attempted this question, however, calculations and manipulation of formulae were major challenges for many of them. Three candidates provided excellent responses for this question (21 – 30 marks range) with a maximum score of 22 marks. Four candidates were able to provide reasonable responses (16 – 20 marks), 54 per cent of the candidates (33) scored between 6 and 16 marks, 19 candidates (31 per cent) scored between 1 and 5 marks, while two candidates scored zero from a possible 30 marks.

Question 2

This question tested the candidates' knowledge and understanding of waveform analysis. Sixteen candidates (26 per cent) chose this question and scored a high14 marks for a possible 20 marks. Three candidates provided reasonable responses (10 – 15 marks), seven candidates scored in the 1 – 4 range, and the remaining four candidates scored zero. Several that candidates experienced difficulties with all aspects of this question.

Question 3

This question tested the candidates' knowledge of resonance and how to determine Q Factor in RLC Circuits. Seventy-five per cent of the candidates (46) chose this question and scored a high of 17 marks from a possible 20 marks. Of this number two candidates (4 per cent) was able to provide excellent responses (16 – 20 mark range), 22 per cent (10 candidates) provided reasonable responses (10 – 15 mark range), 22 candidates (48 per cent) scored in the 5 – 9 marks range, and seven candidates scored between 1 and 4 marks. The remaining 5 candidates (11 per cent) scored zero.

MODULE 2

Digital Electronics and Data Communication

Candidates were required to do Question 4 and one other from this section. From a possible score of 50 from this module, the highest score was 42 and the lowest was three. Six candidates (10 per cent) scored in the 31 – 50 range, 15 candidates (25 per cent) scored in the 20 – 30 range, 30 candidates (49 per cent) scored in the 10 – 19 range, and 10 candidates (16 per cent) scored in the 1 – 9 range.

Question 4

The candidates were required to construct truth table and simplify a logic circuit using Boolean algebra. Seven candidates (11 per cent) scored in the 20 – 30 range, twenty candidates (33 per cent) scored in the 10 – 19 range, whereas 30 candidates (49 per cent) scored in the 1 – 9 range, two scored zero and two did not respond to the question. Most candidates were unable to derive the truth table and experienced difficulties in simplifying the Boolean expression.

Question 6

Forty three candidates (67 per cent) attempted this question and scored in the range 1 – 20. Four candidates scored in the 15 – 20 range, twelve scored in the 10 – 14 range whereas twenty seven scored in the 1 – 9 range. Most candidates could differentiate between the full duplex, half duplex and simplex communications systems but were unable to explain what was meant by FSK and PSK. Most candidates did not know the cause for loss of signal along a line and how to prevent this lost.

MODULE 2

Introduction to AC Machines

Candidates were required to do Question 7 and one other from this section. From a possible score of 50 marks from this module, the marks ranged from 0 to 35. Only one candidate scored above 30. Seven candidates scored in the 20 – 30 range, 26 scored in the 10 – 19 range, 26 scored in the 10 – 19 range, 25 scored in the 1 – 9 range and two candidates scored zero.

Question 7

This question focused on transformers and tested candidates’ knowledge of related terms. Candidates were also required to draw the equivalent circuit of a transformer and calculate the various parameters for the device. From a possible 30 marks, the scores ranged 1 – 23. Two candidates scored in the 20 – 30 range, 17 scored in the 10 – 19 range, 40 scored in the 1 – 9 range, and two candidates did not respond to this question. Most candidates were able to draw the equivalent circuit and calculate the various parameters but were unable to explain the terms requested.

Question 8

This question required the candidate to focus on the synchronous dynamo by describing its construction details and sketching aspects of it. Candidates were also required to calculate motor speed when given certain parameters. Forty-seven candidates attempted this question and scored a high of 14 from a possible 20 marks. Four candidates scored in the 10 – 14 range, 36 scored in the 1 – 9 range and seven candidates scored zero. Most candidates were able to compute the motor speed but were unable to sketch the circuits and diagrams required.

Question 9

This question focused on the split phase induction motor and required candidates to describe its features, sketch and label its diagram and compute parameters for this machine. Eight candidates attempted this question and scored a high of 8 marks from a possible 20 marks. Two candidates scored in the 1 – 9 range and six candidates scored zero. In general, this question was quite challenging for the candidates.

INTERNAL ASSESSMENT

There were 65 submissions for marking. Some centers submitted samples of candidates’ projects as well as written reports whereas other submitted only written reports. The IAs were moderated based on the written samples submitted. For the most part, the reports were properly written. Candidates failed to discuss the findings of the experiment or outcome of the project. Candidates should be encouraged to prepare their reports on projects in a timely manner.

RECOMMENDATIONS

1. All teachers should use the current CXC forms.

2. Candidates could benefit from closer supervision.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

ELECTRICAL AND ELECTRONIC TECHNOLOGY (TRINIDAD AND TOBAGO)

ELECTRICAL AND ELECTRONIC TECHNOLOGY
(TRINIDAD AND TOBAGO)

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

GENERAL COMMENTS

Twenty-five (25) candidates registered for Unit 1 and fourteen (14) candidates registered for Unit 2 in this examination. All candidates who registered sat both papers in both units.

Performance in all papers was quite poor.

The examining team is still of the opinion that improvement in performance would result if the units were divided along the electrical/electronics specialization.

This arrangement, the examiners believe, would facilitate:

1. Better selection of text along electrical and electronic lines.
2. Better teaching since students would benefit from the expertise of teachers who are trained in the various specialties. It is evident from the performance of students that teachers are concentrating on their area of specialization and perhaps neglecting other areas.
3. Candidate concentration on one specialization before moving to the next.

UNIT 1

PAPER 01

SHORT ANSWERS

Candidates were required to do all questions from this paper which accounted for 90 marks. The range of the marks scored by candidates was zero (0) to forty-four (44) with a mean score of 28.4. Of the 25 candidates, four (4) scored in the 40 – 50 range, five (5) scored in the 30 – 39 range, eight (8) scored in the 20 – 29 range. The remaining eight (8) candidates scored below 20 marks.

MODULE 1

DC CIRCUIT THEORY (Questions 1-5)

Candidates were required to use fundamental laws and simple theory to solve problems on simple DC circuits. From a possible 30 marks, the highest score was 24 with a mean score of 14.4. Five (5) candidates scored in the 20 – 30 range, eight (8) scored in the 15 – 19 range, six (6) scored in the 10 – 14 range and the remaining six (6) candidates scored below 10 marks.

COMMENTS ON QUESTIONS

Question 1

Three (3) candidates were able to provide perfect responses (5-6 marks) to this question whereas 13 candidates scored in the 3 – 4 mark range, seven (7) scored between 1 and 2 marks and three (3) scored zero from a possible six (6) marks. Most candidates experienced difficulties identifying which material displayed an increase or decrease in resistance when exposed to a rise in temperature.

Question 2

Two (2) candidates provided perfect (5-6 marks) responses to this question whereas seven (7) scored in the 3-4 mark range, nine (9) scored in the 1-2 mark range and the remaining seven (7) scored zero (0)from a possible six marks. Many candidates knew how to calculate the PD across the capacitors but were unable to determine the charge. Candidates could not identify capacitors which are suitable for HV operations.

Question 3

Four (4) candidates provided perfect (5-6 marks) responses to this question whereas nine (9) scored in the 3-4 mark range, six (6) scored between 1 and 2 marks and five (5) either scored zero (0) or did not provide a response. Most candidates could not identify physical factors which determine inductance.

Question 4

Four (4) candidates provided perfect (5-6 marks) responses, eleven (11) scored in the 3-4 mark range, six (6) scored between 1 and 2 marks and the remaining four (4) either scored zero (0) or did not provide a response. Part (b) of the questions required knowledge of how to calculate parallel impedance which is not covered in Unit 1.

Question 5

Twelve (12) candidates provided perfect (5-6 marks) responses whereas eleven (11) scored in the 3-4 mark range, one (1) candidate scored 1 and another scored zero (0). In general, the candidates understood Kirchoff's Law.

MODULE 2

ANALOGUE ELECTRONICS AND COMMUNICATIONS (Questions 6 - 10)

Basic analogue and electronics and communications concepts were covered in this module. This module proved to be extremely challenging for candidates. The highest score was 10 from a possible 30 points with a mean score of 4.68. One (1) candidate scored in the 10 – 14 range and the remaining 24 scored below 10 points including eight candidates who scored below six points.

COMMENTS ON QUESTIONS

Question 6

Two (2) candidates provided perfect (5-6 marks) responses whereas eight (8) candidates scored in the 3-4 mark range, seven (7) scored between 1 and 2 marks and eight (8) candidate either scored zero or did not provide a response. Only a few candidates were conversant with the bridge rectifier. Most candidates did not know the function of the bleeder resistor.

Question 7

This question proved difficult for most candidates. Two (2) candidates scored in the 3-4 mark range, eight (8) scored in the 1-2 range whereas the remaining 15 candidates scored zero (0) from a possible six marks. Many candidates were not conversant with modulation and how to determine modulation factor.

Question 8

This question also proved extremely difficult for most candidates. Three (3) candidates scored in the 1-2 mark range and the remaining 22 either scored zero (0) or did not respond to the question. The majority of the candidates was unable to identify the configuration of the amplifier circuit and could not calculate the base and emitter voltages.

Question 9

This question also proved quite difficult for most candidates. Ten (10) candidates scored in the 1-2 mark range and the remaining 15 either scored zero (0) or did not respond to the question. Candidates shad limited knowledge about operational amplifiers.

Question 10

This question also proved extremely difficult for most candidates. None provided perfect (5-6 marks) responses, three (3) scored in the 3-4 mark range, 16 scored between 1 and 2 marks from a possible six marks with the remaining six (6) candidates scoring zero. Most candidates were able to identify applications of the light emitting diode but were unable to explain its operations.

MODULE 3

INTRODUCTION TO POWER SYSTEMS (Questions 11-15)

This module was not as challenging as the previous module. From a possible 30 points, the highest score was above 15 and the lowest was zero (0) with a mean score of 6.76 points. Of the 25 candidates, seven (7) scored in the 10-14 range, eight (8) scored between 6-9 points and the remaining 10 scored below 6 points. This reveals that either the candidates were ill prepared for this module or that they did not have enough time to complete it in a satisfactory manner.

COMMENTS ON QUESTIONS

Question 11

Only one candidate provided a perfect (5-6 marks) response whereas five (5) candidates scored in the 3-4 mark range. Ten (10) scored between 1 and 2 marks and nine (9) scored zero from a possible six marks. Most candidates were able to state Lenz's law and some were able to give the formula to calculate the average emf induced in the coil.

Question 12

This question proved extremely difficult for most candidates. None provided a perfect (5-6 marks) response, six (6) scored in the 1-2 mark range. The remaining 19 candidates either scored zero or did not provide a response to this question. Candidates were unable draw the magnetization curve and could not identify the saturation point.

Question 13

This question proved extremely difficult for most candidates. None provided a perfect (5-6 marks) response, one (1) scored in the 3-4 mark range, eleven (11) scored in the 1-2 mark range and the remaining 13 candidates either scored zero or did not provide a response to this question. Most candidates were able to sketch the characteristics of the cartridge fuse but were not able to outline the operation of the fuse.

Question 14

This was a good question for most candidates. One (1) scored in 5 marks, whereas eight (8) scored in the 3-4 mark range sixteen (16) scored between 1 and 2 marks from a possible six marks. One candidate did not respond to the question. Most candidates were able to identify the advantages of digital over analogue. Many candidates were unable to describe the modulation process.

Question 15

This was a good question for most candidates. One (1) scored in 6 marks, whereas four (4) scored in the 3-4 mark range sixteen (16) scored between 1 and 2 marks from a possible six marks. Four candidates either scored zero (0) or did not respond to the question. Candidates were able to state the function of computers and give the purpose of the demodulator.

UNIT 1

PAPER 02

All twenty-five (25) candidates sat this paper. They were required to do six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates were required to select one of the remaining two questions in each module for a value of 20 marks each. Most candidates attempted the required two questions from each module.

The range of the marks obtained was thirteen (13) to a high of sixty-nine (69) and the mean score was 36.96. Five (5) candidates scored in the 50-69 range, eleven (11) scored in the 30-49 range and the remaining nine (9) candidates scored in the 10-29 range.

MODULE 1

DC CIRCUIT THEORY (Questions 1-3)

Candidates were required to do question one and one other from this section. From a possible score of 50 from the module, the highest score was 21, the lowest was zero and the mean score was 11.16. Three (3) candidates scored in the 20-29 range, 13 scored in the 10-19 range and nine (9) scored in the 1-9 range.

COMMENTS ON QUESTIONS

Question 1

This question tested the candidate's knowledge of Kirchoff's law and the use of Superposition theorem. The highest score obtained was 13 from a possible 30 marks. Three (3) candidates scored in the 10*15 mark range whereas 11 candidates scored in the 5-9 range. All other candidates scored below four (4) marks including two (2) candidates who scored zero. This question though basic proved challenging for most candidates. Most knew the conditions for maximum power transfer but were unable to calculate current through a resistor using the Superposition theorem.

Question 2

This question tested candidates' knowledge of capacitors, capacitance and time constant. The majority of the candidates (19) selected this question and scored a high of 12 and a low of 2 marks from a possible 20 marks. One candidate scored 12 marks whereas the remaining 18 scored below 10 marks. Most candidates could define capacitance and state its unit. They were also able to determine time constant and initial charging current but they experienced difficulties with the remaining parts of the question.

Question 3

This question tested the candidates' knowledge of inductors, self inductance and mutual inductance. Only six (6) candidates chose this question and scored a high of 11 marks and a low of three (3) marks from a possible 20 marks. One candidate scored 11 marks whereas the remaining 5 scored below 10 marks. In general, this question was not well done by candidates. However, they seemed to understand the concept of mutual inductance and how to determine time constant in an inductive circuit.

MODULE 2

ANALOGUE ELECTRONICS AND COMMUNICATIONS (Questions 4-6)

Candidates were required to do Question four and one other from this section. From a possible score of 50 from the module, the highest score was 32, the lowest was zero and the mean score was 13.32. Two (2) candidates scored in the 30-50 range, 3 candidates scored in the 20-29 range, six (6) scored in the 1-9 range and one (1) candidate scored zero.

COMMENTS ON QUESTIONS

Question 4

This question tested the candidates' knowledge of wave shaping circuits, oscillators, semiconductors and Zener Diode. All candidates were required to answer this question. The highest score was 20 from a possible 30 marks. Only one candidate was able to provide a good response (20-30 marks), and only three (3) scored between 15 and 19 marks. Three (3) candidates scored between 10 and 14 marks, 13 scored between 5 and 9 marks, 5 scored between 1 and 4 marks, while one scored zero. Candidates experienced difficulties with waving, shaping circuits but were conversant with charge carries in semiconductor materials.

Question 5

This question tested the candidates' knowledge of transistor biasing circuits, amplifier gain and modulation. Seven (7) candidates attempted this question and scored a high of 4 from a possible 20 marks. It is evident that candidates are unfamiliar with transistor biasing circuits and amplifier circuits in general.

Question 6

This question focused on amplifiers, receiver sensitivity and wave propagation. Eighteen (18) candidates attempted this question and scored a high of 14 from a possible 20 marks. Four candidates scored in the 10-15 range whereas seven scored in the 5-9 range, five scored between 1-4 marks, while one (1) scored zero. Most candidates are unfamiliar with frequency response curves and did not understand the concept of sensitivity of receivers.

MODULE 3

INTRODUCTION TO ELECTRICAL POWER SYSTEMS (Questions 7-9)

Candidates were required to do question seven and one other from this section. From a possible score of 50 from the module, the highest score was 26, the lowest was 2 and the mean score was 12.48 Five (5) candidates scored in the 20-29 range, 11 scored in the 10-19 range and 8 scored in the 1-9 range.

COMMENTS ON QUESTIONS

Question 7

This question tested the candidates’ knowledge of dc dynamo and its connection as a generator. In general, the performance on this question was average. The highest score was 20 marks. Four (4) candidates scored in the 15 and 20 mark range, six (6) scored in the 10-14 mark range, ten scored between 5 and 9 marks and five scored between 1 and 4 marks. Candidates were able to label the parts of the dc machine but experienced difficulties in placing the components in functional groups. Most candidates were unable to draw the circuit for the long shunt configuration.

Question 8

This question focused on overload relays. Two (2) candidates attempted this question and scored 6 and 2 marks respectively from a possible 20 marks. It is evident that all candidates were unfamiliar with overload relays

Question 9

This question focused on electromagnetism, permeability, reluctance and magneto motive force (mmf). Twenty-three 23 candidates attempted this question and scored a high of 11 from a possible 20 marks. One (1) candidate scored in the 10-14 range whereas eight (8) scored in the 5-9 range, 11 scored between 1 and 4 marks, while three either scored zero or did not provide a response that was worthy of grading. Most candidates knew how to draw the diagram that explains the effect of a current carrying conductor in a magnetic field. Most experienced difficulties with the B-H curve.

UNIT 2

PAPER 01

SHORT ANSWERS

Candidates were required to do all questions from this paper which accounts for 90 marks. The range of the marks scored by candidates was from a low of ten (10) to a high of forty-two (42) with an average score of 29.5. Of the 14 candidates, one (1) scored in the 40 – 49 range, six (6) candidates scored in the 30 – 39 range, six (6) candidates scored in the 20 – 29 range and one (1) scored in the 10 – 19 range.

MODULE 1

AC CIRCUIT THEORY (Questions 1-5)

Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. This module proved challenging for candidates as evidenced by a low average score of 9.36 form a possible 30 marks. The highest score was 19 and the lowest score was three marks. Two (2) candidates scored in the 15 – 19 range, two (2) scored in the 10 – 14 range, nine (9) scored in the 5 – 9 range and one (1) candidate scored three marks.

COMMENTS ON QUESTIONS

Question 1

This question tested the candidates' knowledge of RLC circuits. One (1) candidate provided an excellent response (six marks), however it was quite challenging to all other candidates since two of them scored one (1) and the remaining 11 candidates either scored zero or did not respond to the question.

Question 2

Candidates were asked to define capacitance and capacitive reactance and to identify the difference between a high pass and a low pass filter. One candidate provided an excellent response (six marks), however it was quite challenging to all other candidates since only four (4) scored in the 3-4 mark range and eight (8) scored in the 1-2 range and one (1) scored zero. Most candidates were able to define terms but were unable to identify the difference between high and low pass filters.

Question 3

Given a RLC circuit, candidates were required to calculate resonant frequency and current. Most candidates responded well to this question, however, they experienced difficulties determining resonant frequency. Two (2) candidates provided perfect responses (6 marks), eleven (11) scored in the 3-4 mark range and one (1) scored 2 marks.

Question 4

Candidates were asked to define the term 'frequency response' and to determine the cutoff frequency of a first order low pass filter. Seven candidates were able to define the term, however most experienced difficulties with calculating cutoff frequency. There (3) scored 4 marks, five (5) scored 1 mark and the remaining six (6) candidates either scored zero or did not provide a response for the question.

Question 5

Candidates were asked to explain the term 'power dissipated' and 'impedance match' and to draw diagrams of 'T' and π . Type low pass filters. Most candidates were able to explain the term 'power dissipated' but could not explain 'impedance match'. Several of them were able to draw the diagrams requested. Two (2) scored in the 3-4 mark range, nine (9) scored in the 1-2 mark range and two (2) scored zero.

MODULE 2

DIGITAL ELECTRONICS & DATA COMMUNICATIONS (Questions 6-10)

Basic analogue and electronics and communications concepts were covered in this module. With a mean score of 9.45 from a possible 30 marks it is evident that the module was generally not understood by most candidates. The highest score was 15 and the lowest score was one mark. Two (2) candidates scored in the 15 – 19 range, five (5) scored in the 10 – 14 range, six (6) scored in the 5 – 9 range and one (1) candidate scored one mark.

COMMENTS ON THE QUESTIONS

Question 6

Candidates were asked to explain 'fixed commutation' and 'latching current'. They were asked to differentiate between the enhancement and depletion modes of the MOSFET. No candidate scored marks for this question.

Question 7

Candidates were asked to use a truth table to prove two quantities different. Candidates did not respond well to this question. Three (3) candidates provided perfect responses (scored in the 5-6 range) whereas one (1) scored in the 3-4 mark range, seven (7) scored in the 1-2 mark range and three (3) either scored zero or did not attempt the question.

Question 8

Candidates were required to state the function of a clock circuit in a logic system and to explain what is meant by asynchronous circuit. This question proved difficult for most candidates. Seven (7) scored in the 1-2 mark range and seven (7) either scored zero or did not attempt the question.

Question 9

This question required candidates to explain the function of A/D and D/A convertors and to define D/A resolution. This question was understood by most candidates. Two (2) candidates provided perfect responses (scored in the 5-6 range), eight (8) scored 4 marks each, one (1) scored 2 marks and two (2) did not respond to the question.

Question 10

Candidates were required to state the characteristics of an ideal switch and to draw symbols and state Boolean expression for several gates. Most candidates understood this question. Two (2) candidates provided perfect responses (scored in the 5-6 range), eight (8) scored in the 3-4 mark range and four (4) scored in the 1-2 mark range.

MODULE 3

INTRODUCTION TO AC MACHINES (Questions 11-15)

This constitutes the best module for candidates. An average sore of 10.36 from a possible 30 mark was achieved. The highest score was 20 and the lowest score was 6 marks. One (1) candidate scored 20, eight (8) scored in the 10-14 range and five (5) scored in the 5-9 range.

COMMENTS ON THE QUESTIONS

Question 11

This question tested candidates' knowledge of transformers. Most candidates performed well on this question. Three (3) provided perfect responses (scored in the 5-6 marks range), ten (10) scored in the 3-4 range and one (1) scored zero.

Question 12

This question tested the candidates' understanding of voltage regulation. It is evident that the candidates lacked knowledge and understanding of this concept. Only one (1) candidate scored a perfect six points, six (6) scored in the 1-2 range, whereas seven (7) either scored zero or did not attempt to answer this question.

Question 13

This question tested the candidates' understanding of synchronous impedance in an ASC dynamo. Candidates were not conversant with this concept. Five (5) scored in the 3-4 mark range, three (3) scored in the 1-2 mark range and six (6) either scored zero or did not attempt the question.

Question 14

Candidates were asked to explain the construction of a rotor for an induction motor and to identify two uses of the induction motor. Interestingly, candidates did not perform well on this question. One (1) candidate scored 5, four (4) scored in the 3-4 mark range, six (6) scored in the 1-+2 mark range and three (3) scored zero.

Question 15

Candidates were required to define the terms 'rotor speed' and 'slip' and to draw a typical torque-slip characteristic curve for the induction motor. Candidates did not perform well on this question. Most did not know how to calculate slip and experienced difficulties defining rotor speed. Most were not able to draw the torque-slip characteristic curve. Seven (7) scored in the 3-4 range, six (6) scored in the 1-2 range and one (1) scored zero.

UNIT 2

PAPER 02

Candidates were required to do six questions from this paper which accounted for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates are required to select one of the remaining two questions in each module for a value of 20 marks each. All 14 candidates attempted the required two questions from each module.

The marks obtained by candidates ranged from nineteen (19) to sixty-seven (67) with a mean score of 44.21. Six (6) candidates scored in the 50-69 range, six (6) scored in the 30-49 range, and the remaining two (2) candidates scored in the 15-29 range.

MODULE 1

AC CIRCUIT THEORY (Questions 1-3)

Candidates were required to do Question 1 and one other from this section. From a possible score of 50 for this module, the highest score was 35 and the lowest was four (4) marks with an average score of 23.38. Two (2) candidates scored in the 30 – 39 range, seven (7) candidates scored in the 20-29 range, and four (4) candidates scored in the 10 – 19 range .

COMMENTS ON QUESTIONS

<u>Question 1</u>

This question tested the candidate's knowledge of AC waveform, specifically the definition of period, amplitude and rms valve. They were required to sketch the waveform and identify various areas of the plot. Candidates were also required to draw an equivalent circuit for a coil, and its phasor diagram, then calculate various circuit parameters. Most have general understanding about the waveform but were unable to draw the phasor diagram and could not calculate the capacitance needed to make the phase angle zero. One candidate scored the maximum score of 30 marks. Five (5) candidates in the 20-29 marks range, seven (7) candidates scored in the 10-19 marks range, whereas one candidate scored 4 marks.

<u>Question 2</u>

This question tested candidates' knowledge of rectangular and polar notations. Given a LRC circuit, candidates were required to determine branch currents and phase angle between supply current and voltage. They were also required to draw a phasor diagram for LRC circuit assuming pure reactances. Eight (8) candidates attempted the question and one scored a maximum of 14 marks from a possible 20 marks. Four candidates scored in the 10-15 marks range, three (3) scored between 2 and 8 marks and one scored zero. It is apparent that candidates were unaware of rectangular and polar notations and how to draw phasor representation.

<u>Question 3</u>

This question tested the candidates' knowledge of filters, particularly the band pass filter. Six (6) candidates attempted this question. The maximum score was seven (7) marks from a possible 20 marks. It is evident that this question was challenging for all candidates that attempted it since all scored below 10 marks. Most candidates were unable to calculate resonant frequency and bandwidth.

MODULE 2

DIGITAL ELECTRONICS AND DATA COMMUNICATIONS (Questions 4-6)

Candidates were required to do Question four and one other from this section. From a possible score of 50 for this module, the highest score was 24 and the lowest was three (3) Three (3) candidates scored in the 20 – 29 range, five (5) scored in the 10-19 range, and six (6) scored in the 1 – 9 range.

COMMENTS ON QUESTIONS

<u>Question 4</u>

The candidates were required to explain the operation of a thyristor and explain the function of a multivibrator. The marks for this question ranged from 0-11 with a mean of 3.5 marks from a possible 30 marks. Three (3) candidates scored in the 10-19 range, five (5) scored in the 1-9 range and six (6) either scored zero or did not respond to the question. The results revealed that all candidates lacked understanding in these areas.

<u>Question 5</u>

This question tested the candidates' knowledge of memory systems and the operation of shift registers. Only two (2) candidates attempted this question and scored 6 and 8 marks respectively from a possible 20 marks. It is evident that this question was quite unpopular and that the candidates that attempted it were not familiar with the topic.

Question 6

This question tested the knowledge of counters and logic gates. Twelve (12) candidates attempted this question it. The highest score obtained was sixteen (16) marks from a possible 20 marks. One candidate scored 16, whereas, six (6) candidates scored in the 10-15 range and five (5) scored in the 1-9 range. This topic was widely known by most candidates. However none was able to describe the operation of counters and develop a truth table for a binary counter with three inputs.

MODULE 3

INTRODUCTION TO AC MACHINES (Questions 7-9)

Candidates were required to do question seven and one other from this section. From a possible score of 50 marks for this module, the scores ranged from 1 to 14 with an average of 8.36. Six (6) candidates scored in the 10-19 range, whereas the remaining eight (8) scored in the 1-9 range.

COMMENTS ON QUESTIONS

Question 7

This question focused on the synchronous motor. Candidates were required to label the parts of a pole of a synchronous dynamo, outline the purpose of the damper winding, outline the effects of excitation on armature reaction, determine shift in electrical degrees given the number of poles and mechanical shifts and to determine speed of a synchronous motor when given the number of poles and the frequency of the supply voltage. From a possible 30 marks, the scores ranged from 0-7 marks with six (6) candidates either scoring zero or not attempting the question. It is evident that the candidates lacked understanding of the synchronous motor and were unable to calculate speed.

Question 8

This question tested candidates' knowledge of single phase induction motors and required them to sketch load speed characteristics and to list uses of this motor. Given starting and running windings currents, candidates were required to calculate the locked rotor current and power factor. No candidate attempted this question which is an indication that they did not cover this topic.

Question 9

This question focused on the equivalent circuit for a practical transformer connected to a load. Candidates were required to calculate currents, internal impedances, voltage drops and induced voltages. All candidates attempted this question but the maximum score was only 10 marks from a possible 20 marks. Two (2) candidates scored 10 marks whereas eight (8) candidates scored in the 5-9 range, three (3) scored between 1 and 4 marks and one (1) scored zero. In general, this question was quite challenging for the candidates. While some could draw the equivalent circuit fro the transformer, most could not perform the calculation required to find currents, impedances and voltages.

SCHOOL BASED ASSESSMENT

All SBA from Trinidad were evaluated and reported on during the first marking session, however, a number of late submissions for the rest of the region (ROR) were evaluated during this session. The comments made on the first submission holds true for those evaluated in this session.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2009

ELECTRICAL AND ELECTRONIC TECHNOLOGY

ELECTRICAL AND ELECTRONIC TECHNOLOGY

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2009

GENERAL COMMENTS

One hundred and seventeen candidates registered for Unit 1 and ninety-two candidates registered for the Unit 2 examination.

As in previous years, the performance was somewhat poor. There is need for investigation to determine the causes for poor performance in this subject area.

DETAILED COMMENTS

UNIT 1

Paper 01

Short Answers

Candidates were required to do all questions from this paper accounting for 90 marks. One hundred and seven candidates completed this paper. The range of the marks scored by candidates was 14 to 69. Three candidates (12.8 per cent) scored in the 60 – 69 range, three (2.8 per cent) scored in the 50 – 59 range, fourteen (13.08 per cent) scored in the 40 – 49 range, twenty-four (22.43 per cent) scored in the 30 – 39 range, thirty-five (32.71 per cent) scored in the 20 – 29 range. The remaining twenty-seven (25.23 per cent) candidates scored below 20 marks.

Module 1

DC Circuit Theory (Questions 1 – 5)

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. From a possible 30 marks, the highest score was 29 and the lowest score was two. Approximately fifty-four (50 per cent) candidates scored 50 per cent or above in Module I. Twenty-three candidates (21.5 per cent) scored in the 20 – 30 range, thirty (28.04 per cent) scored in the 15 – 19 range, thirty-six (33.64 per cent) scored in the 10 – 14 range and the remaining eighteen candidates (16.82 per cent) scored below 10 points.

<u>Question 1</u>

Twenty-two candidates (20.56 per cent) were able to provide perfect responses (5 - 6 marks), whereas thirty-seven candidates (35.58 per cent) scored in the 3 – 4 range, and the remaining forty-eight (44.86 per cent) scored between zero and two marks, of which fourteen scored zero from a possible six marks. Many candidates experienced difficulties explaining the term ‘temperature coefficient’ and giving its symbol.

Question 2

Twenty-five candidates (23.36 per cent) provided a perfect response (5-6 marks), whereas 15 (14.02 per cent) scored in the 3 – 4 range. The remaining sixty-eight (63.55 per cent) scored between zero and two marks, from which 15 scored zero from a possible six marks. Most candidates did not know how to calculate the voltage across a capacitor after a given time.

Question 3

This was a relatively good question for candidates. Nineteen candidates (17.76 per cent) provided perfect responses (5 – 6 marks), whereas fifty (46.73 per cent) scored in the 3 – 4 range. The remaining thirty-eight (35.51 per cent) scored between zero and two marks, of which six scored zero from a possible six marks. Most candidates knew how to answer this problem but experienced difficulties with mathematics.

Question 4

This was a relatively good question for candidates. Thirty-four candidates (32.38 per cent) were able to provide perfect responses (5 – 6 marks), forty-four candidates (41.90 per cent) scored in the 3 – 4 range, whereas the remaining twenty-seven (25.71 per cent) scored between 0 and 2 marks, of which eight scored zero from a possible six marks. Many candidates were unable to determine the energy stored in the capacitor.

Question 5

Twenty-one candidates (19.63 per cent) provided perfect responses (5 – 6 marks), whereas forty (37.38 per cent) scored in the 3 – 4 range. The remaining forty-six (42.99 per cent) scored between zero and two marks, of which eighteen scored zero from a possible six marks. Several candidates were not able to calculate mutual inductance.

Module 2

Analogue Electronics and Communications (Questions 6 – 10)

Basic analogue and electronics and communications concepts were covered in this module**.** This module proved to be somewhat challenging as most candidates either did not respond to the questions or scored zero. The highest score was 22 and nine candidates (8.41 per cent) scored zero from a possible 30 points. One candidate (0.93 per cent) scored in the 20 – 30 range, five scored (4.68 per cent) in the 15 – 19 range, eight (7.48 per cent) scored in the 10 – 14 range and the remaining ninety-three (86.92 per cent) scored below 10 points.

Question 6

Twenty-one candidates provided perfect responses (5 – 6 marks), whereas thirty-three candidates (30.84 per cent) scored in the 3 – 4 range. The remaining fifty-three (49.53 per cent) scored between zero and two marks from a possible six marks with eighteen (16.82 per cent) scoring zero. Some candidates were unable to differentiate between function and application of LEDs, also, many candidates were unable to calculate the volt drop across the limiting resistor when given the voltage across the LED.

Question 7

This question proved difficult for most candidates. Two (1.87 per cent) scored in the 3 – 4 range and seven (6.54 per cent) scored in the 1 – 2 range. The remaining ninety-nine (92.52 per cent) either scored zero or did not respond to the question. The term ‘static characteristics’ was unknown to the candidates. Perhaps input or output characteristics would be better understood by the candidates.

Question 8

This question proved difficult for most candidates. Three (2.80 per cent) provided perfect responses (5 – 6 marks), whereas twenty (18.69 per cent) scored in the 3 – 4 range and seven (6.54 per cent) scored in the 1 – 2 range. The remaining seventy-seven (71.96 per cent) either scored zero or did not respond to the question. Most candidates seemed to be unfamiliar with the terms ‘amplitude’ and ‘frequency modulation’, neither did they know that ‘depth of modulation’ is expressed as a percentage.

Question 9

This question proved difficult for most candidates. Three candidates (2.8 per cent) provided perfect responses (5 – 6 marks), whereas fourteen candidates (13.08 per cent) scored in the 3 – 4 range and forty-eight (44.86 per cent) scored in the 1 – 2 range. The remaining forty-two (39.25 per cent) scored zero or did not respond to the question. Most of the candidates who attempted this question were able to explain what is a “ground wave” and to identify factors on which the range of the wave depends, however, they were unable to write the frequency band for the various carrier waves.

Question 10

This question also proved extremely difficult for most candidates. One candidate (0.93 per cent) provided a perfect response (5 – 6 marks), nine (8.41 per cent) scored in the 3 – 4 range and twenty (18.69 per cent) scored in the 1 – 2 range. The remaining seventy-seven (71.96 per cent) either scored zero or did not respond to the question. A few candidates were able to state what an “oscillator” is. They were unable to identify factors that caused a change in operating frequency of oscillators.

Module 3

Introduction to Electrical Power Systems (Questions 11 – 15)

This was the most challenging of the three modules. The highest score was 21 and four candidates scored zero from a possible 30 points. Of the one hundred and seven candidates, one (0.93 per cent) scored in the 20 – 30 range, nine (8.41 per cent) scored in the 15 – 19 range, twenty-eight (26.17 per cent) scored in the 10 – 14 range, fifty-two (48.60 per cent) scored in the 5 – 9 range, thirteen (12.15 per cent) scored in the 1 – 4 range and the remaining four (3.74 per cent) scored zero. These statistics suggest that the candidates were ill prepared for this module.

Question 11

Only one candidate (0.93 per cent) provided a perfect response (5 – 6 marks), whereas thirty-two candidates (29.91 per cent) scored in the 3 – 4 range and fifty-two candidates (48.60 per cent) scored in the 1 – 2 range. Many candidates could not explain the term ‘relative permeability’ but were able to state differences between a permanent magnet and an electromagnet.

Question 12

This question proved relatively difficult for most candidates. None provided perfect responses, three (2.80 per cent) scored in the 3 – 4 range, seventy-three (68.22 per cent) scored in the 1 – 2 range and the remaining thirty-one (28.97 per cent) either scored zero or did not respond to the question. Most candidates were able to state a difference between a ‘d.c. generator’ and a ‘d.c. motor’ but were not familiar with the use of the commutator and the losses associated with it.

Question 13

This question was quite challenging for many candidates. Only one provided a perfect response (5 – 6 marks), whereas twenty-two (20.56 per cent) scored in the 3 – 4 range and thirty-six (33.64 per cent) scored in the 1 – 2 range. The remaining forty-eight (44.86 per cent) either scored zero or did not respond to the question. Many candidates were unable to draw a circuit to demonstrate Lenz’s Law but were able to calculate the flux density with the parameters given.

Question 14

Fifteen candidates (14.02 per cent) provided perfect responses (5 – 6 marks), whereas seventeen (15.89 per cent) scored in the 3 – 4 range and forty-one (38.32 per cent) scored in the 1 – 2 range and the remaining thirty-four (31.78 per cent) either scored zero or did not respond to the question. Most candidates mis-interpreted Part (a) of the question but were able to explain the term ‘half duplex communication’.

Question 15

Seven candidates (6.54 per cent) provided perfect responses (5 – 6 marks), whereas forty-five candidates (42.06 per cent) scored in the 3 – 4 range and forty-one (38.32 per cent) scored in the 1 - 2 range. The remaining fourteen (13.08 per cent) candidates either scored zero or did not respond to the question. The concept of overload and fault current were well known; however, candidates were unable to explain the operation of the thermally actuated circuit breaker.

UNIT 1

Paper 02

Long Answers

One hundred and seven candidates wrote this paper. They were required to do six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates were required to select one of the remaining two questions in each module for a value of 20 marks each. Most candidates attempted the required two questions from each module.

