Province of the
EASTERN CAPE
EDUCATION

# NATIONAL SENIOR CERTIFICATE

## GRADE 11

## NOVEMBER 2014

# ELECTRICAL TECHNOLOGY MEMORANDUM

**MARKS: 200**

This memorandum consists of 9 pages.

## QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY, TOOLS AND MEASURING INSTRUMENTS

1.1
- Provide and maintain systems of work, plant and machinery that are safe and without risks to health.
- Take steps to eliminate or reduce any danger or potential hazard to the safety or health of employees.
- Make arrangements to ensure the safety and absence of risks to the health of employees in connection with the production, processing, use, handling, storage or transport of articles or substances.
- Provide training and supervision as may be necessary to ensure the health and safety at work of employees.
- Ensure that work is performed and that plant or machinery is used under the general supervision of a person trained to understand the hazards associated with it and who has the authority to ensure that precautionary measures taken by the employer are implemented. (Any 3 x 1) √√√ (3)

1.2
- Set oscilloscope to DC √
- Ascertain resistance √
- Measure voltage √
- Use Ohms law to calculate I √√ (5)

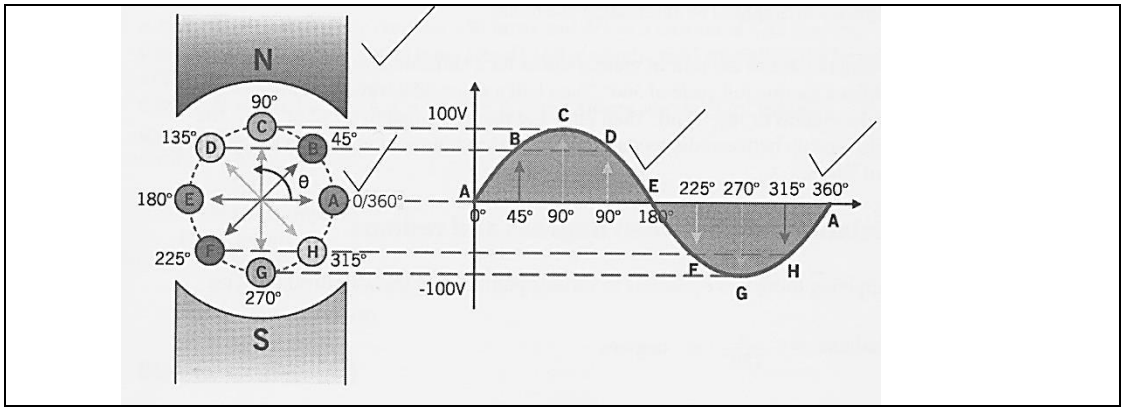
1.3 An insulation tester uses +/- 500 V when testing and insulation is more likely to break down at the higher voltage. √√ (2)

**[10]**

## QUESTION 2: SINGLE-PHASE AC GENERATION SINGLE-PHASE TRANSFORMERS

2.1 DC electricity flows in one direction only, while AC alternates its direction at a constant rate. √√ (2)

2.2




As the loop rotates, so a sinusoidal EMF is induced in the loop. The magnitude of the EMF at any given angle follows $e = E_{max}\sin\theta$. √√√ (7)

2.3 2.3.1 f = rpm / sec = 1 200/60 = 20 Hz √√√ (3)

2.3.2 T = 1/f = 1/20 = 0,05 s √√√ (3)

2.3.3 EMF = $2\pi BAnN\sin\theta$ √
= $2\pi$ x 0,4 x 0,01 x 20 x 100 x sin 90º √
= 50,3 V √ (3)

2.3.4 $E_{RMS}$ = $E_{max}$ x 0,707 √
= 50,3 x 0,707 √
= 35,53 V √ (3)

2.3.5 e = $E_{max}\sin(90º + 40º)$. √
= 50,3 x sin130º √
= 38,5 V √ (3)

2.4 2.4.1
- The larger the area, the longer the conductor rotating in the magnetic field, √
- therefore the greater the induced EMF. √ (2)

2.4.2 If more pole pairs are added then for each revolution √ more cycles will be generated increasing the frequency. √ (2)

2.4.3 Laminated cores reduce Eddy currents induced in the core √ thereby making the coil more efficient. √ (2)

2.5
- A transformer consists of two coils, a primary and a secondary, and a core to support the two coils.
- These two coils are not electrically connected.
- The basic operation of the transformer is based on mutual induction.
- An AC voltage is applied across the primary coil.
- A magnetic field (flux) builds up and collapses in the primary coil.
- This building up and collapsing of the magnetic flux in the primary coil cuts the windings of the secondary coil, inducing an alternating voltage in the secondary coil.
- This induced secondary voltage can be more or less than the supply voltage. (Any 6 x 1) √√√√√√ (6)

2.6 2.6.1 Lights: 10 x 60 = 600 W √√
I = P/V = 600/220 = 2,73 A √√
Appliances: I = P/V = 2 200/220 = 10 A √√
Geyser = 8 A
Total I = 2,73 + 10 + 8 = 20,73 √√ (8)

