Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2012

ELECTRICAL TECHNOLOGY MEMORANDUM

MARKS: 200

This memorandum paper consists of 12 pages.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1
- Find a need and fill it. √
- Find a problem and solve it. √
- Look for possible solutions. √
- Focus on your customers. √
- Invest financially in your business. √ (Any 4) (4)

1.2 Culture is generally the way people do things, e.g. the way we dress, travel; communicate etc. so the development of technology over time has drastically changed the way we communicate, travel etc. The examples can include the following:

- We no longer use donkeys and horse carts, trains and aeroplanes which are faster. √
- The development of telecommunication systems such as landlines phones and mobile phones has changed the old way of communication using letters. √
- The way we dress and what we dress has been changed by designs of new types of clothes. √
- Food technology has also changed the type of food and the way we eat. √ (4)

1.3
- Make sure that you do not come into contact with blood. √√ (2)

[10]

QUESTION 2: TECHNOLOGICAL PROCESS

2.1 Design and construct a simple hand controlled lever device that can be operated by a disabled child who has lost the use of his/her legs. (5)

2.2
- Visit shops or exhibitions to examine existing products. √
- Develop a questionnaire to gather more information. √
- Interview people to investigate the problem. √
- Visit media centres and utilising all forms of media. √
- Visit industry to gather information. √ (5)

[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 Suitable eye protection must be worn. √ (1)

3.2 No person may enter or remain in a workplace under the influence of drugs as he may place himself and other persons in danger while operating machinery. He may also cause damage to the machinery. √√ (2)

3.3 When using an electrical appliance, that has a conducting material, under faulty conditions, the user may be shocked. With the earth leakage unit any earth fault above 20 mA will operate the unit removing the supply rendering the appliance safe. √√√ (3)

3.4 No horseplay in the workshop. √
No working on a machine which does not have correct guards. √ (2)

3.5 Make sure a soldering stand is used to support the iron when not in use to prevent burn damage and possible fire. √√ (ANY CORRECT ANSWER.) (2)

[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Three-phase supply systems are more versatile. They can be operated in star and delta. √
When connected in star, both line and phase voltages are obtainable which allows both three-phase and single-phase utilisation. √ (2)

4.2 A wattmeter measures the power consumed at an instant in time by a circuit. √
A kilowatt meter measures the power consumed over a period of time (energy). √ (2)

4.3 4.3.1 $I_{ph} = \frac{I_L}{\sqrt{3}}$ √

$= \frac{5}{\sqrt{3}}$ √

$= 2{,}87\ A$ √ (3)

4.3.2 $P = \sqrt{3}\, V_L I_L \cos\theta$ √
$= \sqrt{3} \cdot 380 \cdot 5 \cdot 0{,}9$ √
$= 2{,}96\ kW$ √ (3)

[10]

QUESTION 5: R,L and C CIRCUITS

5.1 5.1.1 Inductive reactance √ (1)

5.1.2 Impedance √ (1)

5.1.3 Capacitive reactance √ (1)

5.2 5.2.1 $X_L = 2\pi fL$ √
$= 2.\pi.50.15.10^{-3}$ √
$= 4{,}71\ \Omega$ √ (3)

5.2.2 $X_C = \frac{1}{2\pi fC}$ √
$= \frac{1}{2.\pi.50.147.10^{-6}}$ √
$= 21{,}65\ \Omega$ (3)

5.2.3 $Z = \sqrt{R^2 + (XC - XL)^2}$ √
$= \sqrt{20^2 + (21{,}65 - 4.71)^2}$ √
$= 26{,}21\ \Omega$ √ (3)

5.2.4 $Fr = \frac{1}{2\pi\sqrt{LC}}$ √
$= \frac{1}{2\pi\sqrt{0{,}015x0{,}000147}}$ √
$= 107{,}18$ Hz √ (3)

5.3 5.3.1 $I = \frac{V}{R}$ √

$= \frac{240}{39}$ √

$= 6{,}15$ A √ (3)