The range of marks obtained was from a low of five and one hundred and nine. Only four candidates (3.74 per cent) scored 100 or above. Three candidates (2.80 per cent) scored in the 80 – 99 range, fourteen (13.08 per cent) scored in the 60 – 79 range, thirty-seven (34.58 per cent) scored in the 40 – 50 range, thirty-seven (34.58 per cent) scored in the 20 – 39 range, twelve (11.21 per cent) scored in the 1 – 19 range.

Module 1

DC Circuit Theory (Questions 1 – 3)

Candidates were required to do Question 1 and one other from this section. From a possible score of 50 from this module, the highest score was 45. Four (3.75 per cent) candidates scored in the 40 – 50 range, eighteen (16.82 per cent) candidates scored in the 30 - 39 range, thirty-two candidates (29.91 per cent) scored in the 20 – 29 range, forty-one (38.32 per cent) scored in the 10 – 19 range and twelve (11.21 per cent) scored in the 1– 9 range. These scores represents the best obtained by the candidates per module.

Question 1

Twenty-two candidates (20.56 per cent) were able to provide good responses in the (20 – 30 range), thirty (28.04 per cent) scored in the 15 – 19 range, twenty-five (23.36 per cent) scored in the 10 – 14 range and eleven (10.28 per cent) scored in the 1 – 9 range. Generally, candidates understood capacitors and were capable of calculating parameters associated with capacitive circuits.

Question 2

This question was attempted by forty-four candidates (42.90 per cent) but proved quite challenging for them. Twenty-eight candidates scored in the 5 – 9 range, whereas sixteen scored in the 1 – 4 range. The concept of inductance was not widely known by the candidates.

Question 3

Sixty-one candidates (57.33 per cent) chose this question. Of this number fourteen scored in the 15 – 19 range. Eleven candidates scored in the 10 – 14 range, seventeen scored in the 5 – 9 range, and nineteen scored in the 1 – 4 range of marks. In general, this question was not well done by candidates. However, they seemed to understand Kirchoff's first and second laws.

Module 2

Analogue Electronics and Communications (Questions 4 – 6)

Candidates were required to do Question 4 and one other from this section. From a possible score of 50 from this module, the highest score was twenty-eight. Seven candidates (6.54 per cent) scored in the 20 – 30 range, twelve candidates (11.21 per cent) scored in the 15 – 20 range, twelve (11.21 per cent) scored in the 10 – 14 range, thirty-five (32.71 per cent) scored in the 5 – 9 range, thirty-seven (34.58 per cent) scored in the 1 – 4 range and four candidates scored zero.

Question 4

All candidates were required to answer this question. The highest score was twenty from a possible 30 marks. Only one candidate (0.93 per cent) was able to score in the 20 – 30 range and five (4.67 per cent) scored in the 15 – 19 range. Twelve (11.21 per cent) candidates scored in the 10 – 14 range, twenty-nine (27.10 per cent) scored in the 5 – 9 range, fifty-four (50.47 per cent) scored between 1 and 4 marks, while six (5.61 per cent) either did not attempt the question or scored zero. Candidates experienced difficulties in calculating the voltage and currents requested.

Question 5

Seventy-three (68.22 per cent) candidates chose this question and scored a high of 11 marks from a possible 20 marks. Three candidates (2.80 per cent) scored in the 10 – 14 range, eighteen (16.82 per cent) scored in the 5 – 9 range, while twenty-four (22.43 per cent) either did not attempt the question or scored zero. Most candidates were unfamiliar with the op-amp.

Question 6

Thirty-four candidates attempted this question and scored a high of 10 from a possible 20 marks One candidate scored in the 10 – 15 range, whereas 8 scored in the 1 – 9 range, eleven (10.28 per cent) scored in the 1 – 4 range, while fifteen (14.02 per cent) scored zero. Most candidates were unfamiliar with amplitude modulation and side bands.

Module 3

Introduction to Electrical Power Systems (Questions 7 – 9)

Candidates were required to do question seven and one other from this section. From a possible score of 50 from this module, the highest score was thirty-eight. Ten (9.35 per cent) candidates scored in the 30 – 39 range, seventeen candidates (15.89 per cent) scored in the 20 – 29 range, fifty-four (50.47 per cent) scored in the 10 – 19 range, twenty-three (21.50 per cent) scored in the 1 – 9 range and two (1.87 per cent) scored zero.

Question 7

All candidates were required to answer this question. The highest score was 24 from a possible 30 marks. Five candidates ((4.67 per cent) were able to score in the 20 – 30 range and five (4.67 per cent) in the 15 – 19 range. Seventeen candidates (15.89 per cent) scored in the 10 –14 range, thirty-three (30.84 per cent) scored in the 5 – 9 range, thirty-nine (36.45 per cent) scored between 1 and 4 marks, while seven (6.54 per cent) either did not attempt the question or scored zero. Most candidates were able to answer at least one segment of this question.

Question 8

Sixty-one candidates (57.00 per cent) attempted this question and scored a high of 15 from a possible 20 marks. Two candidates (4.17 per cent) scored in the 15 – 19 range, 5 (10.42 per cent) scored in the 10 – 14 range and thirty-six (81.25 per cent) scored in the 0 – 9 range. Most candidates demonstrated a fair understanding of the SCADA system.

Question 9

Forty-six candidates (43.00 per cent) attempted this question and scored a high of 15 from a possible 20 marks. Two candidates scored in the 15 – 19 range, five candidates scored in the 10 – 14 range whereas twenty-three scored in the 5 – 9 range, fourteen scored between 1 and 4 marks, and two scored zero. Most candidates were unable to state common types of overload relay.

UNIT 2

Paper 1

Short Answers

Candidates were required to do all questions from this paper which accounts for 90 marks. The range of the marks scored by candidates was from a low of 7 to a high of 64. Of the 88 candidates who wrote the paper, eight (9.10 per cent) scored in the 50 – 70 range, eight (9.10 per cent) scored in the 40 – 49 range, nineteen candidates (21.59 per cent) scored in the 30 – 39 range, twenty-three candidates scored in the 20 – 29 range, twenty-three (26.14 per cent) scored in the 10 – 19 range and seven (7.95 per cent) scored below 10 points.

Module 1

AC Circuit Theory (Questions 1 – 5)

Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. From a possible 30 marks, the highest score was 26 and the lowest score was 4 marks. Twenty-five candidates (28.41 per cent) scored in the 20 – 30 range, fourteen (15.51 per cent) scored in the 15 – 19 range, twenty-six (29.55 per cent) scored in the 10 – 14 range and twenty-three (26.14 per cent) scored in the 10 – 14 range and twenty-three (26.14 per cent) candidates scored below 10 marks.

Question 1

This question was generally understood by most candidates. Twenty-six (29.55 per cent) provided excellent responses to this question (5 scored in the 5 – 6 range from a possible 6 marks). Twenty-nine (32.95 per cent) scored in the 3 – 4 range, twenty-nine (32.95 per cent) scored in the 1 – 2 range and four (4.55 per cent) either scored zero or did not respond to the question.

Question 2

This question was generally understood by most candidates. Twenty-six (29.55 per cent) provided excellent responses and scored in the 5 – 6 range. Twenty-five (28.41 per cent) scored in the 3 – 4 range, thirty-one (35.23 per cent) scored in the 1 – 2 range and six scored zero or did not respond to the question. Most candidates were able to draw the phasor diagram for the circuit and were able to calculate the currents.

Question 3

This question posed difficulties for more than fifty per cent of the candidates. Only three candidates (3.41 per cent) provided perfect responses for this question, that is, either 5 or 6 (scored in the 5 – 6 range from a possible 6 marks. Nineteen (21.59 per cent) scored in the 3 – 4 range, fifty (56.81 per cent) scored in the 1 – 2 range and sixteen (18.18 per cent) either scored zero or did not respond to the question. Most candidates were unable to sketch and label the high pass frequency response and describe the function of this filter.

Question 4

Most candidates were comfortable with this question. Fifteen (17.05 per cent) scored from a possible 6 marks, twenty-four (27.27 per cent) scored in the 3 – 4 range, 28 (31.81 per cent) scored in the 1 – 2 range and twenty-one (23.86 per cent) either scored zero or did not respond to the question. Most candidates were able to define reactive and active power but experienced difficulties in calculating the r.m.s. voltage.

Question 5

This question can be considered the favourite for most candidates. Twenty-nine (32.95 per cent) scored in the 5 – 6 range from a possible 6 marks, thirty-six (40.91 per cent) scored in the 3 – 4 range, twelve (13.64 per cent) scored in the 1 – 2 range and eleven (12.50 per cent) scored zero or did not respond to the question. Most candidates were able to calculate reactance and impedance. Few candidates experienced difficulties sketching the phasor diagram.

Module 2

Digital Electronics and Data Communications (Questions 6 – 10)

Basic analogue and electronics and communications concepts were covered in this module which was understood by most candidates. From a possible 30 marks, the highest score was 23 and the lowest score was zero. One candidate (1.14 per cent) scored in the 20 – 30 range, three (3.42 per cent) scored in the 15 – 19 range, twenty-one (23.85 per cent) scored in the 10 – 14 range, sixty-one (70.45 per cent) scored in the 1 – 10 range and one scored zero.

Question 6

This question posed difficulties for most candidates. Only one candidate (1.14 per cent) provided a perfect responses for this question, nine (10.23 per cent) scored in the 3 – 4 range, twenty-eight (31.82 per cent) scored in the 1 – 2 range and fifty (56.82 per cent) scored zero. One-third of the candidates had very little knowledge about MOSFETs.

Question 7

One candidate (1.14 per cent) provided a good response for this question whereas forty-seven (53.41 per cent) scored in the 3 – 4 range, twenty-one (23.86 per cent) scored in the 1 – 2 range and nineteen (21.59 per cent) either scored zero or did not attempt the question. Most candidates were able to complete the truth table for the logic circuit but did not understand the terms “fan-in” and “fan-out”.

Question 8

This question proved to be quite challenging for most candidates. Twelve candidates (13.64 per cent) scored in the 3 – 4 range from a possible 6 marks, whereas thirty-six (40.91 per cent) scored in the 1 – 2 range and forty (45.45 per cent) scored zero. Many candidates knew what were ‘multivibrators’ but knew little about Flip Flops.

Question 9

This was a relatively good question for most candidates. Twelve candidates (13.64 per cent) provided good responses (scored in the 5 – 6 range from a possible 6 marks), thirty-nine (44.32 per cent) scored in the 3 – 4 range, twenty-seven (30.68 per cent) scored in the 1 – 2 range and ten (11.36 per cent) scored zero. Most candidates could state the function of a multiplexer and a de-multiplexer and could describe the difference between EPROM and PROM.

Question 10

This question proved quite challenging for all candidates. One candidate (1.15 per cent) scored in the 3 – 4 range and ten (11.36 per cent) scored in the 1 – 2 range. A total of seventy-seven (87.50 per cent) candidates either scored zero or did not attempt the question. None of the candidates was able to describe the function of the UART in computer systems.

Module 3

Introduction to AC Machines (Questions 11 – 15)

This module posed significant challenges to candidates. From a possible 30 marks, the highest score was 24 and many candidates scored zero. Two (2.28 per cent) scored in the 20 – 30 range, seven (7.95 per cent) scored in the 15 – 19 range, nine (10.23 per cent) scored in the 10 – 14 range, thirty (34.09 per cent) scored in the 5 – 9 range, thirty-one candidates (35.23 per cent) scored in the 1 – 4 range and nine candidates (10.23 per cent) either scored zero or did not attempt the module.

Question 11

This question proved quite challenging for most candidates. One candidate (1.14 per cent) provided a good response (scored in the 5 – 6 range from a possible 6 marks), eight (9.09 per cent) scored in the 3 – 4 range, thirty-six (40.91 per cent) scored in the 1 – 2 range, whereas forty-three (48.86 per cent) either scored zero or did not attempt the question. Most candidates were able to explain the purpose of the field and armature windings of a generator and explain ‘voltage regulation’. Only a few candidates knew what was a synchronous generator.

Question 12

Surprisingly, candidates faced challenges with this question which tested knowledge of the single phase transformer. Only two candidates (2.28 per cent) scored in the 5 – 6 points range and twelve (13.64 per cent) scored in the 3 - 4 range. Thirty-four candidates (36.64 per cent) scored in the 1 – 2 range and forty (45.45 per cent) either scored zero or did not attempt this question.

Question 13

Response to this question was similar to that of Question 12. However, many candidates were able to explain the operation of an induction motor and define the term SLIP. Three (3.42 per cent) scored in the 5 – 6 range, seventeen (19.32 per cent) scored in the 3 – 4 range, twenty-eight (31.82 per cent) scored in the 1 – 2 range, whereas the remaining forty (45.45 per cent) either scored zero or did not attempt the question.

Question 14

The response profile for this question was similar to the previous two questions. Candidates were required to calculate parameters for a single-phase transformer when given the secondary winding information. Eight (9.09 per cent) scored in the 5 – 6 range, eighteen (20.45 per cent) scored in the 3 – 4 range, twenty-five (28.41 per cent) scored in the 1 – 2 range, whereas the remaining thirty-seven (42.05 per cent) either scored zero or did not attempt the question.

Question 15

The response profile for this question was similar to the previous three questions. Many candidates were able to describe the construction of a squirrel-cage, induction motor, and state why induction motors are the preferred choice for industrial motors; however, most candidates were unable to state disadvantages of speed control of WRIMs by means of external resistors. Five (5.68 per cent) scored in the 5 – 6 range, twelve (13.64 per cent) scored in the 3 – 4 range, twenty-two (25.00 per cent) scored in the 1 – 2 range, whereas the remaining forty-nine (55.58 per cent) either scored zero or did not attempt the question.

UNIT 2

Paper 02

Long Answers

Eighty-eight candidates wrote this paper. They were required to do six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 are compulsory and value 30 marks each. Candidates were required to select one of the remaining two questions in each module for a value of 20 marks. Most candidates attempted the required two questions for each module.

The range of marks obtained was from a low of three to a high of one hundred and eight. Only two candidates (2.27 per cent) scored 100 or more marks. Three candidates (3.41 per cent) scored in the 80 – 99 range, seven (7.95 per cent) scored in the 60 – 79 range, twenty-one (23.86 per cent) scored in the 40 – 59 range, thirty-nine (44.32 per cent) scored in the 20 – 39 range, sixteen (18.82 per cent) scored in the 1 – 19 range. These results are encouraging when compared to previous years. It is evident that the marks scored by candidates have improved.

Module1

AC Circuit Theory (Questions 1 – 3)

Candidates were required to do Question 1 and one other from this section. From a possible score of 50 from this module, the highest score was 46 and one candidate (1.14 per cent) scored zero. Three candidates (3.41 per cent) scored in the 40 – 50 range, ten (11.36 per cent) scored in the 30 – 39 range, twelve (13.66 per cent) candidates scored in the 20 – 29 range, thirty-four (38.66 per cent) scored in the 10 – 19 range and twenty-eight (31.82 per cent) scored in the 1 – 9 range.

Question 1

This question tested candidates' knowledge of filters. Most candidates had a general understanding about filters but many were unable to compute bandwidth and determine capacitance and inductance for filters. The maximum score obtained was 28 from a possible 30 marks. Four candidates (4.55 per cent) scored in the 20 – 30 range, eight (9.10 per cent) scored in the 15 - 19 range, five (5.68 per cent) scored in the 10 – 14 range, twenty-six (29.55 per cent) scored in the 5 – 9 range, thirty-four (38.66 per cent) scored in the 1 – 4 range and the remaining eleven candidates (12.50 per cent) either scored zero or did not respond to the question.

Question 2

This question tested the candidates' knowledge of the sinusoidal wave form as well as apparent and reactive power. Eighty-one (92.05 per cent) candidates attempted the question and three (3.70 per cent) scored 20 marks, the maximum for this question. Two candidates scored zero. Twenty (24.69 per cent) candidates scored in the 15 – 20 range, 21 (25.93 per cent) scored in the 10 – 14 range, twenty-seven (33.3 per cent) scored in the 5 – 9 range, eleven (13.58 per cent) scored in the 1 – 4 range and as previously mentioned two candidates either scored zero or did not respond to the question.

Question 3

This question tested the candidates' knowledge of resonance and how to determine circuit parameters for RLC circuits. Only seven candidates (7.95 per cent) attempted and scored a maximum of 13 marks from a possible 20 marks. Three candidates scored in the 10 – 14 range, whereas the remaining four candidates scored in the 1 – 4 range. It is evident that this question was challenging for most of those that attempted it.

Module 2

Digital Electronics and Data Communications (Questions 4 – 6)

Candidates were required to do Question 4 and one other from this section. From a possible score of 50 marks from this module, the marks obtained by candidates ranged from zero to thirty-one. Three candidates (30.41 per cent) scored in the 30 – 39 range, thirteen (14.77 per cent) scored in the 20 – 29 range, twenty-nine (32.95 per cent) scored in the 10 – 19 range, thirty-two (36.36 per cent) scored in the 1 – 9 range and four (4.55 per cent) candidates scored zero.

Question 4

This question tested candidates' knowledge of thyristor and bipolar transistors. The marks for this question ranged from zero to twenty from a possible 30 marks. Five candidates (5.68 per cent) scored in the 15 – 19 range, seven (7.95 per cent) scored in the 10 – 14 range, thirty (34.09 per cent) scored in the 5 – 9 range, twenty-seven (30.68 per cent) scored in the 1 – 4 range and the remaining nineteen candidates (21.59 per cent) either scored zero or did not respond to the question.

Question 5

This question tested the candidates' knowledge about the Shannon Hartley Theorem and 'noise' in communication systems. Seventy-six candidates (86.36 per cent) attempted the question and scored marks ranging from zero to seventeen. Only one candidate scored in the 15 – 20 range, twenty (22.73 per cent scored in the 10 – 14 range, thirty-four (38.64 per cent) scored in the 5 – 9 range, eleven (12.5 per cent) scored in the 1 – 4 range and nine (10.23 per cent) candidates either scored zero or did not respond to the question. Candidates experienced difficulties with the concept of noise, but were able to state how data flow is simplex and duplex modes.

Question 6

This question tested the candidates' knowledge about digital to analogue converters. Twelve candidates attempted this question and scored marks in the range zero to thirteen. Three (3.41 per cent) candidates scored in the 10 – 14 range, three (3.41 per cent) scored in the 5 – 9 range, four (4.55 per cent) scored in the 1 – 4 range and two candidates either scored zero or did not respond to the question. Most candidates revealed a lack of general understanding of D/A converters. In Part (b) a typo error was detected, T-Bit should have been 7-Bit.

Module 3

Introduction to AC Machines (Questions 7 – 9)

Candidates were required to do Question 7 and one other from this section. From a possible score of 50 marks from this module, the marks obtained by candidates ranged from zero to thirty-seven. Three candidates (3.41 per cent) scored in the 30 – 39 range, eight candidates (9.10 per cent) scored in the 20 – 29 range, fifteen (17.05 per cent) scored in the 10 – 19 range, fifty-two (59.09 per cent) scored in the 1 – 9 range and ten candidates (11.36 per cent) scored zero.

Question 7

This question focused on transformer losses, voltage regulation and reduction of leakage flux. The marks obtained by candidates for this question ranged between zero and twenty-six from a possible 30 marks. Three (3.41 per cent) scored 20 marks or above, nine (10.23 per cent) scored in the 15 – 19 range, three (3.41 per cent) scored in the 10 – 14 range, seventeen (19.32 per cent) scored in the 5 – 9 range, forty-six (52.27 per cent) scored in the 1 – 4 range and the remaining ten candidates (11.36 per cent) either scored zero or did not respond to the question. Candidates experienced difficulties with calculations (Part (b). It appeared that they did not know the formulae.

Question 8

This question required candidates to state differences between SCIM and WRIM; explain the term “SLIP” and calculate a SLIP and rotor frequency. Sixty-eight candidates (77.27 per cent) attempted the question and scored marks ranging from zero to fourteen. Six (6.82 per cent) candidates scored in the 10 – 14 range, twelve (13.63 per cent) scored in the 5 – 9 range, twenty-four (27.27 per cent) scored in the 1 – 4 range and twenty-six (29.55 per cent) candidates either scored zero or did not respond to the question. Most candidates did not know the term “SLIP”.

Question 9

This question tested candidates’ knowledge on synchronous motor. Candidates were asked to explain terms such as armature reaction, synchronous speed and per unit regulation. In general, this question was quite challenging for the candidates. Twenty candidates (22.73 per cent) attempted this question and scored marks ranging from zero to nine. Three candidates (3.41 per cent) scored in the 5 – 9 range, ten scored in the 1 – 4 range and seven candidates (7.95 per cent) either scored zero or did not respond to the question.

Internal Assessment (IA)

Fourteen Schools submitted forty-nine IAs for Unit 1 and forty-three for Unit 2 for moderation. The grades submitted from some of the schools appear inflated. In general, the candidates’ reports were properly written. In many instances, however, the candidates failed to discuss the findings of the experiment or outcome of the project.

Some schools failed to submit the appropriate report form with the samples. Likewise, some schools failed to submit project activity books.

It was apparent that candidates might have performed better on the Internal Assessment component if they had benefitted from closer supervision by their class teachers.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2010

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and sixty-two candidates registered for the Unit 1 examination and 87 candidates registered for the Unit 2 examination.

As in previous years, performance was somewhat poor.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

Candidates were required to do all questions from this paper which accounted for 90 marks.

The marks scored by candidates ranged from 2 to 54. Only 1 candidate scored in the 51–60 range. Approximately 2 per cent scored in the 41–50 range, 9 per cent scored in the 31–40 range and 22 per cent scored in the 21–30 range. The remaining 66 per cent scored 20 marks or below.

Module 1 – DC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. From a possible 30 marks, the highest score was 20 and the lowest score was 0. Only 13 per cent of the candidates scored 50 per cent of the possible scores or above in this module. Thirty per cent scored in the 11–15 range, 35 per cent scored in the 6–10 range and the remaining 22 per cent scored in the 1–5 range.

Comments on Questions

<u>Question 1</u>

In general, this question, which tested candidates' ability to manipulate series and parallel circuits and Ohm's law, was not understood by many candidates. Many candidates appeared to have difficulty with manipulating series and parallel circuits. Approximately 25 per cent of the candidates were able to provide perfect responses (5–6 marks), 26 per cent scored in the 3–4 mark range and the remaining 49 per cent scored between 0 and 2 marks. Some candidates did not respond to the question.

<u>Question 2</u>

This was a relatively good question for candidates. It focused on charge stored in the capacitor. Approximately 40 per cent of the candidates provided perfect responses (5–6 marks) whereas 34 per cent scored in the 3–4 mark range. The remaining 27 per cent scored between 0 and 2 marks. Most candidates were able to calculate charge.

Question 3

This question tested candidates' knowledge of inductors. Only eight per cent provided perfect responses (5–6 marks) whereas 30 per cent scored in the 3–4 mark range. The remaining 62 per cent scored between 0 and 2 marks. Many candidates experienced difficulty with this question since they were unaware of the basic inductor.

Question 4

Candidates were asked to state Norton's Theorem and use the theorem to determine currents in a simple circuit. This provided a significant challenge for candidates. Eighty-two per cent of the candidates either scored zero or did not respond to the question. The remaining 18 per cent were only able to score in the 1–3 range. Most candidates were unable to determine the currents in the circuit.

Question 5

Candidates were asked to define relative permittivity and relative permeability. This proved relatively challenging for candidates. It was evident that candidates were unaware of these characteristics of materials. Sixty per cent of candidates either scored zero or did not respond to the question. Thirty-three per cent of the candidates were only able to score in the 1–3 range and only 7 per cent scored 4 marks or more.

Module 2 – Analogue Electronics and Communications (Questions 6–10)

Basic analogue and electronics and communications concepts were covered in this module. The module proved to be somewhat challenging as most candidates either did not respond to the questions or scored zero. The highest score was 16, and approximately 11 per cent of the candidates scored zero from a possible 30 marks. Two per cent scored in the 16–20 range, 6 per cent scored in the 11–15 range, 21 per cent scored in the 6–10 range and the remaining 60 per cent scored in the 1–5 mark range.

Comments on Questions

Question 6

This question tested candidates' knowledge of the PN diode. It proved relatively challenging for candidates. It was evident that candidates were unfamiliar with the construction of PN Diode and were unable to explain what occurs when the diode is reversed biased. Fifty-one per cent of the candidates either scored zero or did not respond to the question. Only 5 per cent scored in the 3–4 mark range and the remaining 44 per cent scored in the 1–2 mark range (from a possible six marks).

Question 7

This question tested candidates' knowledge of the super-heterodyne receiver. It proved difficult for most candidates since they were unfamiliar with the reasons for using this receiver in communication. They were also unfamiliar with the AGC and the purpose it serves. Sixty-four per cent of the candidates either scored zero or did not respond to the question. Only 5 per cent scored in the 3–4 mark range. The remaining 31 per cent scored in the 1– 2 mark range (from a possible 6 marks).

Question 8

This question on Operational Amplifiers proved difficult for most candidates. Three per cent provided responses in the 5–6 mark range, 11 per cent provided responses in the 3–4 mark range and 30 per cent scored in the 1–2 range. The remaining 56 per cent either scored zero or did not respond to the question. Most candidates were unable to determine the voltage gain of an operational amplifier.

Question 9

Several candidates understood the concept of ground and sky wave. Five per cent of the candidates provided good responses (5–6 marks) whereas 22 per cent scored in the 3–4 mark range and 47 per cent scored in the 1–2 range. The remaining 56 per cent scored zero or did not respond to the question. Most of the candidates who attempted this question were able to define ground and sky waves and state factors that influence the range of the waves.

Question 10

This question focused on the basic transistor. However, it proved extremely difficult for most candidates. One per cent of the candidates provided good responses (5–6 marks). Four per cent scored in the 3–4 mark range and 9 per cent scored in the 1–2 range. The remaining 86 per cent either scored zero or did not respond to the question. It was evident that candidates were unfamiliar with the biasing of transistors.

Module 3 – Introduction to Power Systems (Questions 11–15)

This module basically introduced candidates to electrical power systems and continues to be the most challenging of the three. The highest score was 17, and 21 per cent of the candidates scored zero from a possible 30 marks. Of the 141 candidates, 3 per cent scored in the 16–20 range, 5 per cent scored in the 11–15 range, 20 per cent scored in the 6–10 range and 52 per cent scored in the 1–5 range. These statistics suggest that candidates were ill prepared for this module.

Comments on Questions

Question 11

Thirty-five per cent of the candidates scored zero when asked to state Lenz’s Law and explain what happens when a current carrying conductor is placed in a magnetic field. Only 3 per cent of the candidates were able to provide reasonable responses. Twenty-one per cent scored in the 3–4 mark range and 40 per cent scored in the 1–2 mark range.

Question 12

This question proved relatively difficult for most candidates. The majority of candidates were unfamiliar with the concept of armature reaction. Only one candidate provided a perfect response (worth 6 marks). Three per cent scored in the 3–4 mark range, 17 per cent scored in the 1–2 mark range and the remaining 79 per cent either scored zero or did not respond to the question.

Question 13

Most candidates were unfamiliar with the term telemetering and were unable to outline the procedures involved in this process. Eighty-nine per cent of the candidates were unable to respond to this question. The remaining 11 per cent were only able to provide partial responses.

Question 14

This question tested candidates’ knowledge of thermal overloads. Two per cent of the candidates provided good responses (5–6 marks) whereas 9 per cent scored in the 3–4 mark range. Twenty-eight per cent scored in the 1–2 mark range and the remaining 61 per cent either scored zero or did not respond to the question. This result suggests that most candidates lack understanding of thermal overloads.

Question 15

Candidates were asked to sketch the torque-load characteristics for the series, shunt and differential compound motors on one set of axes. Seven per cent provided good responses (5–6 marks), 14 per cent scored in the 3–4 mark range whereas 15 per cent scored in the 1–2 mark range. The remaining 64 per cent either scored zero or did not respond to the question. The performance of candidates suggests that they were unfamiliar with the torque-load characteristics curves of the various d.c. motor configurations.

Paper 02 – Essay Questions

One hundred and thirty eight candidates sat this paper. They were required to do six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and valued 30 marks each. Candidates were required to select one of the remaining two questions in each module worth 20 marks each. Most candidates attempted the two required questions from each module.

The marks obtained on this paper ranged from 1 to 84. Only 2 per cent of the candidates scored above 50 marks. Seven per cent scored in the 41–50 range, 13 per cent scored in the 31–40 range, 28 per cent scored in the 21–30 range, 36 per cent scored in the 11–20 range and the remaining 14 per cent scored in the 1–10 range.

Module 1 – DC Circuit Theory (Questions 1–3)

Candidates were required to answer Question 1 and one other question from this section. From a possible score of 50 marks, the highest score was 35. One candidate scored in the 31–40 range, whereas 8 per cent scored in the 21–30 range, 38 per cent scored in the 11–20 range, 51 per cent scored in the 1–10 range and 2 per cent scored 0. These scores represent the best obtained by the candidates per module.

Comments on Questions

Question 1

The maximum score obtained was 19 from a possible 30 marks. Ten per cent of the candidates scored in the 11–20 mark range, 33 per cent scored in the 6–10 mark range, 51 per cent scored in the 1–5 mark range and 6 per cent either scored zero or did not attempt the question. Generally, candidates did not demonstrate understanding of maximum power transfer and Norton's Theorem. Most candidates were unable to solve for variables in the parallel network.

Question 2

This question was the most popular and was selected by 80 per cent of the candidates, but proved quite challenging for them. From a possible 20 marks, approximately 13 per cent of the candidates scored in the 11–20 mark range, 42 per cent scored in the 6–10, 32 per cent candidates scored in the 1–5 mark range and 13 per cent scored 0 for this question. Candidates demonstrated a fair working knowledge of capacitors in series and parallel, and the terms permittivity and dielectric strength. Most candidates were unable to solve for capacitance, charge, electric field strength and flux density when given all variables for the capacitor.

Question 3

Few candidates chose this question which was worth 20 marks. Of those who selected the questions, 13 per cent scored in the 6–10 mark range and 87 per cent scored in the 0–5 range. It was evident that candidates were unfamiliar with inductive circuits and related calculations.

Module 2 – Analogue Electronics and Communications (Questions 4–6)

Candidates were required to answer Question 4 and one other from this section. From a possible score of 50 for this module, the highest score was 27. Two candidates scored in the 21–30 range, 12 per cent of the candidates scored in the 11–20 range, 29 per cent scored in the 6–10 range, 45 per cent scored in the 1–5 range, and 13 per cent scored zero.

Comments on Questions

Question 4

All candidates were required to answer this question which tested candidates' knowledge of power supplies. The highest score was 12 from a possible 30 marks. Two candidates (approximately 2 per cent) scored in the 11–20 mark range, 17 per cent scored in the 6–10 range, 59 per cent scored between 1 and 5 marks, while 22 per cent either did not attempt the question or scored zero. Several candidates experienced difficulties understanding the power supply and calculating the circuit variables.

Question 5

This was the more popular of the two optional questions in this module. Eighty per cent of the candidates chose this question and scored a high of 15 from a possible 20 marks. Two per cent of the candidates scored in the 11–20 mark range, 8 per cent scored in the 6–10 range, 56 per cent scored in the 1–5 range, and 34 per cent either scored zero or did not attempt the question. Candidates were unable to draw and label the block diagram of the FM receiver and discuss how noise is produced and removed from a receiver.

Question 6

Candidates were asked to explain the construction of a transistor and how it is biased as an amplifier. They were also asked to use the h – parameters to determine the variables of a transistor. This question was attempted by only twenty-seven candidates, from among whom a high of 17 (from a possible 20 marks) was scored. Four per cent of the candidates scored in the 11–20 range whereas 18 per cent scored in the 6–10 range, 41 per cent scored in the 1–5 range, and 37 per cent scored zero. Candidates lacked understanding of hybrid parameters.

Module 3 – Introduction to Electrical Power Systems: (Questions 7–9)

Candidates were required to respond to Question 7 and one other from this section. From a possible score of 50 for this module, the highest score was 37. Two per cent of the candidates scored in the 31–40 range, 19 per cent scored in the 21–30 range, 23 per cent scored in the 6–10 range, 49 per cent scored in the 1–5 range and 7 per cent scored zero.

Comments on Questions

Question 7

All candidates were required to answer this question. The highest score was 19 from a possible 30 marks. Fifteen per cent of candidates were able to score in the 11–20 mark range, another 15 per cent in the 6–10 mark range and 50 per cent in the 1–5 range, while 20 per cent either did not attempt the question or scored zero. Most candidates had a fair understanding of SCADA and were able to answer at least one segment of this question.

Question 8

This was the most popular Module 3 question. It tested candidates' knowledge of magnetomotive force and magnetic field strength. One hundred and twenty eight candidates attempted this question and scored a maximum of 8 from a possible 20 marks. Six per cent of the candidates scored in the 6–10 mark range, 73 per cent scored in the 1–5 mark range and 21 per cent either scored zero or did not attempt the question. It was evident that candidates were unable to solve magnetic field strength, flux density and mmf when given parameters for a coil.

Question 9

This question tested candidates' knowledge of d.c. dynamos. Seven per cent of the candidates attempted this question and scored a maximum of 2 from a possible 20 marks. Thirty per cent of the candidates scored in the 1–5 mark range while 70 per cent either scored zero or did not respond to this question. It was evident that candidates lacked the knowledge required to respond effectively.

UNIT 2

Paper 01 – Short Answer Questions

Candidates were required to do all questions from this paper which accounted for 90 marks. The marks obtained by candidates on this paper ranged from 8 to 65. Of the 58 candidates, approximately 10 per cent scored in the 51–70 range, 26 per cent scored in the 31–50 range, 41 per cent scored in the 21–30 range, 19 per cent scored in the 11–20 range and 4 per cent scored in the 1–10 range.

Module 1 – AC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. From a possible 30 marks, the highest score was 28 and the lowest score was 4 marks. Sixteen per cent of the candidates scored in the 21–30 range, 45 per cent scored in the 11–20 range, 34 per cent scored in the 6–10 range and 5 per cent scored in the 1–5 mark range.

Comments on Questions

Question 1

This question was generally understood by most candidates. Sixty per cent of the candidates provided excellent responses to this question, scoring in the 5–6 range. Thirty five per cent of candidates scored in the 3–4 range, and 5 per cent scored in the 1–2 range.

Question 2

This question was generally understood by most candidates. Twenty-one per cent provided excellent responses and scored in the 5–6 mark range. Twenty-four per cent scored in the 3–4 range, 52 per cent scored in the 1–2 mark range and 3 per cent either scored zero or did not respond to the question. Most candidates were able to draw the phasor diagram for the circuit and were able to calculate the currents.

Question 3

This question posed difficulties for more than 50 per cent of the candidates. Only 9 per cent of the candidates provided perfect responses for this question (scoring in the 5–6 range). Seventeen per cent scored in the 3–4 range, 52 per cent scored in the 1–2 range and 22 per cent either scored zero or did not respond to the question. Most candidates were unable to sketch and label the notch filter frequency response.

Question 4

This question posed difficulties for nearly half of the candidates. Twenty-seven per cent scored in the 5–6 range, 26 per cent scored in the 3–4 range, 40 per cent scored in the 1–2 range and 7 per cent either scored zero or did not respond to the question. Some candidates experienced difficulty determining the resonant frequency and Q-Factor.

Question 5

This question posed difficulties for about 72 per cent of the candidates. Only 9 per cent of the candidates provided perfect responses for this question (scoring in the 5–6 range). Nineteen per cent scored in the 3–4 range, 29 per cent scored in the 1–2 range and 43 per cent either scored zero or did not respond to the question. Most candidates were unable to sketch the phasor diagram.

Module 2 – Digital Electronics and Data Communications (Questions 6–10)

Basic analogue and electronics and communications concepts were covered in this module. This module was understood by only a few candidates. From a possible 30 marks, the highest score was 20 and the lowest score was zero. Twenty-six per cent of the candidates scored in the 11–20 range, 36 per cent scored in the 6–10 range, 36 per cent scored in the 1–5 range and 2 per cent scored zero.

Comments on Questions

Question 6

This question posed difficulties for several candidates. Only 3 per cent of the candidates provided good responses for this question (scoring in the 5–6 range). Thirty-one per cent scored in the 3–4 mark range, 26 per cent scored in the 1–2 mark range and 40 per cent either scored zero or did not respond to the question. Most candidates were unable to explain the operation of the multivibrators.

Question 7

One candidate provided a good response for this question (scoring in the 5–6 range). Nine per cent of candidates scored in the 3–4 mark range, 22 per cent scored in the 1–2 mark range whereas 67 per cent either scored zero or did not attempt the question. Most candidates were unfamiliar with ‘pulse code modulation’.

Question 8

This question proved to be quite challenging for most candidates. Only 9 per cent of the candidates scored in the 3–4 range (from a possible 6 marks), 26 per cent scored in the 1–2 mark range and 65 per cent either scored zero or did not attempt the question. Candidates were unable to define the terms ‘inversion layer’ and ‘threshold voltage’.

Question 9

This question was relatively well understood by most candidates. Forty-one per cent of candidates scored in the 3–4 mark range (out of a possible 6 marks), 45 per cent scored in the 1–2 mark range and 14 per cent scored zero. Most candidates were able to draw the three input symbol for the AND gate and define the term ‘coding’.

Question 10

This question was understood by most candidates. Nine per cent of the candidates provided good responses for this question (scoring in the 5–6 range from a possible 6 marks), 47 per cent scored in the 3–4 mark range, 39 per cent scored in the 1–2 mark range and 5 per cent either scored zero or did not respond to the question.

