Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2011

ELECTRICAL TECHNOLOGY

MEMORANDUM

MARKS: 200

This memorandum paper consists of 12 pages.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1 ENVIRONMENT: The building of the new power station must use the technology that has no negative effect or little effect on the environment that is pollution and global warming. √√ (2)

1.2
- I have to attend to that person. √
- I must take every precaution to protect myself from coming into contact with another person's blood. √
- I must wear protective clothes when helping any bleeding person. √
- If it is not possible I still have a responsibility to report the incident. √ (4)

1.3
- Good financial skills. √
- Good marketing skills. √
- Good communication skills. √
- Good time management skills. √ (4)

[10]

QUESTION 2: TECHNOLOGICAL PROCESS

2.1
- Amplifier gain too low. √
- Possible faulty on/off volume control. √
- Faulty cabling between guard house and reception. √
- Faulty electronics components in amplifier circuit – filter circuit. √

(Any 3 possible answers.) (3)

2.2

(3)

2.3
- The circuit connections and assembling should be correct between the guard house and the reception. √√
- The amplifier should provide an audible sound to meet the needs of the security and give the high amplifier gain that will give a good quality sound. √√ (4)

[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1
- Make sure that you remove the chuck key from the chuck after loosening or tightening the bit. √
- Stand firm when you use a portable drill. √

(Any relevant and applicable answer.) (2)

3.2
- Workshop should be clean. √
- Workshop should not be slippery. √ (2)

3.3
- The selector switch must be on the correct scale. √
- Set the selector switch to the highest full-scale deflection. √ (2)

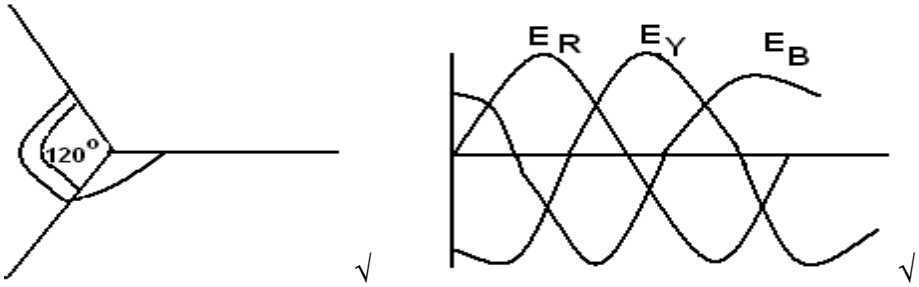
3.4
- Working on live installation. √
- Not wearing safety clothes. √ (2)

3.5
- Exposed live conductors. √
- Slippery surface. √ (2)

[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1



√ √

2 marks for drawing.
3 marks for explanation.

- The coils are rotating in the same field as shown in the diagram. √
- With the armature rotating anti-clockwise the three e.m.fs generated will be as in the diagram. √√ (Any 2) (5)

4.2 $P_t = \sqrt{3}V_L I_L \cos\theta$
$= \sqrt{3}.398, 37.20.\cos 30^o$ √
$= 11\,951{,}1$ W
$= 11{,}95$ kW √

But $V_L = \sqrt{3}\, V_{Ph}$
$= \sqrt{3} \times 230$
$= 398{,}37$ V √

(3)

4.3 120 degrees √ (1)

4.4 To measure the amount of power consumed by a consumer over a period of time (energy). √ (1)

[10]

QUESTION 5: R,L and C CIRCUITS

5.1 5.1.1 Frequency has no effect on resistance. √ (1)

5.1.2 Inductive reactance will increase. √ (1)

5.1.3 Capacitive reactance will decrease. √ (1)

5.2 5.2.1 $I_R = \frac{V}{R} = \frac{100}{20} = 5$ A √

$I_L = \frac{V}{X_L} = \frac{100}{47,12} = 2,12$ A√

$I_C = \frac{V}{X_C} = \frac{100}{21, 22} = 4, 71$ A√

$I_t = \sqrt{I_R^2 + (I_C - I_L)^2}$ √

$= \sqrt{5^2 + (4,71 - 2,12)^2}$ √

= 5,63 A √

$X_L = 2\pi FL$

$= 2.\pi.50.0, 15$

$= 47,12\ \Omega$ √

$X_C = \frac{1}{2\pi FC}$

$= \frac{1}{2.\pi.50.150.10^{-6}}$

$= 21,22\ \Omega$ √ (8)

