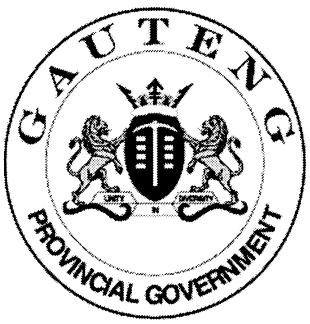
SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN



FEBRUARY / *FEBRUARIE*
MARCH / *MAART*

2005

TECHNIKA (ELECTRICAL)

TECHNIKA (ELEKTRIES)

HG 713-1/0

TECHNIKA ELECTRICAL HG

13 pages
13 bladsye

713 1 0 HG

X05

GAUTENGSE DEPARTEMENT VAN ONDERWYS

SENIORSERTIFIKAAT-EKSAMEN

TECHNIKA (ELEKTRIES) HG

TYD: 3 uur

PUNTE: 300

BENODIGDHEDE:

Tekeninstrumente en 'n goedgekeurde sakrekenaar.

INSTRUKSIES:

- Beantwoord AL die vrae.
- Sketse en diagramme moet duidelik wees.
- Alle formules en berekeninge moet, waar van toepassing, getoon word.
- 'n Lys van formules wat, waar van toepassing gebruik mag word, word op die laaste bladsy van hierdie eksamenvraestel voorsien.

VRAAG 1
WISSELSTROOMTEORIE

1.1 'n Weerstand van 10 ohm, 'n induktor van 200 millihenry en 'n kapasitor van 100 mikrofarad word in serie aan 'n 250 V, 50 Hz-toevoer verbind.

Bereken die

1.1.1 impedansie van die kring. (9)

1.1.2 drywingsfaktor van die kring. (2)

1.1.3 reaktiewe komponent van die stroom. (7)

1.2 'n Spoel met 'n weerstand van 10 ohm en 'n induktansie van 50 millihenry word in parallel met 'n kapasitor van 200 mikrofarad geskakel oor 'n toevoerspanning wat voorgestel word deur die volgende vergelyking.

$$V = 200 \sin (628\,t + \frac{85\,\pi}{180}) \text{ volt}$$

Bereken die

1.2.1 toevoerfrekwensie. (3)

1.2.2 frekwensie waarteen die kring sal resoneer. (6)

1.2.3 dinamiese impedansie van die kring. (3)

GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRICAL) HG

TIME: 3 hours

MARKS: 300

REQUIREMENTS:

Drawing instruments and an approved calculator.

INSTRUCTIONS:

- Answer ALL the questions.
- Sketches and diagrams must be clear.
- All formulae and calculations must, where applicable, be indicated.
- A list of formulae which could be used where appropriate, is given on the last page of this question paper.

QUESTION 1
ALTERNATING CURRENT THEORY

1.1 A resistance of 10 ohms, an inductance of 200 milli-henrys and a capacitor of 100 micro-farads, are connected in series to a 250 V 50 Hz supply.

Calculate the

1.1.1 impedance of the circuit. (9)

1.1.2 power factor of the circuit. (2)

1.1.3 reactive component of the current. (7)

1.2 A coil with a resistance of 10 ohms and an inductance of 50 milli-henrys is connected in parallel with a capacitor of 200 micro-farads across a supply voltage represented by the following equation.

$$V = 200 \sin (628\,t + \frac{85\pi}{180}) \text{ volt}$$

Calculate the

1.2.1 supply frequency. (3)

1.2.2 frequency at which the circuit will resonate. (6)

1.2.3 dynamic impedance of the circuit. (3)

1.3 Wanneer 'n sekere spoel aan 'n 50 V gelykstroomtoevoer gekoppel word, trek dit 'n stroom van 5 ampère, maar as dieselfde spoel oor 'n 140 V, 60 Hz wisselspanningstoevoer gekoppel word, trek dit 'n stroom van 7 ampère.

Bereken die

1.3.1 weerstandswaarde van die spoel. (3)

1.3.2 induktansiewaarde van die spoel. (9)

1.4 'n Spoel met 'n weerstand en induktansie, word in serie met 'n kapasitor aan 'n toevoer met 'n verstelbare frekwensie gekoppel. Verduidelik, met behulp van 'n fasordiagram, aan watter voorwaardes voldoen moet word sodat die kring soos 'n nie-reaktiewe resistor sal reageer. (4)

1.5 Watter invloed sal die verandering in frekwensie op die stroom hê in die volgende gevalle? Toon die formules om jou antwoord te bewys.

1.5.1 Induktiewe las (2)

1.5.2 Kapasitiewe las (2)
[50]

VRAAG 2
EEN- EN DRIEFASIGE WISSELSTROOMSTELSELS

2.1 'n Kapasitiewe, delta-verbinde, driefasige las met 'n toevoerspanning van 380 V, lewer 20 kW teen 'n rendement van 90% en 'n drywingsfaktor van 0,95.

Bereken die

2.1.1 lynstroom. (4)

2.1.2 fasestroom. (3)

2.1.3 fasespanning. (2)

2.1.4 fase-impedansie. (3)

2.1.5 faseweerstand. (3)

1.3 When a certain coil is connected to a 50 V direct current supply, the current drawn is 5 amperes and when the same coil is connected to a 140 V, 60 Hz alternating voltage supply the current drawn is 7 amperes.

Calculate the

1.3.1 value of the resistance of the coil. (3)

1.3.2 value of the inductance of the coil. (9)

1.4 A coil with a resistance and inductance is connected in series with a capacitor to a supply with a variable frequency. Explain, with the aid of a phasor diagram, what conditions must be satisfied so that the circuit will react as a non-reactive resistor. (4)

1.5 What influence does the change of frequency have on the current in the following circumstances? Show the formulae to prove your answer.

1.5.1 Inductive load (2)

1.5.2 Capacitive load (2)

[50]

QUESTION 2
ONE AND THREE-PHASE ALTERNATING CURRENT SYSTEMS

2.1 A capacitive, delta-connected, three-phase load with a supply voltage of 380 V, delivers 20 kW at an efficiency of 90% and a power factor of 0,95.