2.6.2 VA = Volts x Amps √
= 220 x 20,73 √
= 4,56 kVA. √ (3)

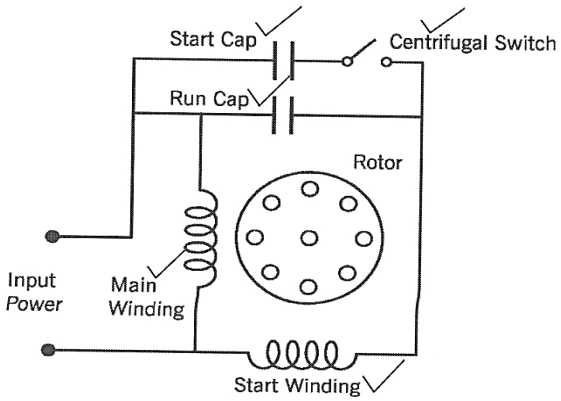
2.6.3 Turns Ratio = Vp / Vs √
= 11 000/220 √
= 50 : 1 √ (3)

**[50]**

## QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTION DEVICES

3.1 Rotor, Stator, End Shields (or end plates) √√√ (3)

3.2



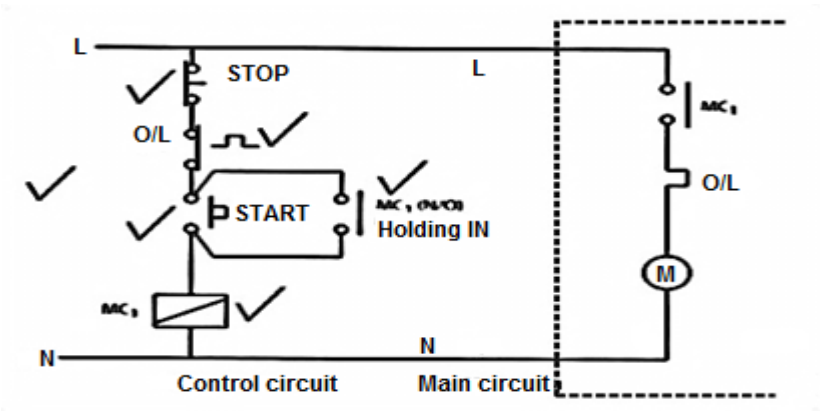

(5)

3.3 The motor has two windings. √ The start winding is made with smaller gauge wire and fewer turns relative to the main winding to create more resistance √ thus putting the start windings field at a different angle to that of the run winding, √ thereby creating a rotating magnetic field.√ (4)

3.4 Overload, √ short circuit, √ earth fault.√ (3)

3.5
- As current flows through the NVC √ it is energised and closes an auxiliary circuit. (Holding circuit) √
- When current stops flowing, the auxiliary holding contact wire releases the retaining circuit. √
- NVC needs to be manually re-energised. √ (4)

3.6




Not asked to include the motor.
One mark for each label, up to 6 marks. (6)

3.7 3.7.1 The purpose of the continuity test is to measure the resistance of the windings. √ (1)

3.7.2 Insulation test between conductors. √
Insulation test between conductors and earth. √ (2)

3.7.3 Insulation tester (or megger) √ (1)

3.7.4 1 MΩ or greater √ (1)

**[30]**

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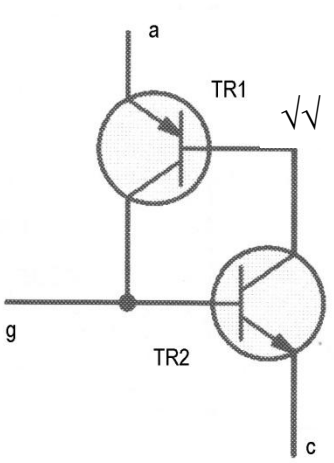
## QUESTION 4: SEMI-CONDUCTOR DEVICES, POWER SUPPLIES, AND AMPLIFIERS

4.1 '+' on anode and '-' on cathode √ = forward bias √
'-' on anode and '+' on cathode √ = reverse bias √ (4)

4.2 Speed control, Temperature control, Voltage level control, lamp dimming circuits, battery chargers, invertors, welding power supplies. (Any 3) √√√ (3)

4.3



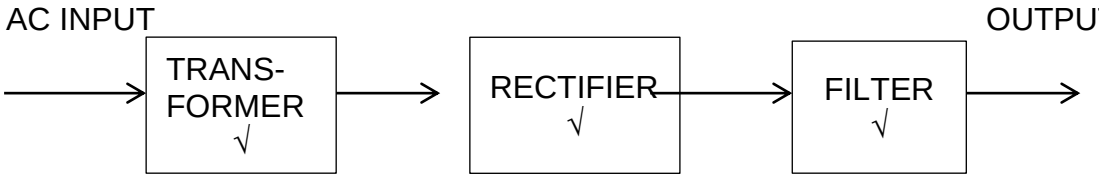

'+' on anode, '-' on cathode √
'+' pulse on g switches TR2 on causing collector of TR2 to become more negative. √
This switches TR1 on, its collector going positive which keeps TR2 on even though the '+' pulse on gate has been removed. √
Current will continue to flow until either the supply is removed between the anode and cathode or the current falls below the holding current. √

