GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE-EXAMINATION

POSSIBLE ANSWERS FOR : TECHNIKA (ELECTRICAL) HG

QUESTION 1

1.1 C

1.2 B

1.3 A

1.4 D

1.5 B

1.6 B

1.7 A

1.8 C

1.9 C

1.10 B

1.11 A

1.12 E

1.13 E

1.14 B

1.15 B **[30]**

QUESTION 2
OCCUPATIONAL SAFETY

(Any 5 suitable measures)

2.1
- Check if core threading was used and the correct wire was connected to the correct pin.
- Check if the earth wire is in good contact with the metal casing.
- Check for broken earthing.
- Check if switches are in good working order. (5)

(Any suitable reasoning is acceptable)

2.2
- Handle such a person immediately, but with caution.
- Obtain medical assistance or support from a person with medical knowledge immediately
- Stop the bleeding by applying pressure.
- Ensure that there is no direct contact with blood.
- Use gloves and glasses, if available (5)

[10]

QUESTION 3
ALTERNATING CURRENT THEORY

3.1 3.1.1 $Z = \sqrt{R^2 + (XL - Xc)^2}$

$= \sqrt{80^2 + (175 - 79,5)^2}$

$= \sqrt{80^2 + (95,5)^2}$

$= 124,58\ \Omega$

$Vt = I \times Z$
$= 5 \times 124,58$
$= 622,9$ Volt (6)

3.1.2 $\cos Q = \frac{R}{Z}$

$= \frac{80}{124,58}$

$= 0,64$

$Q = 50,2°$ (3)

3.2

3.2.1 R coil = $\frac{Vg}{Ig}$

= $\frac{100}{10}$

= 10 ohm (2)

3.2.2. Z = $\sqrt{R^2 + Xl^2}$

XL = $\sqrt{Z^2 + R^2}$

= $\sqrt{(33,3)^2 - (10)^2}$

= 32,76 ohm

Z = $\frac{Vt}{It}$

= $\frac{200}{6}$

= 33,3 ohm

XL = $2\pi fL$

L = $\frac{Xl}{2\pi f}$

= $\frac{32,76}{2 \times 3,14 \times 60}$

= 86,9 mH (7)

3.3 Place a capacitor in parallel across the supply. (2)

3.4

3.4.1 $I_R = \frac{Vt}{R} = \frac{100}{12} =$ 8,3 Amp

$I_L = \frac{Vt}{XL}$

= $\frac{100}{37,68}$

= 2,65 Amp

$X_L = 2\pi fL$

= 2 x 3,14 x 50 x 0,12

= 37,68 ohm

$I_c = \frac{Vt}{Xc}$

= 100

= 3,14 Amp

$Xc = \frac{1}{2\pi fc}$

= $\frac{1}{2 \times 3,14 \times 50 \times 100 \times 10^{-6}}$

= 31,84 ohm (10)

3.4.2 $I_t = \sqrt{IR^2 + (IC - IL)^2}$

$= \sqrt{(8,3)^2 + (3,14 - 2,65)^2}$

$= \sqrt{68,89 + 0,24}$

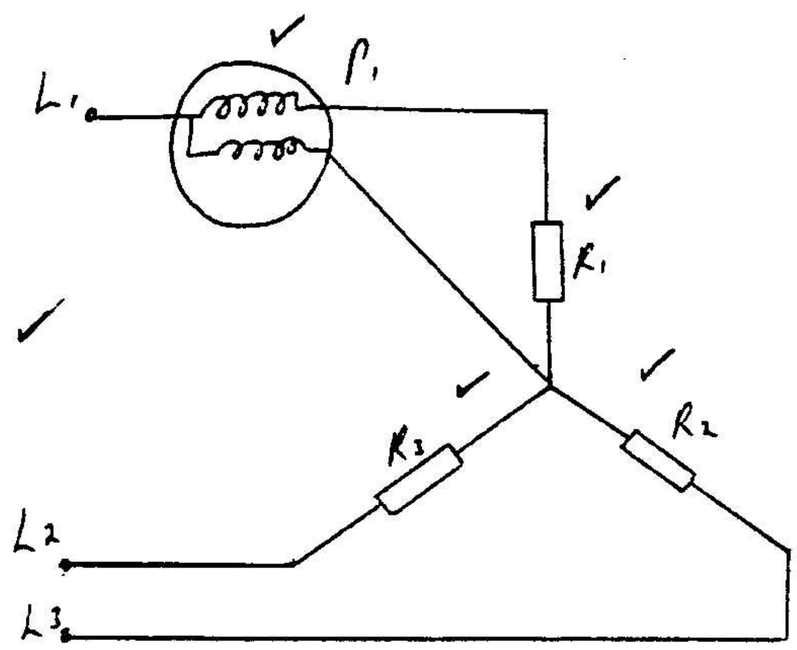
$= \sqrt{69,13}$

= 8,31 A (3)

[33]

QUESTION 4
ONE AND THREE-PHASE ALTERNATING CURRENT SYSTEMS

4.1



Pt = P1 x 3 (7)

4.2

4.2.1 $E_f = \frac{EL}{\sqrt{3}} = \frac{380}{1,732} = 219,4\ V$ (3)

4.2.2 $I_F = I_L$ 10 A (2)

4.2.3 $\cos Q = \frac{P}{Ps} = \frac{3 \times 1000}{\sqrt{3} \times 380 \times 10} = 0,456$ (3)

4.2.4 $Z_f = \frac{Ef}{If} = \frac{219,4}{10} = 21,84$ ohm (3)

4.2.5 $R_f = Z_f \cos Q = 21,94 \times 0,456 = 10$ ohm (3)

4.3

4.3.1 Ia = I cos Q
= 100 x 0,7
= 70 A (3)

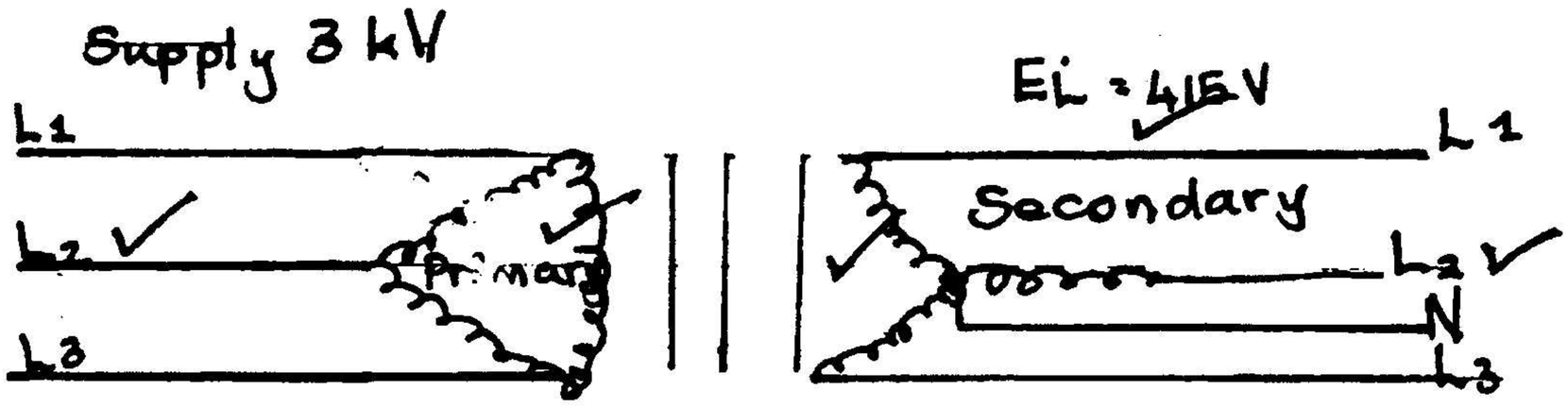
4.3.2 Ps = I x V
= 100 x 500
= 50 kVA (3)

4.3.3 Cos Q = 0,7
Q = 45,5°
Pr = V x I Sin Q
= 500 x 100 x 0,714
= 35,7 kVA (4)

4.3.4 P = I x V x cos Q
= 500 x 100 x 0,7
= 35 kW (3)
[34]

QUESTION 5
TRANSFORMERS

5.1



(5)

5.1.2 E_{Ll} = E_{fl} = 3000 V

N_l = E_{fl} / volt/winding

= $\frac{3000}{4}$

= 750 Windings (5)

5.1.3 EF2 = $\frac{EL\,2}{3}$

= $\frac{415}{3}$

= 239,6 V

N2 $\frac{Ef2}{v/winding}$ or N2 = $\frac{N1\ \ Ef2}{Ef1}$

= $\frac{239,6}{4}$ 59,9 Windings

= 59,9 Windings (5)