Calculate the

2.1.1 line current. (4)

2.1.2 phase current. (3)

2.1.3 phase voltage. (2)

2.1.4 phase impedance. (3)

2.1.5 phase resistance. (3)

2.2 Die meterlesings in 'n sekere eenfasestelsel is:

V = 220 V en I = 30 A.

Die drywingsfaktor is 0,8 nalopend.

2.2.1 Bereken die

(a) skyndrywing van die kring. (3)

(b) effektiewe drywing van die kring. (3)

(c) fasehoek tussen die stroom en die spanning. (2)

2.2.2 Skets volgens enige geskikte skaal, die fasordiagram van die kring en **meet** die aktiewe en reaktiewe komponente van die stroom. (5)

2.3 Noem TWEE voordele van 'n driefasestelsel bo 'n enkelfasestelsel. (2)
[30]

VRAAG 3
TRANSFORMATORS

3.1 'n Sterverbinde, driefase-alternator met 'n fasespanning van 6,6 kV word aan 'n driefase, delta-stertransformator met 'n draaiverhouding van 50:1 verbind.

Bereken die

3.1.1 lynspanning van die alternator. (3)

3.1.2 primêre lynspanning van die transformator. (2)

3.1.3 primêre fasespanning van die transformator. (2)

3.1.4 sekondêre fasespanning van die transformator. (3)

3.1.5 sekondêre lynspanning van die transformator. (3)

3.2 'n Wattmeter het 'n 5 A-stroomspoel en 'n 110 V-potensiaalspoel. Die wattmeter moet gebruik word om die drywing te meet van 'n 11 kW enkelfasige WS-toevoer deur gebruik te maak van instrumenttransformators. Wanneer die las 'n stroom van 300 A neem, het die wattmeter 'n volskaaluitwyking.

3.2.1 Teken 'n kringdiagram om aan te toon hoe die instrumenttransformators aan die wattmeter verbind word. (4)

3.2.2 Bereken die draaiverhouding van die stroomtransformator. (3)

2.2 The meter readings in a certain single-phase system are:

V = 220 V and I = 30 A.

The power factor is 0,8 lagging.

2.2.1 Calculate the

(a) apparent power of the circuit. (3)

(b) effective power of the circuit. (3)

(c) phase angle between the current and the voltage. (2)

2.2.2 Using any appropriate scale, draw the phasor diagram of the circuit and **measure** the active and reactive components of the current. (5)

2.3 List TWO advantages of a three-phase system when compared to a single-phase system. (2)

[30]

QUESTION 3
TRANSFORMERS

3.1 A star-connected, three-phase alternator with a phase voltage of 6,6 kV is connected to a three-phase, delta-star transformer with a turns ratio of 50:1.

Calculate the

3.1.1 line voltage of the alternator. (3)

3.1.2 primary line voltage of the transformer. (2)

3.1.3 primary phase voltage of the transformer. (2)

3.1.4 secondary phase voltage of the transformer. (3)

3.1.5 secondary line voltage of the transformer. (3)

3.2 A watt meter has a 5 A current coil and a 110 V potential coil. The watt meter must measure the power consumed in an 11 kW single-phase AC supply by means of instrument transformers. The watt meter gives a full-scale deflection when the load draws a current of 300 A.

3.2.1 Draw a circuit diagram to show how the instrument transformers are connected to the watt meter. (4)

3.2.2 Calculate the turns ratio of the current transformer. (3)

3.3 'n Eenfase outotransformator het 'n 1 000 : 750 draaiverhouding. Bereken die stroom in die gemeenskaplike gedeelte van die transformator wanneer dit 'n las van 45 kVA by 750 V voorsien. (8)

3.4 Verduidelik kortliks hoe werwelstrome in 'n transformator beperk word. (2)
[30]

VRAAG 4
WISSELSTROOMMOTORS

4.1 'n Vierpool-kourotor induksiemotor word aan 'n 380 V-wisselspanningstoevoer met 'n periodieke tyd van 0,02 sekondes verbind. Die motorglip is op 4% vasgestel.

Bereken die

4.1.1 toevoerfrekwensie. (3)

4.1.2 rotorspoed. (4)

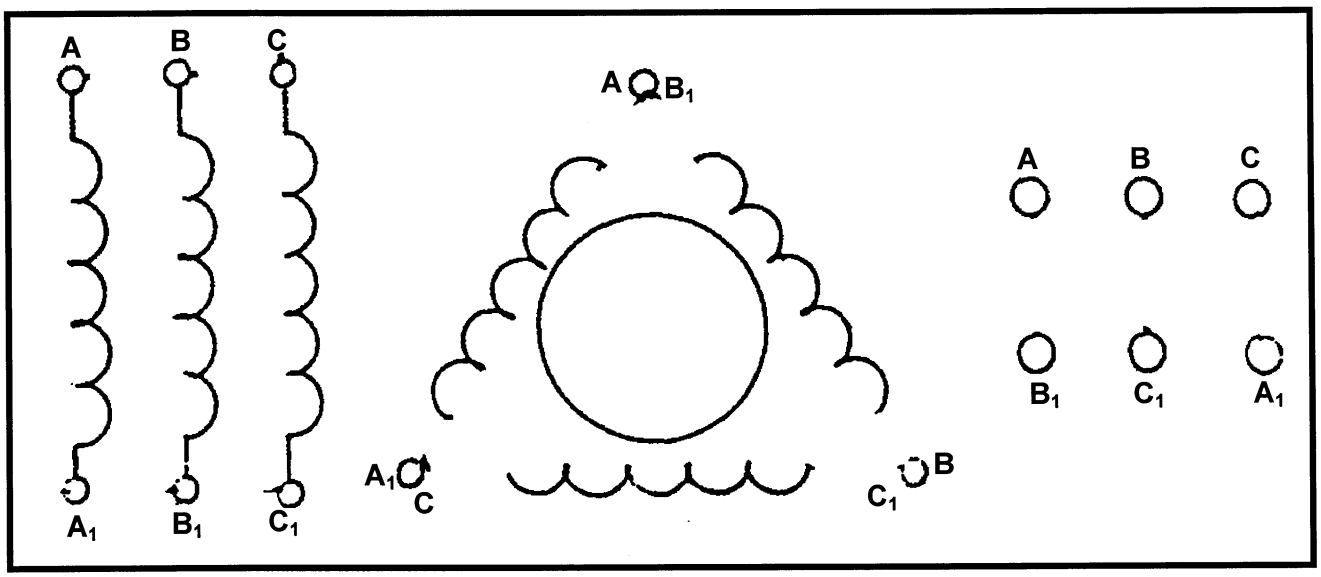
4.1.3 frekwensie van die geïnduseerde emk in die rotor. (2)

