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.

Question 8

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.

Question 9

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.