Secondary currents

5.1.4 P out = $\sqrt{3}$ EL2 IL2 cos Q

IL2 = $\frac{P\,out}{\sqrt{3}\ EL2\ \cos\ Q}$

= $\frac{150000}{\sqrt{3} \times 415 \times 0,8}$

= 260,8 A

If2 = IL2 = 260,8 A

Primary currents

$\frac{If2}{If1}$ = $\frac{N1}{N2}$

If 2 = $\frac{N2 \times If2}{N1}$

= $\frac{59,9 \times 260,85}{750}$

= 20,84 A

IL1 = $\sqrt{3}$ If1
= 36 Amp

1 Neutral = 0A (13)

5.2
- MMC primary do not cancel MMC secondary.
- Current generated by primary causes eddy current in core.
- Eddy current heats core.
- Insulation melts away, causing a short.
- Lethal situation occurs. (6)

[25]

QUESTION 6
ALTERNATING CURRENT MOTORS

6.1 EL = 380 V

Point = 50 kW
Cos Q = 0,85
efficiency = 0,9

6.1.1 $P = \sqrt{3}\, E_L\, I_L \cos Q \times \eta$

$$I_L = \frac{\text{Point}}{\sqrt{3}\, EL \cos Q \times \eta}$$

$$= \frac{50000}{1{,}73 \times 380 \times 0{,}85 \times 0{,}9}$$

= 99,3 Amp (4)

6.1.2 $P_s = \sqrt{3}\, I_L\, E_L$

= 1,73 x 99,3 x 380

= 65,28 kVA (3)

6.1.3 cos Q = 0,85

$Q = \cos^{-1} \times 0{,}85$

= 31,7° (2)

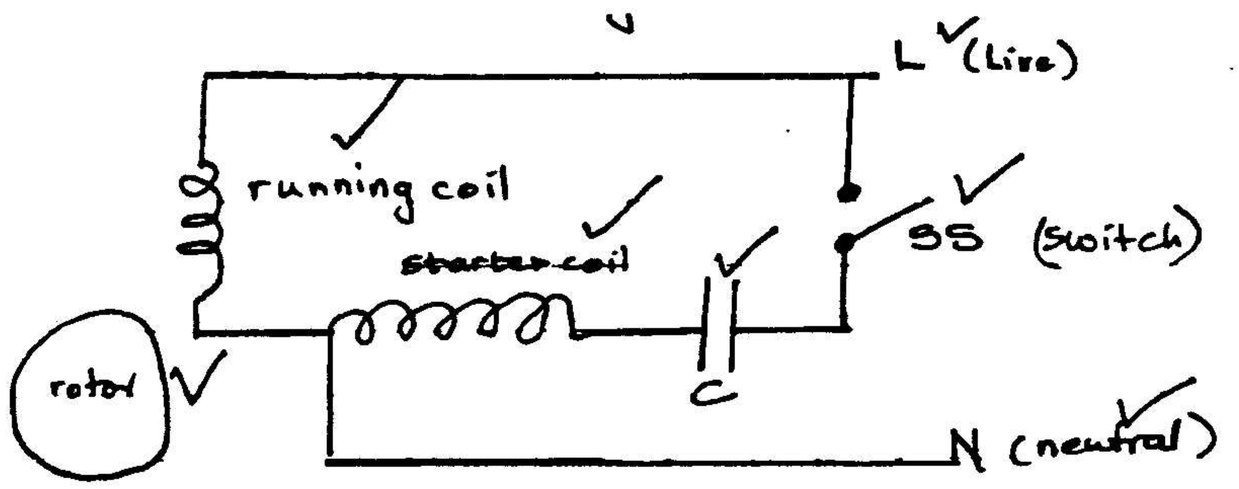
6.2

6.2.1 No rotating magnetic field only an alternating magnetic field because of alternating supply. (2)

6.2.2 "The phase must be split."

* Place a capacitor in series with one of the windings.
* Make one winding more inductive. (4)

6.2.3



Centrifugal switch

* After ± 75% full coil, the switch is opened and current then only flows through running coil. (9)

6.2.4 P = 2 slip speed = 125 r.p.m.

f = 50

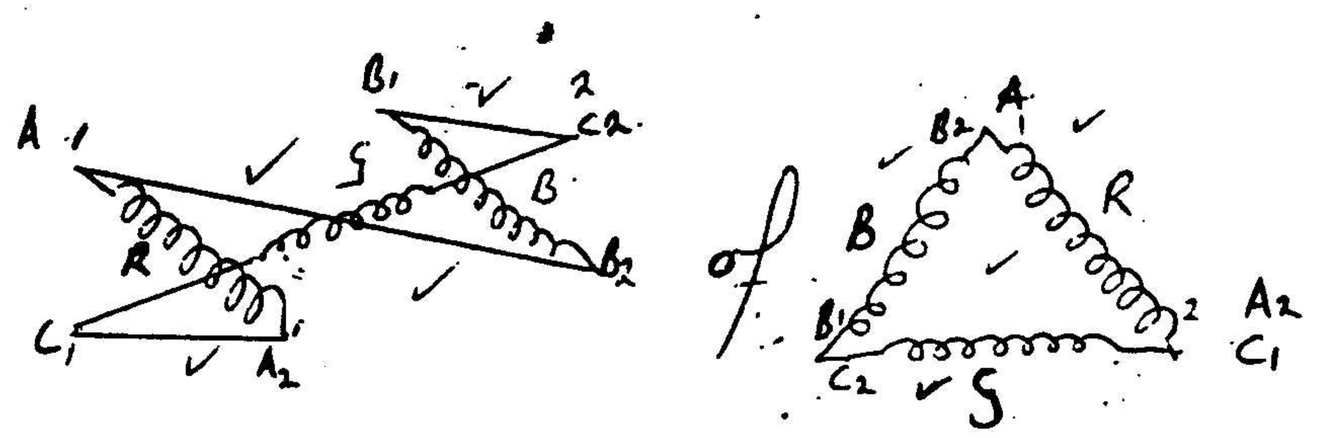
Ns = $\frac{f}{P} = \frac{50}{2}$ = 25 r/sec = 25 x 60 = 1500 r/min

Nr = Ns – slip speed

= 1500 – 125

= 1375 r.p.m (5)

6.3



6.4 Overload mechanism

If the load increases too much and the motor draws too much current, the circuit breaker will short.

Zero load coil

In case of a power failure, the contact points would open and it has to be switched on again by hand. (3)

6.5 Red, Yellow, Blue. (2)

[38]

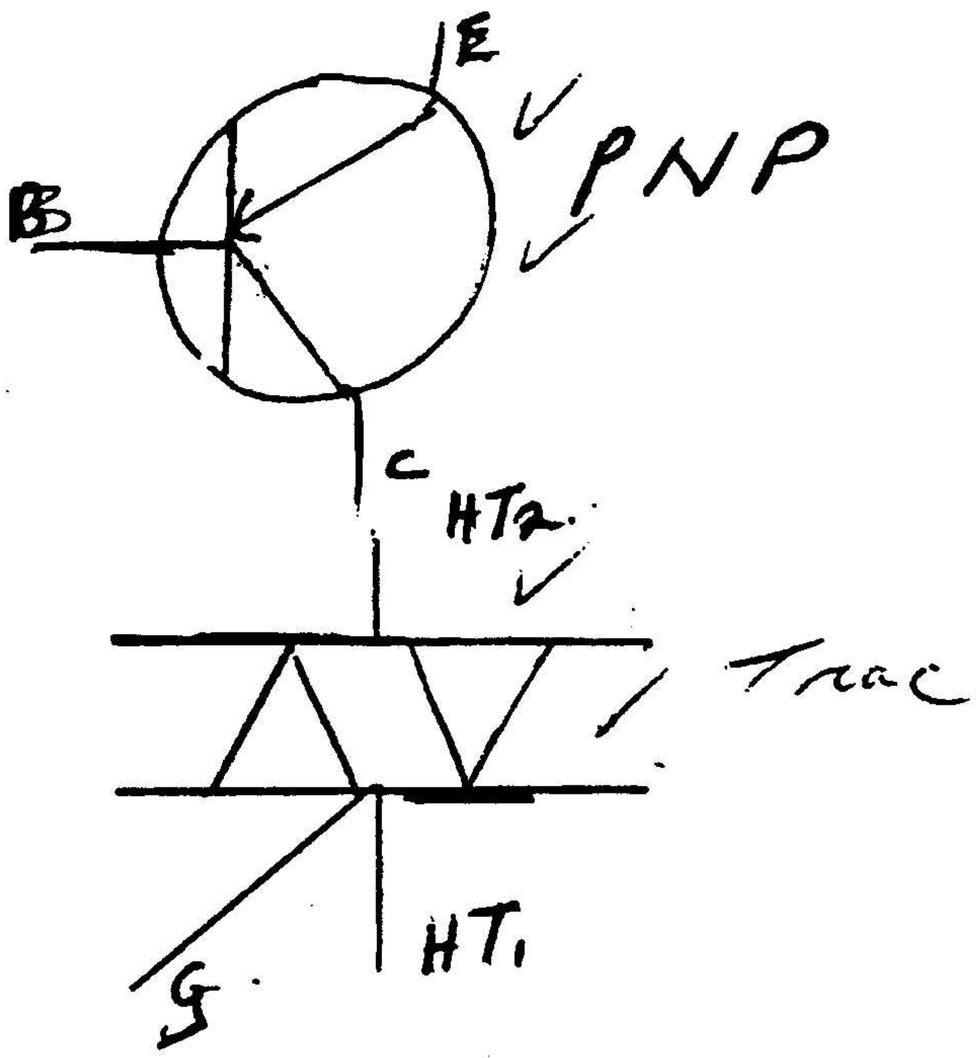
QUESTION 7
SEMICONDUCTORS

7.1 7.1.1 The globe will not glow because the SCR requires a pulse to switch on once power is present. (4)

