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

REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

MAY/JUNE 2011

ELECTRICAL AND ELECTRONIC TECHNOLOGY TECHNICAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The number of candidates who wrote the examination was 3526. This was an increase from last year by about 4.5 per cent. This was due to the fact that all but five territories increased the candidature by a small amount.

The overall performance of candidates resulted in 25.83 per cent Grade II and above. Candidates did well on the practical project of the internal assessment but displayed the need for improvement on the written project. Competencies tested in Paper 01 (Multiple Choice) and Paper 02 (Essay and Problem Questions) were Knowledge and Application. Paper 02 also consisted of compulsory short-answer questions.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Candidates' performance on this paper was comparable with performance in 2009 but the mean was 4.5 per cent smaller than that of 2010; however, the analysis shows that there is still need for better and broader coverage of Modules 1–4 and 6–7 of the syllabus. The result also indicates that candidates need practice in the multiple-choice format used in the paper.

Paper 02 – Essay/Problem Questions

The paper comprised three discreet sections: A, B and C.

Section A consisted of five, short-answer questions. Candidates were required to attempt all five questions. Each question was worth eight marks.

Section B consisted of four questions. Candidates were required to answer any three of the four questions. Each question was worth 20 marks.

Section C consisted of two questions each worth 20 marks. Candidates were required to answer any one question.

SECTION A

<u>Question 1</u>

This question tested knowledge and application of:

- Ohm's Law
- Resistances connected in Series and Parallel and the electric power developed in a resistor

The question was attempted by almost all of the candidates who wrote the examination.

The responses by candidates to Part (a) was satisfactory. Candidates were able to state Ohm's Law in words and also by use of symbols and formula.

For Part (b), the majority of candidates provided responses that suggested knowledge of the series parallel circuit combination. However, the introduction of switching the circuit created difficulty for some candidates when calculating the total resistance with the switch closed and open.

Candidates need performance-based learning experiences in series and parallel connections of resistors, filament lamps and the calculation of how electric power develops in resistors.

Question 2

This was a popular question. It was attempted by 94 per cent of the candidates. The responses suggested that candidates' knowledge and their ability to apply that knowledge were acquired through their general use of computers at home and at school.

Part (a) tested candidates' knowledge on the operation and application systems of the computer. About 65 per cent of the responses were correct. Part (b) assessed candidates' knowledge of software packages whereas Part (c) required them to examine the networking of computers in offices using a single server.

Both Parts (b) and (c) were well answered.

Part (d) was poorly answered as candidates had difficulty defining RAM software. Some candidates confused RAM and ROM. RAM, Random Access Memory, is used to store and retrieve information during the normal execution of application programs.

It is recommended that Introduction to Computers form a part of the laboratory exercises provided to candidates.

Question 3

This question tested candidates' knowledge and application of

- Double wound transformers and Auto-transformers
- Computation of transformer current and turn ratios

It was attempted by 77.3 per cent of the candidates.

For Part (a), candidates were able to draw diagrams to represent the windings of the transformers, but were unable to provide clear explanations of the two transformers.

In Part (b), candidates were able to calculate the secondary voltage using the turns ratio. The responses showed that candidates experienced difficulty in calculating the secondary current.

A visit to a small factory or power supply company would assist candidates in understanding this topic.

Question 4

Almost 65 per cent of candidates attempted this question. Candidates provided satisfactory responses to Part (a) and showed knowledge of the difference between primary and secondary cells.

In Part (b), candidates' responses showed knowledge of polarization and its effect on the operation of the primary cell.

For Part (c), responses showed that candidates were not able to apply knowledge of open circuit volts, terminal volts and load current to compute the internal resistance of a battery.

A Lead Acid battery, hydrometer and a high rate discharge tester should be included as standard laboratory equipment in schools.

Question 5

This question was attempted by 78 per cent of the candidates. Part (a) assessed candidates' knowledge of the p-n junction and semiconductor devices used in industry. Part (b) assessed the application of semiconductors in amplifier circuits. Candidates had difficulty relating the p-n junction to the semiconductor diode.

The responses to Part (c) showed that candidates had no knowledge of the practical application of semiconductors as replacements for conventional relays. Many candidates suggested that a diode could be used to replace a relay.

Practical activities should be provided for candidates to understand the various characteristics of semiconductor devices.