(6)

4.4 The TRIAC is switched on with a pulse on the gate √ whereas the DIAC is switched on by exceeding the forward and reverse break-over voltages. √ (2)

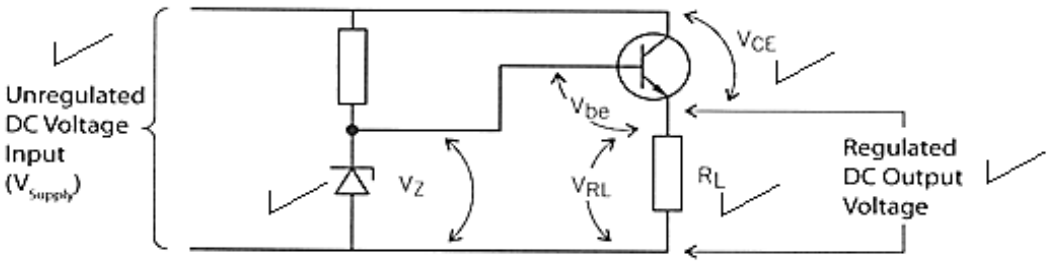
4.5 The disadvantage of this circuit is that the current (which has to be paid for) flows all the time and a lot of unnecessary heat is created across the resistor. √√ (2)

4.6




(3)

4.7




(5)

4.8 Inductors are large and expensive √ whereas (1µF per mA) good sized electrolytics are more suitable. √ (2)

4.9 4.9.1 The Q-point on the load line is the point at which DC bias is provided to the transistor √ to ensure that it operates √ depending upon the class of the transistor amplifier. √ (3)

4.9.2 Half the input signal is amplified. √ (1)

4.9.3 Push-pull amplifiers (audio power amplifiers), RF power amplifiers, √√ (2)

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4.10 Common base

- Small input impedance
- High output impedance
- High voltage gain
- Little current gain
- Minimal power gain
- Phase shift between output and input is 0º

Any 1

Common-collector

- High input impedance
- Low output impedance
- Little voltage gain
- High current gain
- Minimal power gain
- Phase shift between output and input is 0º

Any 1

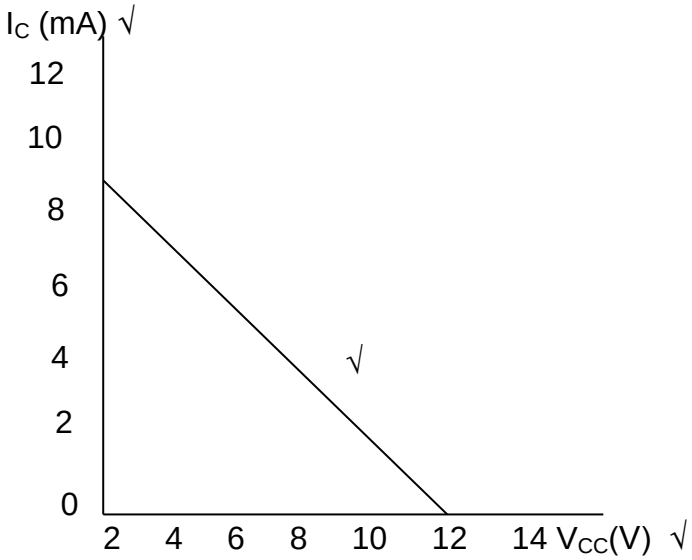
Common-emitter

- Average input impedance
- High output impedance
- High voltage gain
- High current gain
- Very high power gain
- Phase shift between output and input is180º

Any 1 (3)

4.11 $V_{CC}$ = 12 V √

$I_C = V_{CC}/R_C = 12/1.2 = 10mA$ √√√




(7)

4.12

- Reduces noise and distortion at the output.
- Enables one to design for a specific gain.
- Stabilises voltage gain.
- Increases bandwidth.

(Any 3 x 1) (3)

4.13 When current flows through a transistor it heats up and can overheat if too much current is allowed to flow. √√
A resistor is placed in series with the emitter √ to limit the flow of current through the transistor. √ (4)

**[50]**

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## QUESTION 5: RLC SERIES CIRCUITS

5.1 5.1.1 Reactance increases √ (1)

5.1.2 Reactance decreases √ (1)

5.1.3 Impedance is the total opposition √ to the flow of current in an AC circuit. √ (2)

5.1.4 $X_L = X_C$
Z = Minimum
Power factor = 1
Phase angle = 0
I = maximum (Any 2 x 1) √√ (2)

5.2 5.2.1 $X_L = 2\pi fL$ √
$= 2\pi \times 50 \times 0,1$ √
$= 31,42\ \Omega$ √
$XC = \frac{1}{2\pi fC}$ √
$= \frac{1}{2\pi \times 50 \times 47 \times 10^{-6}}$ √
$= 67,725\ \Omega$ √

$Z = \sqrt{R^2 + (X_C - X_L)^2}$ √
$= \sqrt{11^2 + (67,725 - 31,42)^2}$ √
$= 37,9348\ \Omega$ √ (9)