7.1.2 The globe will now be illuminated because a supply is present and a positive pulse is present (4)

7.1.3 The globe will keep on glowing, because the holding current is above threshold value and the supply is still present (4)

7.2 7.2.1



7.2.2

7.3
* IB must be present ± 2%
* The base emitter must be forward biased – i.e. base positive – emitter negative 0,7 volt at least
* The collector – emitter must be reversed biased, the collector positive and the emitter negative.
* Enough DC supply ± 6 volt
* Transistor coupled correct. (5)

[21]

QUESTION 8
AMPLIFIERS

8.1 $\frac{Z_2}{Z_1} = \left(\frac{N_2}{N_1}\right)^2$

$Z2 = Z1 \times \frac{N_2^2}{N_1^2}$

$= 5x10^3 \times \left(\frac{1}{12.5}\right)^2$

= 32 ohm

= $\frac{32}{8}$ loud speakers could therefore be connected

= 4 (6)

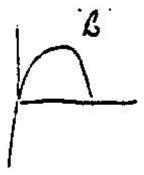
8.2 a. RL = 0V (1)
b. Tr = 6V (1)

8.2.2 a. RL ≅ 6V (1)
b. Tr ≅ 0V (1)

8.2.3 a. RB = Controls the base current / Protects the transistor. (1)
b. RL = Causes a voltage drop on the output (1)

8.3 Class A amplifier is forward biased in such a way that the operating point is in the middle of the load line. The full input signal is amplified.

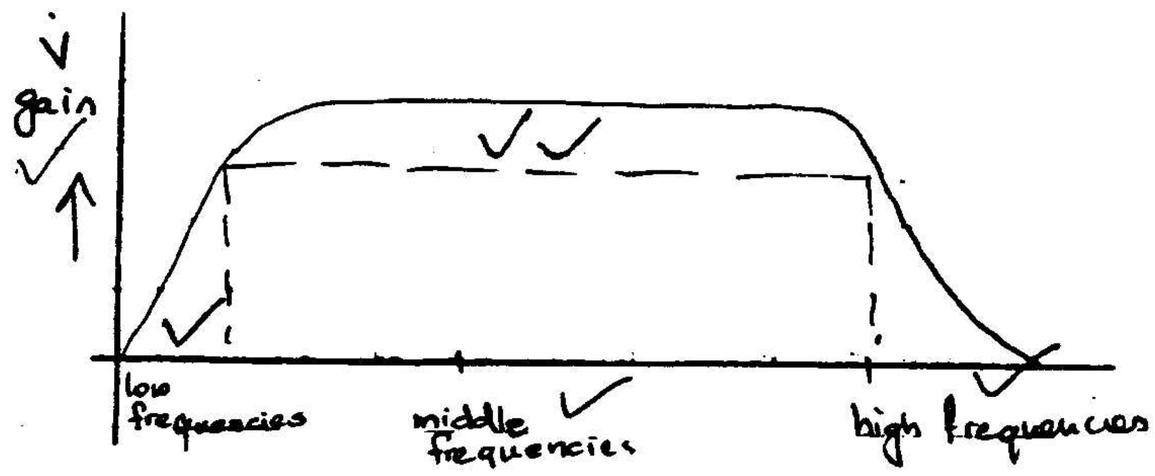
Class B amplifier is forward biased in such a way that the transistor operates at its cut-off point. Only half of the input signal is amplified. (4)



8.4 8.4.1 NPN-bipolar transistor – amplifier 1st stage

8.4.2 Resistor capacitance coupling

8.4.3



(6)

8.4.4 Voltage divider forward bias (2)

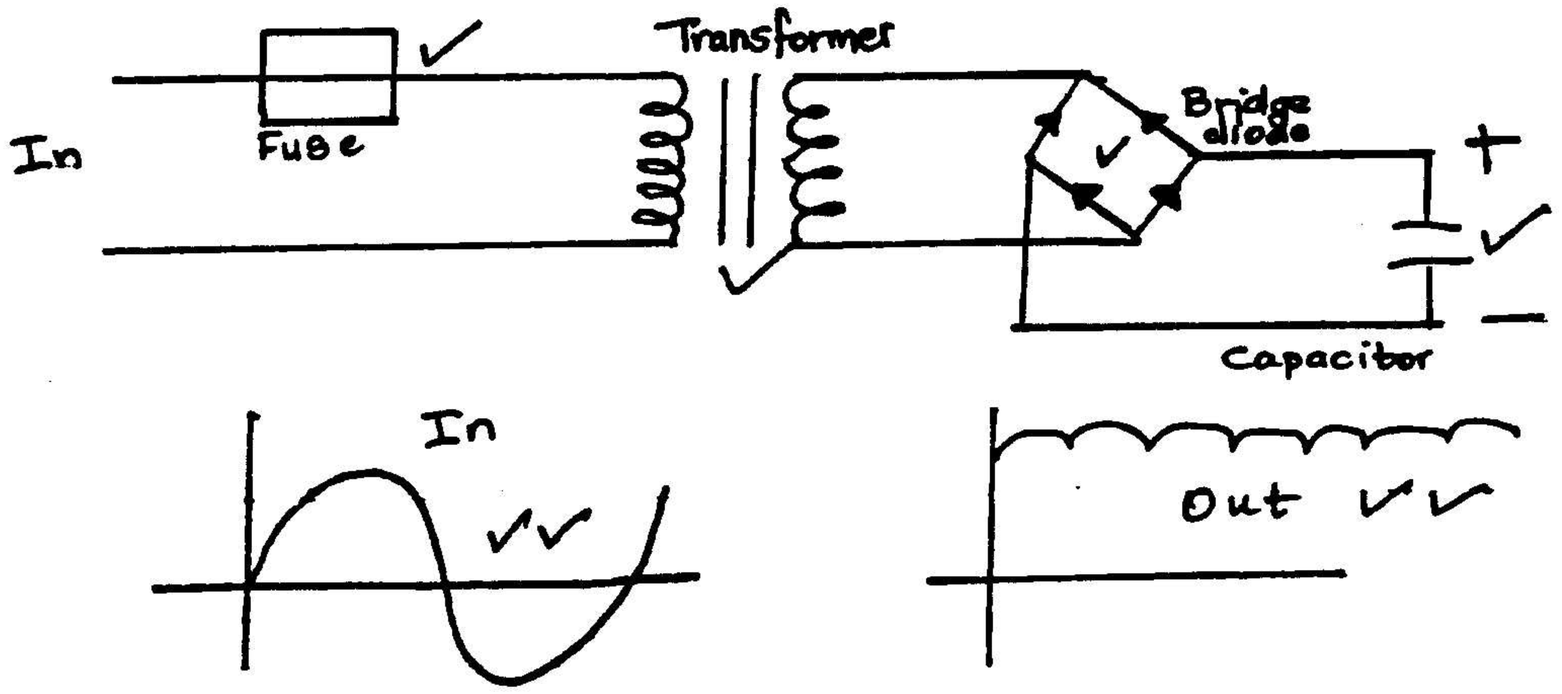
8.4.5 Common emitter amplifier coupled in cascade (2)
[28]

QUESTION 9
SWITCHING AND CONTROL CIRCUITS

Protection Transformation Rectification Filtering

9.1.1 Fuse — Transformer — Rectifier — Filtering circuit (4)

9.1.2



(8)

9.2 It is a circuit where output remains constant even if the load (input) varies or increases. (2)

9.3.1 Motor speed control by means of a SCR (1)
9.3.2 It controls the working of the motor controls the speed of the motor (1)
9.3.3 The time constant t = RxC is changed as R is charged. The capacitor will charge slower and the motor will turn slower as a result. (2)
[18]