5.3.2 $I_L = \frac{V}{XL}$ √

$= \frac{240}{75}$ √

$= 3{,}2$ A √ (3)

5.3.3 $Ic = \frac{V}{Xc}$ √

$= \frac{240}{50}$ √

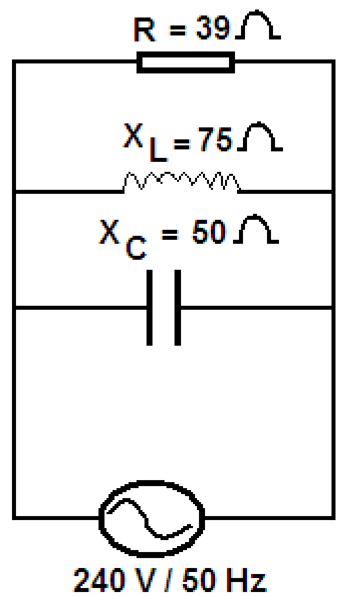
= 4,8 A √ (3)

5.3.4 $It = \sqrt{IR^2 + (Ic - IL)^2}$ √

$= \sqrt{6{,}15^2 + (4{,}8 - 3{,}2)^2}$ √

= 6,35 A √ (3)

5.4

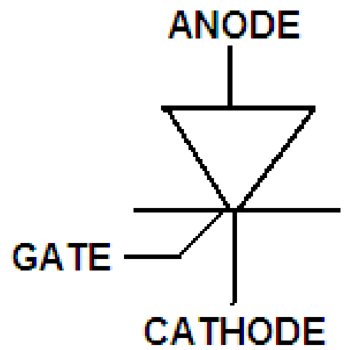


√√√ (3)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1



(3)

6.2 A SCR can be switched ON by:

- Applying a positive trigger voltage to the gate when there is a positive potential on the anode. √
- Raising the foward biasing voltage across the SCR above $V_{bo.}$ √

A SCR can be switched OFF by:

- Reducing the current through the SCR below the level of the holding current I_H √
- Removing or reversing the voltage across the SCR. √ (4)

6.3 6.3.1 During the positive half cycle C will change to a positive voltage via the resistors. √ After a period, determined by the time constant of C multiplied by the value of R1 + R2 the voltage over the capacitor reaches the value at which the DIAC triggers. This is usually around 30 V. The result is that the gate of the TRIAC is triggered and the TRIAC switches on. √√ The TRIAC will now stay on for the remainder of the positive cycle, whether or not a signal is applied to the gate of the TRIAC. √√ (5)