Module 3 – Introduction to AC Machines: (Questions 11–15)

This module posed significant challenges to candidates. From a possible 30 marks, the highest score was 21, however, several candidates scored zero. Twenty-eight per cent of candidates scored in the 11–20 mark range, 44 per cent scored in the 5–10 mark range, 25 per cent scored in the 1–6 range and 3 per cent scored zero.

Comments on Questions

<u>Question 11</u>

This question was perhaps the best understood for most candidates. Forty-three per cent of the candidates provided excellent responses (scoring in the 5–6 range from a possible 6 marks), 38 per cent scored in the 3–4 range, 12 per cent scored in the 1–2 range, whereas 7 per cent either scored zero or did not attempt the question. Most candidates were able to identify the components of the equivalent circuit of a transformer by virtue of their symbols but not in relation to the device.

<u>Question 12</u>

This question was relatively well understood by most candidates. Fourteen per cent of the candidates provided excellent responses (scoring in the 5–6 range from a possible 6 marks), 33 per cent scored in the 3–4 mark range, 34 per cent scored in the 1–2 mark range and 19 per cent scored zero or did not respond to the question. Most candidates did not know the conditions to be met to achieve maximum efficiency in a transformer.

<u>Question 13</u>

This question proved to be quite challenging for most candidates. Only 2 per cent scored in the 5–6 mark range. Ten per cent of the candidates scored in the 3–4 range, 12 per cent scored in the 1–2 mark range and 76 per cent either scored zero or did not attempt the question. It appeared that candidates were not exposed to the concept of synchronous impedance during their studies.

<u>Question 14</u>

The response profile for this question was relatively poor. Candidates were required to explain the relationship between rotor torque and its resistance and to sketch the characteristic curve when rotor resistance equals its impedance. Only one candidate provided an excellent response, scoring the maximum 6 marks. Nine per cent of candidates scored in the 3–4 range, 52 per cent scored in the 1–2 range, whereas the remaining 38 per cent either scored zero or did not attempt the question.

<u>Question 15</u>

Candidates were asked to describe three methods used for starting a synchronous motor. However, only 14 per cent of candidates were able to describe one method and scored in the 1–2 mark range from a possible six marks. The remaining 86 per cent of candidates either scored zero or did not attempt the question.

Paper 02 – Essay Questions

Fifty-eight candidates sat this paper. They were required to do six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and valued 30 marks each. Candidates were required to select one of the remaining two questions in each module worth 20 marks each. Most candidates attempted the two required questions from each module.

The marks obtained on this paper ranged from 4 to 108. Only one candidate scored in the 100 and above range. Seven per cent of candidates scored in the 81–99 range; 9 per cent scored in the 41–80 range; 14 per cent scored in the 31–40 range; 34 per cent scored in the 21–30 range; 29 per cent scored in the 11–20 range and 5 per cent scored in the 1–10 range. The marks scored by candidates in this module have improved in recent years.

Module 1 – AC Circuit Theory (Questions 1–3)

Candidates were required to do Question 1 and one other question from this section. From a possible score of 50, the highest score was 42 and the lowest was 2. Five per cent of the candidates scored in the 40–45 range; 8 per cent scored in the 31–40 range; 17 per cent scored in the 21–30 range; 35 per cent scored in the 11–20 range and 35 per cent scored in the 1–10 range.

Comments on Questions

<u>Question 1</u>

This question tested candidates' knowledge of the sinusoidal wave form as well as active and reactive power. Candidates responded fairly well to the question. The maximum score obtained was 27 from a possible 30 marks. Eleven per cent of the candidates scored in the 21–30 mark range; 7 per cent scored in the 16–20 mark range; 29 per cent scored in the 11–15 mark range; 24 per cent scored in the 6–10 mark range; 24 per cent scored in the 1–5 mark range and the remaining 5 per cent either scored zero or did not respond to the question.

<u>Question 2</u>

This question tested candidates' knowledge of reactive circuits and their ability to describe the action of inductance and capacitance at resonance. The question also determined candidates' knowledge of circuit parameters for RLC circuits. Fifty-three per cent of the candidates attempted this question. One candidate scored 19 marks, the maximum for this question, while another scored zero. Six per cent of the candidates scored in the 11–15 mark range, 50 per cent scored in the 6–10 mark range, and 38 per cent scored in the 1–5 mark range.

<u>Question 3</u>

This question tested candidates' knowledge of filters and specifically their ability to determine cut-off frequencies and to compute component values. Fifty per cent of the candidates attempted and scored a maximum of 17 marks from a possible 20 marks. Four per cent scored in the 16–20 mark range, 11 per cent scored in the 11–15 mark range and a similar number scored in the 6–10 mark range. The remaining 24 per cent of candidates scored in the 1–5 mark range. It was evident that this question was challenging for most of those who attempted it.

Module 2 – Digital Electronics and Data Communications (Questions 4–6)

Candidates were required to respond to Question 4 and one other question from this section. From a possible score of 50 marks, the marks obtained by candidates ranged from 0 to 33. Only one candidate scored in the 31–40 range. Seven per cent of the candidates scored in the 21–30 range; 31 per cent scored in the 11–20 range; 21 per cent scored in the 6–10 range; 28 per cent scored in the 1–5 range and 12 per cent scored zero. Performance on this module was not impressive.

Comments on Questions

Question 4

This question tested candidates' knowledge of the topologies used in computer networks. The scores ranged from 0 to 21, from a possible 30 marks. One candidate scored 21, whereas 7 per cent scored in the 16–20 mark range. Twenty-eight per cent of candidates scored in the 11–15 mark range, 21 per cent scored in the 6–10 mark range, 19 per cent scored in the 1–5 mark range and the remaining 21 per cent either scored zero or did not respond to the question.

Question 5

This question tested candidates' knowledge of multiplexers and memory systems. Forty-seven per cent of the candidates attempted the question and scored marks ranging from 0 to 5. Thirteen candidates scored in the 1–5 mark range and the remaining seven either scored zero or did not respond to the question. It was evident that candidates were not prepared to answer a question of this nature.

Question 6

This question tested candidates' knowledge of multivibrators and shift registers. Thirty one candidates attempted the question and scored marks ranging from 0 to 12. One candidate scored in the 11–15 mark range, four scored in the 6–10 range, 15 scored in the 1–5 mark range and the remaining 11 scored zero. Most candidates were not familiar with 'pulse code modulation' and were unable to differentiate between FSK and DFSK.

Module 3 – Introduction to AC Machines: (Questions 7–9)

Candidates were required to respond to Question 7 and one other question from this section. From a possible score of 50 marks, the marks obtained by candidates ranged from 0 to 38. One candidate scored in the 31–40 range. Nine per cent of the candidates scored in the 21–30 range, one per cent scored in the 11–20 range, 10 per cent scored in the 6–10 range, 38 per cent scored in the 1–5 range and 40 per cent scored zero.

Comments on Questions

Question 7

This question tested candidates' knowledge of the single-phase capacitor-run induction motor. The marks obtained by candidates ranged from 0 to 21 (from a possible 30 marks). Only one candidate scored in the 20–30 mark range; 3 per cent of candidates scored in the 11–15 mark range; 7 per cent scored in the 6–10 mark range; 24 per cent scored in the 1–5 mark range and the remaining 64 per cent either scored zero or did not respond to the question.

While some candidates experienced difficulty with basic theoretical concepts, many experienced difficulty with the calculation requirements in Section (e).

Question 8

This was the more popular of the two optional questions. It required candidates to draw the circuit of a practical transformer and explain the function of each element. In addition, the specification for a transformer was given for candidates to determine voltages and currents. Forty-seven candidates attempted the question and scored marks ranging from 0 to 17. Four per cent of the candidates scored in the 20–30 mark range; 6.5 per cent scored in the 11–15 mark range; another 6.5 per cent scored in the 6–10 mark range; 36 per cent scored in the 1–5 mark range and the remaining 47 per cent either scored zero or did not respond to the question. While many candidates were unable to draw and label the practical transformer, most were able to calculate the parameters requested.

Question 9

This question tested candidates' knowledge of the synchronous motor. Candidates were asked to explain the term 'synchronous impedance' and to determine the resistance of such motors. Only 11 candidates attempted this question scoring marks ranging from 0 to 6. One candidate scored 6 marks, 6 scored in the 1–5 mark range and the remaining 4 scored zero. In general, this question was quite challenging for candidates.

Paper 03 - Internal Assessment (IA)

An adequate number of sample IAs were submitted for inspection and moderation. The following were observed:

- The grades submitted from some of the schools appeared to be inflated.
- No project activity booklets were submitted.
- Students did not adhere to the specific guidelines/requirements for completing IAs.
- Students need to follow the format established for writing reports.
- There is a need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Most observed were unacceptable.
- In many instances, students failed to discuss the findings of the experiment or outcome of the project.

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2011

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and thirty-one candidates registered for Unit 1 of which 111 wrote Paper 01 and 104 wrote Paper 02. Sixty-six candidates who registered for Unit 2 wrote both Papers 01 and 02 in this examination.

As in previous years, performance was somewhat poor; however there were signs of improvement over previous years. It appears as if this low level of performance could be a result of one or more of a number of factors including:

- Poor preparation of candidates for the examination in this subject
- The weak mathematics and science skills of the candidates
- The need for teacher orientation and training
- Unavailability of appropriate facilities to support this subject
- Inappropriate configuration of the units

There is need to conduct further investigation to determine the causes of poor performance in this subject area.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

Candidates were required to do all questions from this paper which accounted for 90 marks.

The marks scored by candidates ranged from 2 to 58. Five per cent of the candidates scored in the range 51–60, 9 per cent scored in the range 41–50, 17 per cent scored in the range 31–40 and 29 per cent scored in the range 21–30. The remaining 40 per cent scored 20 marks or below.

Module 1 – DC Circuit Theory

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. From a possible 30 marks, the highest score was 26 and the lowest score was 2. About 43 per cent of the candidates scored 50 per cent of the maximum score or above in this module; 19 per cent scored in the range11–14, 20 per cent scored in the range 6–10 and the remaining 18 per cent scored in the range 1–5.

Question 1

This question tested candidates' knowledge of Ohm's Law and their ability to manipulate series parallel circuits. All candidates attempted the question of which 16 per cent were able to provide perfect responses (5–6 marks) whereas 31 per cent scored in the 3–4 mark range, 36 per cent scored between 1 and 2 marks; 17 per cent scored zero. In general, the response to this question was poor, even though this is considered a very simple question. Most candidates were able to calculate the total resistance in the series parallel circuit. Surprisingly, several candidates were unable to state Ohm's Law and were unable to determine the power dissipated in components. We recommend that teachers encourage students to review work done in CSEC Electrical Technology since this topic is covered in-depth at that level.

Question 2

This question focused on the capacitor and required candidates to calculate capacitances in series and the charge stored in this device. All except one candidate attempted the question and out of a possible 6 marks, 12 per cent provided perfect responses (5–6 marks) whereas 48 per cent scored in the 3–4 mark range; 34 per cent scored between 1 and 2 marks; 6 per cent scored zero. A number of candidates misinterpreted the question because of a missing punctuation mark; however, given the formula, most candidates were able to calculate the total value of capacitance in series.

Question 3

In this question, candidates were asked to identify the various types of capacitors and sketch a typical discharge curve of a capacitor. Fifteen candidates did not respond to this question. None of the candidates received marks in the 5–6 range, 33 per cent scored in the 3–4 mark range, 56 per cent scored between 1 and 2 marks; 11 per cent scored zero from a possible 6 marks. Most candidates were able to list the types of capacitors and were familiar with the characteristic curve. Many of them were unfamiliar with capacitance ranges and displayed ignorance of the prefixes (Milli, Kilo, etc.) Teachers should place emphasis on the labelling of graphs and working with prefixes.

Question 4

This question tested candidates' knowledge of inductors. All but 2 candidates responded to the question. About 34 per cent of the candidates were able to provide perfect responses (5–6 marks), whereas 32 per cent scored in the 3–4 mark range; 26 per cent scored between 1 and 2 marks; 8 per cent scored zero. This question represented a very good item for the candidates, however several experienced difficulty calculating flux.

Question 5

Candidates were asked to define mutual inductance and state one function of the iron core in an inductor. All except two candidates responded to the question. About 26 per cent of the candidates were able to provide perfect responses (5–6 marks) whereas 19 per cent scored in the 3–4 mark range; 30 per cent scored between 1 and 2 marks; 25 per cent scored zero. Most candidates were able to identify one function of the iron core on which coils are wound but were unable to sketch and label the diagram for demonstrating mutual inductance.

Module 2 – Analogue Electronics and Communications

Basic analogue and electronics and communications concepts were covered in this module. This module proved to be somewhat challenging as most candidates scored low marks. The highest score was 20 and 7 per cent of the candidates scored zero from a possible 30 points; 7 per cent scored in the range 16–20, 12 per cent scored in the range 11–15, 33 per cent scored in the range 6–10 and the remaining 41 per cent scored in the range 1–5.

Question 6

This question tested candidates' knowledge of the transistor. It proved relatively challenging. It is evident that many candidates were unfamiliar with the NPN transistor and what is meant by *dc Beta* of the transistor. Several candidates misinterpreted the formula for the common emitter transistor. Almost 41 per cent of them either scored zero or did not respond to the question. About 12 per cent were able to provide perfect responses (5–6 marks) whereas 21 per cent scored in the 3–4 mark range; 26 per cent scored between 1 and 2 marks.

Question 7

This question tested candidates' knowledge of oscillators. It proved difficult for most candidates since they were unfamiliar with Barkhausen criterion. A few candidates were able to identify the phase shift oscillator from the diagram given but were unable to explain its operation. About 73 per cent of the candidates either scored zero or did not respond to the question. Only 2 per cent scored in the 3–4 mark range. The remaining 25 per cent scored in the 1–2 mark range.

Question 8

Several candidates understood magnetic radiation and the concept of ground wave. About 10 per cent of them provided good responses (5–6 marks) whereas 34 per cent scored in the 3–4 mark range and 37 per cent scored in the range 1–2. The remaining 19 per cent scored zero or did not respond to the question. Most candidates who attempted this question were able to define ground wave. Candidates need to be more familiar with the frequencies for various electromagnetic waves.

Question 9

This question tested candidates' knowledge of the half wave rectifier. Approximately 10 per cent of the candidates provided solid responses (5–6 marks) whereas 30 per cent of the candidates scored in the 3–4 mark range; 48 per cent scored in the 1–2 range. The remaining 12 per cent scored zero or did not respond to the question. Most of the candidates who attempted this question were able to calculate the output voltage of the rectifier but experienced difficulty calculating the power dissipated by the diode.

Question 10

This question tested candidates' understanding of FM carrier waves and how to calculate the frequencies associated with this wave. Only 4 per cent of the candidates provided good responses (5–6 marks) whereas 21 per cent of the candidates scored in the 3–4 mark range and 17 per cent scored in the 1–2 range. The remaining 58 per cent scored zero or did not respond to the question.

Most of the candidates who attempted this question were able to calculate the highest and lowest carrier frequency but were unable to calculate the carrier swing of the FM signal.

Module 3 – Introduction to Power Systems

This module basically introduces candidates to electrical power systems and continues to be the most challenging of the three. The highest score was 16, and 15 per cent of the candidates scored zero from a possible 30 points. Of the 111 candidates, 2 per cent scored in the range 16–20, 2 per cent scored in the range 11–15, 34 per cent scored in the range 6–10 and 47 per cent scored in the range 1–5. These statistics suggest that candidates were ill prepared for this module.

<u>Question 11</u>

This question tested candidates' knowledge of magnetic flux and Fleming's left-hand rule. Surprisingly, it proved difficult for many candidates. Most candidates knew the properties of magnetic flux but were unable to illustrate Flemings left-hand rule. Only 6 per cent of candidates provided good responses (5–6 marks) whereas 21 per cent scored in the 3–4 mark range and 40 per cent scored in the 1–2 range. About 33 per cent of the candidates either scored zero or did not respond to this question. Using a model to illustrate the rule is a good teaching tactic and should improve results in this area.

<u>Question 12</u>

This question proved relatively difficult for most candidates. The majority of candidates were unfamiliar with wave windings however several of them understood the concept of *separately excited* in relation to dc machines. Only 1 percent of the candidates provided a perfect response (5–6 points); 4 per cent scored in the 3–4 mark range; 22 per cent scored in the 1–2 mark range and the remaining 73 per cent either scored zero or did not respond to the question.

<u>Question 13</u>

Most candidates were unable to respond to this question. Candidates were unable to differentiate between earth fault and short circuit fault. A large number, 70 per cent of the candidates, either scored zero or did not provide a response. No candidate scored in the 5–6 mark range and one scored in the 3–4 mark range. The remaining 29 per cent scored in the 1–2 mark range.

<u>Question 14</u>

This question tested candidates' knowledge of the SCADA system. Most candidates displayed a good working knowledge of the system; however several of them were unable to state what the RTV is. About 26 per cent of the candidates provided good responses (5–6 marks) whereas 36 per cent scored in the 3–4 mark range; 24 per cent scored in the 1–2 mark range. The remaining 14 per cent either scored zero or did not respond to the question.

<u>Question 15</u>

This question tested candidates' knowledge of the separately excited generator. Some candidates were able to sketch the characteristic curve and determine what accounts for the remaining output voltage when the field current is removed. Fifty-six per cent of the candidates either scored zero or did not provide a response. Four 4 per cent scored in the 3–4 mark range whereas the remaining 40 per cent scored in the 1–2 mark range.

Paper 02 – Essay Questions

One hundred and six candidates wrote this paper. They were required to respond to six questions worth 150 marks. Questions 1, 4 and 7, each worth 30 marks, were compulsory. Candidates were required to select one of the remaining two questions from each module; these questions were each worth 20 marks. Most candidates attempted the required two questions from each module.

The range of marks obtained was from a low of 4 to a high of 95. An unprecedented 8 per cent of the candidates scored above 80 marks. Almost 21 per cent of candidates scored in the range 50–79; 26 per cent scored in the range 30–49; 33 per cent scored in the range 10–29 and the remaining 12 per cent scored in the range 0–9.

Module 1 – DC Circuit Theory

Candidates were required to respond to Question 1 and one other from this section. From a possible score of 50 from this module, the highest score was 35. Roughly 5 per cent of the candidates scored in the range 31–40 whereas 21 per cent scored in the range 21–30; 33 per cent scored in the range 11–20; 40 per cent scored in the range 1–10 range and one candidate scored zero.

Question 1

This question focused on the inductor and mutual inductance. For the most part, candidates displayed knowledge of the inductor and were able to define the coefficient of coupling. Candidates experienced difficulty calculating the energy stored and the coefficient of coupling for two coils. The maximum score obtained was 19 from a possible 30 marks. About 29 per cent of those who attempted the question scored in the 11–20 mark range; 30 per cent scored in the 6–10 mark range, 36 per cent scored in the 1–5 mark range and 5 per cent either scored zero or did not attempt the question.

Question 2

This question was designed to test candidates' knowledge and understanding of the capacitor and time constant. Candidates were expected to calculate various parameters for a capacitor when given certain values. This question was selected by 37 per cent of the candidates. Although the question proved quite challenging for some candidates, many were able to sketch graphs, calculate energy stored, initial charging current and the time constant. From a possible 20 marks, the highest score was 19. Fifteen candidates scored in the 11–20 mark range; 15 scored in the 6–10 mark range; 10 candidates scored in the 1–5 mark range and one scored zero for this question.

Question 3

This question tested candidates' knowledge of Kirchoff's Laws and how to use this law to solve network problems. About 56 per cent of the candidates chose this question. It was evident that several candidates experienced difficulty calculating the values for the circuit. From a possible 20 marks, the highest score was 15 marks. Of the 60 candidates who attempted the question, 11 scored in the 11–20 mark range, 17 scored in the 6–10 mark range and 31 scored in the 1–5 range. One candidate scored zero.

Module 2 – Analogue Electronics and Communications

Candidates were required to respond to Question 4 and one other from this section. From a possible score of 50 marks from this module, the highest score was 27 marks. Ten per cent of those who attempted this question scored in the range 21–30; 31 per cent of the candidates scored in the range 11–20; 56 per cent scored in the range 0–1 and 3 per cent scored zero.

Question 4

All candidates were required to answer this question which tested their knowledge of semiconductors. This question further aimed at determining candidates' knowledge of rectification in power supplies. Many candidates were unable to state the type of impurities used to dope silicon crystal. They were also unable to calculate the current rating of a Zener diode. The highest score was 17 from a possible 30 marks. Almost 17 per cent of those who attempted the question scored in the 11–20 mark range; 36 per cent scored in the range 6–10 and 44 per cent scored between 1 and 5 marks. About 3 per cent of the candidates either did not attempt the question or scored zero.

Question 5

This question focused on operational amplifiers. Sixty-five per cent of the candidates opted for this question. The highest score was 17 from a possible 20 marks. Approximately 12 per cent of the candidates who wrote the question scored in the 11–20 mark range, 13 per cent scored in the range 6–10, 55 per cent scored in the 1–5 range, and 20 per cent either scored zero or did not attempt the question.

Question 6

This question focused on the NPN transistor. It required candidates to outline the structure and operations of a NPN transistor and to carry out calculations for transistor biasing circuits. Twenty-five per cent of those who attempted this question scored a high of 8 marks from a possible 20. Eleven per cent of the candidates scored in the 6–10 range, 63 per cent scored in the 1–5 range, and 26 per cent candidates scored zero or did not respond to the question.

Module 3 – Introduction to Electrical Power Systems

Candidates were required to respond to Question 7 and one other from this section. From a possible score of 50 for this module, the highest score was 38. Approximately eight per cent of those who attempted this question scored in the range 31– 40, 17 per cent scored in the range 21–30, 27 per cent scored in the range 11–20, 37 per cent scored in the range 1–10 and 11 per cent scored zero.

Question 7

This question tested candidates' knowledge of dc dynamos. Candidates were required to sketch and label the cross-section of the dynamo, draw and label connection diagrams and characteristic curves and calculate dynamo parameters. The maximum score obtained was 23 from a possible 30 marks. About 6 per cent of those who attempted the question scored in the 21–30 mark range; 19 per cent of the candidates scored in the 11–20 mark range; 27 per cent scored in the 6–10 mark range; 31per cent scored in the 1–5 mark range and 17 per cent either scored zero or did not attempt the question.

Question 8

This question tested candidates' knowledge of Lenz's Law, magnetomotive force and magnetic field strength. Fifty-four per cent of the candidates attempted this question and scored a high of 18 from a possible 20 marks. Thirty-three per cent of those who attempted it scored in the 11–20 mark range, 25 per cent scored in the 6–10 mark range, 32 per cent scored in the 1–5 mark range and 10 per cent either scored zero or did not attempt the question. It was evident that several candidates experienced difficulty responding to this question.

Question 9

This question tested candidates' knowledge of the Supervisory Control and Data Acquisition (SCADA) system. The question was attempted by 45.28 per cent of the candidates. The highest score was 20 from a possible 20 marks. Of those who attempted the question, 45 per cent were able to score in the 11–20 mark range, 20 per cent in the 6–10 mark range, 30 per cent in the 1–5 range, while 5 per cent either did not attempt the question or scored zero. Most candidates had a fair understanding of SCADA and were able to answer at least one segment of this question.

UNIT 2

Paper 01 – Short Answer Questions

Candidates were required to do all questions from this paper which accounts for 90 marks. The range of marks scored by candidates was from a low of 3 to a high of 74. Of the 66 candidates, 8 per cent scored in the 51–75 range, 9 per cent scored in the 41–50 range, 12 per cent scored in the 31–40 range, 45 per cent scored in the 21–30 range, 17 per cent scored in the 11–20 range and 9 per cent scored in the 1–10 mark range. This data suggest that less than 20 per cent of the candidates scored above 50 per cent of the available marks.

Module 1 – AC Circuit Theory

Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. From a possible 30 marks, the highest score was 24 and two candidates scored zero; 6 per cent of the candidates scored in the 21–30 range, 12 per cent scored in the 16–20 range, 23 per cent scored in the 11–15 range, 32 per cent scored in the 6–10 range and 26 per cent scored in the 1–5 mark range.

Question 1

This question tested candidates' knowledge of filters. They were asked to label the characteristic curve of a band pass filter, to draw the circuit of a simple low pass filter and explain how it works. Most candidates had basic knowledge of a typical response curve for a band pass filter but the majority of them were unable to label the response curve. Only 6 per cent of those who attempted the question provided excellent responses, scoring in the range 5–6 from a possible 6 marks; 10 per cent scored in the range 3–4, 58 per cent scored in the range 1–2 and 26 per cent either scored zero or did not attempt the question.

Question 2

This question tested candidates' knowledge of reactance. Many candidates understood *phase relationship* and knew the meaning of reactance. Most of them could state the formula for calculating inductive reactance but experienced difficulty transposing in the formula. They also experienced difficulty working with powers. About 26 per cent of those who attempted the question provided excellent responses, scoring in the 5–6 mark range; 34 per cent scored in the range 3–4, 28 per cent scored in the 1–2 mark range and 12 per cent either scored zero or did not respond to the question.

Question 3

Candidates were asked to express values of impedances in regular and polar form. This question was avoided by the majority of candidates. The percentage of candidates who provided perfect responses for this question (scoring in the 5–6 range from a possible 6 marks) was 15. Ten per cent scored in the range 3–4; 40 per cent scored in the range 1–2 and 35 per cent either scored zero or did not respond to the question.

Question 4

This question tested candidates' knowledge of the sine waveform and power factor. Most candidates were able to sketch and label the sine wave and indicate the values requested, however many of them did not understand the concept of power factor. About 23 per cent of those who attempted the question scored in the range 5–6 (from a possible 6 marks); 36 per cent scored in the range 3–4, 35 per cent scored in the range 1–2 and 6 per cent either scored zero or did not respond to the question.

Question 5

Given a series RLC circuit, candidates were asked to explain how the circuit reached resonance and sketch the variation of current and reactance with frequency. This question posed difficulties for more than 50 per cent of the candidates. They were able to draw and label the curves but could not illustrate reactance at resonance. No candidate provided a perfect response for this question; 24 per cent scored in the range 3–4, 41 per cent scored in the range 1–2 and 35 per cent either scored zero or did not respond to the question.

Module 2 – Digital Electronics and Data Communications

Basic analogue and electronics and communication concepts were covered in this module. The module was understood by only a few candidates — 14 per cent of the candidates scored 50 per cent or more of the 30 marks available. The highest score was 22 and the lowest score was 3; only 2 per cent of the candidates scored in the range 21–30; 12 per cent scored in the range 16–20; 35 per cent scored in the 11–15 range; 38 per cent scored in the range 6–10 and 13 per cent scored in the 1–5 mark range.

<u>Question 6</u>

Candidates were asked to define *UART* and terms such as *parity and framing error* as they related to the UART. They were also asked to explain how the UART is used. Most candidates were unaware of the content of this question. Only 12 per cent of the candidates scored in the 3–4 mark range; 55 per cent scored in the 1–2 mark range and 33 per cent either scored zero or did not respond to the question.

<u>Question 7</u>

Candidates were asked to state what a *shift register* is and give its uses. They were also asked to describe the function of the counter in a sequential logic circuit. In general, this question appeared difficult for the large majority of candidates as none was able to provide a perfect response. About 17 per cent of the candidates scored in the 3–4 mark range; 48 per cent scored in the 1–2 mark range and 35 per cent either scored zero or did not attempt the question.

<u>Question 8</u>

This question required candidates to define *ROM* and *PROM* and explain the basic difference between them. They were also asked to explain what a *demultiplexer* is. Most candidates were able to provide reasonable responses and no candidate scored zero; 14 per cent of the candidates scored in the range 5–6 (from a possible 6 marks); 67 per cent scored in the 3–4 range and 19 per cent scored in the range 1–2. No candidate scored zero.

<u>Question 9</u>

Candidates were asked to draw symbols and construct truth tables for the NOR and EX-OR gates. The question was relatively well understood by most candidates. Roughly 27 per cent of the candidates scored in the 5–6 mark range of the 6 point range scale; 42 per cent scored in the range 3–4; 18 per cent scored in the 1–2 mark range and 13 per cent either scored zero or did not attempt the question.

<u>Question 10</u>

This question tested candidates' knowledge of ideal switches and transistors. The question was well understood by most candidates; however many of them were unable to explain the construction of transistors and draw their symbols. About 14 per cent of the candidates provided good responses (scoring in the range 5–6 from a possible 6 marks); 29 per cent scored in the 3–4 mark range; 31 per cent scored in the 1–2 mark range and 26 per cent either scored zero or did not respond to the question.

Module 3 – Introduction to AC Machines

In previous years, this module posed significant challenges to candidates in general but there are signs that candidates are beginning to understand and meet the requirements. From a possible 30 marks, the highest score was 28; 6 percent of the candidates scored zero. Almost 5 per cent of the candidates scored in the range 21–30, another 5 per cent scored in range the 16–20; 16 per cent scored in the range 11–15; 30 per cent scored in the range 6–10, and 38 per cent scored in the 1–5 mark range.

Question 11

This question tested candidates' knowledge of transformers. Surprisingly, candidates did not perform as well as expected. Only 6 per cent of the candidates provided excellent responses (scoring in the 5–6 range from a possible 6 marks); 29 per cent scored in the range 3–4; 60 per cent scored in the range 1–2, whereas 5 per cent either scored zero or did not attempt the question. Most candidates were able to give another name for laminated core transformers.

Question 12

Candidates were asked to draw sketches and explain the operation of the single phase capacitor run and the split phase induction motors. This question proved difficult for most candidates since only 11 were capable of providing a response. Only 7 per cent of the candidates provided excellent responses (scoring in the 5–6 range from a possible 6 marks); 14 per cent scored in the range 3–4; 17 per cent scored in the 1–2 mark range, whereas 62 per cent either scored zero or did not respond to the question.

Question 13

Candidates were asked to explain the term *synchronous impedance* in relation to an AC motor. Additionally, candidates were given the armature resistance and reactance and asked to determine the synchronous impedance of the motor. The question proved to be quite challenging for most candidates as only 50 per cent of them responded. Approximately 25 per cent scored in the 5–6 mark range; 29 per cent scored in the 3–4 range; 14 per cent scored in the 1–2 mark range and 32 per cent either scored zero or did not attempt the question. It appears that candidates were not exposed to the concept of synchronous impedance during their studies.

Question 14

Given the equivalent circuit for a transformer, candidates were required to name the circuit elements and four parameters. Many candidates did not know the difference between circuit elements and circuit parameters. Only 7 per cent of the candidates provided excellent responses, scoring in the 5–6 mark range; 38 per cent scored in the range 3–4, 50 per cent scored in the 1–2 mark range and 5 per cent either scored zero or did not attempt the question.

Question 15

Candidates were asked to draw and label an auto transformer that could be used to boost the voltage at the end of a power line. Additionally, they were given the turns ratio of a transformer and an input voltage and asked to determine the output. Only 5 per cent of the candidates provided excellent responses, scoring in the 5–6 mark range; 33 per cent scored in the range 3–4; 21 per cent scored in the 1–2 mark range and 41per cent either scored zero or did not attempt the question.

Paper 02 – Essay Questions

Sixty-six candidates wrote this paper. They were required to respond to six questions which were worth 150 marks. Questions 1, 4 and 7, each worth 30 marks, were compulsory. Candidates were required to select one of the remaining two questions, worth 20 marks, in each module. Most candidates attempted the required two questions from each module.

The range of the marks obtained was from a low of 2 to a high of 106. Only 1 candidate scored in the 100 and above range; 5 per cent scored in the range 81–99; 9 per cent scored in the range 61–80; 45 per cent scored in the range 41–60; 8 per cent scored in the range 31–40; 15 per cent scored in the range 21–30; 14 per cent scored in the range 11–20 and 3 per cent scored in the range 1–10.

Module 1 – AC Circuit Theory

Candidates were required to respond to Question 1 and one other from this section. From a possible score of 50 marks from this module, the highest score was 30 and the lowest was 2. Approximately 30 per cent of the candidates scored in the range 21–30; 38 per cent scored in the range 11–20; 29 per cent scored in the range 6–10 and 3 per cent scored in the range 1–5.

<u>Question 1</u>

This question tested candidates' knowledge of resonance and magnification factor (Q). Many candidates experienced challenges with this question. Candidates were quite conversant with definitions but were unable to solve basic problems related to resonance circuits. The maximum score obtained was 14 from a possible 30 marks with 16 per cent of the candidates scoring in the 11–15 mark range; 32 per cent scoring in the 6–10 mark range; approximately 52 per cent scoring in the 1–5 mark range and no candidate failed to respond to the question, or obtained zero.

<u>Question 2</u>

This question tested candidates' knowledge of filters, specifically the low pass and notch filters. Although this question tested basic concepts on filters, the majority of candidates did not select it. It appears as if one or a combination of the following occurred:

- this topic was not taught,
- the question was too difficult, or
- the alternative question was more attractive to most candidates.

Only 8 per cent of candidates attempted the question and two scored 14 marks. Two candidates scored in the 6–10 mark range and one scored in the 1–5 range.

<u>Question 3</u>

This question tested candidates' knowledge of sinusoidal wave forms, and active and reactive power. Approximately 94 per cent of the candidates attempted the question and scored a maximum of 19 marks and a minimum of 2 marks from a possible 20 marks. Eighteen per cent of the candidates scored in the 16–20 mark range, 15 scored in the 11–15 mark range, 17 scored in the 6–10 mark range and the remaining 18 candidates scored in the 1–5 mark range. No candidate scored zero. It is evident that most candidates were comfortable with this question.

Module 2 – Digital Electronics and Data Communications

Candidates were required to respond to Question 4 and one other from this section. From a possible score of 50 marks from this module, the marks obtained by candidates ranged from 0 to 40. Approximately 5 per cent of the candidates scored in the range 31–40; 39 per cent scored in the range 21–30, 24 per cent scored in the range 11–20; 12 per cent scored in the range 6–10; 17 per cent scored in the range 1–5 and 3 per cent of the candidates scored zero. These scores represent a significant improvement in the performance on this module when compared to previous years.

Question 4

This question tested candidates' knowledge of flip-flops. Most candidates were able to draw and explain the SR and JK flip-flops but were unable to explain their operation. The marks for this question ranged from 0 to 22 from a possible 30 marks. Approximately 6 per cent of the candidates scored in the range 21–30, whereas 12 per cent scored in the 16–20 mark range; 39 per cent scored in the 11–15 mark range; 25 per cent scored in the 6–10 mark range; 12 per cent scored in the 1–5 mark range and the remaining 6 per cent either scored zero or did not respond to the question.

Question 5

This question focused on MOSFETS and thyristors. Candidates were required to draw and describe the operation of these devices. Only 15 per cent of the candidates attempted this question. It appears that the question was either too difficult or the alternative question was more attractive to most candidates. Marks ranged from 0 to 8. Forty per cent of the candidates scored in the 6–10 mark range, 40 per cent scored in the 1–5 mark range and the remaining 20 per cent scored zero or did not attempt the question. It is evident that candidates were not prepared to answer this question. They were familiar with the symbol of the thyristor but had little knowledge about its operation.

Question 6

Candidates were required to define *noise* and to identify four categories. They were also asked to explain DPSK and FSK techniques as well as half and full duplex modes of communication. Eighty per cent of the candidates attempted this question and scored marks ranging from 0 to 18. Seven per cent of those who attempted the question scored in the range 16–20; 33 per cent scored in the 11–15 mark range; 30 per cent scored in the range 6–10; 24 per cent scored in the 1–5 mark range and the remaining 6 per cent either scored zero or did not respond to the question. Most candidates were able to explain the terms *half* and *full duplex*.

Module 3 – Introduction to AC Machines

Candidates were required to respond to Question 7 and one other from this section. From a possible score of 50 marks from this module, the marks obtained by candidates ranged from 0 to 39. Three per cent of the candidates scored in the range 31–40; 8 per cent of the candidates scored in the range 21–30; 23 per cent scored in the range 11–20; 32 per cent scored in the range 6–10; 21 per cent scored in the range 1–5 and 13 per cent candidates scored zero. Candidates' performance suggests that they were quite conversant with this module.

Question 7

This question tested candidates' knowledge of the synchronous generators. The marks obtained by candidates ranged from 0 to 22 from a possible 30 marks. Of those candidates who attempted the question, only one candidate (about 2 percent) scored in the 21–30 mark range, 7 per cent scored in the 11–20 mark range; 26 per cent scored in the 6–10 mark range; 45 per cent scored in the 1–5 mark range and the remaining 20 per cent either scored zero or did not respond to the question. It appears that many candidates were not familiar with the universal voltage equation for the synchronous dynamo.

Question 8

This question focused on the transformer and required candidates to state the principle on which the transformer operates. They were required to display knowledge of concepts such as coefficient of coupling, mutual inductance and transformation ratio. Sixty-two per cent of the candidates attempted the question and marks ranged from 0 to 19. Approximately 33 per cent of the candidates who attempted it scored in the 11–20 mark range; 40 per cent scored in the 6–10 mark range; 23 per cent scored in the 1–5 mark range and the remainder 4 percent either scored zero or did not respond to the question. It is evident that most candidates were familiar with the transformer and its operation. Most, however, were unable to calculate the transformation ratio.