4.2 Verduidelik kortliks hoe die aansitstroom in 'n ster-delta-aansitter beperk word. (4)

4.3 Toon deur middel van 'n eenvoudige kringdiagram aan hoe die stroomdraende komponente van 'n tipiese kapasitor aansit-en-loopmotor aan die toevoer verbind word. (5)

4.4 Vergelyk kortliks die kapasitoraansitmotor en die kapasitorloopmotor met betrekking tot wringkrag. (5)

4.5 Die volgende drie sketse toon die fase-aansluiters tussen 'n kourotor-induksiemotor en 'n aansitter. Verbind die aansluiters in delta. (6)



4.6 Waarom kan 'n induksiemotor nie teen dieselfde spoed as die sinchrone spoed loop nie? (1)
[30]

b.o.

3.3 A single-phase auto-transformer has a turns ratio of 1 000 : 750. Calculate the current in the common part of the transformer when it supplies a load of 45 kVA at 750 V. (8)

3.4 Explain briefly how eddy currents are reduced in a transformer. (2)

[30]

QUESTION 4
ALTERNATING CURRENT MOTORS

4.1 A four-pole squirrel-cage motor is connected to a 380 V-alternating current supply with a periodic time of 0,02 seconds. The motor slip is calculated to be 4%.

Calculate the:

4.1.1 supply frequency. (3)

4.1.2 rotor speed. (4)

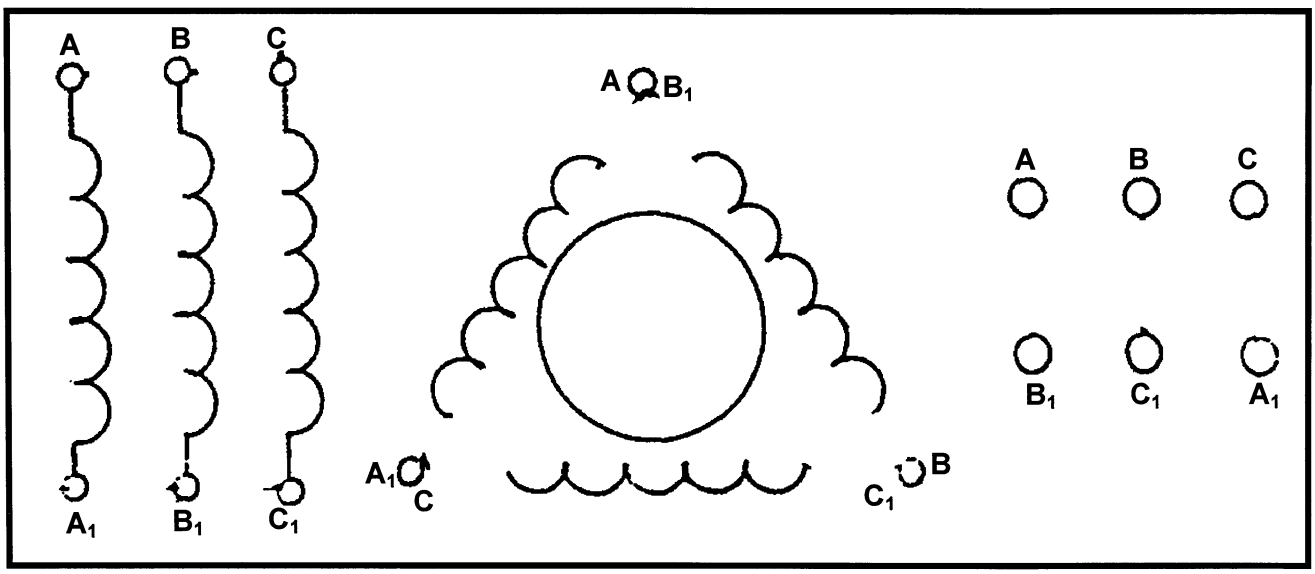
4.1.3 frequency of the induced e.m.f. in the rotor. (2)

4.2 Briefly explain how the starting current is limited in a star-delta starter. (4)

4.3 Show by means of a simple circuit diagram, how the current-carrying components of a typical capacitor start-and-run motor are connected to the supply. (5)

4.4 Briefly compare the capacitor-start motor and the capacitor-run motor with regard to torque. (5)

4.5 The following three sketches show the phase connectors between a squirrel-cage induction motor and a starter. Connect the connectors in delta. (6)



4.6 Why can an induction motor not run at the same speed as the synchronous speed? (1)

[30]

P.T.O.

VRAAG 5
HALFGELEIERS, SKAKEL- EN BEHEERKRINGE

5.1 Diagramvel 5.1 op bladsye 11 en 12 bevat diagramme van simbole en golfvorms, gemerk **A** tot **J**. Skryf die vraagnommers onder mekaar en die korrespondente letters van die betrokke diagramme in jou antwoordboek neer.