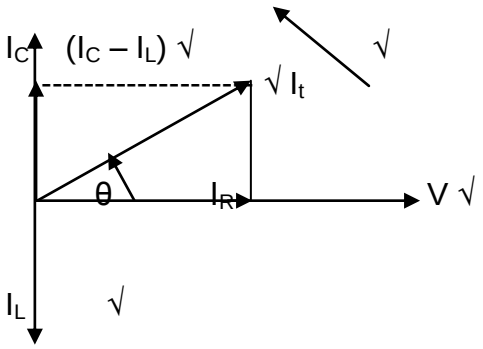
5.2.2 $\cos\theta = \frac{I_R}{I_t}$

$\cos\theta = \frac{5}{5, 63}$ √

$\theta = \cos^{-1} 0, 89$√

$= 27,36^o$ √ Leading √ (4)

5.2.3



(5)

5.3.1 $F_R = \frac{1}{2\pi\sqrt{LC}}$ √

$= \frac{1}{2\pi\sqrt{0,15.150.10\text{-}6}}$ √

$= 33,55$ Hz √ (3)

5.3.2 $Z = R$ √

$I = \frac{V}{R}$

$= \frac{240}{30}$ √

$= 8$ A √ (3)

5.4
- $X_C = X_L$. √
- $Z = R$. √
- $V_C = V_L$.√
- I is at maximum. √ (4)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

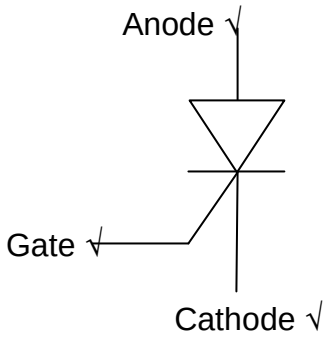
6.1 6.1.1 R_1 limit the current to protect the DIAC when R_2 is set to a minimum or zero. √√ (2)

6.1.2 If R_2 is increased the time constant of the trigger circuit is increased (t = RC). √ This will prolong the time it take for the capacitor to charge to the voltage that is equal to the break over voltage of the DIAC increasing the trigger angle (taking longer to trigger in each half cycle) thus reducing the brightness of the lamp as less time is allowed for current to flow through the lamp. √√√ (4)

6.1.3 The DIAC is use to trigger the TRIAC into conduction with either polarity on the DIAC. √√ (2)

6.2
- It has two main terminals and a common gate. √
- It conducts in both directions. √ (2)

6.3



(3)

6.4 When a voltage is applied to the DIAC two of its internal junctions are forward biased and the third one is reverse biased. √ Once the terminal voltage rises above V_{BO}, the third junction breaks through and the DIAC starts conducting. √√ (3)

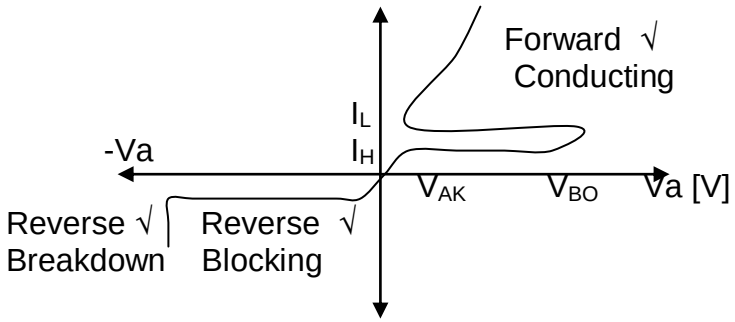
6.5 SCR can be switched on by:

- Applying a positive trigger voltage of about 2 V and 10 mA to the gate terminal of the SCR. √
- Raising the forward biasing voltage above V_{BO}. √

SCR can be switched off by:

- Reducing the current through the SCR below the level of the holding current. √
- Reducing the terminal voltage below V_{AK}. √ (4)

6.6



(3)

6.7 It conducts only in one direction. √√ (2)

[25]

QUESTION 7: OPERATIONAL AMPLIFIERS

7.1 To amplify a small electrical input signal into a large electrical output signal. √ (1)

7.2 A OP-AMP needs a +15 0 -15 supply as it functions in both positive and negative voltage values. √√ (2)

7.3
- Open-loop voltage gain is infinite. √
- Input impedance is infinite. √
- Output impedance is zero. √ (3)

7.4 The inverting input of an op-amp is labelled with a "– "called the inverting terminal. √ If an input signal is fed into the op-amp's input, it will be inverted as it appears at the output. √ The non-inverting input of the op-amp is labelled with a "+" called the non-inverting terminal. √ As an input signal is fed into the op-amp's input, the signal will not be inverted as it appears at the output. √ (4)

7.5 Positive feedback is when the output of the circuit is fed back to the input of the same circuit in phase with the input signal; the resultant will be ever increasing output. The result could be distortion or overloading of the circuit. √