Question 9

This question tested candidates' knowledge of the induction motor. The question focused on slip. Of the candidates who attempted this question, 32 per cent scored marks ranging from 0 to 5. Fifteen candidates scored in the 1–5 mark range and the remaining 16 either scored zero or did not respond to the question. The question was clearly quite challenging for candidates.

Paper 03 – School-Based Assessment (SBA)

An adequate number of SBA samples was submitted for inspection and moderation. The following were observed:

- The grades submitted from some of the schools appeared inflated.
- No project activity booklets were submitted.
- Students did not adhere to the specific guidelines/requirements for completing SBAs.
- Students did not generally follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Most samples observed were unacceptable. Students would benefit from closer supervision.
- In many instances, students failed to discuss the findings of the experiment or outcome of the project.
- Projects submitted from two schools were basically replicas of each other. Students need to submit their own projects.
- Some projects submitted were too simple for the CAPE level.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2012

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

Ninety-seven candidates registered for Unit 1, and all candidates wrote both Paper 01 and Paper 02. The fifty-two candidates who registered for Unit 2 sat both Papers 01 and 02 in this examination. There has been a significant drop in registration for this subject. It appears that there is need for promoting and marketing it.

As in previous years, the performance was somewhat poor but there are signs of improvement. This poor performance could be a result of a combination of factors including:

- The ill-preparedness of candidates for the subject.
- The source from which candidates are drawn does not provide the foundation for this subject.
- The weak mathematics and science background of candidates.
- The need for the training and orientation of teachers.
- The unavailability of appropriate facilities to support this subject.
- The configuration of the units may be inappropriate.

There is need to conduct further investigation to determine the causes of poor performance in this subject area.

As suggested on numerous occasions, it is the opinion of the examiners that improvement in performance would result if the units were divided along the electrical and electronics specialization as follows:

UNIT 1 Electrical Technology

Modules

1. DC Circuit Theory
2. AC Circuit Theory
3. Electrical Power Systems

UNIT 2 Electronics

Modules

1. Analogue Electronics
2. Digital Electronics
3. Communications

This arrangement, the examiners believe, would facilitate:

- Better selection of texts along electrical and electronics lines.

- Better teaching since students would benefit from the expertise of teachers who are trained in the various specialties. It is evident from the performance of students that teachers are concentrating on their area of specialization and perhaps neglecting other areas.

- Candidate concentration on one specialization before moving to the next.

DETAILED COMMENTS
UNIT 1

Paper 01 – Short Answers

This paper consisted of 15 short answer questions, each worth six marks. Candidates were required to attempt all questions. The paper was worth 90 marks.

Candidates' overall scores ranged from zero to 74 marks. The mean for this paper was 31.25 per cent which exceeded the 2011 mean by 4.5 per cent and the 2010 mean by 11 per cent. On this paper, about 45 per cent of the candidates scored at the Grade V level or better. No candidate scored at the Grade I level.

Module 1 – DC Circuit Theory (Questions 1–5)
Candidates were required to use fundamental laws and simple theory to solve problems related to simple DC circuits. From a possible 30 marks, the highest score was 24 and the lowest score was zero. Seventy-five per cent of the candidates achieved grades in the region A–E with five per cent of the candidates achieving Grade A.

Question 1

This question tested candidate's knowledge of Kirchoff's laws and how these laws are represented diagrammatically. All candidates attempted the question; 33 per cent of whom were able to provide perfect responses. In general, this question was answered reasonably well, although some candidates experienced difficulty in drawing the diagrams to depict Kirchoff's laws. Candidates could benefit from more practice in the application of these laws.

Question 2

In this question, candidates were asked to outline the conditions for maximum power transfer in a DC circuit and to calculate the maximum power that will be transferred in a circuit. All except three candidates attempted this question. Seventy-seven per cent of the candidates scored less than three of the six marks. It is evident that this question proved difficult for the majority of candidates. Many were able to outline the conditions for maximum power transfer but were unable to apply the concepts to enable the required calculations.

Question 3

Candidates were required to define *permittivity of free space*. Given this quantity and the permittivity of a material, candidates were required to determine the absolute permittivity of the material. This question was reasonably well done. Only three candidates did not respond to this question. Two candidates provided perfect answers and about 41 per cent scored more than half of the marks. Most candidates were able to define permittivity of free space but were unable to determine, through calculations, the absolute permittivity of the material given.

Question 4

This question tested candidates' knowledge of capacitors. Candidates were asked to calculate the total capacitance in a series-parallel circuit and to determine the time constant of a RC circuit. All except one candidate responded to the question and eight provided perfect responses. This question was not well done. Only 23 per cent of the candidates scored more than three marks. Surprisingly, though simple, this question was quite a challenge for many candidates. Most could not calculate the total capacitance in series and parallel correctly, or the time constant and initial charging current.

Question 5

Candidates were asked to identify three factors that determine the inductance of a coil and to perform calculations related to a coil, given its parameters. All except one candidate responded to the question; however, the responses were quite weak. One candidate provided a perfect response and only about 18 per cent of the candidates produced scores in the 4–6 mark range. Most candidates were able to identify factors that determine the inductance of a coil but were unable to calculate the flux as required.

Module 2 – Analogue Electronics and Communications (Questions 6–10)

Basic analogue electronics and communication concepts were tested in this module. The module proved to be somewhat challenging as most candidates scored low marks. The highest score was 24 and four candidates scored zero from a possible 30 points. About 34 per cent of the candidates achieved Grades A–E.

Question 6

This question tested candidates' knowledge of the half-wave power supply and their ability to perform simple calculations for this device. The question proved relatively challenging for candidates. Eighty-seven per cent of the candidates scored less than three marks. Most candidates were able to calculate the voltages for the transformer but could only state one reason for using a transformer in a circuit.

Question 7

Candidates were asked to define the term *operational amplifier*, state the likely input and output impedances of such device and calculate voltage gain. Responses to this question were quite poor. Only four candidates were able to provide perfect responses. Eighty-four per cent scored poorly. Although candidates were able to define and state basic properties of the amplifier, they were not able to identify the type of amplifier and apply the required formulae.

Question 8

This question tested candidates' knowledge of amplitude modulation. It proved quite difficult for candidates. None of the candidates provided a perfect response and only 13 candidates provided good responses. A significant number of candidates scored zero. Most candidates had some general knowledge about amplitude modulation but were lacking in specific areas such as *modulation factor* and knowledge of the required formula to calculate modulation factor.

Question 9

Given a block diagram of an amplifier, candidates were asked to calculate voltage gain and the input power of the signal. Candidates were also asked to identify methods used to prevent thermal run-away of transistors. Five candidates provided perfect responses and 30 candidates provided good responses. Most candidates were able to calculate the voltage gain and input power but were not conversant with the concept of thermal run-away.

Question 10

This question tested candidates understanding of carrier waves. They were asked to define maximum usable and optimum traffic frequencies (MUF and OTF). The question was attempted by 71 candidates. Only one candidate provided a good response. Ninety-three per cent of the candidates scored poorly. Most candidates did not know the frequency bands for medium and high frequency carrier waves and were unable to define OTF.

Module 3 – Introduction to Power Systems: (Questions 11–15)

This module basically introduces candidates to electrical power systems but continues to be the most challenging of the three. Two candidates scored 26, the highest score, and six candidates scored zero from a possible 30 points. About 40 per cent of the candidates achieved Grades A–E.

The statistics suggest that there is improvement in performance in this module when compared with previous years.

Question 11

This question tested candidates' knowledge of magnetic flux lines. Surprisingly, this question proved difficult for many candidates. Eighty-two candidates attempted the question and 21 of them provided fairly good responses. The remainder scored poorly. Most candidates did not display any understanding of the characteristics of magnetic flux lines.

Question 12

This question tested candidates' knowledge of Fleming's Left Hand Rule (LHR) for the mechanical force exerted by a current-carrying conductor. Seventy-seven candidates attempted the question. Many candidates responded well to this question. Twenty-two candidates provided perfect responses; seven scored in the 4–5 mark range and the remainder scored three marks or less. It was evident that many candidates know Fleming's LHR but were unable to calculate the force on the conductor.

Question 13

Candidates were asked to draw and label the circuit and sketch the magnetization curves for a separately excited DC generator. Fifty-four candidates attempted this question but most of them were unable to respond well. Fifteen candidates provided perfect responses; eight scored four or five marks and the remainder scored three marks or less. It is evident that candidates lacked a good working understanding of the DC generator and hence were unable to adequately draw and label the magnetization curves.

Question 14

This question tested candidates' knowledge of thermal overload relays. They were required to state their primary function, identify two types and explain how any one of the two types operates. Fifty-six candidates attempted the question. Many candidates were unable to respond positively to this question, indicating that they lacked understanding of overload relays. Even though six candidates provided perfect responses, a total of 42 candidates scored less than three marks.

Question 15

This question tested candidates' knowledge of the SCADA System. Many candidates were unable to respond correctly to this question, indicating that they lacked knowledge of the SCADA system inclusive of its sub-systems. Fifty-eight candidates attempted the question and six candidates provided perfect responses; 11 scored in 4–5 mark range and the remainder scored three marks or less.

Paper 02 – Essays

Ninety-eight candidates wrote this paper. They were required to attempt six of nine questions from this paper which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and each worth 30 marks. Candidates were required to select one of the remaining two questions in each module; each question was worth 20 marks each. Most candidates attempted the required two questions from each module.

The marks scored ranged from 2 to 91. The mean for this paper was 22.42 per cent which was approximately two per cent lower than that of 2011 and seven per cent higher than that of 2010. This paper proved difficult for candidates. The percentage of candidates achieving Grades I–V on this paper was 25.51 per cent.

Module 1 – DC Circuit Theory (Questions 1–3)

Candidates were required to do Question 1 and one other from this section. From a possible score of 50 for this module, the highest score was 42, achieved by two candidates. No candidate scored zero and 67 per cent of the candidates achieved Grades A–E.

<u>Question 1</u>

This compulsory question focused on the inductor and mutual inductance. For the most part, candidates displayed knowledge of the inductor and were able to define the coefficient of coupling. Candidates were tested on the concepts of differentially and cumulatively coupled coils as well as the calculation of self-inductance. With these they experienced great difficulty. Scores ranged from zero to 25 with the mean score being 7.87. Ninety-five candidates attempted this question and only eight scored 15 or more marks.

Overall, candidates demonstrated good knowledge of Parts (a), (c) (i) and (d) (i), but experienced difficulties with (b) (i), (c) (ii) and (d) (ii).

<u>Question 2</u>

This optional question was designed to test candidates' knowledge and understanding of the temperature coefficient of resistance. Candidates were expected to explain the effects of temperature on materials and calculate temperature given various parameters. This question was selected by nine candidates. Candidates were quite conversant with defining temperature coefficient of resistance and giving its symbol but had difficulty with calculating the temperature of a coil. Scores ranged from zero to 11 with a mean of 4 marks. Candidates had some difficulty with Parts (a) and (b). Part (c) appeared to be widely known and Part (d) appeared the most difficult.

Question 3

This optional question was aimed at testing candidates' knowledge of capacitance. Candidates were required to define capacitance, sketch discharge curves, calculate time constant and determine energy stored in a capacitor. Eighty-seven per cent candidates chose this question. It was evident that several candidates experienced difficulties with calculating the values required but were quite conversant with sketching discharge curves. From a possible 20 marks, the highest score was 19 marks scored by two candidates. Marks ranged from 1 to 19 with a mean of 11.37. Of the 87 candidates, 65 scored ten or more marks. Candidates demonstrated good knowledge of Parts (a) and (b) (i), and experienced difficulties with Parts (b) (ii) and (iii), and (c) (i–iv).

Module 2 – Analogue Electronics & Communications (Questions 4–6)

Candidates were required to attempt Question 4 and one other from this section. The maximum possible score for this module was 50 marks. Marks ranged from zero to 26. The highest score was achieved by two candidates. Seven candidates scored zero and 23 per cent of the candidates achieved Grades A–E.

Question 4

All candidates were required to answer this question which tested their knowledge of semiconductors. Specifically, the question aimed at ascertaining candidates' knowledge of Zener diodes. Many candidates had a good grasp of the operation of the Zener Diode and could draw the characteristic curve. Most however were not able to draw the output waveform of a clipper circuit and displayed limited knowledge of the LED. Ninety-five candidates attempted the question and five candidates scored 15 marks or more.

Question 5

This optional question focused on RC oscillators and differential amplifiers. Twenty-eight candidates chose this question and scored a high of 14 marks from a possible 20 marks. Most candidates were able to define the term oscillator and to identify types of oscillators. They had difficulty describing the operation of the oscillator and the differential amplifier. Almost 90 per cent of the candidates scored less than 10 marks.

Question 6

This optional question focused on the transistor and the common emitter circuit. It required candidates to calculate DC voltages between the collector and the emitter; explain the terms *saturation* and *active region*; calculate input impedance, current voltage and power gains given various parameters of the transistor. Fifty-nine candidates attempted this question and they encountered severe difficulties. It is evident that they lacked knowledge of the transistor and related formulae. Scores ranged from zero to 12 marks, and 97 per cent of candidates scored less than ten marks.

Module 3 – Introduction to Electrical Power Systems: (Questions 7–9):

Candidates were required to attempt Question 7 and one other from this section. From a possible score of 50 for this module, the highest score was 25. Three candidates scored zero and six per cent achieved Grades A–E.

Question 7

This compulsory question tested candidates' knowledge of DC dynamos. Candidates were required to draw characteristic curves, calculate dynamo parameters and explain armature reaction. Most candidates understood the concept of armature reaction but were not familiar with the characteristic curves and had difficulty calculating the values requested. Seventy-nine candidates attempted the question and only two candidates scored more than ten marks. Marks ranged from zero to 11.

Question 8

This optional question tested candidates' knowledge of quantities and units of electric and magnetic circuits. They were also required to calculate flux density, reluctance and magnetic field strength for a coil. Eighty-two candidates attempted this question. Marks ranged from zero to 14 and 93 per cent of the candidates scored 10 marks or fewer. It is evident that several candidates experienced difficulty in responding to this question, and in most cases were unable to identify and utilize needed formulae for the required calculations.

Question 9

This optional question tested candidates' knowledge of the circuit breaker. Only 13 candidates selected this question. Scores ranged from zero to 12 with one candidate scoring 12 marks. All other candidates scored eight or fewer marks. Most candidates had a fairly good understanding of the parts and features of the circuit breaker as required in Part (b) but in both Parts (c) and (d) candidates experienced difficulty in producing the required answers.

Paper 01 – Short Answers

Candidates were required to attempt all questions from this paper which account for 90 marks. Fifty-two candidates wrote this paper. Candidates scored marks ranging from a low of two to a high of 73. The mean score for this paper was 34.08 and 32.69 per cent of the candidates scored above 50 per cent of the available marks.

Module 1 – AC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve problems related to simple AC circuits. From a possible 30 marks, the highest score was 28 and no candidate scored zero. Seventy-seven per cent of the candidates achieved Grades A–E.

Question 1

This question tested candidates' knowledge of power in AC circuits. They were asked to define the terms *active* and *reactive* power and also provide the meaning of the term *instantaneous value* of an AC waveform. Most candidates demonstrated knowledge of the terms. Fifty-one candidates attempted this question and approximately half of them scored at least three of the six marks.

Question 2

This question tested candidates' knowledge of reactance. Candidates who responded creditably to all areas of the question demonstrated that they knew what reactance and impedance were; however, some of them experienced difficulty calculating values for each by utilizing the characteristics of a given circuit. Fifty-one candidates attempted the question and only 14 of them scored fewer than three marks. In fact, 26 of them scored full marks.

Question 3

Candidates were asked in Part (a) to state what *passive filters* are as well as the components they utilize, and in Part (b), to explain the term *band pass filtering* and to sketch its response curve. Of the 51 candidates who responded to this question, 32 scored three marks or more. Candidates demonstrated limited knowledge of passive filters and the required components, but were able to explain what band pass filtering is, and sketch and label the response curve.

Question 4

Part (a) tested candidates' knowledge of the term *resonance,* through calculation of the resonant frequency of a series circuit comprising of a coil with specific resistance and inductance and a capacitor; Part (b) required candidates to calculate the voltage across the coil and the capacitor at resonance. Forty-eight candidates attempted this question and only 17 candidates scored three marks or more. Most candidates were able to provide the formula to calculate the resonant frequency and to complete the calculation required for Part (a). With regard to Part (b), most candidates experienced difficulty in providing the relevant formulae and completing the voltage calculations.

Question 5

Candidates were asked in Part (a) to define the term *complex numbers* and in Part (b) to add complex numbers. In response to Parts (a) and (b), candidates demonstrated good knowledge of this area of study. But with regard to Parts(c) (i) and (ii), some candidates although expressing basic knowledge of the Q-factor in an RLC circuit, had some difficulty in providing the formula needed to calculate it. Fifty-one candidates attempted the question and 33 candidates scored three marks or more. Seven candidates provided a perfect response to this question.

Module 2 – Digital Electronics and Data Communications (Questions 6–10)

Basic digital electronics and communications concepts were tested in this module. This module was understood by only a few candidates, only nine (17.30 per cent) of the candidates scored 50 per cent or more of the 30 marks available. The highest score, 22, was achieved by only two candidates. Two candidates scored zero. Forty per cent of the candidates achieved Grades A–E.

Question 6

Candidates were asked to provide in Part (a) the meaning of the terms *fan-in* and *fan-out* related to logic gates. Some candidates did not demonstrate basic knowledge of the terms. In Part (b), candidates were required to draw circuit symbols for the NAND and NOR gates and to indicate their outputs. Candidates demonstrated good knowledge of the symbols for the gates, but some had difficulty in providing the respective outputs for the gates. Fifty-two candidates attempted this question and 17 of them scored in the 5–6 range (from a possible 6 marks) while 20 scored in the 3–4 mark range.

Question 7

Candidates were asked in Part (a) to state the function of A/D conversion and why it is needed. Many candidates were able to provide correct answers for this part of the question. For Part (b), many candidates were unable to define the term *resolution* as applied to an A/D converter. With regard to Parts (c) (i) and (ii), candidates did not demonstrate familiarity with the term *dynamic*, but were able to define the term *volatile*, as they relate to memory systems. In general, this question appeared to be difficult for many candidates as only two of them were able to provide answers in the 4–5 mark range. Fourteen candidates scored in the 3–4 mark range.

Question 8

In Part (a), candidates were asked to state the essential difference between the *enhancement mode* and the *depletion mode* MOSFETs. A very small number of candidates demonstrated basic knowledge of MOSFETs. In Part (b), candidates were required to explain the operation of the DC to AC converter shown in a diagram. This part of the question appeared to be even more difficult than Part (a) for candidates, as they did not demonstrate basic knowledge of the operation of the converter, and how the output voltage (AC) is acquired. Only five candidates scored three or more marks. In general, this question appeared to be difficult for all of the candidates.

Questions 9

Candidates were asked in Part (a) to distinguish between the terms *asynchronous* and *synchronous* waveforms. A very small number of candidates were able to provide the required answers which included timing relationships of waveforms. In Part (b), candidates were expected to provide the formula for the Shannon-Hartley law and identify what each element represented. The majority of candidates could not provide the formula and therefore could not state what the elements represented. The entire question was found to be difficult for the majority of candidates. Only six of the 36 candidates who attempted it scored three or more marks.

Questions 10

In Part (a), candidates were required to draw the logic symbol for a 'D' flip flop and to provide its truth table. Many candidates found this part of the question easy to respond to, in terms of providing the logic symbol, but some experienced difficulty in developing the correct truth table. In Part (b), candidates were required to explain how a register is constructed and what it represents. Many candidates demonstrated limited knowledge of the requirements of this section of the question. Candidates could not accurately state what a register is and what it represents. Six of the 41 candidates who attempted this question provided good responses; twelve scored poorly.

Module 3 – Introduction to AC Machines: (Questions 11 – 15)

In previous years, this module posed significant challenges to candidates in general. There are signs that candidates are beginning to understand and meet the requirements. From a possible 30 marks, the highest score was 24 and only two of the 52 candidates who attempted the question scored zero. Sixty per cent of the candidates achieved Grades A–E.

Question 11

This question tested candidates' knowledge of transformers. In Part (a), most candidates met the requirements to draw and label a diagram to show the general layout of a transformer. Part (b) appeared to be challenging to some of the candidates, as they did not demonstrate knowledge of core losses (hysteresis and eddy current). Twenty-nine candidates provided excellent responses and only five candidates scored poorly.

Question 12

Candidates were asked in Part (a) to name two categories of synchronous motors and in Part (b) to explain where each category of synchronous machine is usually used. In both Parts (a) and (b), candidates did not display the required knowledge to answer adequately the two parts of the question. This question proved difficult for most candidates since only four of them were capable of providing some response. Only two candidates provided excellent responses, scoring in the 5–6 range from a possible six marks. Thirty-eight of the 42 candidates who attempted the question either scored zero or did not respond to the question.

Question 13

Candidates were asked to state in Part (a) the conditions under which an induction dynamo becomes an asynchronous induction generator. Responses to this part of the question demonstrated that some candidates had no knowledge of the process for the change. In Parts (b) (i) and (ii), candidates demonstrated limited knowledge of the required formulae to enable correct calculation of either frequency or speed. The question proved to be challenging for most candidates. Forty-three candidates attempted the question and four candidates scored five of the maximum six marks; and 22 scored three or more marks.

Question 14

Candidates were asked in Part (a) to describe the construction of a squirrel cage motor and in Part (b) to list three uses of the induction motor. Forty-three candidates attempted this question. Eleven candidates provided excellent responses, scoring in the 5–6 mark range; half of the candidates scored three or more marks. Responses to the two parts of this question showed that many candidates had knowledge of the requirements of the question, but 13 appeared not to have been exposed to the concepts required during their studies.

Question 15

Part (a) required candidates to state what the synchronous impedance of a generator or motor is and to give the formula. Many candidates found this question to be challenging as they could not readily state what the meaning of synchronous impedance is, nor could they provide the correct formula. In Part (b), candidates had to draw and label an impedance triangle as derived from a vector diagram of a synchronous generator. Many of them were able to complete Part (b) successfully. Five of the 42 candidates provided excellent responses, scoring five of the six marks allotted to the question; 19 candidates scored three or more marks.

Paper 02 – Essays

Fifty-two candidates sat this paper. They were required to do six of nine questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory; each was worth 30 marks. Candidates were required to select one of the remaining two questions in each module, worth 20 marks each. Most candidates attempted the two required questions from each module.

Marks obtained on this module ranged from 3 to 94. Twenty-one candidates scored 40 marks or more.

Module 1 – AC Circuit Theory (Questions 1–3)

Candidates were required to attempt Question 1 and one other from this module. From a possible score of 50 for this module, the highest score was 39 scored by one candidate and the lowest was two marks scored by a single candidate. Fifty-eight per cent of candidates achieved Grades A–E.

Question 1

This question tested candidates' knowledge of phasors, inclusive of the drawing of phasor diagrams to represent an RLC circuit. Further, candidates were required to define terms in relation to a sinusoidal waveform, peak, average and root mean square values. Most candidates were unable to correctly state what a phasor is, draw and label the required diagrams and state six features of a phasor. The strength of candidates was better demonstrated when calculating current flowing in a given circuit, and the phase angle between the current and the applied voltage, and also defining the required terms. Fifty-two candidates attempted this question. Marks ranged from 1 to 24 and 17 candidates scored 15 marks or more. Twelve candidates scored in the 1–5 mark range.

Question 2

This optional question tested candidates' knowledge of resonance, reactance, impedance and magnification factor (Q). Many candidates experienced challenges with this question. Candidates were quite conversant with definitions but many were unable to solve basic calculations related to the resonant circuit. Thirty-four candidates attempted this question and two scored 13 marks (the highest score from a possible 20 marks); 25 scored five marks or fewer.

Question 3

This question tested candidates' knowledge of filters, specifically the band pass, low pass and high pass filter. Although this question tested basic concepts on filters, the majority of candidates did not select it. It appears that one or a combination of the following occurred: this topic was not taught; the question was too difficult; the alternative question was more attractive to most candidates. Most candidates attempted Parts (a) and (b) of the question and showed that they had knowledge of filters. Candidates demonstrated limited knowledge when responding to Parts (c) and (d). Only 16 candidates attempted this question; one scored 19 of the 20 marks and 13 scored 10 marks or more. Although only a few candidates selected this question, those who attempted it did reasonably well. The mean mark was 12.13.

Module 2 – Digital Electronics and Data Communications (Questions 4–6)

Candidates were required to attempt Question 4 and one other from this section. From a possible score of 50 marks for this module, the marks ranged from zero to 32. One candidate scored 32 and eight candidates received zero. Twenty-one per cent of the candidates achieved Grades A–E.

Question 4

This question tested the candidates' knowledge of UART, 4 Wire Full Duplex Mode of communication, computer networks and modulation techniques (FSK and DPSK). Most candidates could define UART and differentiate between the two computer networks, ring and star topology, but were unable to draw the 4 Wire Full Duplex Mode and explain FSK and DPSK. The question was found to be challenging to many candidates. The marks for this question ranged from 0 to 18 from a possible 30 marks. Two candidates scored 18 marks; 93 per cent scored 16 marks or fewer and 74 per cent scored 9 marks or fewer.

Question 5

This question focused on the MOSFET, the thyristor and the DC to AC converter. Candidates were required to draw a biased circuit diagram, describe the operation of the MOSFET and state its threshold voltage. Candidates also had to draw the block diagram of a DC to AC converter, explain its operation and state how the thyristor can be switched into its conducting mode. Many candidates could easily state what the threshold voltage was and the ways of switching the thyristor into its conducting mode. Most candidates however experienced difficulty drawing the diagram of the MOSFET, explaining its operation and also the drawing of a block diagram of the converter and explaining its operation. Only six candidates attempted this question. It appears that the question was either too difficult or the alternative question was more attractive to most candidates. The highest score was five marks and four of the six candidates scored zero. It was evident that candidates were not prepared for this question.

Question 6

Given block diagrams of a BCD encoder and an analogue to digital converter, candidates were required to explain their operation; to explain what a multiplexer is and to define the terms EPROM and RAM as they relate to memory systems. Many candidates displayed knowledge of the *multiplexer* and the terms related to the memory system, but displayed limited knowledge when explaining the operation of the encoder and the converter. Forty candidates attempted the question and scored marks ranging from zero to twelve. One candidate scored 12 marks, 95 per cent scored 10 marks or fewer and 75 per cent scored six marks or fewer.

Module 3 – Introduction to AC Machines: (Questions 7–9)

Candidates were required to attempt question seven and one other from this section. From a possible score of 50 marks for this module, the marks obtained by candidates ranged from zero to 31. One candidate scored 31 marks and three scored zero. Twenty-seven per cent of the candidates achieved Grades A–E. Candidates' performance suggests that they were not quite conversant with this module.

<u>Question 7</u>

This question focused on the transformer and required candidates to sketch and label waveforms of flux variation, and magnetic flux versus time; derive the equation for e.m.f; identify the elements of an ideal transformer, and calculate the efficiency of a transformer on load, given values for the resistance and voltages of the primary and secondary windings and also the core loss and power factor on load. Fifty-two candidates attempted the question and marks ranged from zero to 21. One person scored 21 marks, 96 per cent scored fewer than 15 marks and 72 per cent scored fewer than nine marks. It is evident that most candidates were familiar with the transformer and its operation, but most were unable to calculate the transformation ratio.

<u>Question 8</u>

This question tested candidates' knowledge of the induction motor and required them to sketch a labelled torque versus slip curve, deduce from the curve the usefulness of the motor and to state what slip speed is. Given information on a motor that has four poles, they were also required to calculate full load current, synchronous speed, full load slip, speed regulation and maximum loading speed. Twenty-four candidates attempted this question and scored marks ranging from zero to 14. Two candidates scored 14 marks, 75 per cent scored ten marks or fewer and 50 per cent scored 6 marks or fewer. It appears that this question was quite challenging for most candidates.

<u>Question 9</u>

This question tested candidates' knowledge of synchronous machines and speed control for split phase motors. Candidates were also required to calculate synchronous impedance, reactance, and voltage regulation of a single phase alternator given specific information related to it. Twenty candidates attempted this question and scored marks ranging from zero to six. Only one candidate scored six marks; the other candidates scored three marks or fewer. It appears that many candidates were not familiar with the requirements of this question.

Paper 03 – School-Based Assessment (SBA)

Samples Submitted by Schools

Adequate numbers of sample SBAs were submitted for inspection and moderation. The following were observed:

- The grades submitted from some of the schools appeared inflated.
- No project activity booklets were submitted.
- Students did not adhere to the specific guidelines/requirements for completing SBAs.
- Students need to follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Most observed were unacceptable.
- In many instances, students failed to discuss the findings of the experiment or outcome of the project.
- Some projects submitted were too simple for the CAPE level.

Recommendations

1. A workshop on SBA should be held for schools.

2. Students could benefit from closer supervision.

3. Each student should complete his/her SBA individually.

4. CXC should employ field examiners to monitor SBA activities in schools.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2013

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and sixty-seven candidates registered for Unit 1; however, 154 candidates wrote Paper 01 and 152 candidates wrote Paper 02. None of the candidates who wrote this unit earned a Grade I; however, 76 per cent of candidates earned Grades II–V.

Sixty-nine candidates registered for Unit 2. Sixty candidates wrote Paper 01 and 61 wrote Paper 02. Eighty-three per cent of candidates earned Grades I–V.

There has been a significant increase in registration for this subject but there is still need for more promotion and marketing of the subject to ensure that there is a continuous increase in candidates each year.

As in previous years, performance at Grades I–III in both units has been weak, with the majority of passes being earned at Grades IV–V. The poor performance at the higher grades could be a result of one or a combination of factors including:

- The ill preparedness of candidates for the subject
- The source from which candidates are drawn which does not provide the foundation for this subject
- The weak mathematics and science background of candidates
- The need for the training and orientation of teachers
- The unavailability of facilities to support this subject

DETAILED COMMENTS

UNIT 1

Paper 01 – Short-Answer Questions

This paper consisted of 15 short-answer questions, each worth six marks. Candidates were required to attempt all questions. The paper was worth 90 marks. Candidates' overall marks ranged from 2 to 63. The mean score for this paper was 28.27. Two candidates scored in the 61–75 range, seven candidates scored in the 51–60 range, 18 scored in the 41–50 range, 36 scored in the 31–40 range and 46 scored in the 21–30 range. The remaining 45 candidates scored 20 or less than 20 marks.

Module 1: DC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve simple DC circuits. From a possible 30 marks, the highest score achieved was 24 and the lowest score was zero. Fifty-three candidates scored 50 per cent or above in this module, 43 candidates scored in the 11–14 range, 42 scored in the 6–10 range and the remaining 16 candidates scored five or less than five marks.

Question 1

This question tested candidate's knowledge of current and power in a series-parallel resistor circuit. Candidates were required to calculate in Part (a), current I and in Part (b), total power dissipated. All candidates attempted the question; 60 per cent provided perfect responses whereas six per cent scored zero. In general, this question was answered reasonably well by most candidates. Some candidates experienced problems interpreting the diagram correctly, and therefore, could not complete the required calculations. They, however, demonstrated knowledge of both Ohms' law and the formulae needed to calculate current and power dissipated in a resistive circuit. Candidates could benefit from more practice in determining how resistors are placed in resistive networks.

Question 2

In this question, candidates were asked to define the term *permittivity of free space*, write the symbol and unit for permittivity of free space, and calculate the total electrostatic energy stored in two capacitors connected in parallel. All candidates attempted this question, six per cent of whom were able to give perfect responses. Six per cent of candidates scored zero on this question. Many candidates were unable to demonstrate knowledge of permittivity of free space; however, they were able to select the right formula and calculate the total electrostatic energy stored.

Question 3

Candidates were required to demonstrate knowledge of inductors. In Part (a), they were asked to state one advantage and one disadvantage of an inductor with a ferromagnetic core. In Part (b), they were required to explain the term *coupling coefficient* and determine the coupling coefficient of two coils with mutual inductance, M. None of the candidates scored full marks on this question. Three per cent of those who attempted the question scored five marks, while ten per cent scored zero. Most candidates were able to state the advantage and disadvantage of the inductors and explain the term coupling coefficient. Some difficulty was experienced by candidates calculating the coupling coefficient of the two coils.

Question 4

Candidates were required to calculate the resistance of an aluminum rod and the coefficient of resistance of a coil of copper wire. Six per cent of the candidates who attempted this question gave perfect answers; however, 17 per cent scored zero. In Part (a), the correct formula was used by the majority of candidates who were able to correctly calculate the resistance. In Part (b), many candidates were unable to complete the required calculations and hence could not arrive at the correct solution.

Question 5

Candidates were given a resistive circuit and were required to use the superposition theorem to calculate the voltage V_{out} across resistor R_3. Responses to this question were weak and this was reflected in a question mean of 0.6. One candidate provided a perfect response while 69 per cent of candidates scored zero. The majority of candidates were unable to use the required theorem to partially solve the problem; several candidates incorrectly used Kirchoff's voltage law in an attempt to solve the problem.

Module 2: Analogue Electronics and Communications (Questions 6–10)

Basic analogue electronics and communications concepts were tested in this module. This module proved to be somewhat challenging and most candidates scored low marks. The highest score was 21 and two candidates scored zero from a possible 30 points. Three candidates scored in the 16–20 range, 23 scored in the 11–15 range, 72 scored in the 6–10 range and the remaining 53 candidates scored either five or less than five marks.

Question 6

Part (a) tested candidates' knowledge of *a ground wave*; Part (b) required a definition of the term *antennae* and Part (c) required them to state the frequency bands for LF and VHF carrier waves. This question was not well done by candidates. Only one candidate scored full marks, while 69 per cent scored zero. In Part (a), a number of candidates were able to state only one of the two factors that affect the range of ground waves. Part (b), defining the term *antenna,* was widely attempted with several correct responses being given. In Part (c), candidates were unable to state the required frequency bands.

Question 7

In Part (a), candidates were required to state the meaning of the term *semiconductor* and outline its special feature. In Part (b), candidates were to use a given diagram of a *clipper circuit* to identify the type of clipper shown, draw its output waveform and describe its operation. Candidates did not do well on this question. No candidate scored full marks. Eight per cent of candidates provided good responses, while 18 per cent scored zero. Most candidates demonstrated general knowledge of semiconductors but had challenges describing the operation of the circuit.

Question 8

Candidates were asked to state what an oscillator is, and define *power bandwidth*, *slew rate*, and *unity gain frequency* as they relate to op-amps. Responses to this question were poor. No candidate was able to provide a perfect response; however, ten per cent scored in the range of 3–4 marks. Thirty-three per cent of candidates scored zero. Candidates found this question difficult. They could not accurately state what an oscillator is, and experienced difficulty defining *slew rate* and *unity gain frequency*.

Question 9

Candidates were asked to determine the local oscillator frequency of an AM receiver given an IF frequency of 455KHz and the received signal of 760 KHz, and state four sine waves that are produced when a modulating frequency (F_m) amplitude modulates a carrier frequency (F_c). Seven per cent of candidates were able to score three marks or more in this question; however, 72 per cent scored zero. Most candidates attempted Part (a) but used the incorrect formula. For Part (b), candidates could not identify the sine waves produced.

Question 10

Candidates were required in Part (a), to draw the schematic diagrams of an NPN transistor and a PNP transistor. In Part (b), candidates were asked to calculate the emitter current of a transistor connected in the common emitter configuration, given the collector and base currents. For Part (c), candidates were asked to state the main reason why the common emitter amplifier is most often used in electronic circuits. Forty-five per cent of candidates scored marks ranging from three to six. Nineteen per cent of candidates scored zero. Most candidates answered Part (a) well; however, some candidates drew a diagram showing the structure of a transistor instead of the schematic as required. In Part (b), most candidates did not give clear evidence of understanding that the emitter current is a combination of the collector and base currents. In their responses to Part (c), it was clear that candidates did not understand why the common emitter amplifier is often used in electronic circuits.

Module 3: Introduction to Power Systems (Questions 11–15)

This module introduces candidates to electrical power systems; however, it continues to be the most challenging of the three modules. The highest score on this module was 23. Eight per cent of candidates scored zero. The statistics suggests that there is improvement in performance in this module when compared with previous years.

Question 11

Part (a) tested candidates' knowledge of magnetic flux density, while Part (b) required candidates to calculate the force on a conductor given relevant information. Six per cent of candidates provided perfect responses while 20 per cent scored zero. Most candidates correctly defined magnetic flux density and showed its symbol and unit, but they could not calculate the force on the conductor because they used the incorrect formula.

Question 12

This question tested candidates' knowledge of Faraday's law and Lentz's law. None of the candidates scored full marks on this question. Ninety-two per cent of candidates scored between zero and two marks. Many candidates did not respond well to this question.

Candidates were unable to state the two laws and provide the related equations. Candidates need to become familiar with these two laws and their equations.

Question 13

Part (a) asked candidates to state the role of the *commutator* and *carbon brush* used in a DC machine. In Part (b), they were required to state two common losses in a DC machine. For Part (c), they were asked to draw the excitation circuit of a self-excited shunt generator. No candidate provided a perfect response, and 36 per cent either did not respond to the question or scored zero. Twelve per cent of candidates scored in the range of 4–5 marks and 51 per cent scored in the range of 1–3 marks. Many candidates could not state the role of the *commutator* and the *carbon brush*. Candidates were able to state two sources of losses in a DC machine. Many candidates attempted to draw the excitation circuit but placed the components incorrectly. It is evident that candidates lacked a good working understanding of DC machines and hence were unable to adequately answer the question.