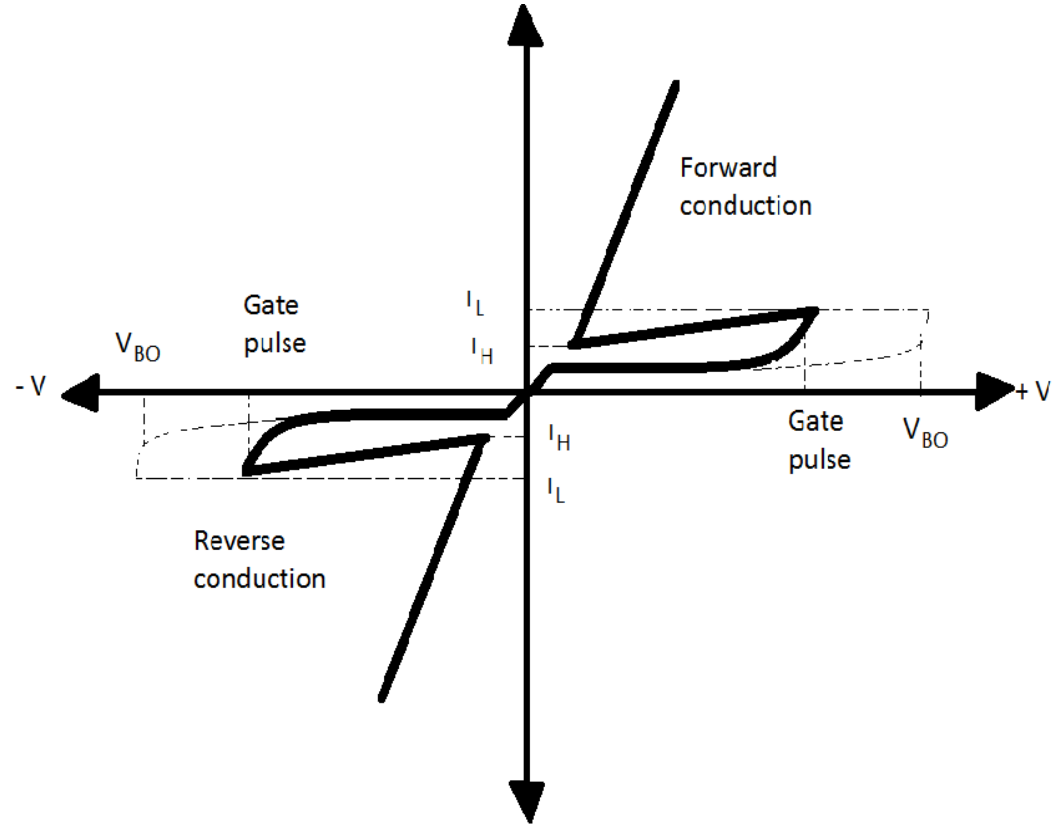
6.3.2 The DIAC is able to switch to exactly the same voltage value in both directions thus allowing for the negative gate pulse to be applied to the TRIAC which in turn also conducts in both directions thus enabling it to regulate AC. √√ (2)

6.3.3 By adjusting the value of R2 the time constant T=(R1+R2)xC is adjusted. This in return regulates the time the TRIAC is switched on during each half cycle. √ The longer the TRIAC stays switched on, the brighter the lamp will light up and vice versa. √√ (3)

6.3.4 C store electrical energy and release when it is needed. √√ (2)

6.4 The SCR has an anode and a cathode. It is polarity sensitive and can only conduct in one direction which is a limitation in AC conditions. √√ (2)

6.5



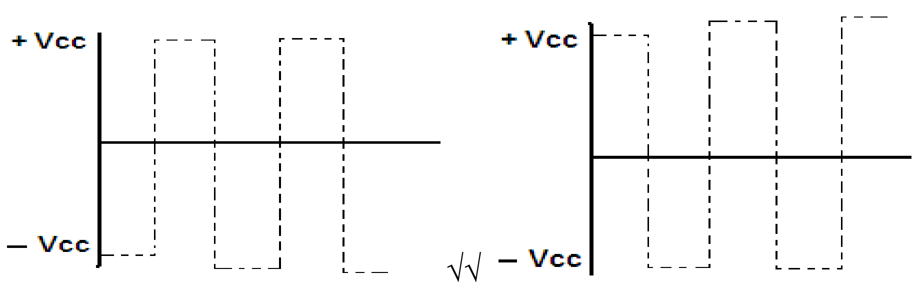
√√√√ (4)

[25]

QUESTION 7: OPERATIONAL AMPLIFIERS

7.1 7.1.1 Inverting √ and Non-Inverting √ (2)

7.1.2



√√ √√ (4)

7.2 7.2.1 Each RC is 60° then 3 x 60° = 180° √
Output of an operational amplifier is 180° √
Total phase shift = 180° + 180° √
= 360° √ (4)

7.2.2 $F = \frac{1}{2\pi(6RC)^{½}}$ √

$= \frac{1}{2\pi(6 \times 1 \times 10^3 \times 100 \times 10^{-12})^{½}}$ √

= 205,47 Hz √ (3)

7.3 Any change at the output is added to the input signal √√ and amplified to compensate for energy losses of a particular signal in the circuit. √√ (4)