Question 6

Fifty-eight per cent of the candidates attempted this question. Candidates' responses showed that they were unable to provide a definition for the inductive reactance of an inductor in an alternating current.

Candidates were able to recall the formula for computing the inductive reactance of a circuit. However, when they applied the formula to compute the current, they referred to inductive reactance as electrical resistance.

Solutions

(a) Inductive Reactance:

The opposition (reactance) which an inductor presents to an alternating current is called inductive reactance (X_2).

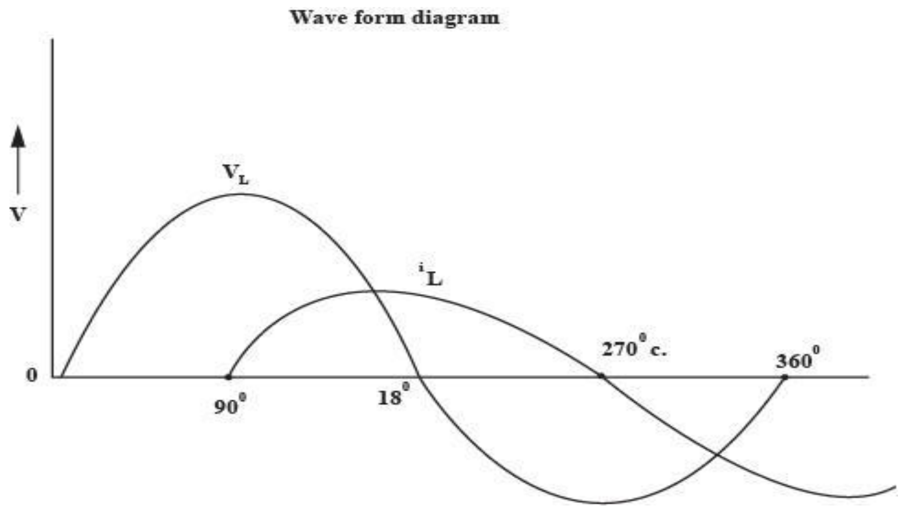
OR

$X_L = 2 \pi fL$

Where L is the inductance and f is the frequency of the alternating current.

(b)

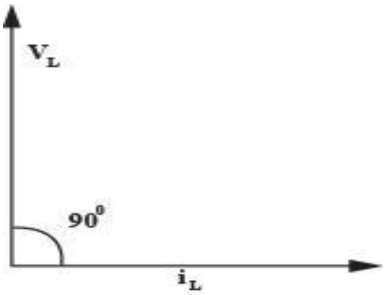
(1)



The i_L lags the V_L by 90°.

Vector diagram

(1)



(1)

90° Phase difference

(c) $X_L = 2\pi fL$

$= 2 \times 3.14 \times 50 \times 0.5$

$= 157\ \Omega$

$$IL = \frac{V}{X_L} = \frac{110V}{157\Omega} = 0.7A$$

(d) e.m.f. self induction is the e.m.f. induced in a coil by the changing current in the coil. K=1 and opposes the applied e.m.f.

The smoothing circuit in a d.c. power supply opposes changes in the applied emt.

Candidates need worksheets on the principles of simple RL circuits.

Question 7

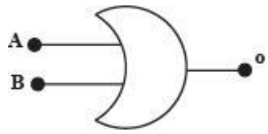
Seventy-nine per cent of the candidates attempted this question. Responses to Part (a) showed that candidates had knowledge of basic logic gates and the construction of truth tables associated with each gate.

For Part (b), candidates displayed little knowledge of the use of Boolean Algebra as an expression of logic gates.

In Part (d), candidates showed little knowledge of the application of logic gates in practical circuits.