Question 14

This question tested candidates' knowledge of the supervisory control and data acquisition (SCADA) system. Three per cent of candidates provided perfect responses while 26 per cent either did not respond to the question or scored zero. Twenty-one per cent scored in the range of 4–5 marks and 49 per cent scored in the range of 1–3 marks. Many candidates were unable to respond positively to this question, indicating that they lacked knowledge of the SCADA system, inclusive of its sub-system and security concerns.

Question 15

This question required candidates to explain the operation of a fuse under the following conditions (a) continuous current, (b) overload current and (c) fault current. Four per cent of candidates provided perfect responses while 34 per cent either did not respond to the question or scored zero. Ten per cent of candidates scored in the range of 4–5 marks and 53 per cent scored in the range of 1–3 marks. Many candidates were able to explain what was meant by *continuous current*, but were unable to adequately explain what was meant by *overload current* and *fault current.* The responses indicated that many candidates lacked understanding of the operation and function of a fuse.

Paper 02 – Essays

One hundred and fifty-three candidates wrote this paper. Candidates were required to answer six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and each worth 30 marks. Candidates were required to select one of the remaining two questions in each of three modules. Each question was worth 20 marks. Most candidates attempted the required question from each module.

Candidates' scores ranged from a low of 3 to a high of 81. One candidate scored above 80 marks, 39 scored in the range of 50–79 marks, 57 scored in the range of 30–49 marks, 50 scored in the range of 10–29 marks, and the remaining 6 candidates scored nine or below.

Module 1: DC Circuit Theory (Questions 1–3)

Candidates were required to answer Question 1 and one other from the remaining two questions in the section. From a possible score of 50 in this module, the highest score was 34. Four candidates scored in the range of 31–40 marks, 43 scored in the range of 21–30 marks, 65 scored in the range of 11–20 marks, and 39 candidates scored either 10 or less than 10 marks.

Question 1

Part (a) focused on candidates' knowledge of Ohm's law and Kirchhoff's Voltage and Current laws. In Part (b), candidates were given a resistive circuit and asked to use Kirchoff's law to calculate V_1 and I_2. In Part (c), candidates were expected to state Thevenin's theorem and determine Thevenin's equivalent for a given series-parallel network. Part (d) asked candidates to state the Maximum Power Transfer theorem. The majority of candidates displayed knowledge of resistance, Ohm's law, Kirchhoff's Current law, and the Maximum Power Transfer theorem. Problems were encountered by candidates when they tried to state Kirchhoff Voltage law and to express it as an equation. Given a series-parallel resistive network to determine the Thevenin's equivalent, candidates were unable to accurately analyse the diagram, form the required equation, and carry out the mathematical aspects. The maximum score obtained was 18 from a possible 30 marks. Thirty-four candidates scored in the range of 11–20 marks, 70 scored in the range of 6–10 marks, 46 scored in the range of 1–5 marks and three candidates either scored zero or did not attempt the question. Overall, candidates demonstrated good knowledge of Parts (a) and (d), but experienced difficulty with Parts (b) and (c).

Question 2

This question was designed to test candidates' knowledge and understanding of capacitors. In Part (a), candidates were expected to define *capacitance* and provide information on the dielectric of capacitors. For Part (b), they were asked to calculate the number of plates required for a multi-plate 60 nF capacitor. In Part (c), candidates were required to calculate potential difference across each capacitor, and the total stored charge and stored energy when given a capacitance network. In Part (d), they were asked to determine the time constant of a capacitor under discharge condition, and draw a graph to show potential difference across the capacitor during discharge.

This question was selected by 133 candidates. Candidates ably defined the term *capacitance*, *unit of capacitance,* stated the dielectric of a capacitor and gave two examples of materials commonly used as a dielectric. Candidates demonstrated good knowledge of the required information. Part (b) was not well done, as most candidates could not provide the required formula, transpose the formula to determine *n* (number of plates), insert the stated values, and calculate correctly using the standard form. Candidates found it challenging to state the correct formulae for Parts (c) and (d), and complete the required calculations. From a maximum of 20 marks, the highest score was 19. Forty-six candidates scored in the range of 11–20 marks, 59 scored in the range of 6–10 marks, and 28 candidates scored 5 marks or below.

Candidates had no difficulty with Part (a), but found Parts (b), (c) and (d) to be the most difficult parts of the question.

Question 3

This question tested candidates' knowledge of inductors. In Part (a), candidates were required to define *inductance* and its unit, and state two applications of an inductor. For Part (b), they were asked to determine the number of turns required to fabricate an inductor, given specific values, and to calculate flux and energy stored by the inductor. In Part (c), candidates were required to state three ways of increasing inductance. In Part (d), they were asked to comment on the origin of resistance in an inductor connected across a DC battery, calculate the time constant and final value of current, and sketch and label the curve showing the growth of current for the circuit.

Candidates were able to define the term *inductance* and the unit of inductance and state applications of inductors. Calculating both the energy stored by the inductor and time constant were well done. Candidates experienced difficulty explaining the inductor's resistance. However, the greatest difficulty was experienced in calculating the number of turns for the inductor. Nineteen candidates chose this question. It was evident that several candidates experienced difficulty calculating the required values. From a possible 20 marks, the highest score was 13. Four candidates scored in the range of 11–20 marks, eight scored in the range of 6–10 marks and seven candidates scored five or less than five marks. Candidates demonstrated good knowledge of Part (a), but experienced difficulty with Parts (b), (c) and (d), especially where calculations were required.

Module 2: Analogue Electronics and Communications (Questions 4–6)

Candidates were required to do Question 4 and one from the other two questions in this section. The maximum possible score for this module was 50, and the highest score achieved was 23. Two candidates scored in the range of 21–30 marks, 44 candidates scored in the range of 11–20 marks, 61 scored in the range of 6–10 marks, and 45 candidates scored five or less than five marks.

Question 4

In this question, Parts (a), (b) and (c) tested candidates' knowledge of the superhet. Part (d) required candidates to explain the major advantage of frequency modulation over amplitude modulation and Part (e) required candidates to state four advantages of single sideband transmission over double sideband transmission. In Part (f), candidates were asked to define the term modulation index of an FM signal and to state how it is calculated. In Parts (g) and (h) respectively, candidates were asked to calculate the modulation index of an FM signal and determine the amount of power contained in each sideband of a double sideband (DSB) signal. Many candidates could not explain how the superhet works but they were able to identify at least one electronic device in which the superhet is used. Although candidates attempted the various parts of the question, they did not demonstrate the required knowledge to answer the different parts of the question effectively. Candidates found it difficult to explain the major advantage of frequency modulation over amplitude modulation. The highest score was 13 from a possible 30 marks. Two candidates scored in the range of 11–20 marks, 28 candidates scored in the range of 6–10 marks, and 93 candidates scored five or less than five marks. Thirty candidates did not attempt the question.

Question 5

In Part (a), candidates were required to provide an illustration of the effects of sky wave propagation. For Part (b), they were asked to state what multiple hop transmission is as it relates to sky wave propagation. In Part (c), candidates had to identify three ways how a radio wave can travel after leaving a transmitter. In Part (d), they were asked to state the wave bands for the three ways identified in Part (c). For Part (e), candidates were required to define the term *ground wave* and outline four of its characteristics.

In Part (a), a few candidates were able to draw and label the diagram, showing the effects of sky wave propagation. In Part (b), many candidates did not demonstrate any knowledge of multiple hop transmission. For Part (c), many candidates could not identify the three natural ways a radio wave can travel after leaving an antenna. In Part (d), most candidates could not provide the wavebands and method of modulation for each waveband. For Part (e), none of the candidates neither correctly defined a ground wave nor outlined four of its characteristics.

Forty-six candidates responded to this question. Generally, the responses were quite weak. No candidate provided a perfect response. One candidate scored 13 marks, one scored in the range of 11–20 marks, 12 scored in the range of 6–10 marks, and 35 scored either five or less than five marks.

Question 6

This question focused on candidates' explanation of the similarity and difference between germanium and silicon semiconductors, and doping as it relates to crystals. They were also asked to state the functions of certain components of a filtered full-wave power supply and calculate voltage and current values at various parts of the power supply. Candidates demonstrated adequate knowledge of the requirements for Parts (a) and (b), but experienced some difficulty stating the functions of the identified components. Candidates were unable to adequately calculate the voltage and current values required. One hundred and six candidates attempted this question. The highest score attained was 13 from a possible 20 marks. Five candidates scored in the range of 11–20 marks, 49 scored in the range of 6–10 marks, and 52 scored either five or less than five marks.

Module 3: Introduction to Electrical Power Systems (Questions 7–9)

Candidates were required to answer Question 7 and one other from the remaining two questions in the section. From a possible maximum score of 50, the highest score was 33. Only one candidate scored in the range of 31–40 marks, 24 candidates scored in the range of 21–30 marks, 69 scored in the range of 11–20 marks, 34 candidates scored in the range of 6–10 marks, and 24 candidates scored either five or less than five marks.

Question 7

This question required candidates to demonstrate knowledge of mutual induction, sketch and label a B-H curve for a ferromagnetic material, determine the average value of the e.m.f induced in a coil, explain the terms *relative permeability*, *reluctance* and *magnetomotive force* and use given information on a coil to calculate magnetic field strength, magnetic flux density, total flux and reluctance. Candidates were able to adequately answer Parts (a) and (d) but experienced difficulty when sketching and labelling the B-H curve for Part (b), and completing the required calculations for Parts (c) and (e). In most cases, candidates were unable to identify and utilize needed formulae for the required calculations.

The maximum score obtained was 17 from a possible 30 marks. Forty candidates scored in the range of 11–20 marks, 67 scored in the range of 6–10 marks, and 41 scored five or less than five marks.

Question 8

This question tested candidates' knowledge of relays and circuit breakers. In Part (a), candidates were asked to distinguish between a relay and a circuit breaker. In Part (b), they were required to explain the operation of the inverse minimum time over current relay. In Part (c) (i), candidates were asked to state the main purpose of using thermal overload relays with electric motors, and three problems that thermal overload relays assist in preventing. In Part (c) (ii), they had to identify four features of thermal overload relays. In Part (d), candidates were required to explain the operation of a voltage surge protector.

Candidates demonstrated the knowledge required to adequately answer Parts (a) and (d), thus indicating understanding of the principles of a relay, a circuit breaker and a voltage surge protector. Candidates could not explain the operation of the inverse minimum time over current relay, nor could they sketch its characteristics. Twenty-seven candidates chose this question with the highest score achieved being 11 from a possible 20 marks. One candidate scored in the range of 11–20 marks, five scored in the range of 6–10 marks, and 21 candidates scored five or less than five marks.

Question 9

This question required candidates to explain the SCADA system, describe how SCADA system data is transmitted, state two advantages and two disadvantages of digital communication, and explain the term *duplex data communication*, giving two examples of it. The majority of candidates was able to adequately answer Parts (c) and (d). Explaining how the SCADA works and how system data is transmitted, as required for Parts (a) and (b), were the areas where candidates encountered challenges. Many candidates did not demonstrate knowledge of SCADA. One hundred and six candidates selected this question. The highest score was 16 from a possible 20 marks. Twenty-two candidates were able to score in the range of 11–20 marks, 39 candidates scored in the range of 6–10 marks, and 47 candidates scored five or less than five marks.

UNIT 2

Paper 01 – Short-Answer Questions

Candidates were required to answer all questions from this paper which accounted for 90 marks. The lowest score achieved was six, while the highest score was 82. The mean score for the paper was 36.03. Of the 60 candidates who wrote this paper, two scored in the range of 75–80 marks, five scored in the range of 61–75 marks, nine scored in the range of 51–60 marks, 12 scored in the range of 41–50 marks, 11 scored in the range of 31–40 marks, 14 scored in the range of 21–30 marks, and seven scored in the range of 11–20 marks.

Module 1: AC Circuit Theory (Questions 1–5)
Candidates were required to use fundamental laws and simple theory to solve simple AC circuits. From a possible maximum of 30 marks, the highest score was 29 and no candidate scored zero. Six candidates scored in the range of 21–30 marks, 17 scored in the range of 11–20 marks, 30 scored in the range of 6–10 marks, and seven scored either five or less than five marks.

Question 1

This question tested candidates' knowledge of a sinusoidal waveform. Candidates were asked to define the terms *frequency*, *RMS value* and *average value*, and express a 400 Hz sinusoidal waveform of rms = 15V in the form $V = V_o \sin \omega t$. Most candidates provided the required definitions for Part (a) but experienced some difficulty in providing the correct equation and carrying out the needed calculations to answer Part (b). The maximum possible mark was six. Twenty candidates provided excellent responses to this question, scoring in the range of 5–6 marks from a possible 6 marks. Sixteen candidates scored in the range of 3–4 marks, and 24 scored either two or less than two marks.

Question 2

Candidates were given the amperage which an electric soldering iron consumes from a given voltage supply and they were asked to determine resistance of the soldering iron, calculate the power consumed, and sketch the phasor diagram. Twenty-seven candidates provided perfect responses for this question, 26 scored in the range of 3–4 marks and six scored either two or less than two marks. Candidates demonstrated knowledge of determining the resistance of the electric soldering iron and calculating the power consumed, but had difficulty sketching the phasor diagram.

Question 3

This question tested candidates' knowledge of reactance. Candidates were asked to define the terms *reactance* and *impedance*, and calculate the *inductive reactance* and *capacitive reactance*, of a series connected RLC circuit, with a given frequency of 50 Hz. Candidates responded well to all areas of the question and demonstrated that they knew what both reactance and impedance were. However, some experienced difficulty completing the calculations requested. Thirty-five candidates provided excellent responses, scoring in the range of 5–6 marks. Fourteen candidates scored in the range of 3–4 marks and eleven scored either two or less than two marks.

Question 4

This question tested candidates' knowledge of the term *resonance*. Candidates were given the values of an inductor and a resistor, connected with a capacitor of unknown value, in a series resonant circuit. They were required to draw and label the circuit, calculate the value of the capacitor, C, for a resonant frequency of 1 KHz, and determine the 'Q' factor. Most candidates demonstrated good knowledge of the RLC resonant circuit, and of the terms *resonant frequency* and *Q factor*. However, some candidates could not transpose the resonant frequency formula to make C the subject, and hence could not complete the required calculations for C correctly. Nineteen candidates scored in the range of 5–6 marks, 19 candidates scored in the range of 3–4 marks, and 21 candidates scored either two or less than two marks.

Question 5

Candidates were asked to define the term *cut off frequency*, explain the operation of a high-pass filter and give two examples of the application of a high-pass filter. In response to Parts (a), (b) and (c), candidates demonstrated sound knowledge. Twenty-five candidates provided perfect responses. Twenty-one candidates scored in the range of 3–4 marks and 14 scored either two or less than two marks.

Module 2: Digital Electronics and Data Communications (Questions 6–10)

Basic digital electronics and communications concepts were covered in this module. This module was not well done by many candidates. Three candidates scored 50 per cent or more of the 30 marks available. The highest score was 27 and the lowest score was zero. Only one candidate scored in the range of 21–30 marks, two scored in the range of 16–20 marks, two scored in the range of 11–15 marks, 17 scored in the range of 6–10 marks, and 38 scored five or less than five marks.

<u>Question 6</u>

Candidates were asked to use a block diagram to explain the operation of a DC to DC convertor. Candidates could not draw the block diagram. Although they appeared to know what the convertor does, they could not explain its operation. Three candidates provided perfect responses to this question and scored in the range of 5–6 marks, one scored in the range of 3–4 marks, thirty-four scored two or less than two marks and 22 candidates did not respond to the question.

<u>Question 7</u>

In Part (a), candidates were asked to define the terms *minterm* and *maxterm* as they relate to combinational logic circuits. In Part (b), they were required to draw the EX-OR logic gate, and write the Boolean expression. Most candidates did not attempt to answer Part (a) which indicated that they were not knowledgeable about the topic. For Part (b), most candidates were able to draw the correct symbol for the EX-OR logic gate, but were unable to derive the Boolean equation. This question was poorly done; only one candidate was able to provide a perfect response. One candidate scored in the range of 3–4 marks, 56 scored two or less than two marks and two candidates did not attempt the question.

<u>Question 8</u>

Candidates were asked to define the following terms: *dynamic*, *destructive* and *volatile*, as they relate to memory systems, and calculate the reference voltage needed for a seven bit D/A convertor to generate a maximum output of 12 volts. Most candidates demonstrated some knowledge of memory systems; however, some gave vague definitions. In Part (b), only a few candidates satisfactorily calculated the reference voltage. Two candidates scored in the range of 5–6 marks from a possible 6 marks, six scored in the range of 3–4 marks, 45 scored two or less than two marks and seven did not attempt the question.

<u>Questions 9</u>

Candidates were asked to identify four components of a universal asynchronous receiver transmitter (UART) and explain pulse code modulation (PCM). The majority of candidates attempted to answer Part (a) but only correctly identified two components. Explaining pulse code modulation in Part (b) was not well done. Candidates lacked basic knowledge of PCM. Two candidates scored in the range of 5–6 marks out of a possible 6 marks, seven candidates scored in the range of 3–4 marks, 40 candidates scored either two or less than two marks and 11 candidates did not attempt the question.

Questions 10

In this question, candidates were required to state what an SR flip flop is, explain the operation of a 555 timer when used in the monostable mode, and state what is a shift register. In Part (a), many candidates seemed to have a good working knowledge of flip flops. In Part (b), most candidates did not demonstrate knowledge of the 555 timer, and in Part (c), few candidates clearly expressed what a shift register is. Two candidates provided good responses which were scored in the range of 5–6 marks from a possible 6 marks, 17 candidates scored in the range of 3–4 marks, 33 scored two or less than two marks and eight candidates did not respond to the question.

Module 3: Introduction to AC Machines (Questions 11–15)

In previous years, this module posed significant challenges to candidates in general. There are signs that candidates are beginning to understand and meet the requirements of this module. From a possible 30 marks, the highest score was 27 and no candidate scored zero. Three candidates scored in the range of 21–30 marks, eight scored in the range of 16–20 marks, 23 scored in the range of 11–15 marks, 18 scored in the range of 6–10 marks, and eight candidates scored either five or less than five marks.

Question 11

Candidates were asked to use a diagram to describe the operating principles of a transformer and show its general arrangement. Candidates were able to use a diagram to describe the operating principles of a transformer. Twenty three candidates provided excellent responses and scored in the range of 5–6 marks from a possible 6 marks, 24 scored in the range of 3–4 marks, 11 scored either two or less than two marks and two candidates did not respond to the question.

Question 12

This question tested candidates' knowledge of a synchronous generator. Candidates were required to explain the purpose of the field winding and armature windings, and sketch and label a graph to show the percentage voltage regulation of a synchronous generator. Candidates were able to give explanations for both types of windings: however, the responses needed to be more detailed. Many candidates were unable to accurately sketch and label the graph to show the percentage voltage regulation. One candidate provided an excellent response and scored in the range of 5–6 marks from a possible 6 marks, ten candidates scored in the range of 3–4 marks, 42 scored two or less than two marks and seven candidates did not attempt the question.

Question 13

In this question, candidates were asked to use a diagram to explain the term *slip* as it relates to an induction motor, and give two reasons why induction motors are now the preferred choice for industrial use. In response to Part (a), candidates were unable to draw the diagram to explain the term *slip*. They therefore did not demonstrate the knowledge required to answer the question. In Part (b), candidates demonstrated that they had knowledge of why induction motors are the preferred choice for industrial use. Two candidates scored in the range of 5–6 marks, six scored in the range of 3–4 marks, 49 scored two or less than two marks and three candidates did not attempt the question.

Question 14

This question required candidates to calculate the percentage efficiency of a transformer given relative values, and state two losses which occur when a transformer is on no load. Responses to the two parts of this question showed that many candidates had knowledge of the requirements for Part (b) but some experienced difficulty when attempting to calculate the percentage efficiency of the transformer. Thirty-one candidates provided excellent responses, scoring in the range of 5–6 marks, five scored in the range of 3–4 marks, and 23 candidates scored two or less than two marks. One candidate did not attempt the question.

Question 15

This question required that candidates explain the operation of an induction motor, and state three machines or appliances in which the single phase induction motor is used. For Part (a), many candidates could not adequately explain the operation of an induction motor. They lacked the necessary information to answer the question. Part (b) was well answered. Seven candidates provided excellent responses, scoring in the range of 5–6 marks, 15 scored in the range of 3–4 marks, and 34 candidates scored two or less than two marks. Four candidates did not attempt the question.

Paper 02 – Essays

Sixty candidates wrote this paper. They were required to answer six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 were compulsory and were worth 30 marks each. Candidates were required to select one of the remaining two questions in each module for a value of 20 marks each. Most candidates attempted the required question from each module. The lowest score achieved on this paper was 13 and the highest mark achieved was 113. The mean score for the paper was 40.48.

Module 1: AC Circuit Theory (Questions 1–3)

Candidates were required to answer Question 1 and one other from this section. From a possible score of 50, the highest score was 39 and the lowest was two. Six candidates scored in the range of 31–40 marks, 16 scored in the range of 21–30 marks, 31 scored in the range of 11–20 marks, and seven candidates scored in the range of 6–10 marks.

Question 1

In Part (a), candidates were required to define *real power*, *reactive power* and *apparent power*, and provide their symbols and units. Part (b) required candidates to explain the relationship between voltage and current and identify the load types in circuits having (i) lagging power factor, (ii) leading power factor and (iii) unity power factor. In Part (c), candidates were given relative values in terms of power factor, voltage, frequency and power consumed by a load and were required to determine (i) apparent reactive powers and (ii) the capacitance of a capacitor required to connect across the load terminals to change the power factor to unity. Parts (d) and (e) dealt with phasors and required candidates to state three properties of phasors, and draw and label two cycles of a sinusoidal wave.

Candidates were able to define the terms given in Part (a) and explain the relationships and load types in Part (b). In relation to Part (c), many candidates experienced difficulty completing the calculations for apparent and reactive powers and the capacitance of the capacitor under the given conditions. In Part (d), most candidates were able to correctly state the properties of phasors, and in Part (e), they were able to draw and label the required diagram. From a possible 30 marks, 26 was the maximum obtained and the minimum was two marks. One candidate scored in the range of 21–30 marks, 12 scored in the range of 16–20 marks, 19 scored in the range of 11–15 marks, 19 scored in the range of 6–10 marks, nine scored five or less than five marks.

Question 2

This question tested candidates' knowledge and application of knowledge. In Part (a), candidates were required to define the term *resonance*. In Part (b), they were asked to define *oscillation of energy* and *Q factor* and to state two characteristics of the potential difference across circuit components when $Q>1$ for a series RLC circuit at resonance. For Part (c), candidates were asked to calculate capacitive and inductive reactance, currents I_r, I_c and I_t, and circuit impedance when given a parallel RLC network. Many candidates experienced challenges with this question. Candidates were quite conversant with the descriptions and definitions expected for Parts (a) and (b) but many were unable to solve basic calculations related to the parallel RLC network, particularly the calculation of the capacitive and inductive reactances. One candidate achieved a maximum score of 16 from a possible 20 marks, nine scored in the range of 11–15 marks, 17 scored in the range of 6–10 marks, and 12 candidates scored five or less than five marks. Twenty-one candidates did not attempt the question.

Question 3

This question tested candidates' knowledge and application of knowledge about filters. In Part (a), candidates were required to state what a filter is. In Part (b), they were asked to sketch the frequency response for the low pass, band pass and notch filters and to show their cut-off frequencies. In Part (c), candidates were required to (i) draw the symbols for a low-pass and a high-pass filter, (ii) explain the function of a high-pass filter with a cut-off frequency f_o, and (iii) draw the circuit diagram of a *T*-section high-pass filter. In Part (d), candidates were required to (i) calculate the required components R_o, and (ii) draw a circuit which will satisfy the specifications outlined in Part (d) (i). Candidates demonstrated some knowledge as required for Parts (a), (b) and (c) but performed poorly when completing the required calculations. Twenty-two candidates attempted this question and one scored a maximum of 17 marks. Two candidates scored in the range of 16–20 marks, four scored in the range of 11–15 marks, 12 scored in the range of 6–10 marks, and four candidates scored five or less than five marks.

Module 2: Digital Electronics and Data Communications (Questions 4–6)

Candidates were required to answer Question 4 and one of the other two remaining questions from this section. From a possible score of 50 marks for this module, the marks obtained by candidates ranged from zero to thirty-three. One candidate scored in the range of 31–40 marks, three scored in the range of 21–30 marks, 29 scored in the range of 11–20 marks, 15 scored in the range of 6–10 marks, and 12 candidates scored five or less than five marks.

<u>Question 4</u>

Part (a) required candidates to describe the characteristics of a synchronous system and an asynchronous system in relation to sequential logic. Part (b) asked them to state what a flip flop is. In Part (c), candidates were asked to draw the equivalent logic circuit of a D type flip flop and develop a table to show its operation. For Part (d), candidates were required to identify three useful applications of flip flops. Part (e) asked them to state the main characteristic of a 555 timer when used in the monostable mode. In Part (f), candidates were asked to state which components determine the output pulse width of a given monostable timer circuit and to calculate the minimum trigger voltage and the width of the output pulse. For Part (g), they were required to explain the operation of a counter.

Some candidates were able to answer Parts (a) (i) and (ii) correctly. Candidates demonstrated knowledge of Parts (b) (c) and (d) and these appeared to be the easiest parts of the question for candidates. Many candidates were unable to state the components which determine the output pulse width of the given monostable timer circuit. Additionally, many were unable to successfully complete the calculations required for Part (f) (ii). For Part (g), many candidates were unable to explain the operation of a counter. The marks for this question ranged from 0–15 from a possible maximum of 30 marks. Five candidates scored in the range of 11–15 marks, 18 scored in the range of 6–10 marks, and 31 scored five or less than five marks. Six candidates did not attempt the question.

Question 5

For Part (a), candidates were asked to explain the basic difference between the simplex, half duplex and full duplex modes of operation as they relate to the transmission of digital information. In Part (b), they were required to explain the purpose of a universal asynchronous receiver transmitter (UART). For Part (c), candidates were required to state two main advantages and two disadvantages of star topology. In Part (d), they were asked to calculate the noise factor given relevant values for noise pertaining to a receiver. For Part (e), candidates were required to explain the differential phase shift keying (DPSK) modulation technique and state its advantage over phase modulation. Candidates demonstrated good knowledge of Parts (a) and (c). Parts (b) and (e) were not well answered, with most responses being too vague. For Part (d), candidates were unable to calculate the noise factor using the given information. Fifty-five candidates attempted this question. Candidates scored marks ranging from zero to eighteen. One candidate scored in the range of 16–20 marks, seven scored in the range of 11–15 marks, 26 scored in the range of 6–10 marks, and 17 candidates scored five or less than five marks. Nine candidates did not attempt the question.

Question 6

Candidates were required to calculate the output voltage given the circuit diagram of a D/A converter with relevant values, explain the term *monotonicity* as it relates to a D/A converter, explain the operation of, and state a major application of a closed loop sample and hold circuit, and state what a multiplexer is. This was not a very popular question, with only six candidates responding to it. The response of candidates to Parts (a), (b) and (c) indicated that they had limited knowledge of D/A converters. Candidates, however, demonstrated knowledge of the multiplexer in Part (d). Marks for this question ranged from zero to six. One candidate scored in the range of 6–10 marks and five candidates scored five or less than five marks.

Module 3: Introduction to AC Machines (Questions 7–9)

Candidates were required to answer Question 7 and one other from the two remaining questions in the section. From a possible 50 marks for this module, the marks obtained by candidates ranged from zero to forty-three. Three candidates scored in the range of 21–30 marks, 13 scored in the range of 16–20 marks, six scored in the range of 11–15 marks, 15 scored in the range of 6–10 marks, and 23 candidates scored five or less than five marks. Candidates' performance suggests that they were conversant with this module.

Question 7

This question tested candidates' knowledge of synchronous generators. In Part (a), candidates were required to describe the principle of operation of a synchronous generator. For Part (b), they had to state two modes in which a synchronous generator can operate. In Part (c), candidates were asked to briefly explain what is meant by the term *armature reaction* as it relates to a synchronous generator. For Part (d), they had to draw the equivalent circuit of a synchronous generator, state what the elements represent and write a formula which can be used to derive the synchronous impedance. In Part (e), candidates were required to calculate resistance of the winding, the impedance of the winding and the reactance of the winding, given data from a synchronous generator under test. For Part (f), candidates were asked to sketch the impedance triangle related to the data given in Part (e). In Part (g), they were required to indicate what is meant by the term *synchronous* as it relates to a synchronous machine. For Part (h), candidates were asked to explain the term *impedance voltage drop* as it relates to a synchronous motor, and support the answer with a vector (phasor) diagram. Most candidates were able to answer Parts (a), (b), (c), (g) and (h); however, Parts (d), (e) and (f) were not well done. Candidates were unable to draw the equivalent circuit of a synchronous generator, state what the elements represent and write a formula which could be used to derive the synchronous impedance. In Part (e), candidates were unable to calculate the resistance, impedance and reactance of the winding of a synchronous alternator. Part (f) was not well done as candidates were unable to satisfactorily use the data given to sketch an impedance triangle.

Fifty-five candidates attempted this question and scored marks which ranged from zero to twenty-three. One candidate scored in the range of 21–30 marks, eight scored in the range of 11–15 marks, 15 scored in the range of 6–10 marks, and 31 either scored five or less than five marks.

<u>Question 8</u>

This question tested candidates’ knowledge of induction motors. They were asked to state what an induction motor is and state three advantages of the squirrel cage and the wound rotor induction motors. Candidates were also required to use an induction motor which is wound on 8 poles and supplied from a 60 Hz system to calculate the synchronous speed, the rotor speed when the slip is 6 per cent, and the rotor frequency when the speed of the rotor is 650 rev/min. They were asked to state the meaning of the term *plugging* as it relates to an induction motor. Most candidates were unable to state what an induction motor is and state three advantages of the squirrel cage and wound rotor. However, candidates who attempted this question were able to correctly complete the needed calculations for the synchronous speed and the rotor speed. Candidates were also able to satisfactorily state the meaning of the term *plugging.* Thirty-one candidates attempted this question and scored marks which ranged from zero to thirteen. One candidate scored in the range of 16–20 marks, six scored in the range of 11–15 marks, six scored in the range of 6–10 marks, and 14 scored five or less than five marks.

<u>Question 9</u>

This question focused on the transformer. In Part (a), candidates were required to identify the two components of the actual flux in a transformer and to state one characteristic of each component. In Part (b), they were to state what is meant by the term *voltage regulation* of a transformer and provide the formula to calculate it. In Part (c), candidates were required to calculate the primary and secondary currents, the number of secondary turns, and the maximum value of flux, when given relative information on a single phase transformer. In Part (d), they had to state the two methods of reducing leakage flux in a transformer. Most candidates could not identify the two components required in Part (a) and as a result were also unable to state a characteristic of each. Though attempts to answer Parts (b), (c) and (d) were better, candidates' responses lacked the depth necessary and the calculations were not well handled. Candidates' answers indicated that they were provided with information on transformers, but were unable to accurately reproduce same.

Thirty-one candidates attempted the question and scored marks which ranged from zero to thirteen. Three candidates scored in the range of 11–15 marks, 13 scored in the range of 6–10 marks, and 15 scored five or less than five marks.

Paper 03 – School-Based Assessment (SBA)

<u>Samples Submitted by Schools</u>

Adequate numbers of SBA samples were submitted for inspection and moderation. The following were observed.

- The grades submitted by some schools appeared inflated.
- Some project activity booklets were submitted.
- Students did not adhere to the specific guidelines/requirements for completing SBAs.
- Students need to follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Most methodologies assessed were unacceptable.
- In many instances, students failed to discuss the findings of the experiment or outcome of the project.
- Some projects submitted were too simple for the CAPE level.

Recommendations

- Students could benefit from closer supervision so that projects are not simplistic and to ensure that they conform to syllabus requirements.

- Students should complete their SBAs individually.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2014

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and eighty candidates registered for Unit 1, however only 161 candidates wrote Paper 01 and 163 candidates wrote Paper 02. Three of the candidates who wrote this unit earned Grade I and in total, 75 per cent of the candidates earned Grades I–V.

Ninety-three candidates registered for Unit 2 and both Papers 01 and 02 were written by 82 candidates. Eighty per cent of the candidates earned Grades I–V.

There has been an increase in registration for this subject, particularly Unit 2.

As in previous years, performance at Grades I–III in both units has been weak with the majority of passes being earned at Grades IV and V. However, there are signs of improvement in some areas over previous years. The poor performance at the higher grades could be a result of one or a combination of factors including:

1. The ill preparedness of candidates for the subject, both in the theoretical and practical aspects
2. The source from which candidates are drawn – one where the foundation needed for good performance in this subject has not been provided
3. The weak mathematics and science background of candidates
4. The need for training and orientation of some teachers in the delivery of subject content which covers the theoretical and practical aspects of both the electrical and the electronics components
5. The need for appropriate textbooks, materials and other resources inclusive of tools, equipment and machines being available in the centres to support this subject.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short-Answer Questions

This paper consisted of 15 short-answer questions, each worth six marks. Candidates were required to answer all questions. The paper was worth 90 marks. Candidates' overall marks ranged from 1 to 57. The mean score for this paper was 18.

Module 1: DC Circuit Theory (Questions 1 – 5)
Candidates were required to use fundamental laws and theory to solve problems associated with DC circuits.

Question 1

This question tested knowledge of Ohms law and resistance. Candidates were required in Part (a) to state Ohms law; in Part (b), they were given the resistance marking on a resistor and asked to state its resistance and in Part (c), the diameter and resistance of a wire were given and candidates were required to calculate its resistance if the diameter is reduced. In response to Part (a), most candidates were able to state Ohms law. However, the majority experienced difficulty interpreting the correct value of the resistor for Part (b), and could not conduct the needed calculations for Part (c) to determine the resistance of the wire when the diameter is reduced.

Question 2

In Part (a), candidates were asked to state the meaning of the term *relative permittivity* and in Part (b), they were required to (i) calculate the relative permittivity of the dielectric of a capacitor, given relative information and (ii) suggest one suitable material for the dielectric. For Part (a), many candidates were unable to state the meaning of the term relative permittivity. However, in Part (b) (i), they were able to apply the right formula and calculate the relative permittivity. Difficulty was experienced in determining a suitable material for the dielectric.

Question 3

In Part (a), candidates were required to define the terms *dielectric* and *electric flux density* and in Part (b), they were asked to calculate (i) the total capacitance and (ii) the total energy stored when all the capacitors in a given series–parallel capacitive circuit are charged. Most candidates were able to define the terms dielectric and electric flux density. However, some candidates were unable to correctly analyse the capacitive network, thus selecting and manipulating the wrong formulae to complete the calculations.

Question 4

Candidates were required in Part (a), to state what happens when the insulation of an inductor fails; in Part (b), they were required to state the meaning of *cumulative coupling* as it relates to two coils connected in series; and in Part (c), candidates were asked to calculate the electromotive force in a solenoid with a decrease in current. For Part (a), the majority of candidates demonstrated knowledge of what happens when the insulation of an inductor fails. Most candidates could not state the meaning of cumulative coupling in Part (b). Their weak responses to this part of the question indicated that they did not fully grasp the concept of cumulative coupling. In Part (c), the majority of candidates was able to use the correct formula to calculate the electromotive force.

Question 5

Given a series–parallel resistive circuit, candidates were required to determine the Norton equivalent circuit. The majority of candidates was able to calculate the total resistance of the parallel branch of the circuit, but was unable to determine the Norton equivalent circuit. Most candidates could not execute the needed calculations and therefore could not redraw the circuit.

Module 2: Analogue Electronics and Communications (Questions 6 – 10)

Basic analogue electronics and communications concepts were covered in this module which proved to be somewhat challenging. Most candidates scored low marks.

Question 6

Part (a) required candidates to state the name of a given schematic of an electronic circuit. In Part (b), candidates were required to sketch the output waveform of the given circuit and in Part (c), explain the operation of the circuit. For Part (a), most candidates were able to correctly state the name of the circuit. However, several claimed that it was a *rectifier* circuit instead of a *clipper* circuit due to the presence of the zener diodes. As a result, they were unable to correctly sketch the output waveform requested in Part (b). Although most candidates correctly recognized the circuit, they experienced much difficulty explaining its operation, as required for Part (c).

Question7

Candidates were asked in Part (a) to define the term *ground wave*; in Part (b), they were asked to name the most effective conductor which enables a ground wave to travel very far distances; and in Part (c), candidates had to explain the meaning of *antenna polarization*. Most candidates were able to define the term *ground wave* but the majority of them could not name the most effective conductor to enable the ground wave to travel far distances.

Question 8

In Part (a), candidates were required to define the terms *frequency modulation* and *frequency deviation*. In Part (b), they were asked to calculate (i) the carrier swing and (ii) the highest frequency attained by a frequency modulated carrier that is modulated by an audio signal. Most candidates could not give accurate definitions as required in Part (a), and found the calculations needed to correctly answer Part (b) to be challenging.

Question 9

Candidates were provided with an oscillator circuit and were required, in Part (a), to state the name of the oscillator; in Part (b), to determine the resonant frequency and the feedback fraction; and in Part (c), to identify three general features of an ideal operational amplifier. Part (a) was widely known by most candidates who easily identified the name of the oscillator. A majority of the candidates were able to state the formula for resonant frequency but could not state the formula for feedback fraction. Candidates easily identified three general features of an ideal operational amplifier as required for Part (c).