5.2.2 Leading √ (1)

5.2.3 $fr = \frac{1}{2\pi\sqrt{LC}}$ √
$= \frac{1}{2\pi\sqrt{0,1 \times 47 \times 10^{-6}}}$ √√
$= 73,41$ Hz √ (4)

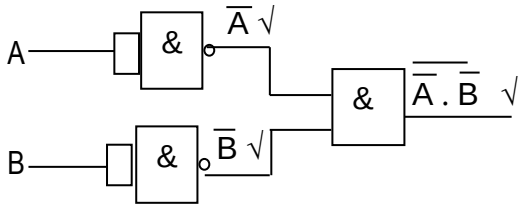
**[20]**

## QUESTION 6: LOGIC

6.1 $\overline{A + B} = X$

$\overline{\overline{A + B}} = X$ √

$\overline{\overline{A} . \overline{B}} = X$ √




(5)

6.2 6.2.1 √ √

| A | | B | | Σ | Carry |
|---|---|---|---|---|---|
| 0 | + | 0 | = | 0 | 0 |
| 0 | + | 1 | = | 1 | 0 |
| 1 | + | 0 | = | 1 | 0 |
| 1 | + | 1 | = | 0 | 1 |

(2)

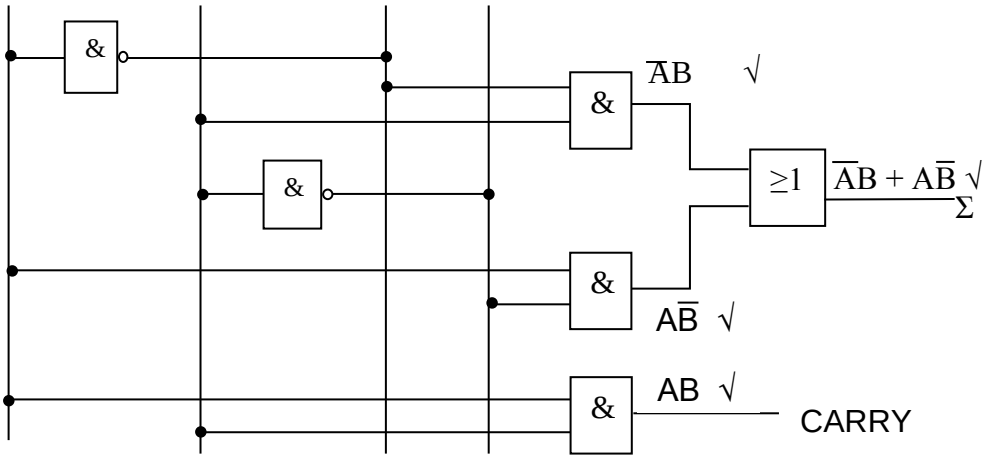
6.2.2 SOP

$AB + AB = \Sigma$ √

$AB = Carry$ √

(2)

6.2.3 $\overline{A}$ $\overline{B}$ $\overline{A}$ $\overline{B}$ √




(5)

6.3 $\overline{A.B + \overline{A}.\overline{B}}$

$= (\overline{A.B}).(\overline{\overline{A}.\overline{B}})$ √

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

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

$= \overline{A}A + \overline{A}B + \overline{B}A + \overline{B}B$ √

$= \overline{A}B + A\overline{B}$ √

LHS = RHS √

(6)

**[20]**

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## QUESTION 7: COMMUNICATIONS

7.1 7.1.1 TRUE √ (1)

7.1.2 TRUE √ (1)

7.1.3 TRUE √ (1)

7.1.4 FALSE √ (1)

7.1.5 TRUE √ (1)

7.1.6 TRUE √ (1)

7.2 7.2.1
- The frequencies √ from both the RF amplifier and local oscillator are fed into the mixer. √
- The result of the "mixing" is that four frequencies are obtained √ namely the two input frequencies, √ the sum of the two, √ and the difference between the two frequencies. √
- The difference between the two frequencies is then fed to the IF amplifier. √
- Heterodyning √ (8)

7.2.2 The IF amplifier just amplifies √ the IF signal received from the mixer. √ (2)

7.3 A detector is simply a circuit where half of the AM signal is rectified and the RF is removed, √ leaving the audio signal. √
The discriminator compares the FM signal with a reference signal √ and the difference between the two signals is the original audio signal. √ (4)
**[20]**

**TOTAL: 200**

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## VRAAG 7: KOMMUNIKASIE

7.1 7.1.1 WAAR √ (1)

7.1.2 WAAR √ (1)

7.1.3 WAAR √ (1)

7.1.4 ONWAAR √ (1)

7.1.5 WAAR √ (1)

7.1.6 WAAR √ (1)

7.2 7.2.1
- Die frekwensies √ van beide die RF versterker en die plaaslike ossillator word binne die menger ingevoer. √
- Die resultaat van die menging is dat vier frekwensies verkry word √ naamlik die twee insetseine, √ die som van die twee, √ en die verskil tussen die twee. √
- Die verskil tussen die twee word na die IF versterker gely. √
- Heterodyning √ (8)