Solutions

(a) OR Gate



NAND Gate

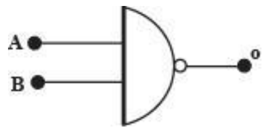


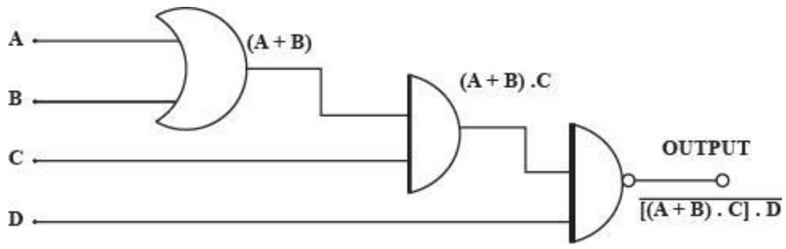
TABLE FOR OR GATE

A	**B**	**O**
0	0	0
0	1	1
1	0	1
1	1	1

TABLE FOR NAND GATE

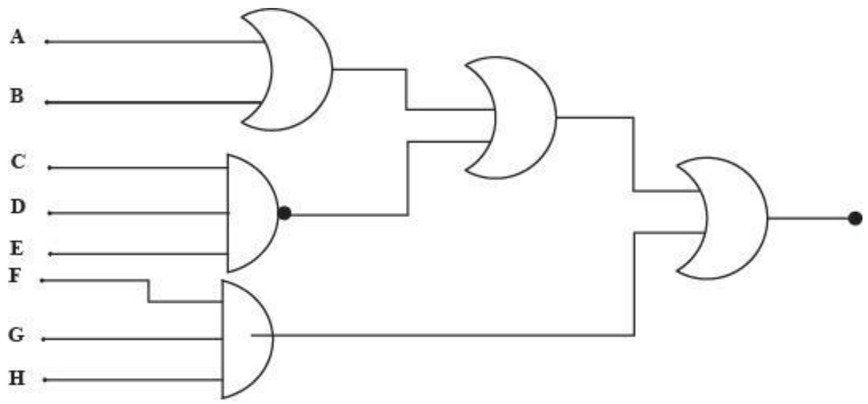
A	**B**	**O**
0	0	1
0	1	1
1	0	1
1	1	0

(b)

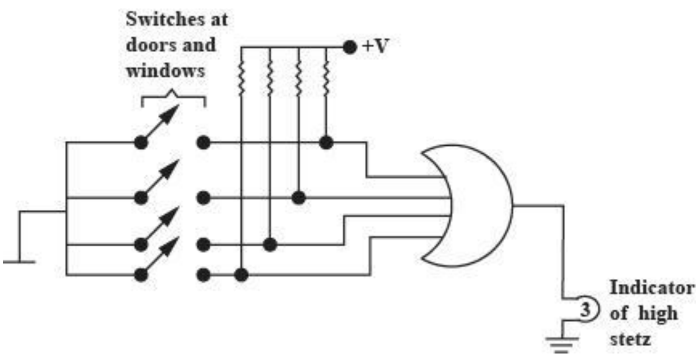


After output OR Gate: (A + B)
Output of AND Gate: (A + B).C
Output of NAND Gate: ((A+B).C).D

(c)



(d)



Open switches → output one (high)
All closed switches → output

The teaching and application of logic circuits should be a component of teaching exercises which focus on electrical electronic principles.

Question 8

This question tested candidates' knowledge and application of theory and principles concerning three-phase induction motors. It was attempted by 58 per cent of the candidates.

Candidates' responses showed knowledge of two main parts of three-phase motors. However, they were unable to provide a definition for synchronous speed.

While candidates received marks for Part (a) (i), the responses provided for the other parts of the question showed no knowledge of the principles and application of the principles of the induction motor.

Solutions

(a)

- STATOR – stationary part
- ROTOR – rotating part

(i) The speed at which the magnetic field of an induction motor is rotating around the stator coils.

(ii) Synchronous Speed = $\frac{f \times 60}{p}$

Where f = line frequency
And p = number of pairs of poles

$\therefore$ Synchronous speed $\frac{60 \times 60}{3}$ = 1200 rev/min

(iii)

- Constant speed operation
- Cheap to construct
- Robust design/construction
- Relatively efficient operation
- Good power factor on full-load

any two

(iv)

- Poor starting torque
- Very high starting current

any one

(v)

- Direct-on-line starting
- STAR-DELTA starting
- Auto transformer

any two

(b) (i)

- To START the motor in the forward direction
- To STOP the motor
- To START the motor in the reverse direction
- To prevent automatic restarting of the motor

<u>any three</u>

(ii) When the reverse push button is activated any two lines of the three-phase supply to the motor is interchanged

(iii) Prevent unbalanced current
Prevent electrical shock
Prevent mechanical damage
Or polling

(c) $X_L = 2\pi fL$

$= 2 \times 3.14 \times 50 \times 0.5$

$= 157\ \Omega$

$$IL = \frac{V}{X_L} = \frac{110V}{157\Omega} = 0.7A$$

(1)

(d) e.m.f. self induction is the e.m.f. induced in a coil by the changing current in the coil. K=1 and opposes the applied e.m.f.