7.4 Fixed based biasing, current feedback √√ (2)

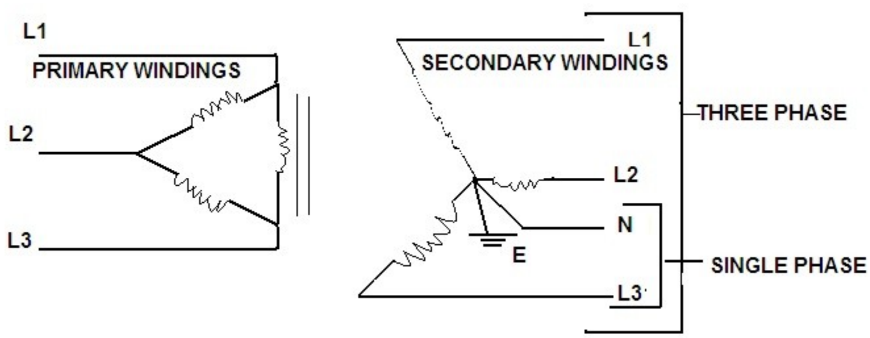
7.5 Overall loop gain of the system must be equal to unity (1). √ With a gain of less than unity the oscillations will die away. √ With a gain of more than unity the output will perpetually increase. √√ (4)

7.6 Increase stability of the overall gain. √
Less distortion. √ (2)
[25]

QUESTION 8: THREE-PHASE TRANSFORMER

8.1 • For cooling purposes √ (1)

8.2



√√√√ (4)

8.3 8.3.1 $Vph = \frac{NpVs}{Ns}$ √

$= \frac{1 \times 11\,000}{45}$ √

= 244,44 V √ (3)

8.3.2 $VL = \sqrt{3}Vph$ √

$= \sqrt{3} \times 244,44$ √

= 423,38 V √ (3)

8.4 $P_o = S \times \text{Cos}\theta$ √
$= 250\,000 \times 0{,}8$ √
$= 200$ kW √ (3)

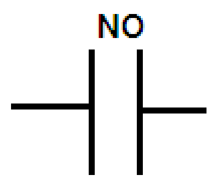
8.5 Copper losses √ (1)
[15]

QUESTION 9: LOGIC CIRCUIT AND PLCs

9.1
- Ladder Logic √
- Statement language / Instruction Sets √
- Graphical format √ (3)

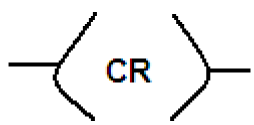
9.2
- Traffic light control. √
- Security system. √
- Data collection. √ (3)

9.3 9.3.1



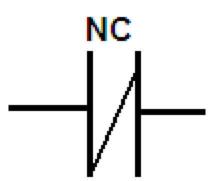
√ (1)

9.3.2



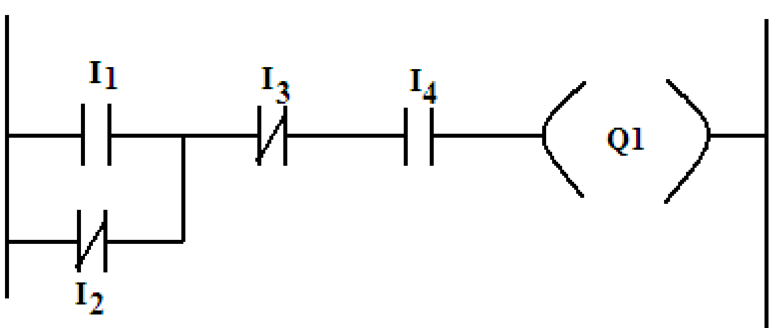
√ (1)

9.3.3



√ (1)

9.4



√√√√√ (5)

9.5 9.5.1 $F = \overline{\overline{(A + B + C)}.(A + B + C)}$ √√ (2)

9.5.2

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

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

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

√√√√ (4)