Question 10

Candidates were given the circuit of a common emitter amplifier and were required to calculate, in Part (a), the voltage across the base resistor; in Part (b), the current flowing through the base resistor; and in Part (c), the collector current. Most candidates found this question to be very challenging because they were unable to correctly use the formulae to complete the calculations for Parts (a), (b) and (c).

Module 3: Introduction to Power Systems (Questions 11 – 15)

This module, which introduces candidates to electrical power systems, continues to be the most challenging of the three modules. From a possible 30 points, the highest score was 22.

Question 11

For Part (a), candidates were required to draw the magnetic flux lines for a given configuration of magnets and, for Part (b), they were asked to define the term *magnetic flux density* and give its symbol and its unit. Most candidates were able to answer Part (a) by drawing the diagram correctly. However, some of them experienced difficulty presenting the direction of the flux lines for the magnets. Most candidates could not define the term magnetic flux density and were unable to provide its symbol and unit.

Question 12

This question required candidates, in Part (a), to list three differences between a bimetallic relay and a solid state relay and, in Part (b), to sketch and label the cross section of a cylindrical fuse. Many candidates, in response to Part (a), could not readily list three differences between a bimetallic relay and a solid state relay. In response to Part (b), most candidates were able to draw the diagram of a fuse but could not label it.

Question 13

In Part (a), candidates were given relevant information and required to calculate the speed of a six-pole DC motor. In Part (b), they were asked to state why shunt-wound, series-wound and compound-wound machines are referred to as self-excited machines. Candidates, in response to Part (a), were able to complete some aspects of the needed calculations correctly by inserting the data given in the required formula. Part (b) presented some difficulty since candidates could not correctly explain the principle of operation of a self-excited machine. It was evident that candidates lacked a good working understanding of a DC machine and hence were unable to adequately answer the question.

Question 14

In Part (a), candidates were required to state the meaning of the terms *armature reaction* and *commutation* and, in Part (b), they were asked to use a suitable diagram to describe the compound-wound DC machine winding connection. Most candidates found it difficult to define the terms as required for Part (a). However, in response to Part (b), most candidates drew a suitable diagram and adequately described the compound-wound DC machine winding connection.

Question 15

For Part (a) (i), candidates were required to define the term *power line carrier* and for Part (a) (ii), they were asked to state two advantages of power line carriers. Part (b) (i) required candidates to define the term *leased lines* as applied to power system communications while Part (b) (ii) asked them to state two disadvantages of leased lines. In response to Parts (a) (i) and (ii), many candidates were able to define the term power line carrier and state two of its advantages. In Part (b), candidates adequately defined the term leased lines but were unable to adequately state two disadvantages.

Paper 02 – Essays

Candidates were required to answer six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and each worth 30 marks. Candidates were required to select one of the remaining two questions in each of the three modules. Each question was worth 20 marks. Candidates' scores ranged from a low of 2 to a high of 97.

Module 1: DC Circuit Theory (Questions 1 – 3)

Question 1

In Part (a), candidates were given a DC network with two voltage sources and were required to state the superposition theorem, use the superposition theorem to determine the current, I, in the given network, calculate the power dissipated in R_1 and calculate the resistance of R (made of copper) when its temperature reached 80^0 C. In Part (b), candidates were required to state Kirchhoff's first and second laws and use a given mesh network with two voltage sources to find the current, I_1, flowing in loop 1. In Part (c), candidates were required to explain Thevenin's theorem, use a given resistive DC network to calculate the equivalent internal resistance of the network, and explain the term *resistance matching*.

Some candidates were unable to state the superposition theorem required for Part (a) (i). In response to Part (a) (ii), most candidates could not calculate the current, I, and therefore could not calculate the power dissipated in R_1 as required for Part (a) (iii). For Part (a) (iv), most candidates stated the formula correctly but could not determine the correct resistance because they placed incorrect values in the formula.

Although for Part (b) (i), some candidates correctly stated Kirchhoff's Laws, the question posed a problem for several others. Also, in Part (b) (ii), many candidates encountered problems when they tried to analyse the network to complete the required calculations.

Most candidates could not explain Thevenin's theorem as they were required to do in Part (c) (i). In addition, candidates found the required calculations for Part (c) (ii) challenging and, therefore, could not complete them. Candidates experienced further difficulty when they tried to explain the term *resistance matching*, as required for Part (c) (iii).

Question 2

This question was designed to test candidates' knowledge and understanding of capacitors. Candidates were expected, in Part (a), to define the term *capacitance*, state and define the *unit of capacitance*, state why variable capacitors require two sets of rigid plates, and name one application of a variable capacitor. In Part (b), candidates were given information on a capacitor and a resistor connected in series across a DC supply. From this, they were required to draw a labelled circuit diagram to show the details. Candidates were also asked to calculate the circuit time constant and the initial charging current as well as sketch the waveforms for both the pd across the capacitor and the charging current. In Part (c), candidates were required to outline three properties of the lines of force in an electric field.

Candidates were quite conversant with Parts (a) (i), (ii), (iii) and (iv) and demonstrated good knowledge of capacitors. Candidates also demonstrated good knowledge of the information required for Parts (b) (i), (ii), (iii), and (iv). Part (c) was the most challenging; the majority of candidates could not outline three properties of the lines of force in an electric field.

Question 3

This question tested candidates' knowledge of inductors. They were required, in Part (a), to (i) define the *unit of inductance*, (ii) list three ways to increase the inductance of a coil and (iii) given relevant information of an inductor, calculate the number of turns of wire for the inductor. In Part (b), candidates were required to explain the term *coupling coefficient* as it relates to inductors that are tightly coupled and loosely coupled. In Part (c), information was given on three inductors connected in series and candidates were required to (i) draw a labelled circuit diagram, (ii) calculate the circuit time constant, and (iii) calculate the final current in the circuit. In Part (d), candidates were required to state where the energy is stored in an inductor.

Candidates had a reasoned approach to answering Parts (a) (i) and (ii) and demonstrated sound knowledge of the information required. However, Part (a) (iii) was found to be challenging; the majority of candidates who attempted this question avoided answering this part and those who tried could not correctly complete the calculations required. Candidates were able to satisfactorily explain the term *coupling coefficient* when used with inductors that are tightly and loosely coupled respectively. Most candidates were able to adequately draw a labelled circuit diagram and satisfactorily complete the calculations required for Parts (c) (ii) and (iii). Candidates also demonstrated knowledge of where energy is stored in an inductor to complete Part (d).

Module 2: Analogue Electronics and Communications (Questions 4 – 6)

Question 4

All candidates were required to answer this question which tested their knowledge of the semiconductor diode. In Parts (a) and (b), respectively, candidates were required to state what is meant by the terms *depletion layer* and *barrier potential*. For Part (c), candidates were asked to use a block diagram to explain current flow in a PN junction diode and in Part (d), they were required to use a given full wave bridge rectifier circuit diagram to (i) explain how the circuit operates, (ii) draw the circuit diagram of a typical resistive filter that can be used with the rectifier and (iii) calculate the mean load current and the r.m.s current. In Part (e), candidates were required to state the function of a zener diode when used in a power supply and indicate how it is placed in the circuit.

In Part (a), many candidates were able to state the meaning of the term depletion layer but were unable, for Part (b), to accurately state what was meant by the term barrier potential. Some candidates, in response to Part (c), were unable to accurately draw the block diagram and explain current flow. Candidates' response to Part (d) (i) indicated that they were not fully aware of the operation of the rectifier circuit and experienced difficulty trying to explain the same. However, they experienced little difficulty drawing the resistive filter for the rectifier required for Part (d) (ii). In response to Part (d) (iii) a), the majority of candidates found it difficult to calculate the mean load current but were better prepared to calculate the r.m.s. current as required for Part (d) (iii) b). In response to Part (e), most candidates were able to correctly state the function of the diode and how it is placed in the circuit.

Question 5

Candidates were required, in Part (a), to state the formula used to calculate the modulation factor of an amplitude modulated waveform and indicate what each of its symbols represents. In Part (b), candidates were given a block diagram of an AM superheterodyne receiver and they were required to (i) calculate the frequency of the local oscillator, (ii) state the function of a) the detector and b) the automatic gain control. In Part (c), candidates were required to state the function of three stages of an FM receiver: (i) limiter, (ii) IF amplifier, and (iii) DC emphasis network. In Part (d), candidates were required to state the effects that noise causes on the amplitude of both AM and FM waveforms at the receiver.

In Part (a), many candidates did not appear to be aware of the correct formula to be used and therefore could not correctly answer the question. However, most candidates were able to correctly calculate the local oscillator frequency for Part (b) (i). Responses to Parts (b) (ii) and (iii) indicated that most candidates were aware of the function of the detector but had limited knowledge of the automatic gain control. In response to Parts (c) (i), (ii) and (iii), candidates demonstrated some knowledge of the limiter, the IF amplifier and the DC emphasis network, but not enough to accurately answer the parts of the question. The majority of candidates, in response to Part (d), demonstrated correct knowledge of the effects of noise on both AM and FM waveforms.

Question 6

This question focused on candidates' knowledge of transistors. Part (a) required candidates to explain how a transistor must be biased for normal operation, while Part (b) required them to state the formula used to calculate the DC current gain of a transistor in the common emitter configuration. In Part (c), candidates were given a common emitter transistor circuit diagram and were required to calculate the (i) DC base voltage, (ii) emitter and collector currents and (iii) collector and emitter voltage. For Part (d), candidates were required to explain what is meant by the term *thermal runaway* as applied to a transistor connected in the common emitter configuration.

Some candidates, in response to Part (a), demonstrated good knowledge of how a transistor must be biased. Most of the candidates in response to Part (b) were able to correctly state the required formula. Some of the candidates were able to adequately respond to Parts (c) (i), (ii) and (iii), whilst others were unable to identify the resistor across which the base voltage is developed and, therefore, could not answer these parts of the question correctly. Identification of the required formula to conduct the calculations also presented a problem for most candidates. Only a few candidates attempted Part (d); this indicated that their knowledge of *thermal* runaway was limited.

Module 3: Introduction to Electrical Power Systems (Questions 7 – 9)

Question 7

This question required candidates, in Part (a), to (i) describe the armature as it relates to a DC machine and (ii) sketch and identify the two winding configurations in the armature construction of a DC machine. In Part (b), candidates were given relevant information on a four-pole DC armature and they were required to calculate the (i) terminal voltage at no load, (ii) total power generated on full load, and (iii) efficiency of the machine. In Part (c), candidates were required to (i) identify an alternative armature winding construction for the DC machine and state its number of parallel paths, (ii) state the impact of the alternative armature winding identified in (i) on the terminal voltage and the total power generated on full load. In Part (d), candidates were required to (i) sketch and label speed-current plots for shunt, series and compound motors on one graph, (ii) explain two methods employed to achieve speed control of a DC motor and (iii) name two applications of a DC motor.

Candidates were able to adequately respond to Parts (a) (i) and (ii). Parts (b) (i), (ii) and (iii) were very challenging for candidates due to the fact that they could not complete the required calculations. In most cases, candidates were unable to identify and utilize needed formulae for the required calculations. Some candidates in response to Parts (c) (i) and (ii) demonstrated knowledge of the information needed to adequately answer the sub-sections of the question. In response to Parts (d) (i), (ii) and (iii), most candidates were able to answer the sub-sections of the question correctly.

Question 8

This question required candidates, in Part (a), to (i) outline the operation of a frequency relay, (ii) list four reasons why generators in power systems are equipped with frequency relays and (iii) list four conditions which can activate frequency relays. Part (b) asked candidates to distinguish between a fuse and a circuit breaker and to indicate the use of each in a typical household. In Part (c) (i), candidates were to suggest two possible causes for a blown fuse associated with a new household electric kettle, and (ii) sketch a graph to show the inverse characteristic of a fuse. Parts (a) (i), (ii) and (iii) were found to be most challenging for many candidates who could not demonstrate enough knowledge of frequency relays to adequately answer the sub-sections of Part (a). Most candidates were able to adequately answer Part (b) and the sub-sections of Part (c).

Question 9

This question required candidates to (a) state Lenz’s law, (b) state Faraday’s law and (c) define each of the following terms and provide symbols and units for each (i) *relative permeability*, and (ii) *reluctance*. In Part (d), candidates were required to use the information given in a figure of a mild steel ring with magnetization characteristic of soft magnetic materials to (i) calculate the current in the coil required to produce a flux density of 1.1 T and (ii) with a 2mm air gap created in the ring, calculate the reluctance of the air gap.

The majority of candidates adequately answered Parts (a), (b) and (c) (i) and (ii). Parts (d) (i) and (ii) required several calculations. However, most candidates could not present the required formulae needed for each section and therefore, could not complete the required calculations.

UNIT 2

Paper 01 – Short-Answer Questions

Candidates were required to attempt all questions from this paper which accounted for 90 marks. The lowest score achieved was five while the highest score was 65.

Module 1: AC Circuit Theory (Questions 1 – 5)

Candidates were required to use fundamental laws and simple theory to solve problems associated with simple AC circuits. From a possible maximum of 30 marks, the highest score was 25 and the lowest score was two.

<u>Question 1</u>

In Part (a), candidates were given information on a resistor and a pure inductor connected in series across a 110 V, 60 Hz supply, and they were required to calculate (i) the circuit current magnitude and (ii) the phase angle between the circuit current and the applied voltage. In Part (b), candidates were required to sketch a phasor diagram for the circuit current with reference to the applied voltage. Most candidates were able to calculate the circuit current required in Part (a) (i) but experienced difficulty calculating the phase angle in Part (a) (ii). Candidates also experienced difficulty sketching the phasor diagram for the circuit current with reference to the applied voltage in Part (b).

<u>Question 2</u>

Candidates were asked in Part (a) to define the following terms in relation to an AC sinusoidal wave: (i) *period*, and (ii) *average value*. In Part (b), candidates were given that an alternating voltage has the equation V = 141.4 sin 377t, and they were required to calculate (i) the frequency, and (ii) the r.m.s. voltage. Most candidates defined the terms for Part (a); however, they were unable to calculate the frequency and the r.m.s. voltage as required in Part (b).

<u>Question 3</u>

In Part (a), candidates were given two circuit measurements and they were required to use complex arithmetic to calculate the circuit impedance Z and express it in rectangular notation. In Part (b), candidates were required to define the term *Q factor* and state its formula. Most candidates had difficulty using complex arithmetic to calculate the circuit impedance and expressing it in rectangular notation. However, the majority of candidates were able to define the term Q factor.

Question 4

This question tested candidates' knowledge of filters. Candidates were required in Part (a) to define the terms *filter* and *noise*. In Part (b), candidates were required to explain what is meant by the *cut-off frequency* of a filter. Most candidates attempted Parts (a) and (b) and gained most of the allotted marks by correctly defining the terms. However, some found difficulty explaining what is meant by the cut-off frequency of a filter.

Question 5

In Part (a), candidates were given a figure showing a frequency response graph. From this, they were required to (i) identify the type of filter and (ii) name the area represented by X on the graph. In Part (b), candidates were required to draw the symbols for low pass and high pass filters. In Part (c), candidates were given a drawing of a typical RC filter and were required to calculate the cut-off frequency. Parts (a) and (b) were satisfactorily answered by most candidates who demonstrated knowledge of filters; however, in Part (c), most candidates could not provide the right formula to enable them to correctly calculate the cut-off frequency of the RC filter.

Module 2: Digital Electronics and Data Communications (Questions 6 – 10)
Basic digital electronics and communications concepts were assessed in this module. Only a few candidates seemed to understand this module with three of them scoring 50 per cent or more of the 30 available marks.

Question 6

Part (a) required candidates to draw the symbol for a thyristor; in Part (b), they were asked to describe a thyristor and for Part (c), candidates were required to draw and label a diagram to show the static characteristics of a thyristor. In Part (a), most candidates were able to draw the symbol of the thyristor, but experienced some difficulty describing the thyristor as required in Part (b). Candidates also experienced difficulty drawing and labelling the required diagram.

Question 7

Candidates were required, in Part (a), to state two applications of the 'D' type flip flop and, in Part (b), to describe the function of a *counter* in logic circuits. For Part (a), most candidates were able to at least provide one application of the 'D' type flip flop, but experienced difficulty in Part (b) to accurately describe the function of a *counter*.

Question 8

For Part (a), candidates were required to draw the symbols and state the Boolean expressions for (i) a three input AND gate and (ii) a three input OR gate. In Part (b), candidates were required to state the difference between *FAN-IN* and *FAN-OUT* as they relate to logic circuits. For Part (a), most candidates demonstrated knowledge of logic circuits by providing the required symbols and stating the Boolean expressions. In Part (b), however, they were unable to correctly state the difference between FAN-IN and FAN-OUT as related to logic circuits.

Question 9

Candidates were required in Part (a), with reference to D/A converters, to explain what is meant by the terms *resolution* and *accuracy*. In Part (b), candidates were required to calculate the maximum output voltage of an 8-bit converter with a step size of 10 mV. Most candidates attempted to answer Part (a) but could not correctly define the two terms and in Part (b), they experienced difficulty completing the required calculations.

Question 10

In this question, candidates were required for Part (a), to state the formula used to calculate noise factor as it relates to communication systems and for Part (b), to identify where in a computer network, a network interface card is used and state two factors that must be considered when choosing the card. In Part (c), candidates were required to explain the term *frequency shift keying* (FSK) used in digital modulation techniques. The majority of candidates avoided answering Part (a) and appeared not to be knowledgeable about the formula required to calculate noise factor. In Part (b), some candidates demonstrated knowledge of a network interface card and gave at least one factor that must be considered when choosing the card. Some candidates also demonstrated that they had a general idea of what was meant by the term FSK used in digital modulation techniques.

Module 3: Introduction to AC Machines (Questions 11 – 15)

In previous years, this module posed significant challenges to candidates; however, there are signs that candidates are beginning to better understand the requirements. From a possible 30 marks, the highest score was 23 and the lowest score was zero.

Question 11

Part (a) required candidates to state what must be done to make a synchronous machine function as either a motor or a generator and Part (b) asked them to explain the terms *armature reaction* and *synchronous speed* as each is related to a synchronous generator. Some candidates displayed limited knowledge of what must be done to make a synchronous machine function as either a motor or a generator. In Part (b), most candidates were unable to correctly explain the terms armature reaction and synchronous speed. This question proved to be challenging for most candidates.

Question 12

This question tested candidates' knowledge of transformers. In Part (a), candidates were required to give one reason why the equivalent circuit of a transformer is useful, while in Part (b), they were required to use a diagram to explain how an air core transformer is constructed and indicate one advantage and one disadvantage of using it. In Part (a), some candidates correctly stated that *the transformer equivalent circuit is a powerful analytical tool*. Though most candidates were able to draw the required diagram for Part (b), many were unable to indicate one advantage and one disadvantage of using the air core transformer.

Question 13

In this question, candidates were required to state three advantages and three disadvantages of a synchronous motor. The majority of candidates found this question to be very challenging; they demonstrated limited knowledge of the advantages and disadvantages of a synchronous motor.

Question 14

This question required candidates, in Part (a), to define the terms *slip* and *plugging*, as they relate to an induction motor and, in Part (b), to list four machines or tools in which single-phase induction motors are used. In response to Part (a) (i), it was found that many candidates could adequately define the term slip, but found it difficult in (ii) to define the term plugging. Most candidates in response to Part (b), correctly listed four machines or tools which use single-phase induction motors.

Question 15

This question tested candidates' knowledge of transformers. Given relevant information on a single-phase transformer, candidates were required to calculate, in Part (a), the number of turns on the primary winding and, in Part (b), the full load primary and secondary currents. For Part (a), many candidates were able to correctly calculate the number of turns on the primary winding of the transformer but in response to Part (b), most candidates were unable to correctly calculate the full load primary and secondary currents.

Paper 02 – Essays

Eighty two candidates wrote this paper. They were required to answer six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and worth 30 marks each. Candidates were required to select one of the remaining two questions in each module which were worth 20 marks each. Most candidates attempted the required two questions from each module. The marks obtained ranged from a low of 2 to a high of 79.

Module 1: AC Circuit Theory (Questions 1 – 3)

Question 1

For Part (a), candidates were required to define the terms *active power* and *apparent power*, provide the formula for calculating each and the units for each term. In Part (b), candidates were required to give two reasons why reactive power is sometimes referred to as imaginary power. In Part (c), candidates were given information on a 60 Hz operated load and they were required to (i) identify the reactive load type, (ii) calculate the reactive power supplied by the addition of parallel capacitors and (iii) calculate the percentage reduction in apparent power. In Part (d), candidates were given a series RLC circuit and were required to draw a labelled phasor diagram to illustrate phasor determination of the total circuit impedance at frequency f, such that the capacitive reactance exceeds the inductive reactance. Part (e) required candidates to draw two cycles of a 1 KHz, 4V peak to peak sinusoidal waveform, and calculate and label (i) the amplitude, (ii) the period and (iii) the r.m.s. value.

In Parts (a) (i) and (ii), candidates correctly defined the terms; however in Part (b), they were unable to explain why reactive power is sometimes referred to as imaginary power. In relation to Part (c), many candidates experienced difficulty identifying the reactive load type and completing the required calculations. Most candidates, in response to Part (d), correctly drew and labelled the phasor diagram and provided the additional information required. For Part (e), most candidates were able to draw the two cycles of the sinusoidal waveform and label them but experienced some difficulty completing the required calculations.

Question 2

This question tested candidates’ knowledge of filters. In Part (a), candidates were required to explain the operation of, and sketch and label the frequency response of the following filters: (i) notch, and (ii) high pass. Part (b) required candidates to (i) state the relationship between the ‘Q’ factor and the bandwidth of a filter, and (ii) determine the edge frequencies F_1 and F_2 given information on an LC circuit at resonance. In Part (c), candidates were required to draw labelled diagrams for a $\boldsymbol{\pi}$

section low pass filter and a **π** section high pass filter. In Part (d), candidates were given information on a T-section low pass filter and they were required to calculate the nominal impedance and the cut-off frequency.

In response to Part (a) (i), most candidates were unable to explain the operation of the notch filter and were also unable to sketch and label the frequency response. However, the majority of candidates was able to explain the operation of the high pass filter and sketch and label the frequency response. Most candidates responded adequately to Parts (b) (i) and (ii). In response to Part (c), many candidates were able to draw and label the required diagrams, however, the majority of candidates was unable to complete the calculations required for Parts (d) (i) and (ii).

Question 3

Part (a) required candidates to explain the following terms as applied to electrical circuits: (i) *resonance* and (ii) *selectivity*. For Part (b), candidates were given a series RLC circuit with relevant component values and were required to (i) sketch one graph each to show variations of current magnitude with frequency and phase with frequency; (ii) calculate the resonant frequency; (iii) calculate the voltage across the capacitor at the resonant frequency; (iv) determine the 'Q' factor of the circuit; and (v) determine the bandwidth of the circuit. In Part (c), candidates were required to explain why a series RLC circuit at resonance is referred to as an acceptor circuit.

For Parts (a) (i) and (ii), candidates were unable to clearly explain the terms. Most candidates experienced difficulty when attempting Parts (b) (i), (ii), (iii) and (v) due to an inability to complete the calculations needed to answer each sub-part. Part (b) (iv) was widely known by the candidates who used the correct formula and were able to correctly determine the 'Q' factor of the circuit. Part (c) was widely known by candidates; they were able to state why the RLC circuit at resonance is referred to as an acceptor circuit.

Module 2: Digital Electronics & Data Communications (Questions 4 – 6)

Question 4

For Part (a), candidates were required to explain one limitation of thyristor operation and for Part (b), they were asked to explain the terms *holding current* and *latching current* as they relate to a thyristor. In Part (c), candidates were required to use a drawing to show the two-transistor analogy of a thyristor and to explain what is meant by *break over voltage*. Part (d) required candidates to state the typical range of values for the input resistance of a MOSFET while Part (e) asked them to state four advantages of using an enhancement mode MOSFET in digital circuits. Part (f) required an explanation of the concept of the *inversion layer* for an enhanced type

MOSFET and for Part (g), candidates were required to state three characteristics of an ideal switch. In Part (h), candidates were given a figure of a transistor connected in the common emitter configuration and they were required to use a load line drawing to explain how the transistor can be used as a switch to control large load currents.

Candidates found this question to be very challenging. Most were capable of answering Parts (b), (e) and (g) as the topics appeared to be well known. In response to Parts (c), (d), (f) and (h), most candidates experienced much difficulty presenting the required information, thus indicating that they had limited knowledge of the MOSFET, the two transistor analogy of a thyristor, and the transistor as a switch to control large load currents.

Question 5

In Part (a), candidates were required to define the terms *channel capacity* and *bandwidth*. Part (b) required candidates to give one possible reason why errors occur in the signal received in a data communication system and to state how they can be detected and corrected. In Part (c), candidates were given a block diagram of a universal asynchronous receiver transmitter (UART), and they were required to use it to explain the basic operation of a UART. Part (d) required candidates to identify two types of noise found in amplifiers used in communication systems and state two sources of each type of noise identified. In Part (e), candidates were asked to explain the term *differential phase shift keying* as it relates to modulation techniques.

Many candidates demonstrated good knowledge of Parts (a) and (c), providing the required definitions and explaining the general operation of the UART respectively. Parts (b), (d) and (e) posed the greatest challenges; many responses were found to be vague. The purpose of *error detection* and *error correction* were not correctly explained as required for Part (b). Some candidates were able to identify two types and sources of noise for Part (d) but could not explain the term *Differential Phase Shift Keying* required for Part (e).

Question 6

In Part (a), candidates were given a block diagram of a three-stage shift register and were required to outline the operation of the three stages. Part (b) required a sketch of a block diagram of a J–K flip flop and the development of its truth table. Part (c) asked candidates to outline two features of multivibrators while Part (d) asked candidates to explain the operation of a bistable multivibrator. In Part (e), candidates were given a diagram of a 555 timer used in the monostable mode, and they were required to (i) calculate the minimum trigger voltage that would produce an output pulse and the width of the output pulse, and (ii) state the name often given to the 555 timer when it is operating in the monostable mode and indicate why it is given that name. The responses of most candidates to Parts (a) and (b) indicated that they had acquired some knowledge of the information requested but not enough to accurately respond to these parts of the question. Parts (c), (d) and (e) created challenges for most of the candidates; they demonstrated limited knowledge of multivibrators.

Module 3: Introduction to AC Machines (Questions 7 – 9)

<u>Question 7</u>

This question tested candidates' knowledge of transformers. In Part (a), candidates were required to identify the losses which occur in a transformer when loaded. Part (b) required candidates to draw and label a phasor diagram for a single-phase loaded transformer that has negligible voltage drop in its windings. In Part (c), candidates were required to state the condition that must be met in order to achieve maximum efficiency in a transformer. In Part (d), candidates were told that the primary winding of a transformer is connected to a sinusoidal voltage; they were required to sketch and label a typical waveform of flux variation with time in the transformer. Part (e) required candidates to state why there is a no-load current in a transformer. In Part (f), candidates were given specifications for a transformer and were required to calculate (i) the equivalent impedance of the primary and (ii) the voltage regulation and secondary voltage at full load with a power factor of 0.8 lagging.

It appears that this question was quite challenging for most candidates. Most of them were able to provide correct answers for Parts (a) and (b) but experienced some difficulty answering Parts (c), (d) and (e). Parts (f) (i) and (ii) were not well done due to candidates' inability to complete the required calculations.

<u>Question 8</u>

For Part (a), candidates were required to state four reasons why synchronous machines are constructed with stationary armature and rotating field poles. In Part (b), they were required to explain the synchronous impedance voltage drop of a synchronous motor. Part (c) required the use of a labelled graph of an AC generator to explain what is meant by *percentage voltage regulation*. In Part (d), candidates were required to (i) draw a labelled diagram of the equivalent circuit of a synchronous generator and (ii) state what each element represents on the diagram drawn in (d) (i) as well as state how the synchronous impedance can be derived. Part (e) required candidates to state the formula used to calculate the synchronous impedance of the generator.

Most candidates experienced difficulty answering this question. The majority of candidates who attempted Parts (a), (b) and (c) demonstrated some knowledge of the requirements of these parts but Parts (d) and (e) created much difficulty for most of the candidates; they could not adequately answer these two parts of the question due to limited knowledge.

Question 9

Candidates were required, in Part (a), to describe the construction of a squirrel-cage induction motor. In Part (b), candidates were required to use a diagram to assist with describing the operation of a single-phase capacitor run induction motor which incorporates a centrifugal switch. Part (c) required candidates to state six general features of the split-phase capacitor run induction motor. In Part (d), candidates were given a figure showing the torque slip curves for an induction motor; they were required to state the relationship between torque and motor resistance when the resistance is (i) small compared to motor reactance and (ii) large compared to motor reactance.

Most candidates provided adequate answers for Parts (a) and (c) which indicated knowledge of induction motors. Parts (b) and (d) (i) and (ii) were more challenging for most candidates. Candidates could not provide the diagram required for Part (b) and most also could not provide the required answers for Parts (d) (i) and (ii). Their answers indicated that they had limited knowledge of the information required, and therefore, were unable to accurately state the relationship between torque and motor resistance in the two situations given.

Paper 03 – School-Based Assessment (SBA)

Samples Submitted by Schools

Adequate numbers of SBA samples were submitted for inspection and moderation.

The following were observed.

- The grades submitted from some of the schools appeared inflated.
- All students did not adhere to the specific guidelines/requirements for completing SBAs.
- Students need to follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Most observed were unacceptable.
- In many instances, candidates failed to adequately discuss the findings of the experiment or outcome of the project.
- Some projects submitted were too simple for the CAPE level.

Recommendations

1. An SBA workshop should be held for schools.
2. Students could benefit from closer supervision.
3. Each student should complete his/her SBA individually.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2015

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and twenty-seven candidates wrote Unit 1. Two of the candidates who wrote this unit earned Grade I and in total 66 per cent earned Grades I–V. Eighty-four candidates wrote Unit 2. One candidate earned Grade I and in total 64 per cent earned Grades I–V.

There has been a decrease in registration for Unit 1 compared with 2014, while registration for Unit 2 is comparable with 2014.

As in previous years, performance at Grades I–III in both units has been weak with the majority of passes being earned at Grades IV and V. However, there are signs of improvement in some areas over previous years. The poor performance at the higher grades could be a result of one or a combination of factors including:

- The ill-preparedness of candidates for the subject, both in the theoretical and practical aspects
- The source from which candidates are drawn — where the foundation needed for good performance in this subject has not been provided
- The weak mathematics and science background of candidates
- The need for training and orientation of some teachers in the delivery of subject content which covers the theoretical and practical aspects of both the electrical and the electronics components
- The need for appropriate textbooks, materials and other resources inclusive of tools, equipment and machines to be made available in the centres to support this subject
- The configuration of the units.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short-Answer Questions

This paper consisted of 15 short-answer questions, each worth six marks. Candidates were required to answer all questions. The paper was worth 90 marks. Candidates' overall marks ranged from 3 to 66. The mean score for this paper was 25.

Module 1: DC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve problems associated with simple DC circuits. From a possible 30 marks, the highest score was 25, and the lowest score was zero.

Question 1

This question tested candidates' knowledge of capacitors. Candidates were given a number of capacitors connected in a series–parallel circuit and required to calculate the equivalent capacitance of the circuit.

Many candidates were able to accurately calculate the equivalent capacitance of the circuit. Some were able to correctly calculate capacitance in series and capacitance in parallel, but were unable to correctly analyse and calculate the equivalent capacitance of the circuit. Some candidates' responses clearly indicated that they needed much more exposure to solving questions involving series–parallel circuits.

Question 2

In this question, candidates were provided with a resistive circuit comprising three resistors and were required to use the superposition theorem, to calculate the voltage V_{out} across the 5 ohm resistor, R_3, in the resistive circuit. The question proved difficult for most candidates. Most of those who attempted this question appeared not to have grasped the concept of the superposition theorem, and were, therefore, unable to correctly complete all of the required steps to calculate the voltage V_{out}.

Question 3

In Part (a), candidates were required to define the term *temperature coefficient of resistance* and state its symbol. Candidates were required for Part (b) to explain why some materials which exhibit a negative temperature coefficient of resistance can suffer from thermal runaway. Some candidates were able to correctly define the term temperature coefficient of resistance and to state its symbol as requested for Part (a). In response to Part (b), some amount of difficulty was experienced by candidates to correctly explain why some materials which exhibit a negative temperature coefficient of resistance can suffer from thermal runaway. The concept of thermal runaway appeared to have not been fully grasped by many of the candidates.

Question 4

Part (a) required candidates to use a suitable graph to explain Ohm's law. For Part (b), candidates were required to determine which given materials were acceptable for the task of winding a coil with maximum resistance of 0.15 ohm from a 5 m length of a conductor having a cross-sectional area of 2 mm^2.

Material	**ρ(Ω m) at 0 °C**
Aluminium	2.7×10^{-8}
Brass	7.2×10^{-8}
Copper	1.59×10^{-8}
Eureka	49×10^{-8}

In Part (a), the majority of candidates demonstrated knowledge of Ohm's law, and were able to provide a suitable graph as part of the explanation. Part (b) presented some degree of difficulty for candidates mainly because of their inability to correctly complete the required calculation, for which they needed to use the scientific method. Without the correct calculation being done, the right material could not have been determined.

Question 5

Candidates were given an RL circuit with a time constant of 0.25 s and a final value current of 3.2 A. From the circuit, candidates were required to (a) calculate the values of R and L, and (b) determine the value of the current 0.5 s after the switch is closed.

Many candidates in response to Part (a) were able to correctly calculate the values of R and L. However, the majority of candidates' responses to Part (b) indicated that this part of the question was very challenging for them. Some candidates, although they knew the right formula to use, could not successfully complete the required calculation.

Module 2: Analogue Electronics and Communications (Questions 6–10)

Basic analogue electronics and communications concepts were covered in this module which proved to be somewhat challenging. From a possible 30 marks, the highest score was 23, with the lowest score being zero.

Question 6

In Part (a), candidates were required to name the four sine waves that are produced when a modulating frequency (f_m) amplitude modulates a carrier frequency (f_c). For Part (b), candidates were required to define the term *demodulation*. In Part (a), many candidates were unable to correctly state the four sine waves that are produced, which indicated inadequate knowledge of amplitude modulation. For Part (b), most candidates were able to correctly define the term demodulation, which relates to amplitude modulation.

Question7

Candidates were asked in Part (a) to draw the circuit diagram of a half-wave, voltage stabilized power supply which utilizes a CRC filter and a zener diode. For Part (b), they were required to state the formula that is used to calculate the peak to peak ripple out of the capacitor input filter of a half-wave power supply. Most candidates demonstrated knowledge of the symbols used to represent the components in a circuit diagram of a power supply. Some of the candidates drew the circuit diagram correctly, but some placed components in the wrong positions and the zener diode in the forward bias position instead of the reversed bias position. Some drew the full-wave power supply instead of the half-wave power supply. In Part (b), many candidates provided the correct formula to calculate the peak to peak ripple out of the capacitor input filter of a half-wave power supply.

Question 8

Candidates were required in Part (a) to name the method of wave propagation used for radio transmission of (i) low frequency, (ii) medium frequency, and (iii) high frequency. In Part (b), candidates were required to use a labelled diagram to illustrate what is meant by the term *skip distance*. Most candidates who responded to this question were able to clearly state the three methods of propagation for radio transmission required in Part (a). For Part (b), many candidates produced a diagram to represent skip distance, but few were able to correctly label the diagram. Some candidates gave a definition for skip distance.

Question 9

Candidates were required in Part (a) to state two methods that can be used to prevent thermal runaway of a transistor in an electronic circuit. For Part (b), they were required to draw and label the h-parameter equivalent circuit of a transistor connected in the common emitter configuration. The majority of candidates who responded to this question was able to state only one method to prevent thermal runaway, instead of the required two for Part (a). In response to Part (b), most candidates were able to draw the h-parameter equivalent circuit, but were unable to correctly identify the components and in some cases the components were incorrectly placed.

Question 10

Candidates were required in Part (a) to define the term *operational amplifier* and to state three of its operating characteristics. In Part (b), they were given the circuit of an inverting operational amplifier with relevant values for the components (resistors), and were asked to calculate the voltage gain of the amplifier. Most candidates found this question to be very challenging. Some candidates were able to accurately define an operational amplifier and they stated three of its operating characteristics. For Part (b), many candidates were able to provide the formula to be used to calculate voltage gain, but were unable to correctly complete the needed calculation. Some did not include the negative sign for the calculations, but attached a unit to the end result, which does not carry a unit.

Module 3: Introduction to Power Systems (Questions 11–15)

This module, which introduces candidates to electrical power systems, continues to be the most challenging of the three modules. From a possible 30 points, the highest score was 26 and the lowest score was zero.

Question 11

In Part (a), candidates were required to distinguish between overload current and fault current, while Part (b) required candidates to state the main reason for using thermal overload relays with electric motors. Part (c) asked candidates to describe the function of a circuit breaker. In response to Part (a), most candidates were unable to distinguish between overload current and fault current. Knowledge of overload current was good, but candidates displayed limited knowledge of what was meant by fault current. Many candidates, in response to Part (b), displayed adequate knowledge of the main reasons for use of thermal overload relays with electric motors. For Part (c), many candidates were able to adequately describe the function of a circuit breaker.