The smoothing circuit **(**K=1) in a d.c. power supply opposes changes in the applied e.m.f.

A three-phase work station with motors and motor starters must be part of the electrical and electronic laboratory. A visit to the electrical power company will also assist candidates in understanding this module.

<u>Question 9</u>

This question tested candidates' knowledge of the Wheatstone Bridge and Moving Coil Instrument.

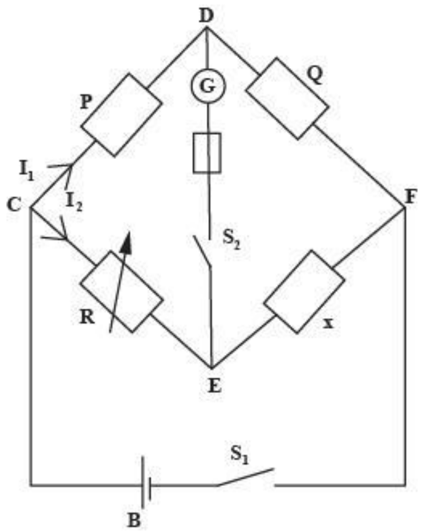
Twenty-eight per cent of the candidates attempted it. Part (a) was poorly done. Only 25 per cent of candidates who attempted it had passing knowledge of what was required.

Part (c) was well answered with many candidates giving general precautions of instruments.

Part (d) was also poorly done; very few candidates could extend the moving coil to a voltmeter and ammeter.

Solutions

(a) It is used to measure the value of an unknown resistance by the balance of the bridge (shown below).



1. With S_1 and S_2 closed, R is adjusted until there is no deflection in G. Thus, the bridge is balanced.

2. Therefore P.d. at CD = CE and DF = EF.

3. I_1 and I_2 will be the same current passing through Q and X respectively.

4. By deduction $\frac{Q}{P} = \frac{X}{R}$. Thus the unknown value can be calculated by the formula:

$$X = \frac{QR}{P}$$

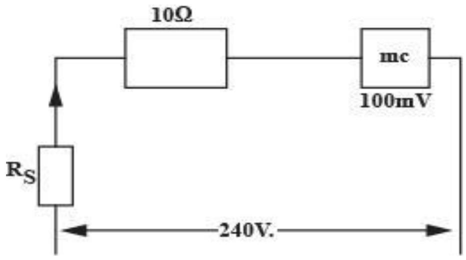
(b) Used to measure unknown resistance

(c) 1. Correct polarity connections

2. Correct selector range/function

3. Ensure that circuit is de-energized when measuring resistance/continuity

(d)



(i) $V_{R_S} = V_{fso} - V_{mc}$

= 240 – 100 mV

= 239.9 V

$I = \frac{V_{mc}}{R_{mc}} = \frac{100mV}{10}$

= 10 ma

$R_S = \frac{V_{RS}}{I} = \frac{239.9}{10ma}$

= 23.99KΩ

(ii) $IS = I_T - I_a$

= 10 A – 10 ma

= 9.99 A

$RS = \frac{V_{mc}}{I_S} = \frac{10mV}{9.99A}$

0.001Ω

Candidates would benefit from laboratory activities involving the Wheatstone Bridge and having practical use of a multimeter.

Question 10

This question was attempted by 64 per cent of the candidates. It tested candidates' knowledge and application of an electrical installation. It was poorly done; candidates had difficulties in each section.

Part (a) was not done well. Many candidates had little or no knowledge of the electrical circuit symbols, especially the two-way switch.

Parts (c), (d), (e), and (f) which tested candidates ability to test an electrical installation before it is energized was very challenging.