7.2.2 Die IF versterker versterk eenvoudig √ die IF sein wat ontvang word van die menger. √ (2)

7.3 'n Detektor is eenvoudig 'n kring waar die helfte van die AM-sein gelykrig word en die RF verwyder word, √ sodat net die audio oorbly. √
'n Diskriminator vergelyk die FM sein met 'n verwysings sein √ en die verskil tussen die twee seine is die oorspronklike audio-sein. √ (4)

**[20]**

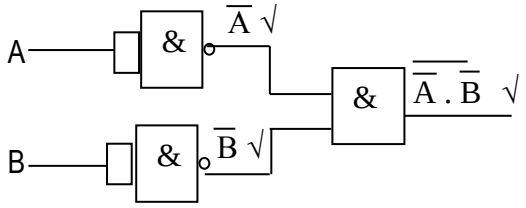
**TOTAAL: 200**

## VRAAG 6: LOGIKA

6.1 $\overline{A + B} = X$

$\overline{\overline{A + B}} = X$ √

$\overline{\overline{A} . \overline{B}} = X$ √




(5)

6.2 6.2.1 √ √

| A | | B | | Σ | Oordra |
|---|---|---|---|---|---|
| 0 | + | 0 | = | 0 | 0 |
| 0 | + | 1 | = | 1 | 0 |
| 1 | + | 0 | = | 1 | 0 |
| 1 | + | 1 | = | 0 | 1 |

(2)

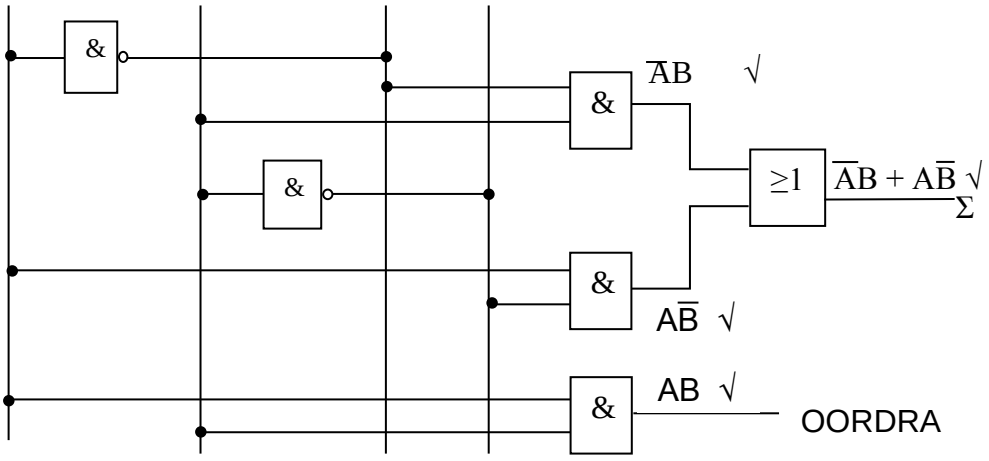
6.2.2 SOP

$A\overline{B} + \overline{A}B = \Sigma$ √

$A\overline{A} + B\overline{B} = Oordra$ √

(2)

6.2.3 $\overline{A}$ $\overline{B}$ $\overline{A}$ $\overline{B}$ √




(5)

6.3 $\overline{A.B + \overline{A}.\overline{B}}$

$= (\overline{A.B}).(\overline{\overline{A}.\overline{B}})$ √

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

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

$= \overline{A}A + \overline{A}B + \overline{B}A + \overline{B}B$ √

$= \overline{A}B + A\overline{B}$ √

LHS = RHS √

(6)

**[20]**

## VRAAG 5: RLC SERIE STROOMBANE

5.1 5.1.1 Toename in reaktansie √ (1)

5.1.2 Afname in reaktansie √ (1)

5.1.3 Impedansie is die totale opposisie teen √ die vloei van stroom in 'n WS stroombaan. √ (2)

5.1.4 $X_L = X_C$
Z = Minimum
Arbeidsfaktor = 1
Fasehoek = 0
I = maksimum (Enige 2 √√) (2)

5.2 5.2.1 $X_L = 2\pi fL$ √
$=2\pi \times 50 \times 0,1$ √
$=31,42\ \Omega$ √
$XC = \frac{1}{2\pi fC}$ √
$= \frac{1}{2\pi \times 50 \times 47x10^{-6}}$ √
$= 67,725\ \Omega$ √

$Z = \sqrt{R^2 + (X_C - X_L)^2}$ √
$= \sqrt{11^2 + (67,725 - 31,42)^2}$ √
$= 37.9348\ \Omega$ √ (9)

5.2.2 Voorlopend √ (1)

5.2.3 $fr = \frac{1}{2\pi\sqrt{LC}}$ √
$= \frac{1}{2\pi\sqrt{0,1 \times 47 \times 10^{-6}}}$ √√
$= 73,41$ Hz √ (4)

**[20]**

4.10 Gemeenskaplike versterkers:
- Klein inset impedansie
- Hoog uitset impedansie
- Hoë spanningswins
- Klein stroomwins
- Minimale kragwins
- Fase verskil tussen ineen uitset is 0º