5.1.1 Bipolêre transistor

5.1.2 Veldeffektransistor

5.1.3 Triak

5.1.4 Diak

5.1.5 BSG (10)

5.2 Noem TWEE metodes om 'n beheerde silikongelykrigter af te skakel. (4)

5.3 Teken 'n netjies benoemde kringdiagram van 'n N-kanaalvoeg-veldeffektransistor wat as 'n versterker gekoppel is. Toon ook die invoer- en afvoergolfvorms aan. (6)

5.4 'n Praktiese toevoer kan ontwerp word om 'n 220 V-toevoerspanning na 'n meer bruikbare GS-spanning om te skakel. Ontwerp 'n eenvoudig gereguleerde 12 Volt GS-kragtoevoerkringbaan wat 'n hoofsaaklik konstante uitsetspanning onder veranderde lastoestande kan lewer. Jou kringbaan moet van 'n verlagingstransformator, 'n diode-gelykrigterkring, 'n filtreerkring en 'n sjunt-reguleerder voorsien wees. Al die toepaslike golfvorms moet aangedui word.

(Neem kennis dat hierdie **nie** 'n blokdiagram mag wees nie.) (15)

5.5 Toon aan deur middel van 'n diagram hoe lampdemping verkry kan word deur van 'n diak-triakkombinasie gebruik te maak. (5)
[40]

VRAAG 6
VERSTERKERS

6.1 Om 'n sein vanaf 'n mikrofoon vir 'n luidspreker te versterk, word sekere vlakke van versterking benodig. Verduidelik met behulp van 'n netjies benoemde stroomdiagram, die basiese werksbeginsel van 'n Resistorkapasitor-koppelings-versterker of 'n balansversterker. (15)

6.2 Die invoerdrywing van 'n toestel is 10 000 watt en 'n spanning van 1 000 volt. Die uitsetdrywing is 500 watt.

Bereken die drywingswins in desibel. (3)

QUESTION 5
SEMICONDUCTORS, SWITCHING AND CONTROL CIRCUITS

5.1 Diagram Sheet 5.1 on pages 11 and 12 contain diagrams of symbols and wave-forms marked **A** to **J**. Write down the question numbers, one below the other, and the corresponding letters of the relevant diagrams in your answer book.

5.1.1 Bipolar transistor

5.1.2 Field effect transistor

5.1.3 Triac

5.1.4 Diac

5.1.5 SCR (10)

5.2 Name TWO methods of switching off a Silicon-Controlled Rectifier. (4)

5.3 Draw a neatly labelled circuit diagram of an N-channel joint field effect transistor, coupled as an amplifier. Also indicate the relevant input and output waveforms. (6)

5.4 A practical power supply can be designed to convert a 220 V supply voltage into a desired DC voltage. Design a simple 12 volt DC regulated power supply circuit to maintain an essentially constant output voltage under changing load conditions. Your circuit should include a step-down transformer, a diode rectifier circuit, a filter circuit and a shunt regulator. All the relevant wave forms should be indicated.

(Please note that this should **not** be a block diagram). (15)

5.5 Show by means of a diagram how light dimming can be obtained by using a diac-triac combination. (5)
[40]

QUESTION 6
AMPLIFIERS

6.1 To amplify a signal of a microphone for a loudspeaker, certain levels of amplification are required. Explain by means of a neatly labelled circuit diagram, the principle of operation of a Resistor-Capacitor amplifier or a push-pull amplifier. (15)

6.2 The input power of an appliance is 10 000 watt and the voltage is 1 000 volt. The output power is 500 watt.

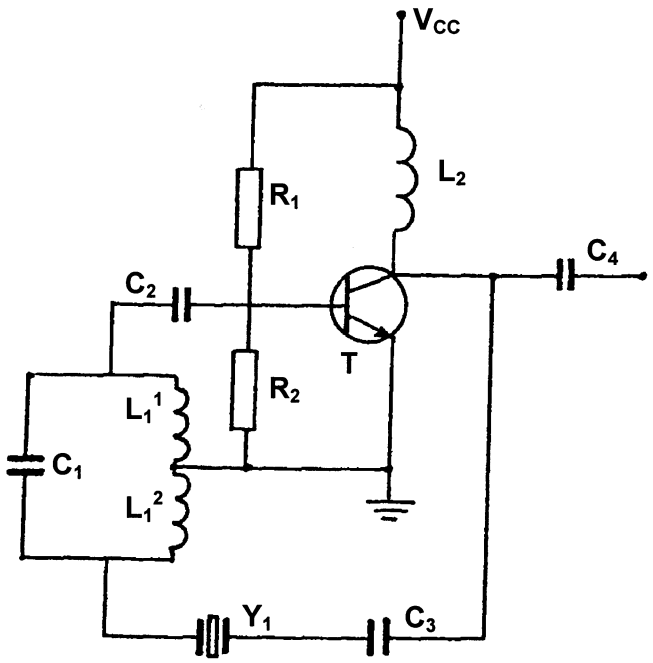
Calculate the power gain in decibels. (3)

6.3 Die funksioneringspotensiaal van 'n transistor kan die beste met behulp van 'n laslyn beskryf word. Bepaal deur middel van berekeninge, asook 'n netjiese benoemde grafiek, die laslyn vir 'n gemeenskaplike emittorgekoppelde versterker deur van die volgende data gebruik te maak:

Toevoerspanning : 20 volt
Lasweerstand : 2k2 ohm (12)
[30]

VRAAG 7
OSSILLATORS

7.1 Maak gebruik van die kringdiagram in **Figuur 7.1** om die volgende vrae te beantwoord.



FIGUUR 7.1

7.1.1 Identifiseer die kringdiagram. (2)

7.1.2 Wat is die doel van R_1 en R_2? (2)

7.1.3 Watter komponente kom in die tenknetwerk voor? (2)

7.1.4 Watter komponent kan die terugvoer verander? (2)

7.1.5 Wat is die doel van Y_1? (2)

6.3 The working potential of a transistor can best be described with a load line. Determine, by means of calculations and a neatly labelled graph, the load line for a common emittor-connected amplifier by using the following data:

Supply voltage : 20 volt
Load resistor : 2k2 ohm (12)

[30]