Question 12

This question required, in Part (a), that candidates describe the operation of a SCADA system, and for Part (b), that candidates explain how *telemetering* is accomplished. In response to Part (a), many candidates were able to adequately describe the operation of a SCADA system. For Part (b), some candidates were able to explain how telemetering is accomplished, whilst others experienced difficulty providing a reasonable answer. The answers presented for telemetering clearly indicated that candidates were not adequately prepared in this aspect of the syllabus.

Question 13

This question required candidates to (a) state Lenz's law and (b) calculate the flux density of a circuit in tesla, with the circuit having a flux of 400 µWb through an area of 0.0005 m^2. In response to Part (a), some candidates experienced difficulty stating Lenz's law. However, for Part (b), most candidates provided the needed formula and were also able to correctly calculate the flux density of the circuit. Some candidates experienced difficulty utilizing the scientific method to complete the required calculation.

Question 14

This question required candidates to (a) explain why it is necessary to use a commutator in a d.c. machine and (b) identify two categories of commutator losses in d.c. machines. In Part (c), candidates were told that a d.c. machine having a resistance of 0.45 ohms is connected to a 240 V supply. They were required to calculate the generated emf when the machine is functioning as a generator providing current of 65 A. Most candidates found Parts (a) and (b) to be very difficult. Their responses indicated that their knowledge of the commutator, its usage and losses pertaining to d.c. machines was limited. Adequate exposure of candidates to information pertaining to the commutator was found to be a necessity. Candidates' response to Part (c) demonstrated that most of them were adequately prepared to answer this part of the question. They easily identified the formulas to be used and were able to utilize the given data to correctly complete the required calculations.

Question 15

Part (a) (i) required candidates to define the *unit of magnetic flux density*. In Part (b), they were required to state what is meant by the term *permeability*, while Part (c) required candidates to determine the average emf induced in a coil having 1600 turns, if the flux of 450 µWb is reversed in 0.1 seconds. Many candidates experienced difficulty when responding to Parts (a) and (b). Many could not define the unit of magnetic flux density required for Part (a), neither could they state the meaning of the term permeability. Many produced a formula for each, which was not requested. In response to Part (c), some candidates were able to provide the correct formula and complete the calculations. Some candidates, although producing the correct formula, could not correctly complete the calculations, having not taken into consideration that in the question it was stated that the flux is reversed.

Paper 02 – Essays

Candidates were required to answer six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and each was worth 30 marks. Candidates were required to select one of the remaining two questions in each of the three modules. Each question was worth 20 marks. Candidates' scores ranged from a low of 4 to a high of 93.

Module 1: DC Circuit Theory (Questions 1–3)

Candidates were required to attempt Question 1 and one other from the remaining two questions in this section. From a possible score of 50 in this module, the highest score was 42 and the lowest score was zero.

Question 1

In Part (a), candidates were required to state Kirchhoff's first and second laws. In Part (b), they were required to (i) state Thevenin's theorem, (ii) use a given network, with open circuit terminals *ab*, to determine the Thevenin's equivalent circuit as seen from terminals *ab*, and (iii) use the Thevenin circuit produced in (b) (ii) to derive the Norton equivalent circuit. For Part (c), candidates were required to (i) state the maximum power transfer theorem, (ii) determine the value of the load resistance which should be connected at terminals *ab* in Figure 1 to yield maximum power transfer, (iii) calculate the maximum power transferred using the determined value of resistance in (c) (ii), and (iv) describe the impact on the power transferred, if the magnitude of the voltage in Figure 1 is increased.

Candidates’ responses to Part (a) indicated that Kirchhoff’s laws were well-known. Most candidates found Parts (b) (i) and (ii) very challenging. Many could not accurately state Thevenin’s theorem and furthermore experienced difficulty when they attempted to determine the Thevenin equivalent circuit. This was due to their inability to accurately analyse the network provided, and therefore, they could not derive the Norton equivalent circuit. Part (c) (i) was well-known by most candidates. In response to Parts (c) (ii) and (iii), many candidates experienced difficulty correctly completing the required calculations. In responding to Part (c) (iv), many candidates could not provide a correct answer.

Question 2

This question was designed to test candidates’ knowledge and understanding of capacitors. Candidates were expected in Part (a) to (i) define the term *capacitance* and give its unit and symbol, and (ii) sketch and label on the same time scale, charging and discharging curves of current and potential difference for a capacitor. In Part (b), it was stated that a potential difference of 100 V is maintained across a capacitor constructed with ten metal plates separated by sheets of polyethylene, each having a thickness of 0.4 mm and relative permittivity of 2. Candidates were also given details that $\varepsilon_o = 8.85 \times 10^{-12}$ F/m and that the area of one side of each plate is 500 cm^2. They were required to calculate the (i) capacitance of the capacitor, (ii) charge on the capacitor, (iii) electric flux density in the dielectric, and (iv) energy stored in the capacitor.

Many candidates in response to Parts (a) (i) and (ii) were able to accurately define the term capacitance and to give its unit and symbol. They also accurately sketched and labelled the charging and discharging curves. In response to Parts (b) (i–v), many candidates were unable to correctly complete the required calculations.

Question 3

This question tested candidates’ knowledge of inductors. They were required to (a) state three ways by which the inductance, of a coil can be increased, (b) distinguish between self and mutual inductance, and (c) explain the term *coupling coefficient*. Part (d) provided candidates with the dimensions of a ferromagnetic ring. They were expected to calculate (i) the self-inductance of each coil, and (ii) the mutual inductance. Part (e) required candidates to draw the circuit symbols for a (i) ferromagnetic-cored inductor, and (ii) a variable inductor.

Candidates’ approach to answering Part (a) was good as they demonstrated knowledge of the information required. For Part (b), many candidates experienced difficulty whilst trying to distinguish between self and mutual inductance. Candidates in response to Part (c) clearly explained the term *coupling coefficient*. Parts (d) (i) and (ii) were found to be most challenging for candidates. Though the majority who attempted these parts of the question was familiar with the required formulae for both parts, they could not accurately complete the calculations required, due to their inability to correctly insert the given data. In addition, their use of the scientific method was incorrect. In Part (e), candidates clearly demonstrated their ability and knowledge in drawing the required circuit symbols.

Module 2: Analogue Electronics and Communications (Questions 4–6)

Candidates were required to answer Question 4 and one other from this section. The maximum possible score for this module was 50. The highest score achieved was 28 and the lowest score was zero.

Question 4

All candidates were required to answer this question which tested their knowledge of the bipolar junction transistor. In Part (a), candidates were required to use a suitable block diagram to explain how a bipolar junction transistor is constructed. In Part (b), they were required to state what is meant by the d.c. beta (β_{dc}) of a transistor and to provide the formula used to calculate it. In Part (c), candidates were given a transistor under certain conditions and required to calculate the (i) input impedance, (ii) current gain, (iii) voltage gain, and (iv) power gain. Part (d) required candidates to state the two equations by which the small signal h-parameters are defined. They were also expected to indicate what each subscript represents.

In Part (e), candidates were provided with a common emitter circuit with relevant component values. They were required to calculate (i) voltage $V_{R1,}$ (ii) current flowing through R_1 and (iii) collector current $I_{c.}$ Part (f) required candidates to use a diagram to explain the term *saturation* as it relates to the characteristic curves of the operation of a bipolar transistor.

In Part (a), most candidates drew suitable block diagrams and were able to explain how the transistor is constructed. A few candidates drew the schematic diagram of the transistor and some drew block diagrams of a diode. This clearly indicated that some candidates did not understand the difference between a block diagram for a diode and that for a transistor. In Part (b), whilst the formula to calculate *Beta* was known by the majority of the candidates, many could not accurately state what was meant by the d.c. beta of a transistor. In Part (c), many candidates were able to correctly calculate the values required for (i), (ii), (iii) and (iv). In Part (d), many candidates were able to state the two equations by which the small signal h-parameters are defined, but could not indicate what each of the stated subscripts represented. In Part (e), most candidates were able to calculate the required values for (i), (ii) and (iii), but some candidates experienced difficulty correctly using the scientific method. Part (f) was found to be very difficult by most candidates. They were unable to present a suitable diagram and could not provide a suitable explanation for the term *saturation*.

Question 5

In Part (a), candidates were given a schematic diagram of an operational amplifier and were required to calculate (i) the voltage gain and (ii) the value of the output signal and state the phase relationship of the output signal to the input signal. For Part (b), candidates were required to draw the circuit diagram of a Wein Bridge oscillator and state the formula used to calculate the frequency of oscillation. Part (c) required candidates to list four factors that contribute to the change in frequency of an oscillator, while Part (d) asked them to state the Barkhausen criterion as it relates to an oscillator.

In Part (a) (i), some candidates provided the right formula to be used to calculate the voltage gain and answered the question correctly. Other candidates calculated the voltage gain correctly, but provided a unit when the answer should have been a number, not followed by a unit. For Part (b), most candidates were unable to draw correctly the circuit diagram of the Wein Bridge oscillator and stated the formula used to calculate its frequency of oscillation. In Part (c), many candidates experienced difficulty listing four factors that contribute to the change in frequency of an oscillator. Part (d) was found to be the most difficult by candidates. Few of them were able to correctly state the Barkhausen criterion as it relates to an oscillator.

Question 6

This question focused on candidates’ knowledge of electromagnetic waves. Candidates were required, in Part (a), to state what is meant by *multiple hop transmission* as it relates to sky propagation. Part (b) required candidates to define (i) maximum usable frequency (MUF) and (ii) optimum traffic frequency (OTP) as they relate to the propagation of a high frequency wave. In Part (c), candidates were required to identify the three natural ways a radio wave can travel after leaving an antenna. In Part (d), candidates were required to use a diagram to illustrate what is meant by *line of sight propagation*. They were also required to state two frequency bands where it is utilized. Part (e) required candidates to state the function of an antenna, while Part (f) required them to state two factors on which the range of a ground wave depends. In Part (g), candidates were required to identify the frequency spectrum for (i) the medium frequency — standard broadcast, and (ii) the FM — broadcast band.

Many candidates in response to Part (a) demonstrated good knowledge of multiple hop transmission. Parts (b) (i) and (ii) were found to be difficult by the majority of candidates. They were unable to accurately define the two terms. Part (c) was found to be known by the majority of candidates. They easily identified the three natural ways a radio wave can travel after leaving an antenna. In response to Part (d), most candidates were unable to correctly illustrate what was meant by line of sight propagation and to state two frequency bands where it is utilized. Many drew vague diagrams and demonstrated that they had limited knowledge of this type of propagation. In Part (e), some candidates correctly stated that the antenna radiates waves into space and also receives the waves from space. Some candidates stated that an antenna only receives waves from space. This indicated that more work needs to be done on the topic of antennas. In response to Part (f), many candidates were unable to provide two factors on which the range of a ground wave depends. Many candidates were able to provide the correct responses for Parts (g) (i) and (ii). Responses to the different parts of the question clearly indicated that much more work needs to be done on electromagnetic waves.

Module 3: Introduction to Electrical Power Systems (Questions 7–9)

Candidates were required to answer Question 7 and one other from this section. From a possible maximum score of 50, the highest score was 39 and the lowest score was zero.

Question 7

This question required candidates, in Part (a), to outline the eight steps utilized as the general procedure involved in telemetering. In Part (b), they were required to state five advantages of using digital communication over analogue communication and, in Part (c), to distinguish between simplex and duplex systems as applied to data communication. Parts (d), (e) and (f) focused on SCADA systems and required candidates to explain briefly how SCADA is used in power systems management, to identify four industries that use SCADA and identify four subsystems of SCADA and outline one function of each.

In response to Part (a), many candidates experienced difficulty outlining the eight steps involved in telemetering. In Part (b), many candidates were able to state the five advantages of using digital over analogue communication. In response to Part (c), some candidates were able to distinguish between simplex and duplex systems. Many candidates were unable to explain how SCADA is used in power systems management, but were able, in Part (e), to identify four industries that use SCADA, and for Part (f), to identify four subsystems of SCADA.

Question 8

Part (a) required that candidates identify five features of thermal overload relays. In Part (b), they were required to describe the construction and operation of (i) bimetallic and (ii) eutectic alloy relays. Part (c) required candidates to explain the operation of a fuse and state two of its applications. In Part (d), they were required to state when inverse-time overcurrent relays are used. Parts (a) and (b) appeared to be very challenging for many candidates. They appeared to have very limited knowledge of relays. Part (c) appeared to be widely known by candidates. Part (d) appeared to be the most difficult part for candidates, as some of them gave vague answers.

Question 9

This question required candidates, in Part (a), to list three situations where d.c. motors are used. Part (b) required candidates to state one difference between a d.c. generator and a d.c. motor, while for Part (c), candidates were given the dimensions of a shunt motor and required to calculate the resistance required in series with the armature to reduce the speed to 650 r/min, assuming that the armature current is 15 amperes. In Part (d), candidates were required to use diagrams to describe (i) shunt wound, (ii) series wound, and (iii) compound wound machine connections. In Part (e), candidates were to identify one problem introduced in the d.c. dynamo as a result of the commutation process.

In response to Part (a), many candidates were unable to list three situations where d.c. motors are used. For Part (b), many candidates were able to state the difference between a d.c. generator and a d.c. motor. In Part (c), many candidates experienced difficulty correctly completing the required calculations for the shunt motor. In Part (d), most candidates drew the three diagrams, but many could not accurately describe them. In response to Part (e), many candidates were unable to identify one problem. It appears that much more theoretical and practical work needs to be done in this area of the syllabus.

UNIT 2

Paper 01 – Short Answer Questions

Candidates were required to attempt all questions from this paper which accounted for 90 marks. The lowest score achieved was eight while the highest score was 67.

Module 1: AC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve problems associated with simple AC circuits. From a possible maximum of 30 marks, the highest score was 25 and the lowest score was four.

Question 1

This question required candidates to (a) list four types of filters, (b) define the term *half-power frequency* and (c) state the main purpose of filters used in communication equipment. Most candidates were able to list four types of filters. For Part (b), most candidates were unable to define the term *half power frequency*. In Part (c), most candidates were able to state the main purpose of filters.

Question 2

In Part (a), candidates were asked to define (i) *peak value*, (ii) *period*, and (iii) *instantaneous value* in relation to a sinusoidal waveform. In Part (b), they were required to sketch a sinusoidal waveform and identify on the sketch the (i) peak to peak value and (ii) rms value. Most candidates demonstrated knowledge of Parts (a) (i), (ii) and (iii) and were able to define the three terms correctly. In Part (b), the majority of candidates was able to sketch correctly the peak to peak and rms values.

Question 3

Given an RLC circuit, candidates were required to calculate the impedance of the circuit expressed in rectangular notation. Most candidates had difficulty using complex arithmetic to calculate the circuit impedance and to express it in rectangular notation. A small number of candidates knew the required formulas to be used and were able to complete the required calculations correctly. Converting and representing complex numbers in rectangular form was found to be very challenging for most candidates.

Question 4

Part (a) required candidates to state three properties of phasors, while in Part (b), they were given a phasor representation and were required to (i) express quantities *I* and *V* in polar notation, and (ii) identify the dominant load level type, given the orientation of the phasor diagram provided. Most candidates were able to correctly state three properties of phasors as required for Part (a). The majority of candidates found Part (b) (i) to be very difficult and could not correctly express the quantities *I* and *V* in polar notation. Part (b) (ii) was also found to be very difficult as most candidates could not identify the dominant load type.

Question 5

Candidates were provided with the following equations of an alternating voltage, *V*, and current, *I*:

$$V = 150 \sin(\omega t) \text{ V}$$
$$I = 2.5 \sin(\omega t - 50^0) \text{ A}$$

They were required to calculate (a) the reactive power, and (b) the power factor. Most candidates demonstrated knowledge of the formulas required to calculate the reactive power for Part (a) and the power factor for Part (b), but found it extremely difficult to complete the required calculations for reactive power and power factor.

Module 2: Digital Electronics and Data Communications (Questions 6–10)

Basic digital electronics and data communications concepts were covered in this module. From a possible maximum of 30 marks, the highest score was 23 and the lowest score was zero.

Question 6

Candidates were required in Part (a) to state three ways by which a thyristor can be switched into forward conduction, and in Part (b) to identify three situations in which the thyristor can be used. In response to Part (a), most candidates were unable to state three ways a thyristor can be switched into forward conduction. Similarly, responses to Part (b) indicated that candidates had some degree of difficulty identifying three situations in which the thyristor can be used.

<u>Question 7</u>

Candidates were given a figure of two connected logic gates and were required in Part (a) (i) to state the name of each logic gate, and in Part (a) (ii) to name the gate produced as a result of the connection of the two gates. Part (b) required that candidates define the term *coding* as it relates to logic circuits, and Part (c) required them to draw the symbol of a NAND gate and state its Boolean expression. For Part (a) (i), most candidates were able to identify the name of the two gates and for (ii) they were able to name the gate produced. In Part (b), some candidates were unable to define the term *coding*. In response to Part (c), most candidates were able to provide the symbol for the NAND gate, but some provided the symbol for the NOR gate instead. Further, some of them could not provide the Boolean expression and provided the truth table instead.

<u>Question 8</u>

Part (a) required candidates to use a block diagram to explain the operation of an SR flip-flop and Part (b) asked them to state what are multivibrators. In Part (a), most candidates were able to explain the operation of the SR flip-flop, but were unable in many cases to provide the required block diagram. In response to Part (b), few candidates were able to accurately state what are multivibrators.

<u>Questions 9</u>

Candidates were required, in Part (a), to state the full name of and briefly describe (i) EPROM and (ii) PROM memory systems. In Part (b), candidates were given a block diagram of a 1 to 4 demultiplexer, and required to explain its operation. For Parts (a) (i) and (ii), most candidates were able to state the full name of both memory systems, but some were unable to correctly describe them, especially the PROM. Part (b) proved to be challenging for the majority of the candidates, as they were unable to correctly explain the operation of the 1 to 4 demultiplexer.

<u>Questions 10</u>

In Part (a), candidates were required to state what is meant by the term *frequency shift keying* (FSK) as it relates to digital modulation techniques. For Part (b), they were required to state what is meant by *asynchronous* and *synchronous* waveforms as they relate to data communication. In Part (c), candidates were to state the formula used to express the Shannon-Hartley law. The majority of candidates did not answer Part (a) and appeared not to be knowledgeable about what was meant by the term *frequency shift keying* (FSK). In Part (b), some candidates experienced difficulty when they tried to state what is meant by asynchronous and synchronous waveforms. For Part (c), most candidates were able to state the formula used to express the Shannon–Hartley law.

Module 3: Introduction to AC Machines (Questions 11–15)

In previous years, this module posed significant challenges to candidates in general. From a possible 30 marks, the highest score was 21 and the lowest score zero.

<u>Question 11</u>

Candidates were required to use a diagram to aid in briefly explaining the principle of operation of a single-phase, capacitor-run induction motor which incorporates a centrifugal switch. The majority of candidates was unable to draw the required diagram, inclusive of the centrifugal switch, and they were also unable to correctly explain the principle of operation of the motor. Candidates' responses clearly indicated that they need much more theoretical and practical exposure to this type of motor.

Question 12

In this question, candidates were required to sketch and label the equivalent circuit of a transformer. Some candidates were able to correctly sketch and label the equivalent circuit of a transformer. Some drew a sketch of a transformer, which was not required. The responses indicated that much more theoretical and practical work needs to be done on transformers.

Question 13

In this question, candidates were provided with information about an induction motor operating at 1742 rpm. They were required to calculate (a) the efficiency of the motor, and (b) the output torque. Responses from the majority of candidates indicated that they found this question to be very challenging. In Parts (a) and (b), candidates were able to identify the correct formula to be used, but experienced difficulty when inserting the data and correctly using the scientific method.

Question 14

Part (a) required candidates to state the condition to be satisfied for maximum efficiency of a transformer. In Part (b), candidates were given the dimensions of a 60 Hz single-phase transformer and required to calculate the maximum value of flux. For Part (c), candidates were required to sketch a typical hysteresis B-H loop for a transformer core. In Part (a), some candidates demonstrated that they had some knowledge of the condition that was needed to be satisfied for maximum efficiency of a transformer. In Part (b), a small number of candidates used the correct formula and were able to correctly insert the data provided. Many candidates displayed limited knowledge of a typical hysteresis B-H loop of a transformer. Candidates need much more exposure on the theory of transformers.

Question 15

In Part (a), candidates were required to use the operation of the synchronous generator to identify the purpose and location of (i) the field winding and (ii) the armature winding. In Part (b), candidates were told that a synchronous generator has eight poles and operates at 1600 rpm, and required to calculate the frequency of the voltage generated. In response to Parts (a) (i) and (ii), few candidates were able to state correctly the purpose and location of the field winding and the armature winding. In relation to Part (b), the majority of candidates was unable to conduct the required calculations. Candidates’ responses indicated that much more work needs to be done on synchronous generators.

Paper 02 – Essays

Eighty-five candidates wrote this paper. They were required to answer six questions from the paper which accounts for 150 marks. Questions 1, 4 and 7 were compulsory and worth 30 marks each. Candidates were required to select one of the remaining two questions in each module which were worth 20 marks each. Most candidates attempted the required two questions from each module. The marks obtained ranged from a low of zero to a high of 87.

Module 1: AC Circuit Theory (Questions 1–3)

Candidates were required to attempt Question 1 and one other from this section. From a possible score of 50 in this module, the highest score was 44 and the lowest was zero.

Question 1

Part (a) required candidates to describe (i) passive filters, (ii) frequency response, and (iii) noise as they relate to filters. In Part (b), candidates were required to draw and label the frequency response characteristics for (i) notch and (ii) band pass filters. For Part (c), candidates were required to draw labelled diagrams for (i) π section low pass and (ii) the π section high pass filters. In Part (d), candidates were required to state why the Q factor is a measure of selectivity. Part (e) stated that a filter is required to pass all frequencies below 12 KHz and have a nominal impedance of 980 ohms candidates were required to (i) calculate the required circuit values for both T and π filter arrangements and (ii) draw both completed circuits from (c) (i) with the designated values. In Part (f), candidates were to draw the symbol for a low pass filter.

Candidates were able, in Parts (a) (i), (ii) and (iii), to easily describe the terms as they relate to filters. For Parts (b) (i) and (ii), many candidates were unable to draw and label the frequency response characteristics for the two filters. For Part (c), many candidates did not draw the diagrams, but provided graphs. In Part (d), many candidates could not correctly state why the Q factor is a measure of selectivity. In Part (e), many candidates experienced much difficulty when they tried to complete the required calculations. In response to Part (f), many candidates were able to draw the symbol for a low pass filter.

Question 2

Part (a) required candidates to (i) define the term *resonant frequency*, (ii) briefly describe the oscillation of energy in an RLC circuit, and (iii) explain how the tuning of a radio is a common example of resonance. In Part (b), candidates were given a series RLC circuit which was connected to a variable frequency supply. They were required to calculate (i) resonant frequency, (ii) voltage across the coil and capacitor at resonance, (iii) Q factor of the circuit, (iv) bandwidth, and (v) half-power frequency. In response to Part (a) (i), many candidates were able to define the term resonant frequency, while some were able in Part (a) (ii) to describe the oscillation of energy, and in Part (a) (iii) to explain how the tuning of a radio is a common example of resonance. For Parts (b) (i), (ii), (iii), (iv) and (v), some candidates were able to recall the needed formulas, but experienced some degree of difficulty when inserting the correct data and completing the required calculations. Part (b) (v) was observed to be the most difficult part for candidates.

Question 3

Candidates were required in Part (a) to define and state the symbol and unit for (i) active power, (ii) reactive power and (iii) apparent power. For Part (b), candidates were told that a load of 400 KW, with power factor 0.70 lagging, has its power factor improved to 0.85 lagging by the inclusion of parallel capacitors. They were required to calculate (i) the reactive power required for this improvement in power factor, and (ii) the reduction in apparent power.

Some candidates were able to clearly define the three terms required in Parts (a) (i), (ii) and (iii). Most candidates experienced difficulty when attempting Parts (b) (i) and (ii). Many of them experienced problems when they tried to manipulate the required formulas, and were therefore, unable to correctly complete the required calculations. The provided responses clearly indicated that much more theoretical and practical work, inclusive of calculations, needs to be done.

Module 2: Digital Electronics and Data Communications (Questions 4–6)

Candidates were required to answer Question 4 and one of the other two remaining questions from this section. From a possible score of 50 marks in this module, the highest score was 26 and the lowest zero.

Question 4

In Part (a), candidates were required to explain briefly what is meant by (i) accuracy, (ii) monotonicity, and (iii) settling time as they relate to D/A converters. In Part (b), candidates were given a circuit diagram of a D/A converter and required to calculate (i) the currents I_0 , I_1 and I_2 , and (ii) the weights for each input bit. For Part (c), candidates were required to state the function of A/D conversion and indicate why it is necessary. Part (d) asked candidates to describe an encoder. For Part (e), candidates were required to state how identical ROMs can be connected to provide an expanded memory and in Part (f), they were required to identify three expanded memory possibilities that could be provided by identical ROMs.

Candidates found this question to be very challenging. In relation to Part (a) (i), most candidates were able to provide a correct answer; while for Part (ii), the majority of candidates was unable to provide an answer. In response to Part (a) (iii), few candidates were able to provide a correct answer. Part (b) (i) was completed correctly by many candidates. However, in Part (b) (ii), many candidates experienced challenges. Many candidates found Parts (c)–(f) very difficult. Many appeared to have limited knowledge of A/D conversion, encoders, ROMs and expanded memory and so could not correctly answer these parts of the question.

Question 5

Candidates were required, in Part (a), to define the term *truth table* as it relates to logic gates. Part (b) required them to list three applications of logic gates and Part (c) asked them to explain Karnaugh maps in relation to combination logic. In Part (d), candidates were given a logic gate circuit and were required to prepare the truth table for the logic gate and state the type of logic gate it represents. For Part (e), candidates were required to draw two symbols used to represent a three-input AND gate and state the Boolean expression for the AND gate. In Parts (f) (i) and (ii), candidates were required to determine the decimal numbers that are represented by the binary numbers 1011_2 and 0111_2 respectively.

Most candidates demonstrated some knowledge of the content needed to answer Parts (a)–(f); however, some could not provide complete answers. Their responses indicated that some work needs to be done on logic gates with some emphasis on Karnaugh maps.

Question 6

Part (a) required candidates to state three advantages of MOSFETs. In Part (b), candidates were required to draw a transfer characteristic curve of a MOSFET to illustrate its modes of operation. For Part (c), candidates were required to draw a diagram to show how the N channel depletion mode MOSFET is constructed and how it must be biased for normal operation. Part (d) required candidates to describe briefly what a thyristor is, and what it is used for. In Part (e), candidates were required to define the term *forced commutation* as it relates to a thyristor, and in Part (f) to state three characteristics of an ideal switch.

This question appeared to be very difficult for the majority of candidates. Only seven candidates responded. Parts (a), (b), (d) and (e) were not adequately answered. Part (c) appeared to be the most difficult and in Part (f) candidates only provided one characteristic of an ideal switch.

Module 3: Introduction to AC Machines (Questions 7–9)

Candidates were required to answer Question 7 and one other from the two remaining questions in this section. From a possible score of 50 marks in this module, the highest score was 30 and the lowest zero.

Question 7

Candidates were required, in Part (a), to state two advantages of each of the following types of induction motors: (i) squirrel cage and (ii) wound rotor. In Part (b), candidates were required to briefly describe the differences in construction between the squirrel cage and wound rotor induction motors. In Part (c), candidates were required to (i) list four types of equipment that use single-phase motors and (ii) list three types of single-phase motors. For Part (d), candidates were given information on a four-pole induction motor and required to calculate the (i) synchronous speed of the motor, (ii) operating slip of the motor, (iii) frequency of the rotor currents, and (iv) loading speed that would yield a slip of 4%. In Part (e), candidates were required to sketch and label a typical torque versus speed curve for an induction motor.

It appears that this question was quite challenging for most candidates. Most candidates were able to provide correct answers for Parts (a) and (b), but experienced some difficulty answering Part (c) (ii) as they were only able to list two of the three types of single-phase motors. In relation to Parts (d) (i) to (iv) many candidates experienced difficulty completing the required calculations. Part (e) was also found to be difficult for many candidates because of their inability to sketch and label a typical torque versus speed curve for an induction motor.

Question 8

This question concentrated on candidates' knowledge of transformers. Candidates were required in Parts (a) to (i) identify the core or no-load losses of a transformer and state their origins, (ii) state four methods used in the construction of a transformer to reduce leakage flux, and (iii) define the term *voltage regulation* as it relates to a transformer. In Part (b), information was provided for a 100 KVA distribution transformer operating at full load. Candidates were required to calculate (i) the voltage of the primary winding and (ii) the total losses.

Candidates experienced challenges with this question. In Part (a) (i), candidates were able to identify the losses but were unable to state their origin. Few candidates were able to state the four methods used in the construction of a transformer to reduce leakage flux, and for Part (iii), most candidates could not define the term *voltage regulation*. For Parts (b) (i) and (ii), most candidates were unable to provide the correct formulas to be used and therefore, could not complete the required calculations. The responses clearly indicated that much more work needs to be done on transformers.

Question 9

Candidates were required in Part (a) to define the following terms as it relates to the synchronous generator: (i) *armature reaction*, (ii) *synchronous impedance* and (iii) *voltage regulation*. In Part (b), candidates were required to (i) sketch and label a per phase equivalent circuit of a synchronous generator, (ii) state the equation for the terminal voltage of a synchronous generator in terms of its equivalent circuit components, and (iii) sketch a phasor diagram of a synchronous generator operating at unity power factor. For Part (c), candidates were required to explain the method used to estimate the value of the synchronous impedance for a synchronous generator.

Most candidates were able to provide adequate answers for Parts (a) (i) to (iii). Some candidates were unable to accurately complete Parts (b) (i) to (iii), which indicated limited knowledge of the synchronous generator. In response to Part (c), problems were encountered because of limited knowledge of the subject.

Paper 03 – School-Based Assessment (SBA)

Adequate numbers of SBA samples were submitted for inspection and moderation. The following were observed:

- The grades submitted from some of the schools appeared inflated.
- Irregularities were observed in the submissions of two students from one centre.
- Some project activity booklets were submitted.
- All students did not adhere to the specific guidelines/requirements for completing SBAs.
- Students need to follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation.
- Students need more guidance in documenting their methodology. Some of those observed were unacceptable.
- In many instances, students failed to discuss the findings of the experiment or outcome of the project.
- Some projects submitted are too simple for the CAPE level.

Recommendations

- Students could benefit from closer supervision.
- Each student should complete his/her SBA individually.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2016

ELECTRICAL AND ELECTRONIC TECHNOLOGY

GENERAL COMMENTS

One hundred and eighty-two candidates wrote Unit 1. None of the candidates who wrote this unit earned Grade I. In total, 49 per cent of candidates earned acceptable Grades I–V. Ninety-two candidates wrote Unit 2. One candidate earned Grade I and in total 72 per cent earned acceptable Grades I–V.

Registration for Unit 1 increased compared with 2015, while registration for Unit 2 is comparable with 2015.

As in previous years, performance at Grades I–III in both units has been weak with the majority of candidates achieving at the level of Grades IV and V. However, there are signs of improvement in some areas over previous years, particularly in Unit 2. The poor performance at the higher grades could be a result of one or a combination of factors including:

- The ill-preparedness of candidates for the subject, both in the theoretical and practical aspects
- The prior learning of the candidates — where the foundation needed for good performance in this subject has not been provided
- The weak mathematics and science background of candidates
- The need for training and orientation of some teachers in the delivery of the subject content which covers the theoretical and practical aspects of both the electrical and electronics components
- The need for appropriate textbooks, materials and other resources inclusive of tools, equipment and machines to be made available in the centres to support this subject

DETAILED COMMENTS

UNIT 1

Paper 01 – Short Answer Questions

This paper consisted of 15 short-answer questions, each worth six marks. Candidates were required to answer all questions. The paper was worth 90 marks. Candidates' total marks ranged from zero to 61. The mean score for this paper was 25.

Module 1: DC Circuit Theory (Questions 1–5)

Candidates were required to use fundamental laws and simple theory to solve problems associated with simple DC circuits. From a possible 30 marks, the highest score was 24, and the lowest score was zero.

Question 1

This question tested candidates' knowledge of Ohm's law and resistance. Candidates were required in Part (a) to state the resistance of a resistor with a marking of 4R7. Candidates were required in Part (b) to sketch the characteristic of area A, versus resistance R of a conductor wire. In Part (c) candidates were told that a current of 4 mA flows through two identical series connected resistors. The total power dissipated is 128 mW. They were required to calculate the value of each resistor.

In response to Part (a), most candidates were unable to state the correct value of the resistor, thus indicating no knowledge of this type of resistor code. For Part (b), most candidates could not sketch the required characteristics, and they were unable to conduct the needed calculations for Part (c), although they were able to state the correct formula to be used.

Question 2

In this question, candidates were asked to define and state the symbols for the terms *relative permittivity* in Part (a), and in Part (b) *relative permeability*.

The majority of candidates were unable to correctly define the two terms. However, they were able to provide the symbols required.

Question 3

In Part (a), candidates were required to state Thevenin's theorem and in Part (b) they were given a figure showing a Norton's equivalent for a network and were required to determine and sketch the equivalent Thevenin's network. Most candidates were able to state Thevenin's theorem for Part (a). In response to Part (b), some amount of difficulty was experienced by many candidates to correctly sketch and determine the equivalent Thevenin's network.

Question 4

Candidates were given a figure showing three inductors in series-parallel combination and were required in Part (a) to calculate the total inductance. In Part (b), assuming a current I, of 3 mA, flows through the given network, candidates were required to calculate the total energy stored. In Part (c), candidates were required to state where the energy in (b) is stored.

In Part (a), most candidates were able to calculate the total inductance. The other candidates used the wrong formula and were unable to correctly calculate the total inductance. In response to Part (b), many candidates did not have knowledge of the correct formula to be used, hence they were unable to correctly calculate the total stored energy. Most of the candidates experienced difficulty when responding to Part (c). Their responses indicated that they did not fully grasp the concept of inductors and, therefore, could not correctly state where the energy is stored.

Question 5

Candidates were required in Part (a) to define the term *capacitance*. In Part (b), a charged 470 μF mica capacitor is allowed to discharge through a resistor, R, connected in parallel. The time constant of the discharge being 940 ms; candidates were required to (i) calculate the value of the resistor, R, and (ii) suggest what the impact would be if the mica capacitor is replaced by a polyester capacitor of the same value.

The majority of candidates were able to define the term capacitance in Part (a). In response to Part (b) (i), many candidates, although stating the formula for time constant T = RC, experienced difficulty transposing the formula to enable the correct calculation of the resistor R. For Part (b) (ii), many candidates could not provide any information on the expected impact, thus indicating no knowledge of the same.

Module 2: Analogue Electronics and Communications (Questions 6–10)

Basic analogue electronics and communications concepts were covered in this module which proved to be somewhat challenging. From a possible 30 marks, the highest score was 21, with the lowest score being zero.

Question 6

This question required candidates to draw the circuit symbol for a PNP transistor in Part (a). In Part (b), candidates were required to state what is meant by the DC beta (β_{dc}) of a transistor. Part (c) required candidates to calculate (i) current gain and (ii) emitter current, I_E, for a common emitter circuit, where the transistor has a collector current, I_C, of 30 mA and a base current, I_B, of 0.5 mA.

In response to this question, candidates demonstrated limited knowledge of transistors. In response to Part (a), the majority of candidates were able to correctly draw the required symbol. For Part (b) most of the candidates could not correctly state what is meant by the DC beta of a transistor. Similarly, in response to Part (c), the majority of candidates could not calculate (i) the current gain and (ii) the emitter current, I_E.

Question 7

In this question, candidates were given a half-wave rectifier circuit. From the circuit, candidates were required to calculate (a) the peak primary voltage, (b) the peak secondary voltage and (c) the DC load voltage.

Most candidates were able to state the required formula and to correctly calculate the peak primary voltage for Part (a). In Part (b), many candidates experienced difficulty whilst trying to calculate the peak secondary voltage, due to use of the incorrect formula. Calculation of the DC load voltage for Part (c) was in most cases incorrectly done due to the use of the wrong formula.

Question 8

Candidates were required in Part (a) to state what is an oscillator. In Part (b), candidates were given a schematic drawing of a non-inverting operational amplifier and were required to calculate (i) the voltage gain of the amplifier and (ii) the output signal voltage of the amplifier. In response to Part (a), many candidates were able to state what an oscillator is. Some candidates, however, stated what an oscilloscope is instead, thus reflecting that they did not know the difference between the two devices. For Parts (b) (i) and (ii), many candidates used the incorrect formulae to for the required calculations, hence producing incorrect results.

Question 9

In Part (a) (i), candidates were required to determine the local oscillator frequency of a super-heterodyne receiver if the intermediate frequency (IF) is 455 kHz and the received signal is 560 KHz. In Part (a) (ii), candidates were required to state the purpose of a detector. Part (b) required candidates to state what is meant by the term *frequency modulation*.

Parts (a) (i) and (ii) proved challenging for the majority of candidates. They demonstrated limited knowledge of a super-heterodyne receiver and the purpose of a detector. Most of the candidates, in response to Part (b), found this part to be challenging. They demonstrated limited knowledge of modulation.