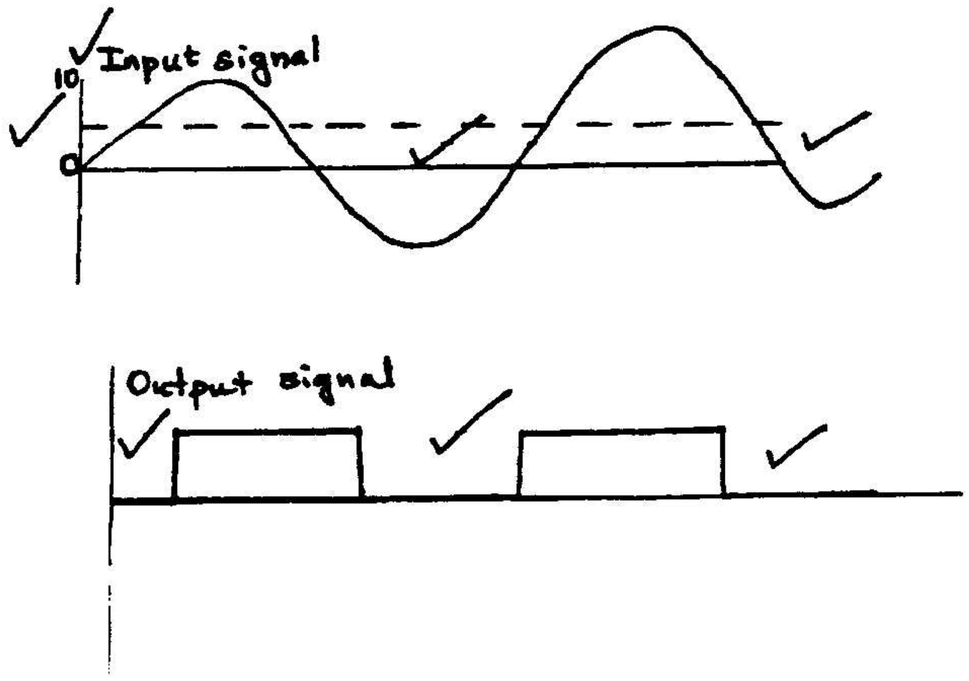
QUESTION 10
OSCILLATORS

10.1 When mechanical pressure is placed on a crystal, an emf will develop on the opposite sides of the crystal. (2)

10.2 10.2.1 L C oscillator (1)
10.2.2 C1 and L1 (2)
10.2.3 Transistor T1 (1)
[6]

QUESTION 11
OPERATIONAL AMPLIFIER

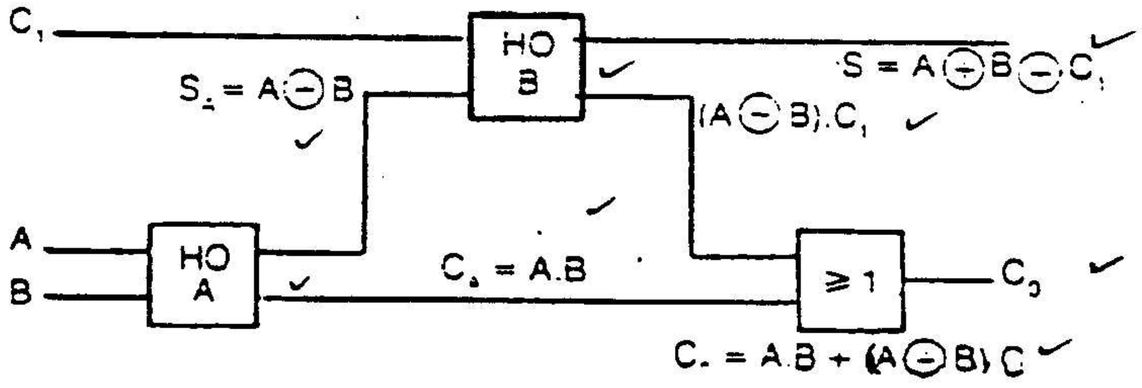
11.1 11.1.1 A comparator circuit with limitation on the output (2)
11.1.2 Voltage regulator on output
Clamping circuit



(6)
[8]

QUESTION 12
COMPUTER PRINCIPLES

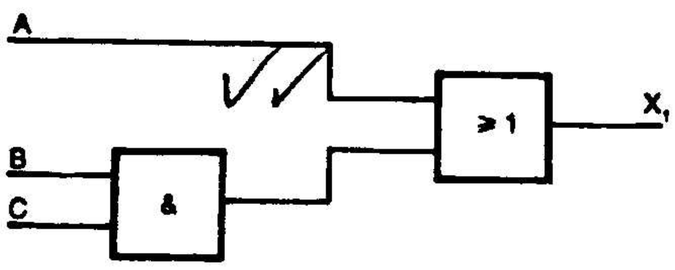
12.1



(8)

12.2 **Distribution rule: A + (B.C) = (A + B).(A + C)**

Combination circuit for left side.

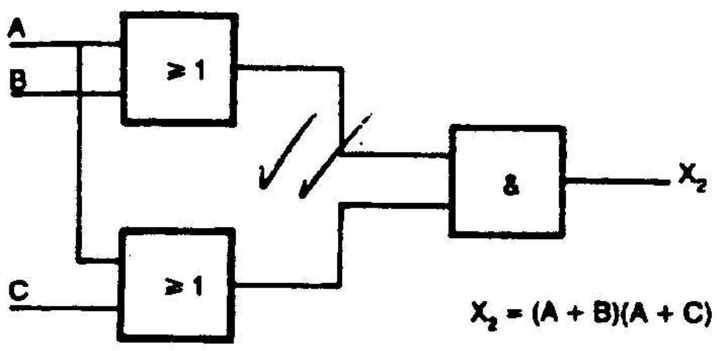


Truth table

A	B	C	A + B	A +C	B.C	X_1	X_2
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	1	1	1	1
1	0	0	1	1	0	1	1
1	0	1	1	1	0	1	1
1	1	0	1	1	0	1	1
1	1	1	1	1	1	1	1

Table 10.15

Combination circuit for reft side.



The truth table shows that X_1 and X_2 are identical

12.3 X = ABC + AB
= AB(C + 1)
= AB (3)

12.4.1

A	B	C	D	X
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(–1 per font)

(9)

12.4.2 $X = A\bar{B}CD + AB\bar{C}D + ABC\bar{D}$ or $X = A(BC + BD + CD)$ (2)

12.4.3 $A\bar{B}CD + AB\bar{C}D + ABCD$

$= (A\bar{B}CD + ABCD) + (AB\bar{C}D + ABCD)$

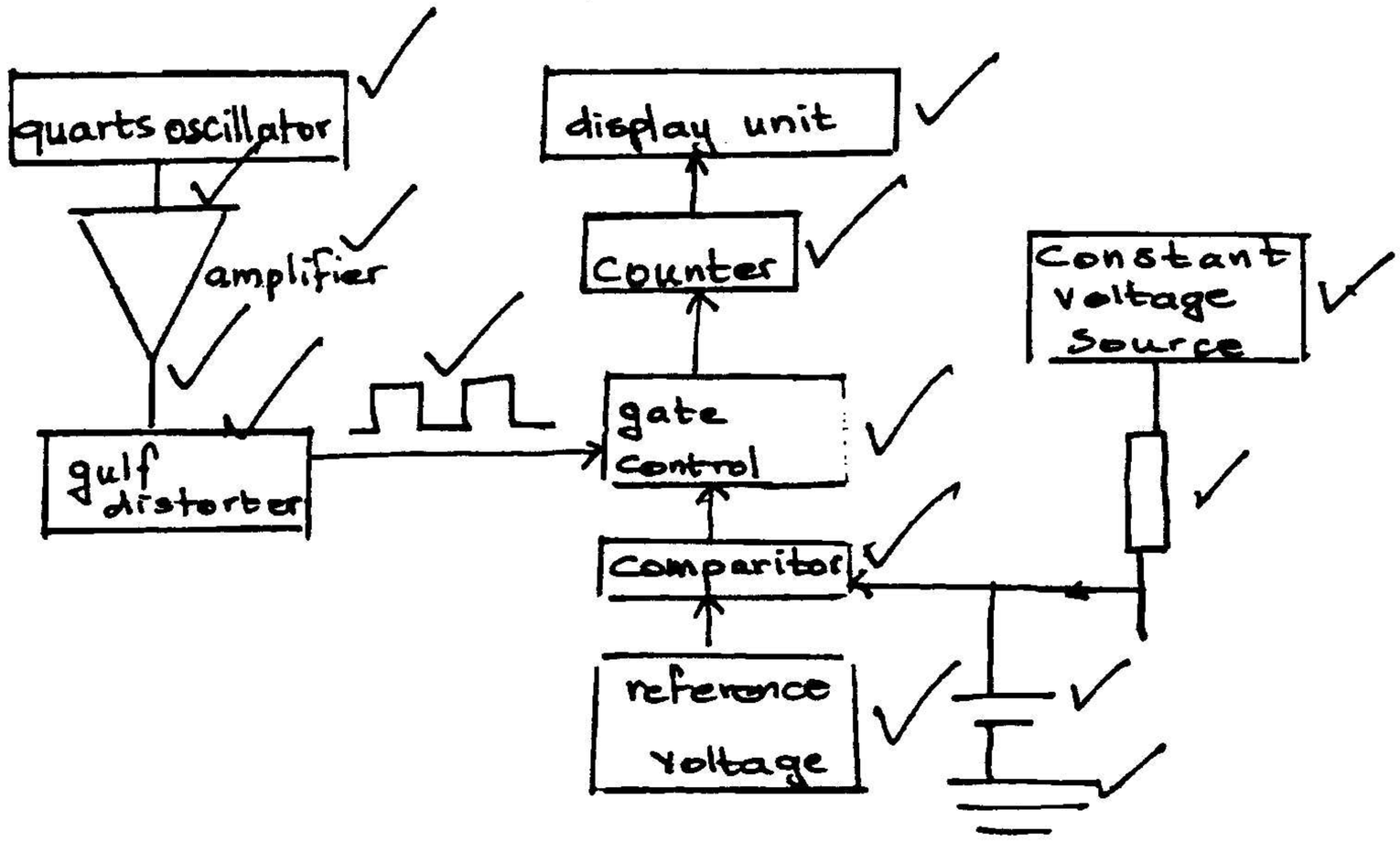
$= ACD(\bar{B} + B) + (ABD(\bar{C} + C)$