QUESTION 7
OSCILLATORS

7.1 Use the circuit diagram in **Figure 7.1** to answer the questions that follow.

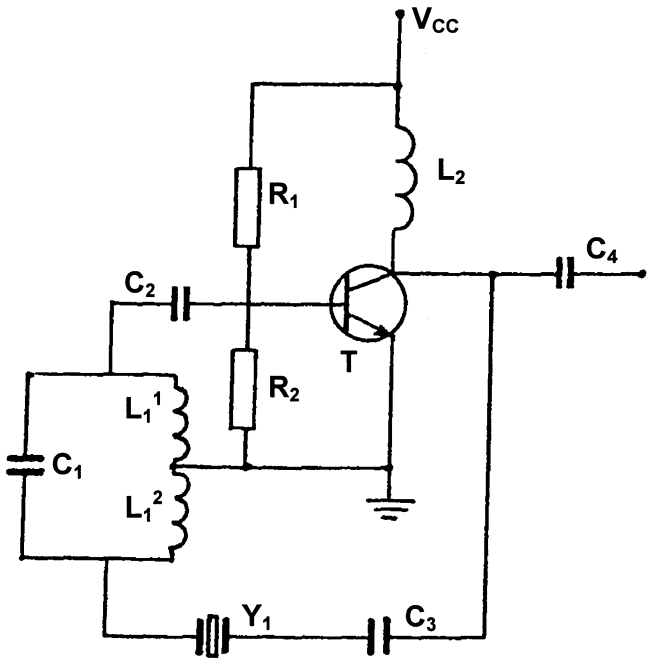


FIGURE 7.1

7.1.1 Identify the circuit diagram. (2)

7.1.2 What is the purpose of R_1 and R_2? (2)

7.1.3 Which components are in the tank network? (2)

7.1.4 Which component can change the feedback? (2)

7.1.5 What is the purpose of Y_1? (2)

7.2 Verklaar die volgende begrippe:

7.2.1 Positiewe terugvoer (2)

7.2.2 Natuurlike frekwensie (2)

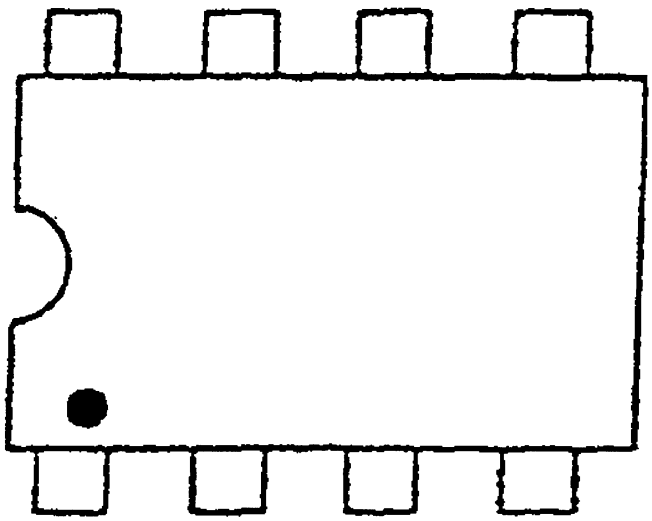
7.2.3 Terugkoppelingsfaktor (2)

7.2.4 Swerfkapasitansie (2)

7.2.5 Piëso-elektriese effek (2)
[20]

VRAAG 8
OPERASIONELE VERSTERKERS

8.1 Bestudeer die onderstaande skets van 'n integreerstroombaan ("IC"). Teken hierdie skets oor in jou antwoordboek en identifiseer die terminale met behulp van nommers. (4)



8.2 Die differensiaalversterker vorm die bousteen van die operasionele versterker. Bespreek hierdie stelling met behulp van 'n kringdiagram en verduidelik kortliks wat met die uitsette (V_1 en V_2) gebeur wanneer 'n klein verandering by die insette plaasvind. (11)
[15]

7.2 Explain the following principles:

7.2.1 Positive feedback (2)

7.2.2 Natural frequency (2)

7.2.3 Back-feed factor (2)

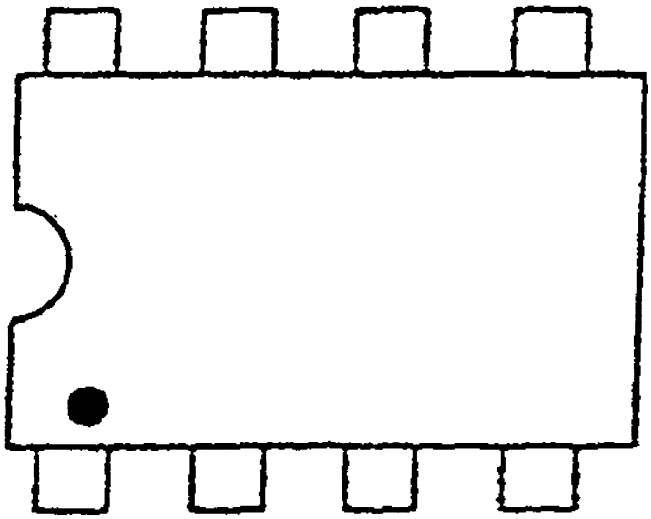
7.2.4 Stray capacitance (2)

7.2.5 Piezo-electrical effect (2)

[20]

QUESTION 8
OPERATIONAL AMPLIFIERS

8.1 Study the sketch of an integrated circuit ("IC") below. Copy this sketch into your answer book and identify the terminals by means of numbers. (4)



8.2 The differential amplifier is the building block of an operational amplifier. Discuss this statement using a circuit diagram and explain briefly what happens to the outputs (V_1 and V_2) when a small change occurs on the inputs. (11)

[15]

VRAAG 9
REKENAARBEGINSELS

9.1 Jy is die elektroniese ingenieur van 'n plaaslike verpakkingsmaatskappy en word versoek om 'n logikakringdiagram vir julle maatskappy se drie vervoerbande te ontwerp. Die stroombaan moet aan die volgende vereistes voldoen:

- Twee van die drie vervoerbande **moet** aaneenlopend werk.
- Al drie bande **mag nie** gelyktydig werk nie.
- **Nie net een** mag **alleen** werk nie.