} Enige 1

Gemeenskaplike kollektor:
- Hoë inset impedansie
- Lae uitset impedansie
- Min krag spanningswins
- Hoë stroomwins
- Minimale kragwins
- Fase verskil tussen in en uitset is 0º

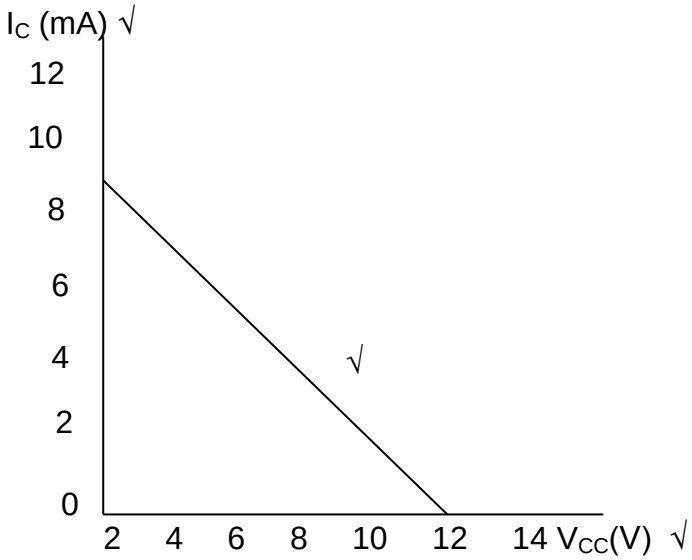
} Enige 1

Gemeenskaplike emitter
- Gemiddelde inset impedansie
- Hoë uitset impedansie
- Hoë spanningwins
- Hoë stroomwins
- Baie hoe kragwins
- Fase verskil tussen in en uitset is180º

} Enige 1

(3)

4.11 $V_{CC}$ = 12 V √
$I_C = V_{CC}/R_C$ = 12/1,2 = 10 mA √√√




(7)

4.12
- Verminder geraas en distorsie by die uitset.
- Kan vir 'n spesifieke wins ontwerp word.
- Spanningswins word gestabiliseer.
- Bandbreedte verhoog. (Enige 3 x 1) (3)

4.13 Wanneer stroom deur 'n transistor vloei kan dit oorverhit word as te veel stroom toegelaat word om te vloei. √√
'n Resistor is in serie gekoppel met die emittor √ om die stroom vloei te beperk. √ (4)

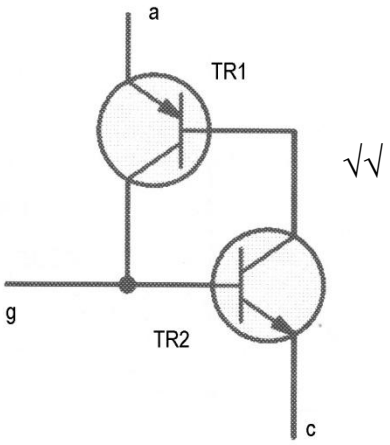
**[50]**

## VRAAG 4: HALF-GELEIRS, KRAGBRONNE EN VERSTERKERS

4.1 '+' op anode en '-' op katode √ = voorspanning √
'-' op anode en '+' op katode √ = teenvoorspanning √ (4)

4.2 Spoedbeheer, temperatuurbeheer, spanningsvlak beheer, ligdemper-kringe, batterylaaiers, omkeerders, wys kragbronne. (Enige 3) √√√ (3)

4.3




√√

'+' op anode, '-' op katode √
'+' puls op g skakel TR2 aan wat veroorsaak dat kollektor van TR2 negatief word. √
Dit skakel TR1 aan, sy kollektor gaan positief wat TR2 aanhou alhoewel die '+' puls van die hek verwyder is. Stroom √ sal aanhou vloei totdat die toevoer tussen die anode en katode verwyder word of die stroom onder die aanhou stroom daal. √ (6)

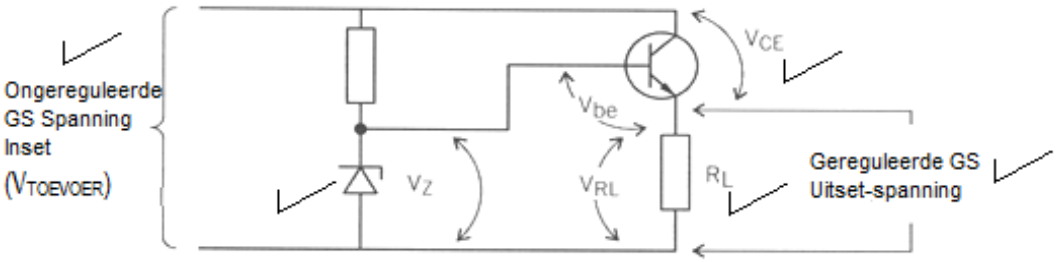
4.4 Die TRIAK word aangeskakel met 'n puls op die hek √ waar die DIAK aangeskakel word wanneer die spanning die meevoorspanning en deurbreek spanning oorskry. √ (2)

4.5 Die nadeel van die kring is dat die stroom (waarvoor betaal word) aanhou vloei en ongewensde hitte word oor die resistor geskep. √√ (2)

4.6


(3)