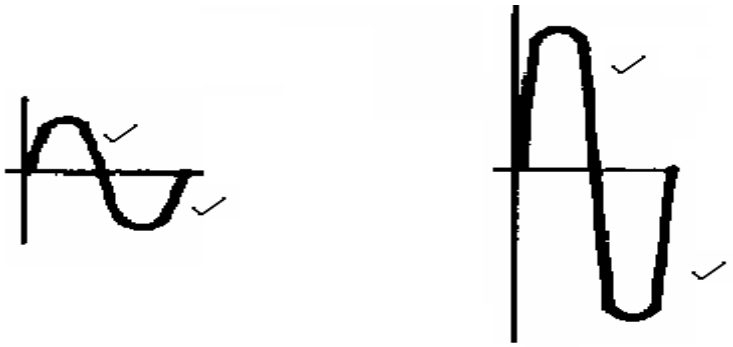
Example: When the microphone of an audio amplifier is held close to the speaker, positive feedback causes the speaker to whistle causing great discomfort to the human ear. √

Negative feedback is the output of a circuit is fed back to the input same circuit out of phase with the input, the result is that the output signal becomes smaller and may even disappear. √

Example: Negative feedback is utilised in amplifiers to obtain volume control and gain control such as is used in the oscilloscope. √ (4)

7.6 7.6.1 Non-inverting OP-AMP √ (1)

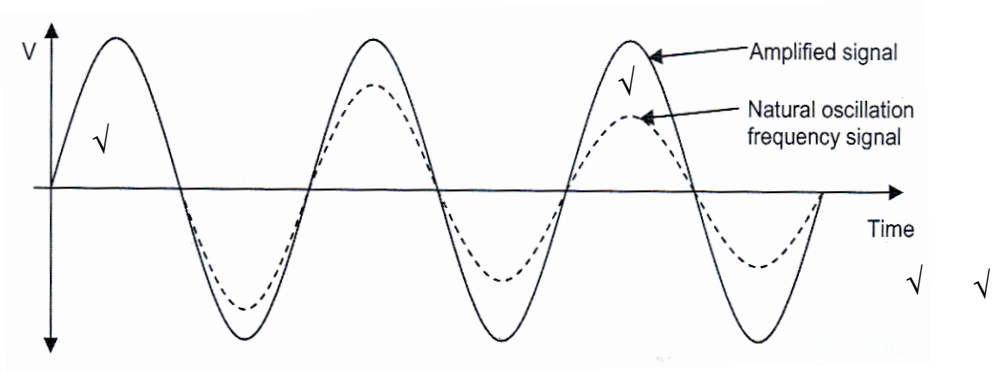
7.6.2



INPUT WAVEFORM OUTPUT WAVEFORM

(2 marks for each waveform) (4)

7.7



The electrical signal that an oscillator provides is referred to as the natural oscillating frequency signal. √ Natural oscillations diminish in amplitude as a result of a lack of positive feedback. √ (6)

[25]

QUESTION 8: THREE-PHASE TRANSFORMER

8.1
- Star-delta. √
- Delta-star. √
- Star-star. √
- Delta-delta. √ (2)

8.2 To reduce eddy current losses. √ (1)

8.3
- Stray losses. √
- Dielectric losses. √
- Copper losses. √ (3)

8.4 8.4.1 $V_{ph2} = \frac{V_{2L}}{\sqrt{3}}$

$= \frac{380\ \sqrt{}}{\sqrt{3}}$

$= 219,39\ V\ \sqrt{}$ (2)

8.4.2 $V_{L1} = \frac{N_1 V_{2ph}\ \sqrt{}}{N_2}$

$= \frac{50,219,39\ \sqrt{}}{1}$

$= 10\ 969,5\ V\ \sqrt{}$ (3)

8.4.3 $P = \sqrt{3} V_L I_L \cos\theta$

$= \sqrt{3}\ 380.45,\ 58.\ 0,\ 85\ \sqrt{}$

$= 25\ 499,\ 84\ W$

$= 25,5\ kW\ \sqrt{}$

Where $I_L = \frac{S}{\sqrt{3} V_{2L}}$

$= \frac{30\ 000\ \sqrt{}}{\sqrt{3},380}$

$= 45,58\ A\ \sqrt{}$ (4)

[15]

QUESTION 9: LOGIC CIRCUIT AND PLCs

9.1
- Traffic light control √
- Factory automation √
- Robotics √
- Railroad switching √
- Security systems √
- Data collection √ (Any 3) (3)

9.2 9.2.1 PLC is a device that was invented to replace the necessary sequential relay circuits for machine control. √√ (2)

9.2.2 Address is a location within the PLC system and generally consists of either a 1 or 0. √√ (2)

9.2.3 Ladder diagram is a standard method of representing electrical controlled schematic diagram. √√ (2)

9.2.4 Overhead time is that time taken for the programme to execute a given command. √√ (2)

9.2.5 Logic element is an element that may be used in a ladder diagram that will have an influence on the desired operation of the programme. √√ (2)