$= ACD + ABD$

$= AD(B + C)$ (4)

QUESTION 13
MEASURING INSTRUMENTS

Capacitance meter



[8]

TOTAL: 300

GAUTENGSE DEPARTEMENT VAN ONDERWYS
SENIORSERTIFIKAAT-EKSAMEN

MOONTLIKE ANTWOORDE VIR : TECHNIKA (ELEKTRIES) HG

VRAAG 1

1.1 C

1.2 B

1.3 A

1.4 D

1.5 B

1.6 B

1.7 A

1.8 C

1.9 C

1.10 B

1.11 A

1.12 E

1.13 E

1.14 B

1.15 B

[30]

VRAAG 2
BEROEPSVEILIGHEID

(Enige 5 toepaslike reels)

2.1
- Gaan na of daar van die kernbedrading gebruik gemaak is en indien wel of die regte draad aan die regte pen verbind is.
- Gaan na of die aarddraad goeie kontak maak met die metaalomhulsel.
- Kyk vir gebroke aarding
- Kyk of skakelaars in goeie werkende toestand is (5)

(Enige geldige redenasie is korrek)

2.2
- Hanteer so 'n persoon dadelik maar versigtig.
- Kry dadelik mediese hulp of ondersteuning van 'n ander persoon met mediese kennis.
- Stop die bloeding d.m.v. drukking wat toegepas word.
- Sorg dat daar geen direkte kontak met die bloed is nie.
- Gebruik handskoene en 'n bril indien beskikbaar brille. (5)

[10]

VRAAG 3
ELEKTRIESE WISSEL STROOMTEORIE

3.1 3.1.1 $Z = \sqrt{R^2 + (XL - Xc)^2}$

$= \sqrt{80^2 + (175 - 79,5)^2}$

$= \sqrt{80^2 + (95,5)^2}$

$= 124,58\ \Omega$

$Vt = I \times Z$
$= 5 \times 124,58$
$= 622,9$ Volt (6)

3.1.2 $\text{Cos } Q = \frac{R}{Z}$

$= \frac{80}{124,58}$

$= 0,64$

$Q = 50,2°$ (3)

3.2

3.2.1 R spoel = $\frac{Vg}{Ig}$

= $\frac{100}{10}$

= 10 ohm (2)

3.2.2 Z = $\sqrt{R^2 + Xl^2}$

XL = $\sqrt{Z^2 + R^2}$

= $\sqrt{(33,3)^2 - (10)^2}$

= 32,76 ohm

Z = $\frac{Vt}{It}$

= $\frac{200}{6}$

= 33,3 ohm

XL = $2\pi fL$

L = $\frac{Xl}{2\pi f}$

= $\frac{32,76}{2 \times 3,14 \times 60}$

= 86,9 mH (7)

3.3 Plaas 'n kapasitor in parallel oor die toevoer. (2)

3.4

3.4.1 $I_R = \frac{Vt}{R} = \frac{100}{12} =$ 8,3 Amp

$I_L = \frac{Vt}{XL}$

= $\frac{100}{37,68}$

= 2,65 Amp

$X_L = 2\pi fL$

= 2 x 3,14 x 50 x 0,12

= 37,68 ohm

$I_c = \frac{Vt}{Xc}$

= 100

= 3,14 Amp

$X_c = \frac{1}{2\pi fc}$

= $\frac{1}{2 \times 3,14 \times 50 \times 100 \times 10^{-6}}$

= 31,84 ohm (10)

3.4.2 $I_t = \sqrt{IR^2 + (IC - IL)^2}$

$= \sqrt{(8,3)^2 + (3,14 - 2,65)^2}$

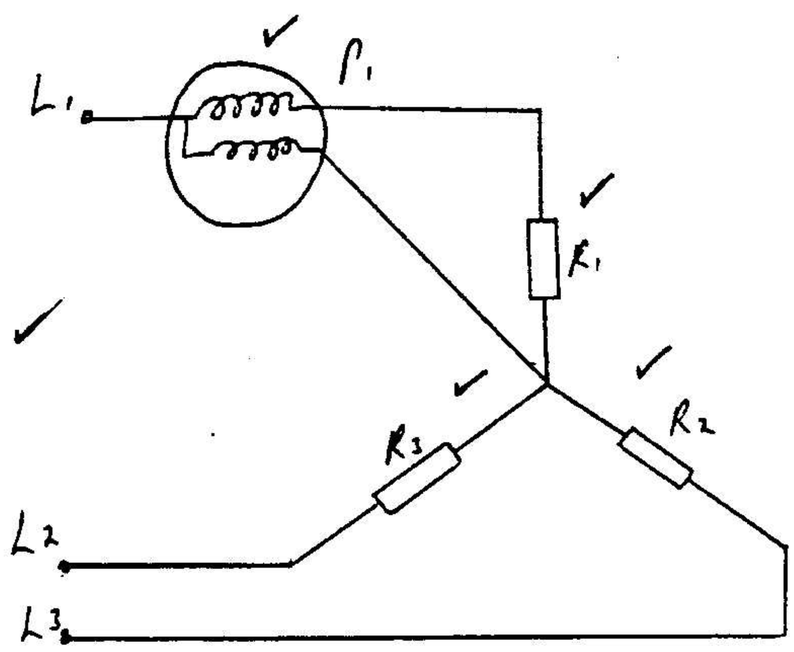
$= \sqrt{68,89 + 0,24}$

$= \sqrt{69,13}$

= 8,31 A (3)
[33]

VRAAG 4
EEN-EN DRIEFASIGE WISSELSTROOMSTELSELS

4.1



Pt = P1 x 3 (7)

4.2

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4.3

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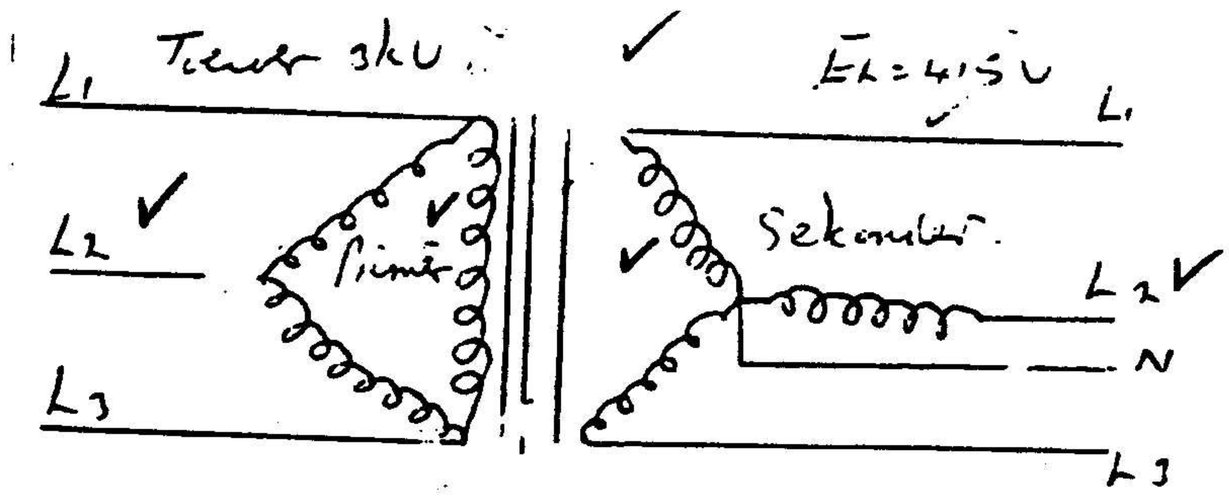
4.3.3 Cos Q = 0,7
Q = 45,5°
Pr = V x I Sin Q
= 500 x 100 x 0,714
= 35,7 kVA (4)

4.3.4 P = I x V x cos Q
= 500 x 100 x 0,7
= 35 kW (3)
[34]

VRAAG 5
TRANSFORMATORS

5.1



(5)

5.1.2 E_{Li} = E_{fi} = 3000 V

N_i = E_{fi} / volt/winding

= $\frac{3000}{4}$

= 750 Windings (5)

5.1.3 EF2 = $\frac{EL\,2}{3}$

= $\frac{415}{3}$

= 239,6 V

N2 $\frac{Ef2}{v/winding}$ of N2 = $\frac{N1\ \ Ef2}{Ef1}$

= $\frac{239,6}{4}$ 59,9 Windings

= 59,9 Windings (5)