4.7




(5)

4.8 Induktors is groot en duur √ waar elektrolitiese kapasitor van 'n goeie grootte (1µF per mA) meer geskik is. √ (2)

4.9 4.9.1 Die Q-punt op die laslyn is die punt waar GS voor spanning aan die transistor verskaf word √ om te verseker dat dit werk afhangende √ van die klas van die transistor versterker. √ (3)

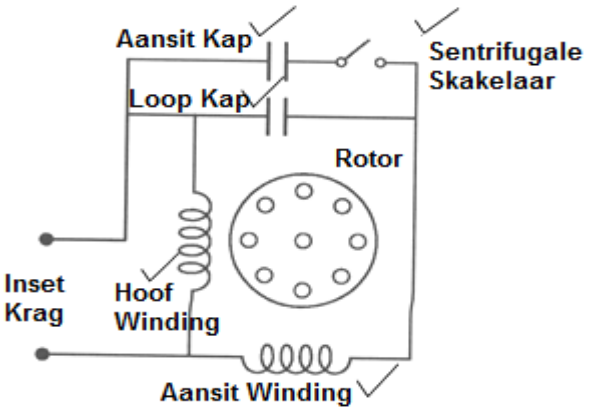
4.9.2 Helfte van die sein word versterk. √ (1)

4.9.3 Gebalanseerde versterkers (oudiokrag versterkers), RF krag versterkers. √√ (2)

## VRAAG 3: ENKELFASE-MOTORS EN BESKERMINGSTOESTELLE

3.1 Rotor, Stator, Eindplaat (of statorwindings) √√√ (3)

3.2



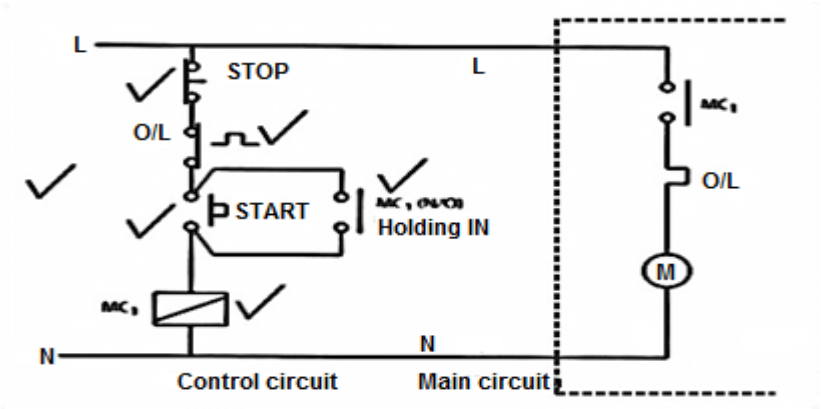

(5)

3.3 Die motor het twee windings. √ Die aansitwinding is van 'n kleiner dikte en minder draaie relatief tot die hoofwinding om meer weerstand te skep. √ met die gevolg dat die aansitwinding se magneetveld 'n ander hoek het as die loop-winding √, wat 'n roterende magneetveld veroorsaak. √ (4)

3.4 Oorlas, √ kortsluiting √ en aard-fout√ (3)

3.5
- Wanneer stroom deur die NSS vloei, √ word dit bekrag (ge-energiseerd) wat 'n hulpkontak sluit (aanhoukring). √
- Wanneer die krag onderbreek word, stop die stroomvloei, die hulpkontak gaan oop en die aanhoukring sluit oop. √
- NSS moet dan met die hand bekrag word. √ (4)

3.6




Nie nodig om die motor in te sluit nie,
Een punt per byskrif, tot 6 punte (6)

3.7 3.7.1 Die doel van die kontinuïteit-toets is om die weerstand van die windings te toets. √ (1)

3.7.2 Isolasie-toets tussen geleiers. √
Isolasie-toets tussen geleiers en aarde. √ (2)

3.7.3 Isolasie-toetser of megger (1)

3.7.4 1 MΩ of groter (1)

**[30]**

2.3.3 EMK = 2πBAnNsinθ √
= 2π x 0,4 x 0,01 x 20 x 100 x sin 90º √
= 50,3 V √ (3)

2.3.4 $E_{WGS}$ = $E_{max}$ x 0,707 √
= 50,3 x 0,707 √
= 35,53 V √ (3)

2.3.5 e = $E_{max}$sin(90º + 40º). √
= 50,3 x sin130º √
= 38,5 V √ (3)

2.4 2.4.1
- Hoe groter die area, hoe langer die geleier wat in die magneetveld roteer, √
- en dus hoe groter die geïnduseerde EMK. √ (2)

2.4.2 Sodra meer pool pare by gesit word vir elke omwenteling, √ sal meer siklusse opgewek word wat die frekwensie sal verhoog. √ (2)

2.4.3 Gelamineerde kerns verminder werwelstrome wat in die kern geïnduseer word, √ en daarom word die spoel meer doeltreffend. √ (2)