Wenk:

- Skets die waarheidstabel en lei die Boole-vergelyking daarvan af.
- Vereenvoudig die Boole-vergelyking en teken die logikakring. (13)

9.2 Verduidelik deur middel van 'n netjies benoemde logika kringdiagram die funksionele werksbeginsels van die geklokte RS-"flip-flop" grendel. (6)

9.3 Teken die simbool vir 'n halfopteller. (3)

9.4 Deur gebruik te maak van logikabane en waarheidstabelle, bewys De Morgan se eerste wet wat verklaar dat

$$\overline{A + B} = \overline{A} \cdot \overline{B}$$ (8)

[30]

QUESTION 9
COMPUTER PRINCIPLES

9.1 You are the electronic engineer at a local packaging company and you must design a logic circuit diagram for your company's three conveyor belts. The circuit diagram must meet the following requirements:

- Two of the three conveyor belts **must** run continuously.
- All three belts may **never** work at the same time.
- **Not one** belt may work **alone**.

Hint:

- Sketch a truth table and deduce a Boolean equation from this.
- Simplify the Boolean equation and draw the logic circuit. (13)

9.2 Explain by means of a neatly labelled logic circuit diagram the functioning operating principles of a clocked RS "flip-flop" latch. (6)

9.3 Give the symbol of a half-adder. (3)

9.4 By using logic circuits and truth tables prove the first law of De Morgan which states that

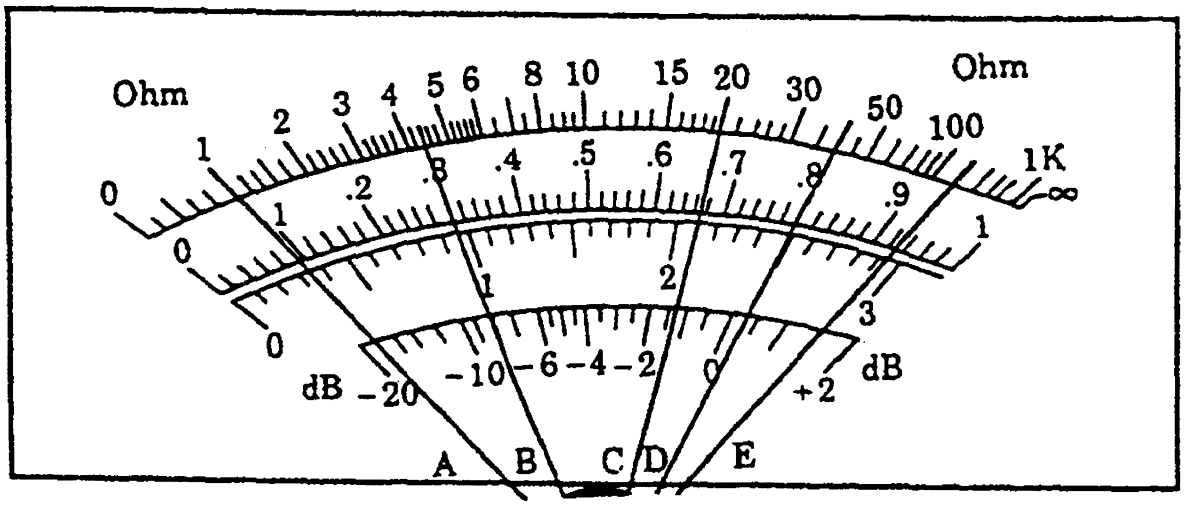
$$\overline{A + B} = \overline{A} \cdot \overline{B}$$ (8)

[30]

VRAAG 10
MEETINSTRUMENTE

10.1 'n Meetinstrument is 'n toestel wat gebruik word om die elektriese waarde van 'n onbekende veranderlike te bepaal. Deur gebruik te maak van die tabel en die diagram van die wyserplaat, skryf die letters (A tot E) in jou antwoordboek en gee die korrekte lesings, met die skakelaarverstellings in gedagte. (10)

Naald se posisie	Reeksverstelling	Funksie
A	1 000 V	GS
B	0,03 V	GS
C	300 V	WS
D	R x 100	Ω
E	100 V	WS



10.2 Teken 'n netjies benoemde blokdiagram van die digitale frekwensiemeter. (5)
[15]

VRAAG 11
BEROEPSVEILIGHEID

11.1 Noem VIER handelinge wat as onveilig in 'n werkswinkel beskou word. (4)

11.2 'n Persoon word aan 'n elektriese skok blootgestel en haal nie meer asem nie. Verduidelik hoe jy kunsmatige asemhaling op hom sou toepas. (4)

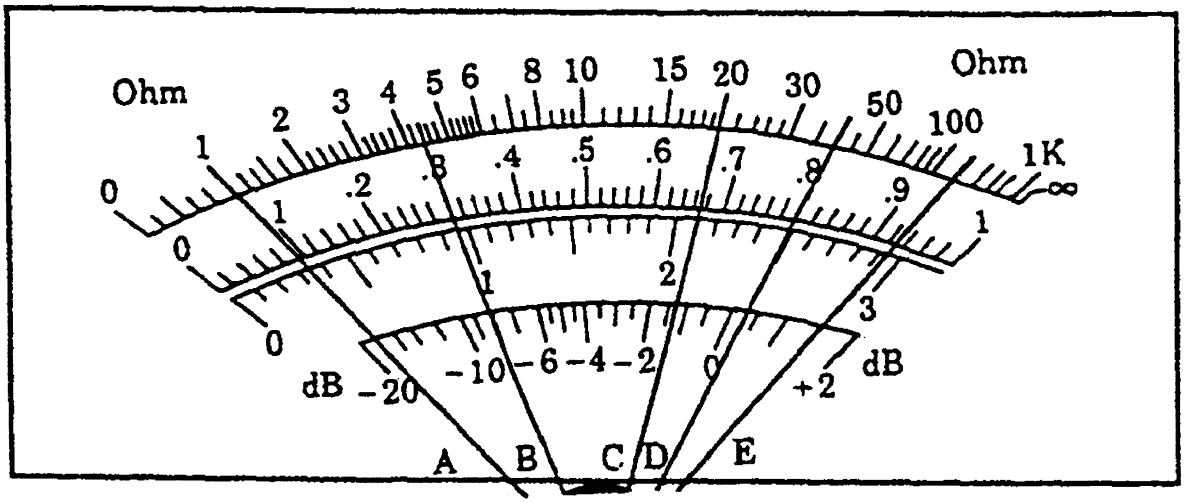
11.3 'n Persoon doen per ongeluk 'n snywond in die werkswinkel op en jy moet die wond behandel. Watter voorsorgmaatreëls sal jy tref teen die moontlike besmetting met die MI-Virus? (2)
[10]