9.3
- Economical. √
- Quick delivery. √
- Simplified design. √
- Improve reliability. √ (Any 3) (3)

9.4 $\overline{(A + \overline{B} + C)(A + \overline{B} + \overline{C})(\overline{A} + \overline{B})}$

$\overline{(A+\overline{B}+C)} + \overline{(A+\overline{B}+\overline{C})} + \overline{(\overline{A} +\overline{B})}$ √

$(\overline{A}.B.\overline{C}) + (\overline{A}.B.C + A.B)$ √

$AB+\overline{A}BC$ √

$AB + BC$ √ (4)

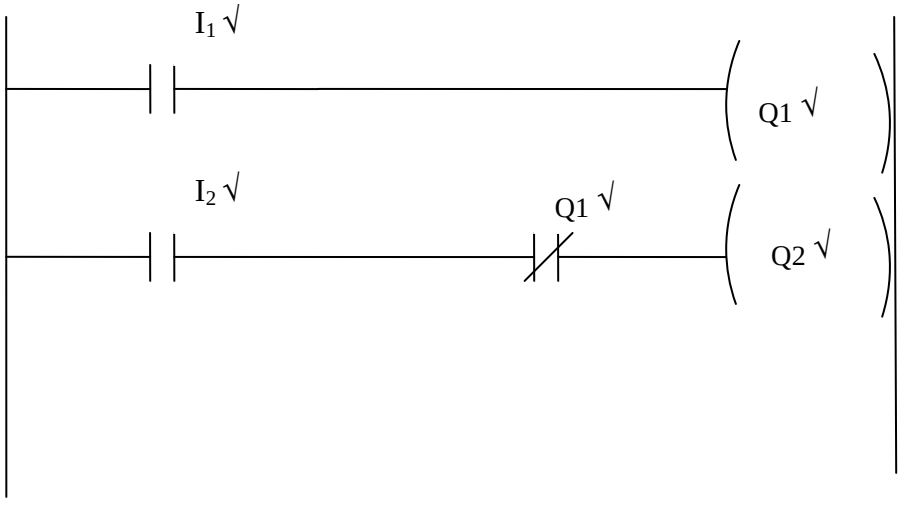
9.5 SET and RESET LATCH (memory)

Input		Output	
S	R	Q	$\overline{Q}$
0	0	No change√	
0	1	1	1√
1	0	1	0√
1	1	Invalid√	

(4)

9.6 Controller Relay. √ (1)

9.7



(5)

9.8.1 √ F = A.B.C √ + A.B.C √ + A.B.C √ + A.B.C √ (5)

[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 10.1.1 Are all electrical connections fastened and insulated? √ (1)

10.1.2 Does the frame have any cracks? √ (1)

10.2
- When the motor is connected to the supply, current starts to flow in the windings of the stator. √
- Owing to the phase difference of the currents, a rotating magnetic field is produced in the stator. √
- The rotating stator field cuts the static rotor conductors, inducing an emfs and currents in them. √
- The current in the rotor conductors creates a magnetic field around these conductors in such a way that they try to oppose the action of the stator field. √
- Magnetic field lines around the rotor conductors weaken the stator field on the side of the conductors and strengthen the stator field on the other side of the conductors. √
- A magnetic force is exerted of the rotor conductors, pulling them in the direction of the rotating magnetic field. √
- Owing to the torque on the rotor, it starts turning faster in an attempt to reach the speed of the rotating magnetic field. √ (Any 5) (5)

10.3 By swapping any two lines. √ (1)

10.4 10.4.1 $I_L = \frac{P}{\sqrt{3}VL\cos\theta}\sqrt{}$

$= \frac{4\,000}{\sqrt{3}.380.\ 0{,}8}\sqrt{}$

$= 7{,}6\ A\ \sqrt{}$ (4)

10.4.2 $I_{ph} = \frac{I_L}{\sqrt{3}}$ √

$= \frac{7,6}{\sqrt{3}}$ √

$= 4,39$ A √ (3)

10.4.3 $P_r = \sqrt{3}V_L I_L \sin\theta$ But $\cos\theta = 0,8$

$= \sqrt{3} .380. 7,6 \sin 36,87^o$ √ $\theta = \cos^{-1} 0,8$ √

$= 3\,001,3$ W $= 36,87^o$ √

= 3 kW √ (4)

10.5
1. Overload contacts. √
2. Normally closed stop button. √
3. Normally open start button. √
4. Normally hold-in. √
5. Normally open contacts. √ (5)

10.6
- Overload unit in a starter is there to protect the motor in event of an over current situation. √√ (2)

10.7
- Copper losses. √
- Iron losses. √ (2)

10.8
- To switch or activate the main contact. √
- For safety purpose. (Cannot restart automatically) √ (2)

TOTAL: 200