2.5
- ’n Transformator bestaan uit twee spoele, ’n primêre en ’n sekondêre, en ’n kern waarop die spoele gedraai is.
- Die twee spoele is glad nie elektries gekoppel nie.
- Die basiese werking van die transformator is op wedersydse induksie gebaseer.
- ’n WS-spanning word oor die primêre spoel aangewend.
- ’n Magnetiese veld bou op en breek af in die primêre spoel.
- Hierdie verandering in die magnetiese veld in die primêre spoel “sny” die windings van die sekondêre spoel sodat ’n wisselende spanning oor die sekondêre spoel geïnduseer word.
- Hierdie geïnduseerde sekondêre spanning kan meer of minder as die toevoerspanning wees. (Enige 6 van 7 punte) √√√√√√ (6)

2.6 2.6.1 Lampe: 10 x 60 = 600 W √√
I = P/V = 600/220 = 2,73 A √√
Toestelle: I = P/V = 2 200/220 = 10 A √√
Geyser = 8 A
Totaal I = 2,73 + 10 + 8 = 20,73 √√ (8)

2.6.2 VA = Volts x Amps √
= 220 x 20,73 √
= 4,56 kVA. √ (3)

2.6.3 Draaiverhouding = Vp / Vs √
= 11 000/220 √
= 50 : 1 √ (3)

**[50]**

## VRAAG 1: BEROEPSVEILIGHEID EN GESONDHEID, GEREEDSKAP EN MEETINSTRUMENTE

1.1
- Verskaf en onderhou werkstelsels, installasies en masjinerie wat veilig is en sonder gesondheidsrisiko's is.
- Neem stappe om enige gevaar of moontlike toeval wat die veiligheid en gesondheid van werknemers kan bedreig te elimineer of te verminder.
- Reëlings te maak om die veiligheid en afwesigheid van gevare vir die gesondheid van werknemers met betrekking tot die produksie, ontwikkeling, gebruik, hantering, verberging of vervoer van onderdele of stowwe te verseker.
- Verskaf opleiding en toesig wat nodig mag wees om die gesondheid en veiligheid van werknemers te verseker.
- Om te verseker dat werk wat voltooi is en installasies en masjinerie gebruik word onder die algemene toesig van 'n persoon wat die nodige opleiding het wat die gevare wat daarmee saam loop verstaan en gesag het om te verseker dat voorsorgmaatreëls wat voorsien is deur die werkgewer geïmplementeer . (Enige 3 x 1) √√√ (3)

1.2
- Skakel die ossilloskoop vir GS √
- Bepaal die weerstand (kleurkode) √
- Meet spanning √
- Gebruik Ohm se wet om stroom te bereken √√ (5)

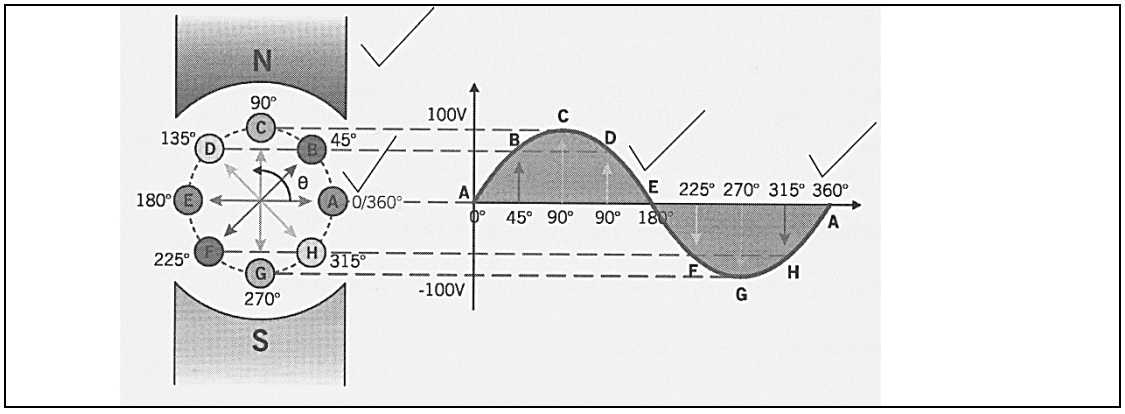
1.3 'n Isolasiemeter gebruik +/- 500 V wanneer isolasie gemeet word en daar is 'n groter kans dat die isolasie sal afbreek teen die hoër spanning. √√ (2)

**[10]**

## VRAAG 2: ENKELFASE WS-OPWEKKING ENKELFASE TRANSFORMATORS

2.1 GS elektrisiteit vloei alleenlik in een rigting, terwyl WS rigting teen 'n konstante tempo verwissel. √√ (2)

2.2




Sodra die lus roteer, word 'n sinusoidal EMK in die lus geïnduseer. Die grootte van die EMK by enige gegewe hoek volg e = $E_{max}$sinθ. √√√ (7)

2.3 2.3.1 f = rpm / sec = 1 200/60 = 20 Hz √√√ (3)

2.3.2 T = 1/f = 1/20 = 0,05 s √√√ (3)

Province of the
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## GRAAD 11

## NOVEMBER 2014

# ELEKTRIESE TEGNOLOGIE
# MEMORANDUM

**PUNTE: 200**

Hierdie memorandum bestaan uit 9 bladsye.