Question 10

Candidates were required in Part (a) to state a definition of an antenna. In Part (b), they were required to define the term *ground wave.* For Part (c), candidates were required to state the frequency spectrum of (i) medium frequency (MF) and (ii) very high frequency (VHF) methods of propagation. Most candidates were able to state what an antenna is, and to correctly define ground wave. For the majority of the candidates, Part (c) proved to be very challenging, as they could not state the required frequency spectrums.

Module 3: Introduction to Power Systems (Questions 11–15)

This module, which introduces candidates to electrical power systems, continues to be the most challenging of the three modules. From a possible 30 marks, the highest score was 22 and the lowest score was zero.

Question 11

Candidates were required in Part (a) to determine the average emf induced in a coil having 1200 turns, if the flux of 400 µWb is reversed in 0.1s. For Part (b), candidates were required to explain the difference between a *permanent magnet* and an *electromagnet*. In response to Part (a), most candidates presented an incorrect answer, though some of them used the correct formula. However, they did not get the correct answer because they did not multiply the stated flux by 2, which is a requirement when there is a reversal of flux. Most candidates, in response to Part (b), were able to explain the difference between a permanent magnet and an electromagnet.

Question 12

This question required candidates, in Part (a), to identify one common type of thermal overload relay and describe its operation. In Part (b), candidates were asked to describe the function of a voltage surge protector. Part (c) required candidates to state what is meant by *fault current* as used in a protection scheme.

A small number of candidates responded correctly to Part (a) and readily identified one common type of thermal overload relay and correctly described its operation. The majority demonstrated limited knowledge of the thermal overload relay. In response to Part (b), most candidates demonstrated limited knowledge of a voltage surge protector. Part (c) proved to be challenging to most candidates who appeared to have limited knowledge of what was meant by fault current.

Question 13

Candidates were required, in Part (a), to state the difference between the *generated emf* and the *terminal voltage* of (i) a DC generator, and (ii) a DC motor. Part (b) required candidates to sketch and label on one set of axes, the torque load characteristic curves for the following DC motor configurations: (i) series, (ii) shunt and (c) differential compound.

The entire question proved to be challenging to the candidates. In response to Part (a), some candidates were able to state the difference between the generated emf and the terminal voltage. Part (b) presented the most difficulty. The majority of candidates were unable to correctly sketch and label the torque load characteristics curve for the required DC motor configurations.

Question 14

In Part (a), candidates were required to explain what is meant by the term *half-duplex communication*. For Part (b), they were required to identify two industries where the SCADA system can be used. Most candidates, in response to Part (a), demonstrated knowledge of half-duplex communication, but some could not adequately explain what was meant by the term. In response to Part (b), some candidates were unable to identify two industries where the SCADA system can be used.

Question 15

Candidates were required in Part (a) to give the symbols and state what is meant by (i) *reluctance* and (ii) *magnetomotive force*. In Part (b), candidates were told that a circuit has a flux of 400 µWb through an area of 0.0005 m^2, and they were required to calculate the flux density of the circuit in tesla units. In response to Part (a), most candidates readily stated the meaning of reluctance and magnetomotive force, but some could not provide their symbols. In response to Part (b), most candidates provided the correct formula to calculate the flux density, but could not correctly complete the calculation, due to incorrect use of the scientific notation.

Paper 02 – Essay Questions

Candidates were required to answer six questions which accounted for 150 marks. Questions 1, 4 and 7 were compulsory and each was worth 30 marks. Candidates were required to select one of the remaining two questions in each of the three modules. Each question was worth 20 marks. Candidates' scores ranged from a low of zero to a high of 91.

Module 1: **DC Circuit Theory (Questions 1–3)**

Candidates were required to attempt Question 1 and one other from the remaining two questions in this module. From a possible score of 50 in this module, the highest score was 45 and the lowest score was zero.

Question 1

Candidates were required, in Part (a), to state and define the *unit of capacitance*. For Part (b), they were required to define the following terms and state their symbols: (i) *electric field strength*, and (ii) *electric flux density*. In Part (c), candidates were given a series-parallel capacitive circuit and were required to calculate the (i) potential difference, (ii) stored charge and (iii) stored energy for the capacitor C_1. For Part (d), candidates were told that the charged combination of capacitors in the given series-parallel capacitive circuit discharges through resistor, R. Candidates were required to sketch the expected variation of current and potential difference. In Part (e), candidates were told that a capacitor having a capacitance of 0.133 nf, consists of two metal plates of side 5 cm, separated 1 mm by a dielectric. Candidates were required to (i) calculate the relative permittivity of the dielectric and (ii) suggest two suitable materials for the dielectric.

Part (a) was well done by the candidates. In response to Parts (b) (i) and (ii), most candidates defined the two terms, but some could not provide the symbols and units for each term. In Parts (c) (i), (ii) and (iii), although demonstrating knowledge of the formulae required to correctly calculate potential difference, stored charge and stored energy, most candidates experienced difficulty completing the calculations correctly, due to their inability to effectively use scientific notation. Part (d) proved to be difficult for all candidates. Some candidates attempted this part of the question but could not correctly sketch and label the required curves. Part (e) (i) presented some challenges for the candidates. Although the required formula was presented by many candidates, the required calculation was not correctly completed, due mainly to the ineffective use of the scientific notation method. In response to Part (e) (ii), many candidates provided one, instead of the required two materials for the dielectric.

Question 2

Candidates were required, in Part (a) (i), to state what is meant by the term *temperature coefficient of resistance* and give its symbol and unit. In Part (a) (ii), they were to explain why materials which possess a negative temperature coefficient of resistance can suffer from thermal runaway. Part (b) required candidates to state (i) Kirchoff's first and second laws and (ii) the maximum power transfer theorem. For Part (c), candidates were given a resistive circuit with resistors, R_1, R_2, R_3, and the supply voltage, E. They were then required to (i) calculate the total current I_T, and (ii) determine the value of supply voltage, E.

In response to Part (a) (i), the majority of candidates demonstrated knowledge of 'temperature coefficient of resistance', but some had problems providing its symbol and unit. For Part (a) (ii), candidates could not adequately explain why the materials suffer from thermal runaway. Candidates demonstrated limited knowledge of Parts (b) (i) and (ii) when they tried to state Kirchoff's laws and the maximum transfer theorem. In Parts (c) (i) and (ii), many of the candidates experienced some difficulty providing the required formulae and calculating the correct value of I_T and determining the supply voltage, E.

Question 3

This question was designed to test candidates' knowledge of inductors. Candidates were required in Part (a) (i) to define the term *inductance*; (ii) draw the circuit symbols for a) an inductor, b) a ferromagnetic-core inductor and c) a variable inductor; (iii) state the main advantage of an air core inductor and identify its impact on inductance and (iv) state two physical factors which determine the inductance of a coil. For Part (b), candidates were provided with the following information: when two coils L_l and L_2 are connected in series, their effective inductance is 12 H. When the connections to one coil are reversed, the effective inductance is 8 H. The coefficient of coupling is 0.8. Candidates were required to calculate the possible values for L_2 only. In Part (c), candidates were asked to explain the term *loosely coupled* as it relates to the coupling coefficient of inductors.

Candidates' approach to answering Parts (a) (i) and (ii) was good, as they demonstrated knowledge of the term *inductance* and were able to draw the circuit symbols required. Part (a) (iii) proved to be challenging for candidates, the majority of those who attempted this part of the question could not state the main advantage of an air core inductor nor identify its impact on inductance. In Part (a) (iv), some candidates were able to correctly state two physical factors which determine the inductance of a coil. Part (b) proved to be challenging to the candidates as it required them to provide the correct formulae and complete the required calculations, which was not done by many. For Part (c), the majority of candidates were able to adequately explain the term *loosely coupled*.

Module 2: **Analogue Electronics and Communications (Questions 4–6)**

Candidates were required to attempt Question 4 and one other from this section. The maximum possible score for this module was 50, and the highest score achieved was 28 and the lowest score was zero.

Question 4

This question tested candidates' knowledge of modulation. In Part (a), candidates were required to state the meaning of the term *amplitude modulation.* In Part (b), candidates were told that a 140 MHz frequency modulated carrier (F_C) is modulated by an audio signal which creates a frequency deviation (F_D) of 30 KHz. They were required to calculate the (i) carrier swing of the signal, (ii) highest frequency attained by the signal, (iii) lowest frequency attained by the signal, and (iv) modulation index (m_I) of the FM wave. For Part (c), candidates were required to state the four sine waves that are produced when a modulating frequency (F_M) amplitude modulates a carrier frequency (F_C). In Part (d), candidates were told that an amplitude modulated wave has a maximum value of 8 volts and a minimum value of 3.5 volts. They were required to calculate the depth of modulation.

For Part (e), candidates were given the diagram of an AM detector circuit, and they were required to state the purpose of (i) diode D_1, (ii) capacitor C_1 and (iii) resistor R_1. Part (f) required candidates to calculate the bandwidth of a narrowband FM signal which is generated by a 5 kHz audio signal that modulates a 130 MHz carrier. In Part (g), candidates were required to explain what is meant by the term *frequency deviation*. Part (h), required candidates to state two benefits that are derived from the use of single sideband (SSB) transmission.

In response to Part (a), many candidates were unable to state the correct meaning of the term *amplitude modulation.* For Parts (b) (i)–(iv), the majority of candidates stated the correct formulae to be used, and correctly completed the required calculations in most cases. Most candidates, in response to Part (c), were unable to state the four sine waves. Candidates' response to Part (d) indicated in the majority of cases lack of knowledge of the correct formula to be used, and therefore, they could not correctly complete the calculation for depth of modulation. In Part (e), many of the candidates were unable to correctly state the purpose of the components of the AM detector circuit. In response to Part (f), most of the candidates were able to calculate the bandwidth correctly. The majority of candidates, in response to Part (g), were unable to accurately explain what was meant by the term *frequency deviation*. For Part (h), some candidates were able to state two benefits derived from the use of SSB transmission.

Question 5

In Part (a), candidates were given the circuit diagram of a full-wave rectifier and were required to explain its operation. For Part (b), candidates were required to (i) state the function of a clipping circuit and (ii) state one type of circuitry where clipping circuit processing is useful. Part (c) required candidates to state the function of a zener diode when used in a power supply (rectifier circuit) and how it is placed in the circuit. Part (d) required candidates to sketch the characteristic curve of a zener diode. In Part (e), candidates were required to name the type of semiconductor produced when a crystal is doped with (i) a pentavalent impurity and (ii) a trivalent impurity.

Part (a) was widely known to the candidates. Many candidates were able to identify the fact that the rectifier converts AC to DC, but some were unable to correctly explain the full operational details of the circuit. In response to Part (b) (i), the majority of the candidates were able to state the function of a clipping circuit, but for Part (b) (ii), many were unable to state one type of circuitry where clipping circuit processing is useful. In response to Part (c), many of the candidates were unable to state the function of the zener diode and how it is placed in a circuit. Parts (d) and (e) proved to be very challenging for most candidates. They were unable to sketch the characteristic curve of a zener diode and to demonstrate knowledge of the type of semiconductor that is produced when a crystal is doped with a pentavalent or a trivalent impurity.

<u>Question 6</u>

This question focused on candidates' knowledge of transistors. In Part (a), candidates were required to state how a bipolar transistor must be biased when placed in a circuit to operate as an amplifier. For Part (b), candidates were given a common emitter amplifier circuit diagram and were required to calculate (i) the collector current (I_c) and (ii) the collector emitter voltage (V_{ce}). In Part (c), candidates were required to state the main reason why the common emitter amplifier is most often used in electronic circuits. Part (d) required candidates to explain what is meant by the term *thermal runaway* as applied to a transistor connected in the common emitter configuration. In Part (e), candidates were told that a transistor, having an $h_{ie} = 1500$ Ω, and $h_{fe} = 70$, is connected in the common emitter configuration as an amplifier, with a load resistance of 12 kΩ. They were required to calculate (i) the voltage gain and (ii) the power gain.

Some candidates, in response to Part (a), demonstrated good knowledge of how a transistor must be biased. Most candidates, in response to Parts (b) (i) and (ii) were able to correctly state the required formulae, but were unable to correctly complete the required calculations. In response to Part (c), many candidates were unable to state the main reason why the common emitter amplifier is most often used. In response to Part (d) the majority of candidates could not correctly explain the term *thermal runaway* as it relates to a transistor connected in the common emitter configuration. The majority of candidates were able for Parts (e) (i) and (ii) to provide the required formulae, but in many cases were unable to correctly complete the calculations.

Module 3: Introduction to Electrical Power Systems (Questions 7–9)

Candidates were required to attempt Question 7 and one other from this section. The maximum possible score for this module was 50, and the highest score achieved was 21 and the lowest score was zero.

Question 7

In Part (a) of this question, candidates were required to use a diagram to explain what happens when a coil is wound on an iron rod and connected to a battery. For Part (b), candidates were given that the current in a coil with a ferromagnetic core is increased from zero to a large value. They were required to sketch and explain the resulting BH curve. Part (c) required candidates to state Faraday's law. In Part (d), candidates were given that a wooden ring of mean circumference 400 mm and cross sectional area of 300 mm^2 has a coil of 300 turns wound uniformly over it. The current through the coil is 3.0 amperes. Candidates were required to determine (i) the magnetic field strength, (ii) the flux density, and (iii) the total flux. For Part (e) (i), candidates were required to state Lenz's law, while (ii) required them to draw a circuit which can be used to demonstrate Lenz's law and explain its operation.

For Part (a), many candidates demonstrated limited knowledge when they tried to draw the diagram and explain what happens when the circuit is connected to a battery. The majority of candidates, in response to Part (b), found it difficult to sketch and explain the BH curve. For Part (c), some candidates were able to correctly state Faraday's law, whilst the majority demonstrated limited knowledge of it. Parts (d) (i), (ii) and (iii), proved to be very challenging to candidates due to the fact that though they were able to provide the relevant formulae, they were unable to correctly complete the required calculations. Ineffective use of the scientific notation method and incorrect use of symbols and units was also a major challenge. Some candidates, in response to Part (e) (i), demonstrated knowledge of Lenz's law, but could not draw the required circuit nor explain its operation.

Question 8

This question required candidates, in Part (a), to define the term *armature reaction*. For Part (b), candidates were required to state the role of each of the following components of a DC machine (i) carbon brush and (ii) commutator. Part (c) required candidates to explain two methods used to achieve speed control of a DC motor. In Part (d), candidates were required to draw and label the circuit for a separately excited DC generator. Part (e) required candidates to list three sources of losses in a DC machine, while Part (f) asked candidates to describe the armature as it relates to a DC machine.

In response to Part (a) some candidates were able to correctly define the term *armature reaction*. In response to Parts (b) (i) and (ii), many candidates demonstrated limited knowledge concerning the role of the two components. Part (c) proved to be very challenging for most of the candidates, as they were unable to explain two methods used to achieve speed control of a DC motor. Part (d) also proved to be challenging for the majority of candidates. Most did not attempt to draw the circuit and those who did, were unable to complete it correctly. For Part (e), the majority of the candidates correctly listed three sources of losses in a DC machine, while in response to Part (f), many candidates could not accurately describe the armature as it relates to a DC machine.

<u>Question 9</u>

This question required candidates in Part (a) to state what the acronym SCADA means and what it refers to. In Part (b), candidates were asked to explain the function of the remote terminal unit (RTU) subsystem of a SCADA system. Part (c) required a description of how information is transmitted in a SCADA system from the remote station to the master station. Part (d) required candidates to state what is meant by the term *power line carrier*, while Part (e) required the identification of four advantages of power line carrier for companies using SCADA. For Part (f), candidates were asked to state what *leased lines* are and to list three disadvantages of leased lines.

In response to Parts (a) and (b) the majority of candidates were able to adequately state what SCADA means, to what it refers, and explain the function of the RTU. For Part (c), a few candidates were able to adequately describe how information is transmitted in a SCADA system from remote station to the master station. However, many had limited knowledge on how the information is transmitted. In response to Part (d), many candidates could not correctly state what is meant by the term *power line carrier*. Parts (e) and (f) proved to be challenging for candidates as they could not adequately state four advantages of power line carriers for companies using SCADA nor state what are leased lines and list three of their disadvantages.

UNIT 2

Paper 01 – Short Answer Questions

Candidates were required to attempt all questions from this paper which accounted for 90 marks. The lowest score achieved was three, while the highest score was 62.

Module 1: **AC Circuit Theory (Questions 1–5)**

Candidates were required to use fundamental laws and simple theory to solve problems associated with simple AC circuits. From a possible maximum of 30 marks, the highest score was 28 and the lowest score was zero.

<u>Question 1</u>

In Part (a) of this question, it was given that a resistor with a marking 4k7 is connected in series with a pure inductor of 10 H and the circuit is powered with a 115 V, 60 Hz supply. Candidates were required to calculate (i) the circuit current magnitude and

(ii) the phase angle. For Part (b), candidates were required to sketch a phasor diagram for the circuit current in (a), with reference to the applied voltage. In response to Part (a) (i), some candidates were able in to calculate the circuit current magnitude. However, the majority experienced difficulty when calculating the phase angle required for Part (a) (ii) and in sketching the required phasor diagram for the circuit current in Part (b).

Question 2

Candidates were asked in Part (a) to state the relationship between the Q factor and the bandwidth of a filter. For Part (b), candidates were told that an LC circuit has edge frequencies F_1 = 10 MHz and F_2 = 13 MHz and they were required to determine the Q factor. Most candidates, in response to Part (a), were able to state the relationship between the Q factor and the bandwidth of a filter, but experienced much difficulty when calculating the Q factor in Part (b). This was mainly because many candidates were unable to state the correct formula to be used and therefore had difficulty completing the required calculation.

Question 3

This question required candidates to define the terms (a) *real power* and (b) *reactive power* and to state the symbol and unit for each. In response to Part (a), some candidates were unable to accurately define *real power*. However, they demonstrated knowledge of the term *reactive power* for Part (b). Some of the candidates were unable to accurately state the symbols and units for the two terms.

Question 4

Candidates were required to (a) define the terms (i) *average value* and (ii) *amplitude* as each relates to a sinusoidal wave and (b) calculate the (i) RMS voltage and (ii) frequency of an alternating current which has an equation V = 381 sin 100 t.

Most candidates who attempted Parts (a) (i) and (ii) correctly defined the required terms. Parts (b) (i) and (ii) proved to be challenging to some candidates. They provided the correct formulae, but were unable to correctly complete the calculations.

Question 5

In this question, candidates were required to (a) define the terms (i) *filter* and (ii) *noise* and (b) draw the symbols for (i) low pass, and (ii) high pass filters.

In response to this question, some candidates were unable to accurately define the terms *filter* and *noise*. For Parts (b) (i) and (ii), the majority of candidates demonstrated good knowledge of filters, by correctly drawing the symbols for the two filters.

Module 2: Digital Electronics and Data Communications (Questions 6–10)

Basic digital and electronics and communications concepts were covered in this module. From a possible maximum of 30 marks, the highest score was 19 and the lowest score was zero.

Question 6

Candidates were required, in Part (a), to draw the symbol for the EX – OR logic gate and state its Boolean expression. For Part (b), candidates were given the symbols for two logic gates and were required to (i) state the names of the two gates, and (ii) state the name of the logic gate produced when the two gates are joined. Part (c) required candidates to state the meaning of the term *truth table* as it relates to logic gates.

In Part (a), the majority of the candidates were able to draw the symbol for the EX-OR logic gate, but some were unable to correctly state the Boolean expression. In response to Parts (b) (i) and (ii), the majority of candidates were able to state the names of the two gates, and name the logic gate produced when the two given gates were joined. For Part (c), some candidates were unable to correctly state the meaning of the term *truth table*.

Question 7

In this question, candidates were required to (a) state three characteristics of an ideal switch and (b) explain how the transistor, in a given a transistor circuit, can be used as a switch to control large load currents.

In Part (a) some of the candidates were able to state the three characteristics of an ideal switch, but it proved to be challenging for many candidates. In response to Part (b), only a few candidates were able to accurately explain how the transistor can be used as a switch to control large load currents.

Question 8

This question required candidates (a) explain the operation of the 555 timer when used in the monostable mode, (b) state the meaning of the term *shift register* and (c) draw the symbol for a D-type flip flop.

In response to Part (a), most candidates demonstrated limited knowledge of the operation of the 555 timer when used in the monostable mode. For Part (b), the majority of the candidates were able to correctly state the meaning of the term *shift register* while for Part (c) many candidates were unable to draw the symbol for a D-type shift register.

Question 9

Candidates were required to (a) determine the reference voltage required for a 7-bit DA converter to generate a maximum output voltage of 9 volts, (b) state the meaning of *A/D conversion* and indicate why it is necessary and (c) describe the function of a demultiplexer.

In response to Part (a), most candidates were unable to determine the reference voltage for a 7-bit DA converter to generate a maximum output of 9 volts, because they did not know the correct formula to use. Hence, they were unable to complete the required calculation. For Parts (b) and (c) most of the candidates demonstrated knowledge of A/D conversion and of the function of a demultiplexer.

Question 10

This question required candidates to (a) state the main advantage of 'star topology' over 'ring topology' computer networks, (b) draw the block diagram of a full duplex 4-wire mode operation used in communication systems and (c) state, when in communication systems, waveforms can be termed as (i) asynchronous and (ii) synchronous.

In response to Part (a), the majority of candidates demonstrated knowledge of the two types of topology and were, therefore, able to correctly state the main advantage of star topology over ring topology computer networks. For Part (b), the majority of candidates were unable to correctly draw the required block diagram and for Part (c), the majority of candidates were unable to state when waveforms can be termed asynchronous and synchronous.

Module 3: **Introduction to AC Machines (Questions 11–15)**

In previous years, this module posed significant challenges to candidates. From a possible 30 marks, the highest score was 21 and the lowest was zero.

Question 11

In Part (a) of this question, candidates were required to state the condition required to achieve maximum efficiency in a transformer. For Part (b), candidates were required to calculate the full load voltage of a 40 KVA, 3300 V/400 V, 60 Hz single-phase transformer operating with 1% voltage regulation at full load. In Part (c), candidates were required to state the purpose of core laminations.

In response to Part (a), the majority of candidates were unable to state the condition required to achieve maximum efficiency in a transformer. For Part (b), the majority of the candidates were unable to correctly state the required formula to calculate the full load voltage, hence produced incorrect calculations. In Part (c), many candidates were able to state the purpose of core laminations.

Question 12

This question tested candidates' knowledge of induction motors. In Part (a), candidates were required to list three applications of an induction motor and in (b), calculate the slip of a 4-pole, 60Hz induction motor, operating at 1780 rpm.

Many of the candidates, in response to Part (a), were unable to list three applications of an induction motor, while for Part (b), most candidates though being able to provide the required formula were unable to complete the needed calculation.

Question 13

In Part (a) of this question, it was given that a 50KVA, 12000 V/230 V, 60 Hz single-phase transformer has 100 turns on the secondary winding. Candidates were required to calculate (i) the full-load secondary current, and (ii) the maximum value of flux. For Part (b), candidates were given a figure of a B-H characteristic loop, and were required to name the loop. In Part (c), candidates were asked to state the main reason why transformers use a ferromagnetic core.

Part (a) of the question proved to be challenging for the majority of candidates. Though they were able to provide the required formulae for Parts (i) and (ii), they could not correctly complete the required calculations. In response to Part (b), the majority of the candidates were able to correctly name the loop. For Part (c), most of the candidates were able to correctly state the main reason why transformers use a ferromagnetic core.

Question 14

This question required candidates to (a) state the meaning of the term *synchronous* as it relates to a synchronous machine, (b) identify two applications of synchronous motors, and (c) state two disadvantages of synchronous motors. In response to Part (a), many candidates could not adequately explain the term *synchronous* as it relates to a synchronous machine. In Part (b), most candidates could not provide two applications of synchronous motors while Part (c) proved to be very challenging for candidates. The majority of candidates could not provide two disadvantages of synchronous motors.

Question 15

This question tested candidates' knowledge of induction motors. Candidates were required to (a) list three sources of power losses in an induction motor and (b) identify the regions marked A, B and C on a given torque/slip curve for an induction machine.

In response to Part (a), the majority of the candidates were unable to list the required three sources of power losses in an induction motor. Some provided one or two of the losses. In response to Part (b), most of the candidates could not correctly identify the three marked regions of the figure.

Paper 02 — Essay Questions

Candidates were required to answer six questions from this paper which accounts for 150 marks. Questions 1, 4 and 7 were compulsory and worth 30 marks each. Candidates were required to select one of the remaining two questions, each worth 20 marks, in each module. Most candidates attempted the required two questions from each module. The marks obtained ranged from a low of two to a high of 99.

Module 1: AC Circuit Theory (Questions 1–3)

Candidates were required to attempt Question 1 and one other from this section. From a possible score of 50 in this module, the highest score was 35 and the lowest was two.

Question 1

In Part (a) of this question, candidates were given the plot for a sinusoidal waveform and were required to express the waveform in the form $I = I_o \sin \omega t$. For Part (b), candidates were asked to define the term *power factor* and state its formula. In Part (c), candidates were asked to state the relationship between voltage and current in circuits for the characteristics (i) lagging power factor, (ii) leading power factor, and (iii) unity power factor. They were also required to identify the load type in each characteristic. For Part (d), candidates were to identify two ways a power utility company can act to improve the power factor. In Part (e) candidates were required to (i) state the meaning of the term *phasor* and (ii) list three properties of phasors. For Part (f), it was given that a transformer rated at a maximum of 40 kVA supplies a 14 kW load at a power factor 0.65 lagging. Candidates were required to calculate the (i) percentage of transformer rating supplied to the load, and (ii) the additional unity power factor load that can be safely added to the transformer.

In response to Part (a), the majority of the candidates were unable to express the waveform in the form $I = I_o \sin \omega t$. For Part (b), the majority of the candidates demonstrated that they had acquired relevant knowledge and were able to correctly define the term *power factor* and to state its formula. For Part (c), most of the candidates demonstrated that they had acquired relevant knowledge to correctly state the relationship between voltage and current for the characteristics: lagging power factor, leading power factor and unity power factor. In response to Part (d), most of the candidates were able to identify two ways a power utility company can act to improve the power factor. For Part (e) (i), most candidates were able to state the meaning of the term *phasor*, but for (e) (ii), the majority could not accurately list three properties of phasors. Part (f) proved to be very challenging for the majority of the candidates. Selecting the correct formula to be used was a problem, and even when the correct formula was stated, candidates encountered problems correctly completing the required calculations.

<u>Question 2</u>

This question tested candidates' knowledge of filters. In Part (a), candidates were asked to state what is meant by the *cut-off frequency* of a filter. For Part (b), candidates were required to sketch and label the frequency response for (i) high pass, (ii) band stop, and (iii) notch filters. For each filter they were required to show the cut-off frequency. Part (c) required labelled circuit diagrams for (i) the T section of a low pass filter, and (ii) the π section high pass filter. In Part (d), candidates were asked to design a π section low pass filter to achieve a nominal impedance of 2 000 Ω and a cut-off frequency of 3 600 Hz. Candidates were required to draw the circuit which satisfied these specifications. For Part (e), candidates were required to state two applications of high pass filters.

In response to this question, candidates demonstrated some knowledge of filters, but appeared to need more in-depth exposure. For Part (a), many candidates were unable to state what was meant by the *cut-off frequency* of a filter. In Part (b), the majority of candidates were quite conversant with what was required of them in terms of the sketches and expected labelling of the frequency responses. For Part (c), many candidates were able to accurately draw the required circuit diagrams for the two filters. In Part (d), some candidates were able to complete this section correctly, but the majority experienced much difficulty identifying the required formula and completing calculations. This affected the development of the correct values for the inductor and the capacitors required to correctly complete the design of the circuit to satisfy the given specifications. For Part (e), the majority of candidates were able to state two applications of high pass filters.

<u>Question 3</u>

This question tested candidates' knowledge of impedance and reactance. Candidates were required, in Part (a), to define the terms (i) *resonant frequency* and (ii) *selectivity*. For Part (b), candidates were asked to consider an RLC series circuit at resonance and (i) briefly describe the oscillation of energy, (ii) state two characteristics of the potential difference across circuit components when $Q > 1$ and (iii) state why the circuit is referred to as an acceptor circuit. In Part (c), it was given that a coil of resistance 10 Ω and inductance 1.2 mH is connected in series with a 47 µF capacitor. The circuit is connected to a 5 V variable frequency supply. Candidates were required to (i) sketch the circuit, (ii) calculate the resonant frequency (F_r), (iii) calculate the voltage across the capacitor at F_r and (iv) sketch the phasor diagram for this circuit at $F_{r.}$

In response to Part (a), candidates were able to clearly define the term *resonant frequency*, but experienced difficulty defining the term *selectivity*. In response to Part (b) (i), the majority of candidates were able to describe the oscillation of energy; however, in Part (ii) they experienced difficulty stating two characteristics of potential difference across the given circuit components. In Part (b) (iii), candidates were able to correctly state why the circuit is referred to as an acceptor circuit. In response to Part (c) (i), the majority of candidates accurately sketched the required circuit, while for Part (ii), most of the candidates were able to provide the needed formula and to calculate the resonant frequency. For Part (iii), many candidates were unable to use the required formulae to correctly complete the calculation for the voltage across the capacitor at F_r. In Part (iv), the majority of the candidates were unable to correctly sketch the phasor diagram for the circuit at Fr.

Module 2: **Digital Electronics and Data Communications (Questions 4–6)**

Candidates were required to answer Question 4 and one of the other two remaining questions from this section. From a possible score of 50 in this module, the highest score was 30 and the lowest was zero.

Question 4

Part (a) of this question required candidates to use a block diagram to assist with explaining the function of a computer network using 'ring' topology. In Part (b), candidates were asked to compare the 'reliability' and 'geographical coverage ability' features of the BUS, STAR and RING computer network topologies. Part (c) required candidates to describe the process of receiving and transmitting information using UART. For Part (d), candidates were asked to define the terms: (i) *bandwidth*, and (ii) *channel capacity*. In Part (e), candidates were asked to calculate the noise factor if the input signal to a receiver is 60 μV and the internal noise at the input is 6 μV. The signal at the output after being amplified is 3 V and the noise at the output is 0.6 V. For Part (f) candidates were required to state the role of the regenerator in a digital system and in Part (g), to identify two types of data that can be transmitted during data communication.

In response to Part (a) the majority of the candidates were able to accurately draw the block diagram and explain the function of a computer network using 'ring' topology. For Part (b), most of the candidates demonstrated limited knowledge when they tried to compare the two features of the BUS, STAR and RING computer network topologies. In many cases they provided the wrong features under a specific topology. In Part (c), the majority of the candidates could not accurately describe the process of receiving and transmitting information using UART. For Part (d) (i), the majority of the candidates were able to correctly define the term *bandwidth*, but encountered problems in (ii) where limited knowledge of the term *channel capacity* was demonstrated. In Part (e), many of the candidates, although providing the correct formula, were unable to correctly complete the required calculation, while in Part (f), the majority of the candidates displayed limited knowledge of the role of the regenerator in a digital system. In response to Part (g), most of the candidates could not identify two types of data that can be transmitted during data communication.

Question 5

Candidates were required to (a) state the meaning of the term *flip flop*, (b) describe the operation of a monostable multivibrator and (c) state the production feature in relation to time of 555 timer when used in the monostable mode. For Part (d), candidates were given the logic symbol for a J-K flip flop, and they were to develop its truth table. In Part (e), candidates were given a schematic diagram for a three-stage shift register and were required to explain the operation of the register. For Part (f), candidates were asked to explain the operation of a counter.

In response to Part (a), candidates demonstrated limited knowledge of the meaning of the term *flip flop*. For Part (b), the majority of candidates were unable to correctly describe the operation of a monostable multivibrator. In response to Part (c), the majority of candidates were unable to state the production feature in relation to time of a 555 timer used in the monostable mode. In Part (d), the majority of the candidates demonstrated limited knowledge of the development of the truth table. For Part (e), some of the candidates were able to explain the operation of the three-stage shift register while for Part (f), the majority of the candidates were unable to correctly explain the operation of a counter.

<u>Question 6</u>

Candidates were required in Part (a) to define each of the given terms as it relates to a thyristor: (i) *holding current* (I_H), and (ii) *latching current* (I_L). In Part (b), candidates were required to list three ways in which a thyristor can be switched on and in Part (c) they were asked to draw and label the static characteristics of a thyristor. For Part (d), candidates were asked to draw the schematic symbol for an n-channel MOSFET and for Part (e), they were required to state two applications of the enhancement mode MOSFET. Part (f) required four advantages of using an enhancement mode MOSFET in digital circuits to be listed, while Part (g) required a description of the operation of a bipolar junction transistor as a switch.

This question proved to be very challenging. The responses of most of the candidates to Parts (a) and (b) indicated that they had some knowledge of the information requested, but could not accurately define the two terms nor list three ways in which a thyristor can be switched on. In response to Parts (c) and (d), some candidates were able to draw and label the static characteristics of a thyristor and draw the schematic symbol for an n-channel MOSFET. Candidates' responses to Parts (e), (f) and (g) were weak, as these parts of the question proved to be challenging. They demonstrated very limited knowledge of the MOSFET and the bipolar junction transistor as a switch.

Module 3: **Introduction to AC Machines (Questions 7–9)**

Candidates were required to answer Question 7 and one other from the two remaining questions in this section. From a possible score of 50 in this module, the highest score was 41 and the lowest was zero.

<u>Question 7</u>

This question tested candidates' knowledge of transformers. In Part (a) of this question, candidates were required to draw and label, with variables, a complete equivalent circuit of a transformer and state the meaning of each variable used. For

Part (b) (i), candidates were asked to state two methods used in the construction of transformers to reduce leakage flux and (ii) define the term *voltage regulation* as it relates to a transformer and state its formula. In Part (c), it was given that a utility company utilizes a single-phase 250 KVA, 230/6600 V, 60 Hz pole-mounted transformer with primary and secondary resistances of 0.003 Ω and 0.4 Ω respectively. The no-load losses are 1 KW. The transformer is delivering half load at 0.95 power factor lagging. Candidates were required to calculate (i) the primary and secondary currents, (ii) the primary and secondary copper losses, and (iii) the efficiency.

A few candidates were able to draw and label, with variables, a complete equivalent circuit of a transformer; however, many demonstrated limited knowledge. Some drew the diagram but could not correctly state the meaning of each variable. Candidates' responses to Part (b) (i) indicated that the majority had knowledge of the methods used in the construction of transformers to reduce leakage flux, while for Part (b) (ii), many candidates demonstrated knowledge of the meaning of the term *voltage regulation*, but could not state its formula. In response to Parts (c) (i), (ii) and (iii), many candidates stated the required formulae, but some were unable to correctly complete the needed calculations.

<u>Question 8</u>

Candidates were required in Part (a) to describe the principle of operation of a synchronous generator. For Part (b), candidates were asked to define the terms: (i) *armature reaction*, and (ii) *synchronous impedance* as they relate to the synchronous generator. In Part (c) it was given that a three-phase, wye connected, synchronous generator is rated at 1200 KVA, 12 KV, 60 Hz. The armature resistance is 0.5 Ω and the synchronous reactance is 10 Ω. The synchronous generator is delivering full load at a power factor of 0.7 lagging. Candidates were required to (i) sketch a labelled per phase equivalent circuit diagram of the synchronous generator and include component values, (ii) calculate the excitation voltage of the synchronous generator, and (iii) sketch the phasor diagram.

This question proved challenging to most candidates. In response to Part (a), many candidates could not correctly describe the operation of a synchronous generator. For Part (b) (i), the majority of candidates demonstrated limited knowledge when defining the term *armature reaction*, but were able in Part (b) (ii), to correctly define *synchronous impedance*. In Part (c) (i), most candidates were able to sketch and label the requested circuit diagram, while for Part (c) (ii), the majority of the candidates were unable to provide the required formulae and thereafter, could not correctly complete the calculation. This therefore impacted on their ability to complete Part (c) (iii) which depended on an accurate calculation in order to correctly sketch the phasor diagram.

<u>Question 9</u>

Part (a) of this question focused on the squirrel cage and wound rotor induction motors. Candidates were required to (i) describe the differences in the construction of squirrel cage and wound rotor induction motors and (ii) state two advantages of each of the motors. For Part (b), it was given that a 36 KW three-phase, 4-pole, 60 Hz, 400 V star connected induction motor had the following output:

Efficiency = 92.4%
Slip S = 4%
Friction and windage = 200 W
Stator copper loss (per phase) = 600 W
Rotor copper loss (per phase) = 300

Using this information, candidates were required to calculate the (i) output torque and (ii) core iron losses.

Many candidates demonstrated limited knowledge in response to Part (a) (i). They were unable to correctly describe the differences in the construction of squirrel cage and wound rotor induction motors. In response to Part (a) (ii), the majority of candidates were able to state two advantages of the squirrel cage and wound rotor induction motors. For Parts (b) (i) and (ii), many candidates were able to state the required formulae, but were unable to correctly complete the needed calculations.

Paper 03 — School-Based Assessment (SBA)

An adequate number of SBA samples was submitted for inspection and moderation. The following were observed:

- All students did not adhere to the specific guidelines/requirements for completing SBAs.
- All students need to follow the format established for writing reports.
- There is need to address sentence construction and spelling in the project documentation. Students need more guidance in documenting their methodology.
- In some instances, students failed to adequately discuss the findings of the experiment or outcome of the project.
- Some projects submitted were too simple for the CAPE level.

Recommendations

- A workshop on SBAs should be held for teachers in the schools.

- Candidates could benefit from closer supervision as they develop their SBA projects.