Sekondêre strome

5.1.4 P uit = $\sqrt{3}$ EL2 IL2 cos Q

IL2 = $\frac{P\,uit}{\sqrt{3}\ EL2\ cos\ Q}$

= $\frac{150000}{\sqrt{3} \times 415 \times 0,8}$

= 260,8 A

If2 = IL2 = 260,8 A

Primêre strome

$\frac{If2}{If1}$ = $\frac{N1}{N2}$

If 2 = $\frac{N2 \times If2}{N1}$

= $\frac{59,9 \times 260,85}{750}$

= 20,84 A

IL1 = $\sqrt{3}$ If1
= 36 Amp

1 Neutraal = 0A (13)

5.2
- MMK primêr kanseleer nie uit met MMK sekondêr.
- Stroom opgewek by primêr veroorsaak werwelstroom in kern.
- Werwelstroom verhit kern
- Isolasie smelt en 'n kortsluiting ontstaan.
- Lewensgevaarlike situasie vind plaas. (6)

[25]

VRAAG 6
WISSELSTROOMMOTORE

6.1 EL = 380 V

Punt = 50 kW
Cos Q = 0,85
doeltreffendheid = 0,9

6.1.1 $P = \sqrt{3}\, E_L\, I_L \cos Q \times \eta$

$$I_L = \frac{\text{Punt}}{\sqrt{3}\, EL \cos Q \times \eta}$$

$$= \frac{50000}{1{,}73 \times 380 \times 0{,}85 \times 0{,}9}$$

= 99,3 Amp (4)

6.1.2 $Ps = \sqrt{3}\, I_L\, E_L$

= 1,73 x 99,3 x 380

= 65,28 kVA (3)

6.1.3 $\cos Q$ = 0,85

$Q = \cos^{-1} \times 0{,}85$

= 31,7° (2)

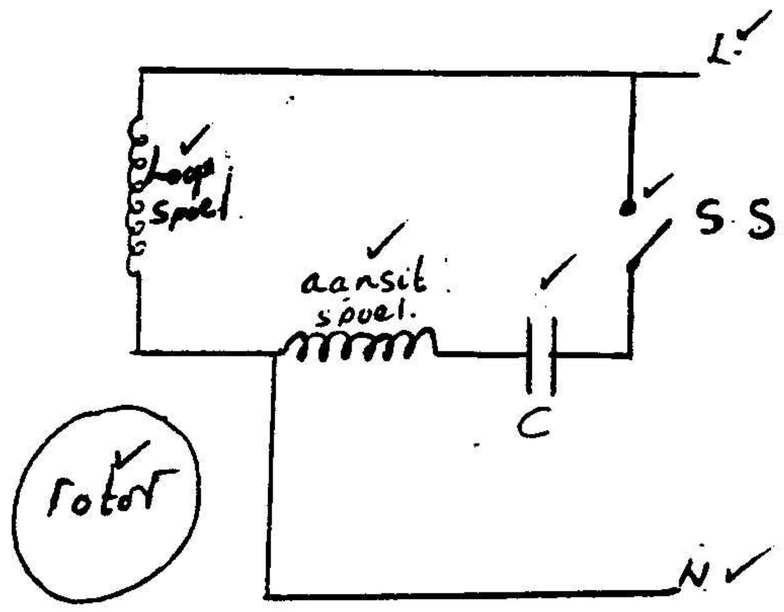
6.2

6.2.1 Geen roterende magneetveld slegs 'n wisselende magneetveld. a.g.v. wisselstroomtoevoer. (2)

6.2.2 "Die fase moet gesplit word."

* Sit 'n kapasitor in serie met een van die windings
* Maak een winding meer induktief. (4)

6.2.3



Sentrifugale skakelaar

* Na ± 75% volspoel maak die skakelaar oop en stroom vloei dan slegs deur loop spoel. (9)

6.2.4 P = 2 Glipspoed = 125 r/min.

f = 50

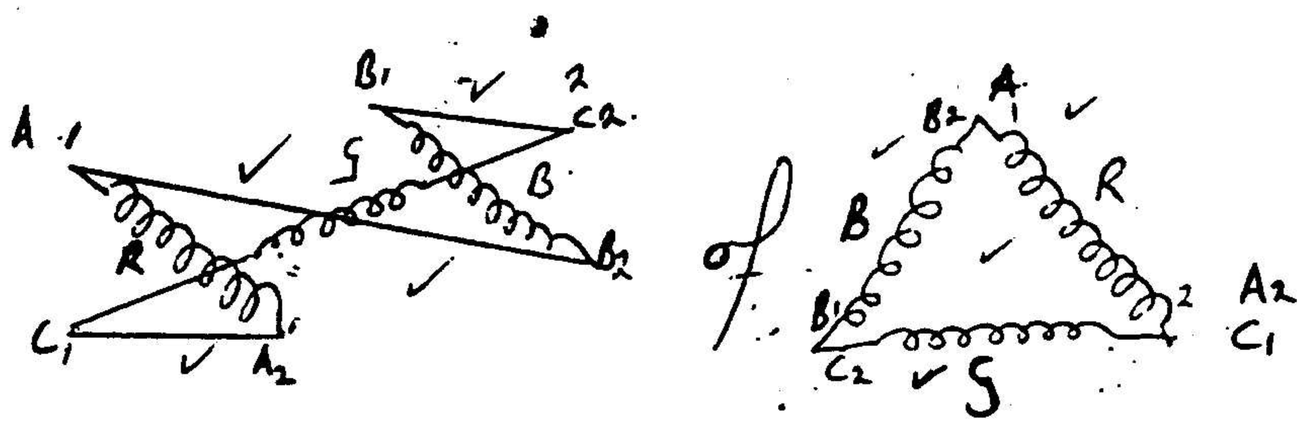
Ns = $\frac{f}{P} = \frac{50}{2}$ = 25 r/sek = 25 x 60 = 1500 r/min

Nr = Ns – glipspoed

= 1500 – 125

= 1375 rpm (5)

6.3



6.4 Oorbeladings meganisme

Indien die las te groot word en die motor trek te veel stroom sal die stroombreker uitklink.

Nulspanningspoel

Ingeval van 'n kragonderbreking sal die kontrakpunte oopmaak en moet dit weer met die hand aangeskakel word. (3)

6.5 Rooi, Geel, Blou. (2)

[38]

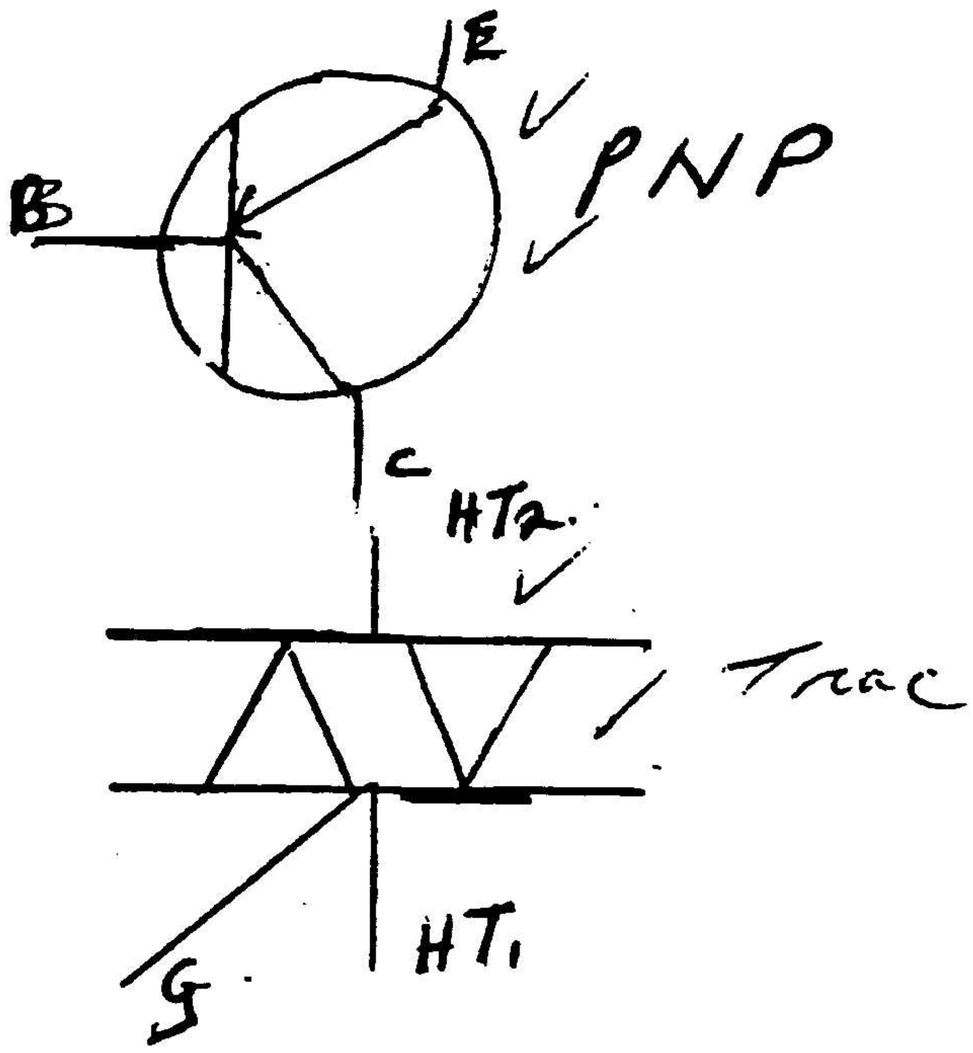
VRAAG 7
HALFGELEIERS

7.1 7.1.1 Die lamp sal <u>NIE brand nie</u> want die BSG het 'n puls nodig om aan te skakel nadat die toevoer teenwoordig is. (4)