TOTAAL: 300

QUESTION 10
MEASURING INSTRUMENTS

10.1 A measuring instrument is an appliance that is used to determine the electrical value of an unknown variable. By using the table and the diagram of the meter dial, write down the letters (A to E) in your answer book and provide the correct measurements, keeping the switch settings in mind. (10)

Position of needle	Setting	Function
A	1 000 V	DC
B	0,03 V	DC
C	300 V	AC
D	R x 100	Ω
E	100 V	AC



10.2 Sketch a neatly labelled block diagram of the digital frequency meter. (5)

[15]

QUESTION 11
OCCUPATIONAL SAFETY

11.1 Name FOUR actions that can be considered unsafe in a workshop. (4)

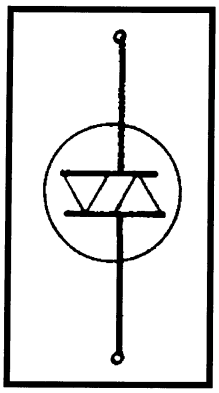
11.2 A person is subjected to an electrical shock and stops breathing. Explain how you would go about resuscitating him. (4)

11.3 A person accidentally cuts himself in the workshop. You have to treat the wound. Which preventative measures would you take to avoid possible HIV infection? (2)

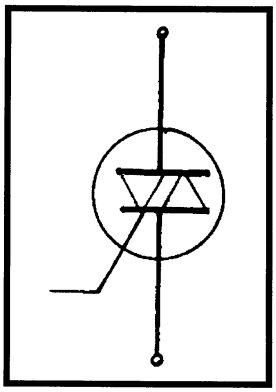
[10]

TOTAL: 300

DIAGRAMSHEET 5.1 / *DIAGRAMVEL 5.1*



A



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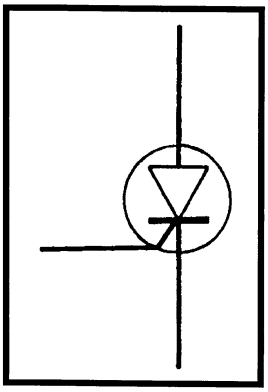

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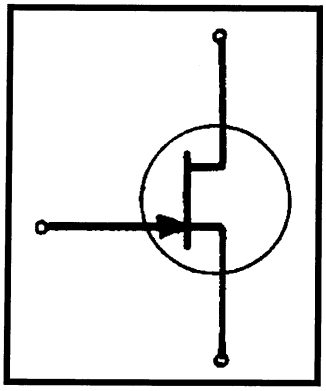

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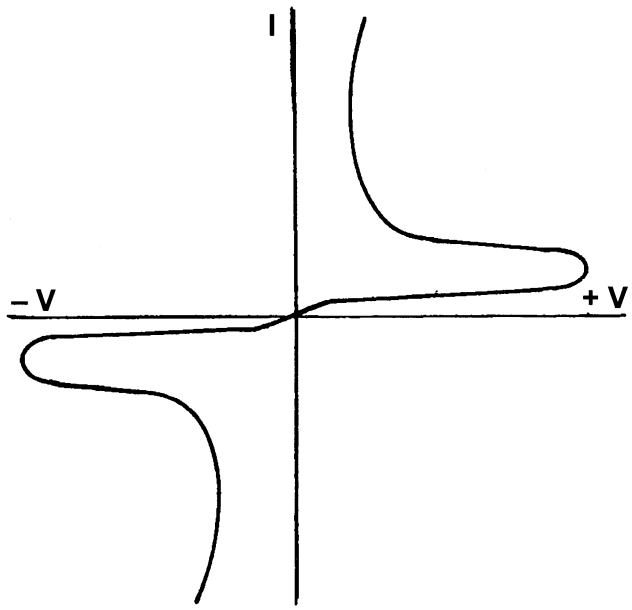
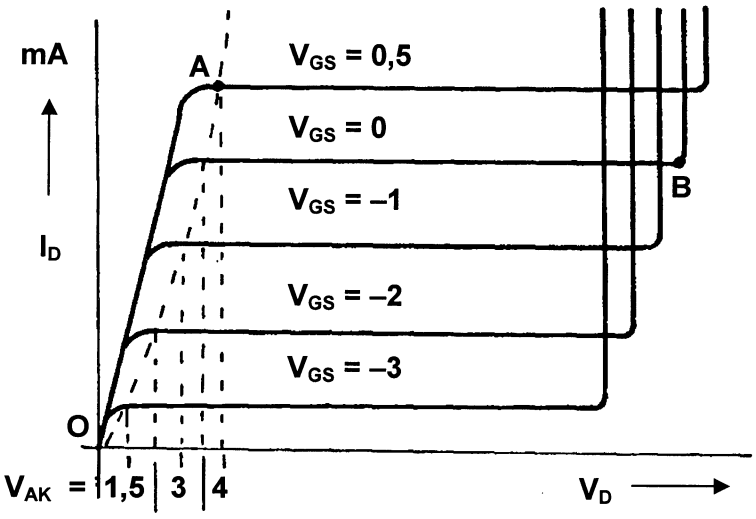