Solutions

(a) (1) Electricity meter (Kilowatt-hour meter)

(2) Distribution board (Distribution panel)

(3) Fluorescent lamps

(4) Socket outlet

(5) Two-way switch

(b) (1) Measures the electrical energy utilized by the consumer in kilowatt-hours

(2) Distributes the electrical energy to the various sub-circuits within the premises (e.g. lighting or power circuits). May be used to turn OFF sub-circuits

(3) Efficiently converts electrical energy to light energy

(4) Allows for appliances to be conveniently connected/disconnected with the power source

(5) Allows consumer to control one lamp from two positions

(c)
- Insulation Resistance Test between conductors and earth
- Insulation Resistance Test between conductors
- Polarity Test
- Earth Electrode Resistance Test

<u>any two</u>

(d)
- Verification of polarity test

(e)
- Continuity Tester
- Insulation Resistance Tester
- Earth-Fault Loop Impedance Tester
- OHM meter

<u>any two</u>

Candidates need to design and construct a model domestic installation or visit an electrical installation in progress or interview an electrician or electrical inspector.

<u>Question 11</u>

This question attracted responses from only 22 per cent of the candidates. It tested candidates' knowledge and application of illumination and the fluorescent lamp circuit.

It was poorly answered even though it was part of the laboratory exercise for the SBA.

For Part (a), many candidates were able to define illumination; some however confused illumination with luminous flux.

In Part (b), the inverse square law was poorly done.

Part (c) which required candidates to calculate the illumination at a particular point was hardly attempted.

In Part (d), many candidates were unable to sketch a fluorescent lamp circuit and to explain the purpose of the choke.

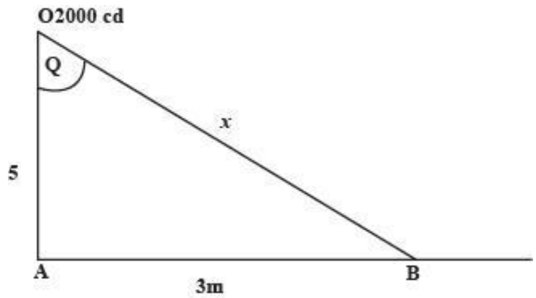
Solutions

(a) (i) Illumination: Density of flux falling on a evoking plane
Lumars/m^2 –

(ii) Luminous Flux: Light emitting from a source

(b) Inverse Square Law: The quantity of light falling on a working plane varies inversely as the square of the distance from the light source

(c)

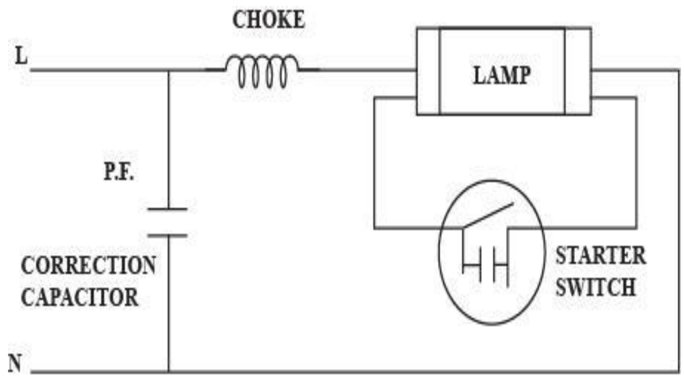


(i) $$EA = \frac{I}{d_2}(Lx)$$
$$= \frac{2000}{(5m)^2}$$
$$= \frac{2000}{25} = 80\ Lx$$

(ii) $$E_B = \frac{Icos\theta}{d^2}(Lx)$$
$$cos\theta = \frac{OA}{OB} = \frac{5}{x}$$
$$\therefore x = \sqrt{OA^2 + AB^2}$$
$$= \sqrt{5^2 + 3^2}$$
$$= \sqrt{25+9} = \sqrt{34}$$
$$= 5.83 \text{ m}$$

$$cos\theta = \frac{5}{5.83} = 0.858$$
$$\therefore E_b = \frac{2000 \times 0.858}{(5.83)^2}$$
$$= 50.45 \text{ L}x$$

(d) (i)



Switch - start Fluorescent Lamp Circuit

Correct Symbols –
Correct Connection –

(ii) CHOKE:

- It involves a high initial voltage on starting caused by the breaking of an inductive circuit.

- It limits the current in the lamp when the lamp is running.

Generally, it appeared as though this module was not taught. Candidates need to be taught the entire syllabus and should also have related field trips on a timely basis.