7.1.2 Die lamp sal nou aanskakel want die toevoer is teenwoordig en daar is 'n positiewe puls. (4)

7.1.3 Die lamp <u>sal bly brand</u> want die <u>houstroom is bo drempelwaarde</u> en die <u>toevoer is nog steeds teenwoordig</u>. (4)

7.2 7.2.1



7.2.2

7.3
* IB moet teenwoordig wees ± 2%
* Die basisemitter voeg moet meevoorgespan wees – dus basis positief – emitter negatief ten minste 0,7 volt.
* Die kollektor – emitter voeg moet teenvoorgespan wees – die kollektor positief en die emitter negatief.
* Voldoende GS-toevoer ± 6 volt
* Transistor reg gekoppel.

(5)
[21]

VRAAG 8
VERSTERKERS

8.1 $\frac{Z_2}{Z_1} = \left(\frac{N_2}{N_1}\right)^2$

$Z2 = Z1 \times \frac{N_2^2}{N_1^2}$

$= 5x10^3 \times \left(\frac{1}{12.5}\right)^2$

= 32 ohm

Dus kan daar $\frac{32}{8}$ luidsprekers gekoppel word

= 4 (6)

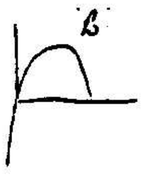
8.2 a. RL = 0V (1)
b. Tr = 6V (1)

8.2.2 a. RL ≅ 6V (1)
b. Tr ≅ 0V (1)

8.2.3 a. RB = Beheer die basisstroom /Beskerm die transistor (1)
b. RL = Veroorsaak 'n spanningsval op die uitset. (1)

8.3 Klas A-versterker word so voorgespan dat die werkpunt in die middel van die laslyn is. Die volledige insetsein word versterk.

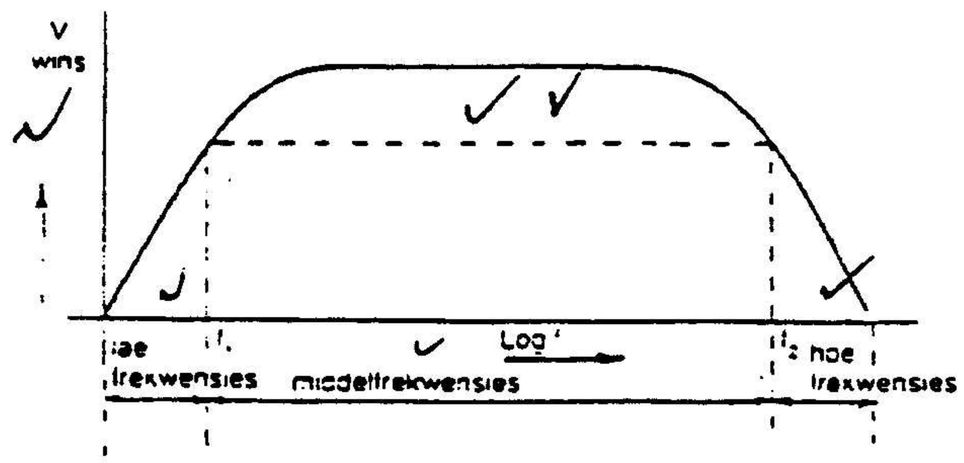
Klas B-versterker word so voorgespan dat die transistor by sy afsnypunt werk. Slegs die helfte van die invoersein word versterk. (4)



8.4 8.4.1 NPN-bipolêre transistor – Versteker in 1ste trap

8.4.2 Resistorkapasitansiekoppeling

8.4.3



(6)

8.4.4 Spanningsverdelervoorspanning (2)

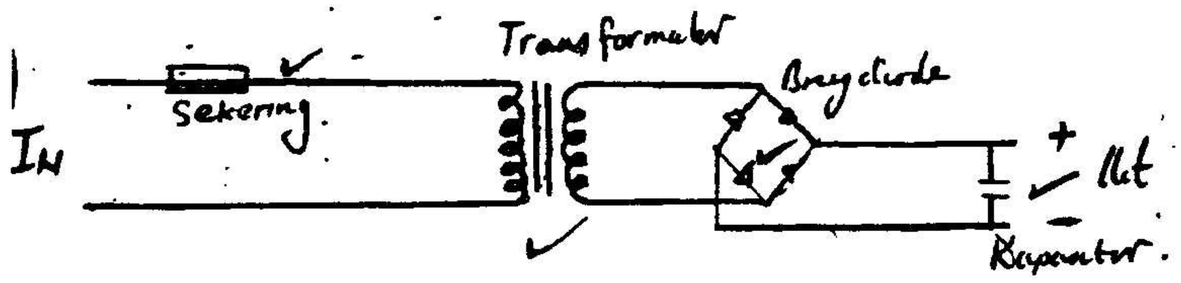
8.4.5 Gemeenskaplike emitterversterker in kaskade gekoppel (2)
[28]

VRAAG 9
SKAKEL- EN BEHEERKRINGE

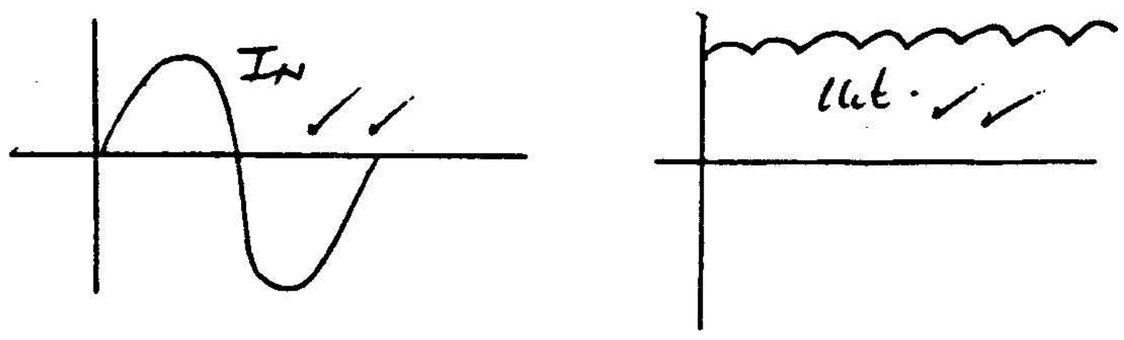
Proteksie (Beskerming) Transformasie Gelykrigting Filtering

9.1.1 Sekering — Transformator — Gelykrigter — Filterkring (4)

9.1.2



(8)



9.2 Dit is 'n kringbaan waarvan die uitset konstant sal bly, selfs al wissel of vergroot die inset (las). (2)

9.3.1 Motorspoedbeheer d.m.v. B.S.G. (1)
9.3.2 Dit beheer die drywing van die motor. Beheer die spoed van motor (1)
9.3.3 Die tydkonstante t = RxC word verander as R gestel word. Dus sal die kapasitor stadiger laai en die motor stadiger draai. (2)
[18]

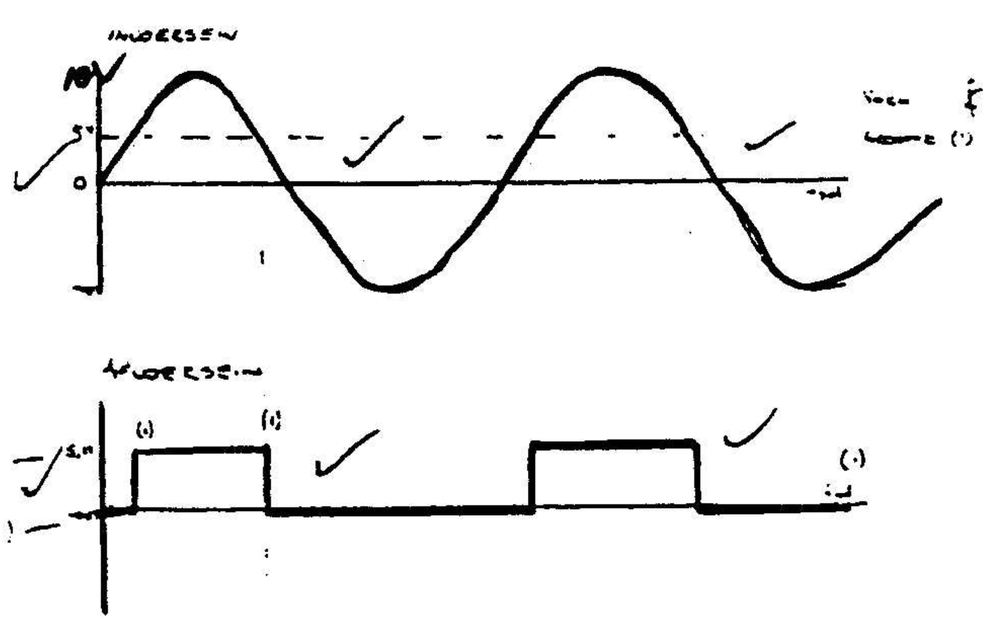
VRAAG 10
OSSILATORS

10.1 Wanneer daar meganiese druk op 'n kristal uitgeoefen word sal die emk daarin oor die teenoorgestelde kante van die kristal ontwikkel. (2)