E



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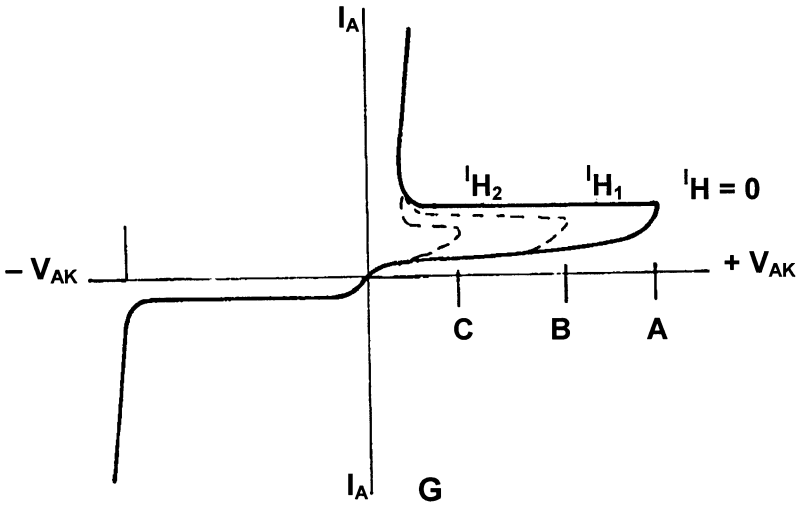
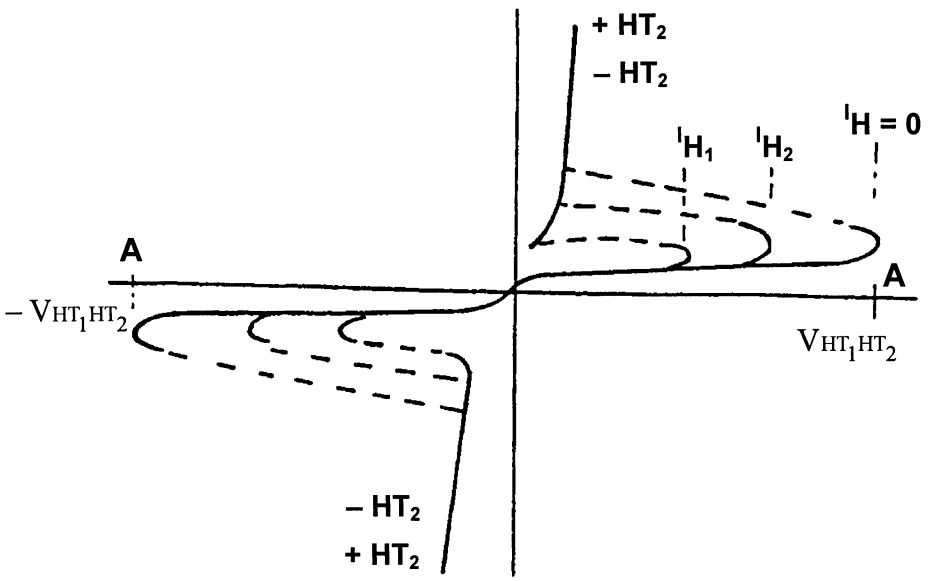
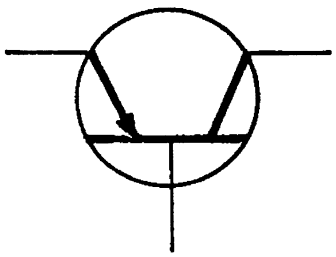

I_A
I_{H_2}
I_{H_1}
$I_H = 0$
$-V_{AK}$
$+V_{AK}$
C
B
A
I_A

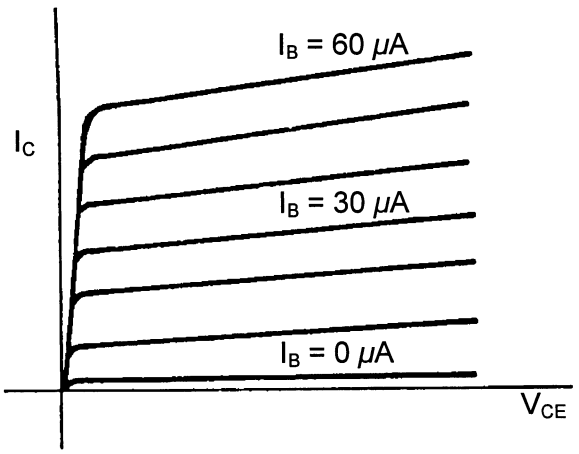
G


$+HT_2$
$-HT_2$
$I_H = 0$
I_{H_1}
I_{H_2}
A
A
$-V_{HT_1HT_2}$
$V_{HT_1HT_2}$
$-HT_2$
$+HT_2$

H



I


$I_B = 60\ \mu A$
I_C
$I_B = 30\ \mu A$
$I_B = 0\ \mu A$
V_{CE}

J

FORMULAE / *FORMULES*

$X_L = 2\pi LF$

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

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

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

$I_C = V.\sqrt{\frac{C}{L}}$

$f = \frac{W}{2\pi}$

$t = R.C$

Star / *Ster*

$V_L = V_P.\sqrt{3}$

$I_L = I_P$

$Ir = I \sin\theta$

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

$\cos\theta = \frac{P}{P_{\text{apparent / skynbaar}}}$

$\text{Efficiency / } \textit{Rendement} = \frac{\text{Output/ } \textit{Uitset}}{\text{Input/ } \textit{Inset}}$

$N_S = \frac{f}{P}$

$\frac{N_P}{N_S} = \sqrt{\frac{Z_P}{Z_S}}$

$\beta = \frac{I_C}{I_B}$

$V_R = IR$

$V_L = LX_L$

$V_C = I.X_C$

$Q = \frac{X_L}{R}$

$\cos\theta = \frac{R}{Z}$

$f = \frac{1}{T}$

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

$Z = \frac{L}{C.R}$

Delta

$I_L = I_P.\sqrt{3}$

$V_L = V_P$

$Ia = I \cos\theta$

$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$

$N_r = N_S - S$

$S = \frac{N_S - N_r}{N_S}$

$I_E = I_B + I_C$

$I_C = \frac{V_{CC}}{R_L}$

$N = 10 \text{ Log} \frac{P_2}{P_1}$

END / *EINDE*