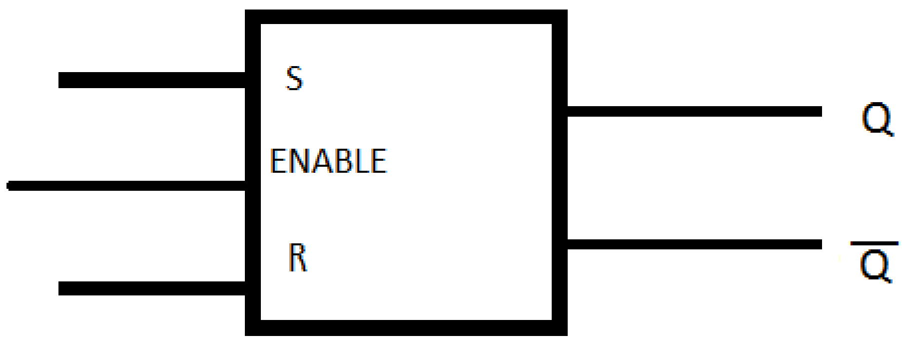
9.6 9.6.1 JK flip-flop (1)

9.7 9.7.1

SET	RESET	Q	$\overline{Q}$
0	0	NO CHANGE	
0	1	0	1
1	0	1	0
1	1	INVALID	

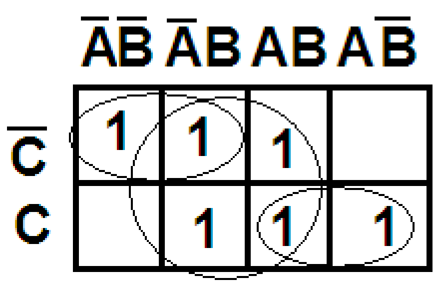
√√√√ (4)

9.7.2



√√ (2)

9.8



$F = B + \overline{A}\,\overline{C} + A\,C$ (6)

9.9
- Monostable multivibrator. √
- Astable multivibrator. √
- Bistable multivabrator. √ (Any 2 x 1) (2)

[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 The casing of a motor is made from a conducting material, earthing it will activate protection under fault conditions preventing electric shock. √√ (2)

10.2 Swop any two phases of the motor connections. √√ (2)

10.3 10.3.1 When the N/O start is depressed the main contactor, the timer contactor and the star contactor are all energised supplying the motor, which is now connected in the star mode with power. √
The timer contactor now begins to time through. √
Once timed through to pre-set time the N\C timer contacts open de-energising the star contactor. √ The N/O timer contactor closes energising the delta contactor. This now connects the motor in delta. √ The N/C star and delta contacts provide interlocking to prevent both contactors been energised at the same time. √ (5)

10.3.2 A star-delta starter is used to reduce the starting current of a motor at start. √√
At start a motor draws four to five times full load current. √
At start the motor is connected in star. The phase voltage is reduced by $\sqrt{3}$. √
This reduces the phase current by $\sqrt{3}$ reducing the current. √ (5)

10.3.3 The overload switch opens under over conditions protecting the motor. √√ (2)

10.4 Normally open contacts are contacts open in the de-energised state and close in the energised state. √√ (2)

10.5 An AC supply is connected to the stator windings, which sets up currents in the stator windings. √
Due to the phase difference of the currents a rotating magnetic is set up in and around the stator. √
The rotating magnetic field sweeps across the rotor conductors, cutting the conductors, √ inducing an emf across them, this in turn sets up currents in the rotor. √
The currents produce a rotating magnetic field in the rotor. √
A force is exerted between the two magnetic fields.
This results in a torque on the rotor and the rotor rotates. √ (6)

10.6 10.6.1 $P = \sqrt{3}\, V_L I_L \cos\theta$

$I_L = \dfrac{P}{\sqrt{3}\, V_L \cos\theta}$ √

$= \dfrac{5\,000}{\sqrt{3} \cdot 380 \cdot 0{,}8}$ √

$= 9{,}5$ A √ (3)

10.6.2 $I_{ph} = \dfrac{I_L}{\sqrt{3}}$ √

$= \dfrac{9{,}5}{\sqrt{3}}$ √

$= 5{,}48$ A√ (3)

[30]

TOTAL: 200