10.2 10.2.1 Ingestemde kollektor ossillator (L C ossillator) (1)
10.2.2 C1 en L1 (2)
10.2.3 Transistor T1 (1)
[6]

VRAAG 11
OPERASIONELE VERSTERKERS

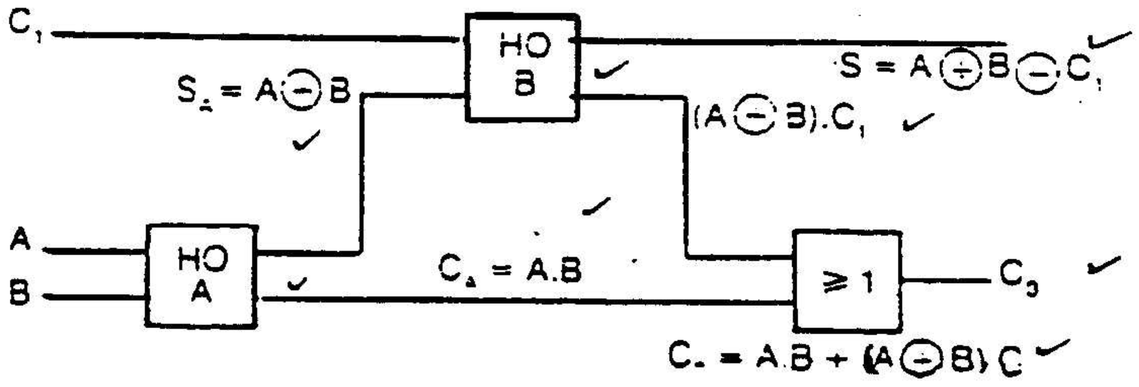
11.1 11.1.1 'n Vergelykingskring met beperking op die afvoer (2)
11.1.2 Spanningsregulering op uitset
(Clamping circuit)



(6)
[8]

VRAAG 12
REKENAARBEGINSELS

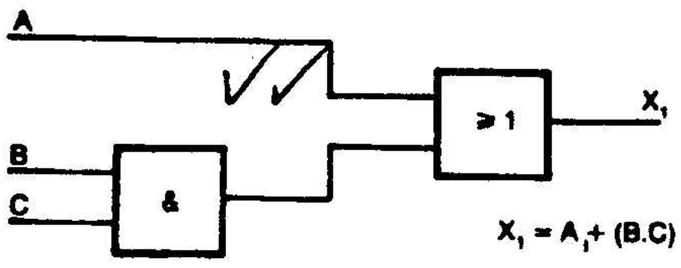
12.1



(8)

12.2 **Distribusiereël: A + (B.C) = (A + B).(A + C)**

Kombinasiebaan vir linkerkant

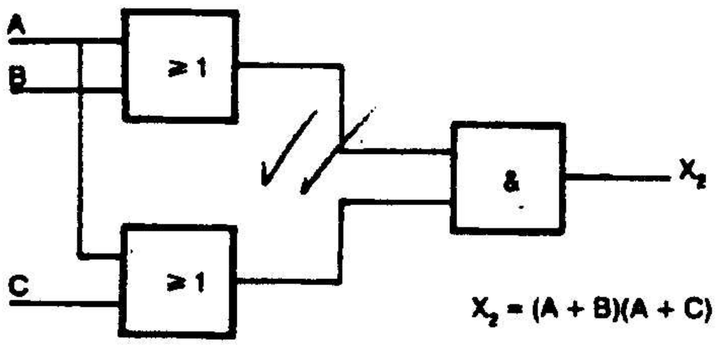


Waarheidstabel

A	B	C	A + B	A + C	B.C	X_1	X_2
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	1	1	1	1
1	0	0	1	1	0	1	1
1	0	1	1	1	0	1	1
1	1	0	1	1	0	1	1
1	1	1	1	1	1	1	1

Tabel 10.15

Kombinasiebaan vir regterkant



Die waarheidstabel toon dat X_1 en X_2 identies is.

12.3 X = ABC + AB
= AB(C + 1)
= AB

12.4.1

A	B	C	D	X
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(–1 per font)

(9)

12.4.2 $X = A\bar{B}CD + AB\bar{C}D + ABC\bar{D}$ of $X = A(BC + BD + CD)$ (2)

12.4.3 $A\bar{B}CD + AB\bar{C}D + ABCD$

$= (A\bar{B}CD + ABCD) + (AB\bar{C}D + ABCD)$

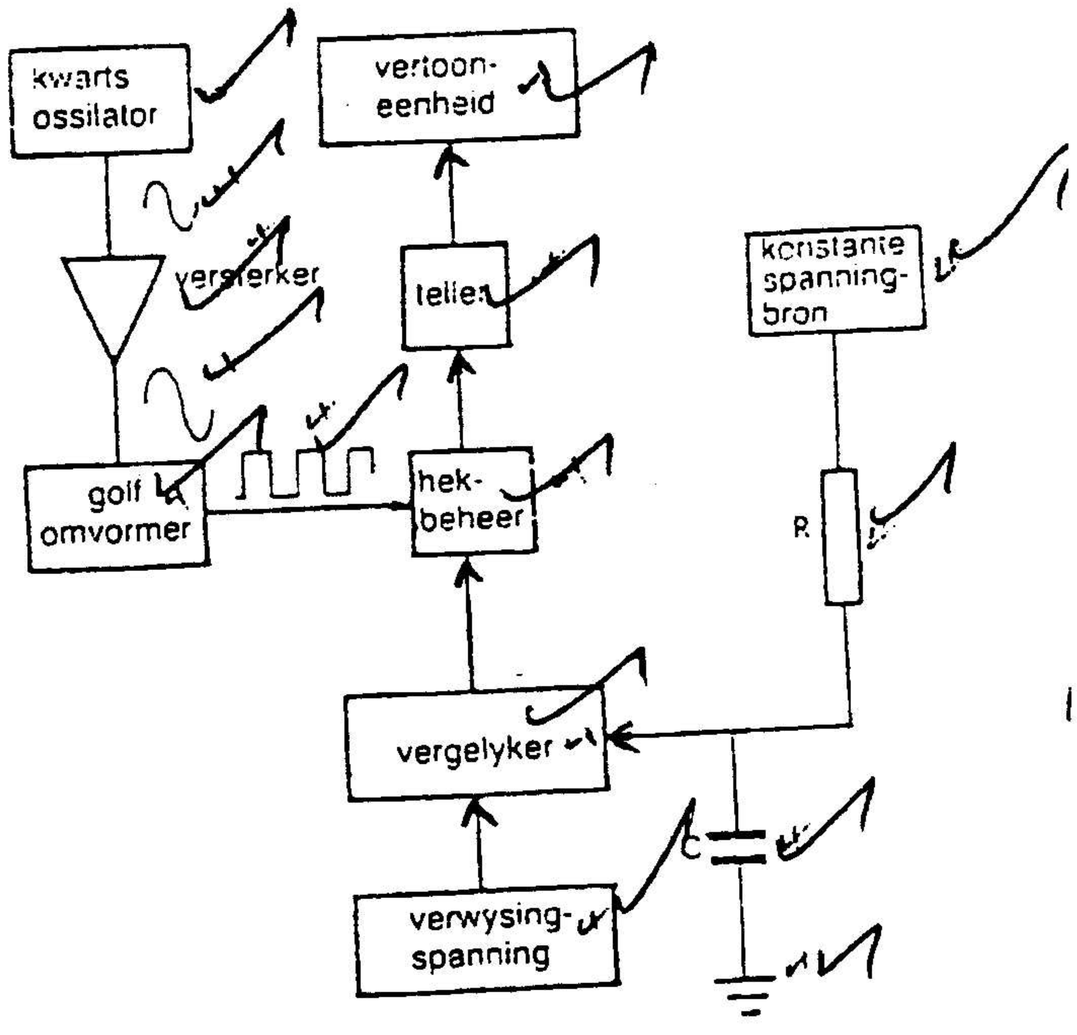
$= ACD(\bar{B} + B) + (ABD(\bar{C} + C)$

$= ACD + ABD$

$= AD(B + C)$ (4)

VRAAG 13
MEETINSTRUMENTE

Kapasitansiemeter



[8]

TOTAAL: 300