SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

FEBRUARY / FEBRUARIE
MARCH / MAART

2005

TECHNIKA (ELECTRONICS)

TECHNIKA (ELEKTRONIES)

HG 714-1/0

TECHNIKA ELECTRONICS HG

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13 pages
13 bladsye

X05

GAUTENGSE DEPARTEMENT VAN ONDERWYS
SENIORSERTIFIKAAT-EKSAMEN

TECHNIKA (ELEKTRONIES) HG

TYD: 3 uur

PUNTE: 300

INSTRUKSIES:

- Beantwoord AL die vrae.
- Sketse en diagramme moet groot, netjies en van byskrifte voorsien wees.
- Alle berekeninge moet getoon word.
- Antwoorde moet duidelik genommer wees, in ooreenstemming met die nommers wat in die vraestel gebruik is.
- 'n Formuleblad (bladsy 11 – 13) is aangeheg aan die einde van die vraestel.

VRAAG 1
ELEKTRIESE STROOMTEORIE

1.1 'n Serie stroomkring bestaan uit 'n spoel met 'n induktansie van 100 mH, 'n kapasitor met 'n kapasitansie van 100 µF en 'n weerstand met 'n waarde van 10 Ω. Die kring word vanaf 'n 250 Volt / 50 Hz-toevoer voorsien.

Bereken

1.1.1 die induktiewe reaktansie. (3)

1.1.2 die kapasitiewe reaktansie. (3)

1.1.3 die impedansie. (3)

1.1.4 die fasehoek. Teken 'n netjies benoemde impedansiediagram. (12)

1.2 'n Serie resonante stroomkring van 'n radio bestaan uit 'n spoel met 'n induktansie van 400 µH, 'n kapasitor met 'n kapasitansie van 305,7 pF en 'n 10 Ω weerstand. Die insetsein is 0,2 V.

Bereken

1.2.1 die resonante fekwensie. (3)

1.2.2 die Q-Faktor. (3)

1.2.3 die stroomwaarde tydens resonansie. (4)

GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRONICS) HG

TIME: 3 hours

MARKS: 300

INSTRUCTIONS:

- Answer ALL the questions.
- Sketches and diagrams must be large, neat and labelled.
- All calculations must be shown.
- Answers must be clearly numbered in accordance with the numbering used on the question paper.
- A formula sheet (pages 11 – 13) is provided at the end of the paper.

QUESTION 1
ELECTRIC CURRENT THEORY

1.1 A series circuit consists of a coil with an inductance of 100 mH, a capacitor with a capacitance of 100 µF and a resistor with a resistance of 10 Ω. The circuit is supplied from a 250 Volt / 50 Hz supply.

Calculate

1.1.1 the inductive reactance. (3)

1.1.2 the capacitive reactance. (3)

1.1.3 the impedance. (3)

1.1.4 the phase angle. Sketch a neatly labelled impedance diagram. (12)

1.2 A series resonant circuit of a radio consists of a 400 µH coil, a 305,7 pF capacitor and a 10 Ω resistor. The input signal is 0,2 V.

Calculate the

1.2.1 resonant frequency. (3)

1.2.2 Q-Factor. (3)

1.2.3 current value at resonance. (4)

1.3 Bereken die draaiverhouding van 'n impedansie-aanpassingstransformator om te voldoen aan die vereistes van 'n luidspreker met 'n 8 Ω-spraakspoel. Die transistor benodig 'n 500 Ω-las vir maksimum drywingsverplasing. (4)

[35]

VRAAG 2
HALFGELEIER-TOESTELLE

2.1 Identifiseer die volgende elektroniese komponente met verwysing na die kragbronkring in **Figuur 2.1**.
Byvoorbeeld: R6 is 'n 10 kΩ-weerstand.

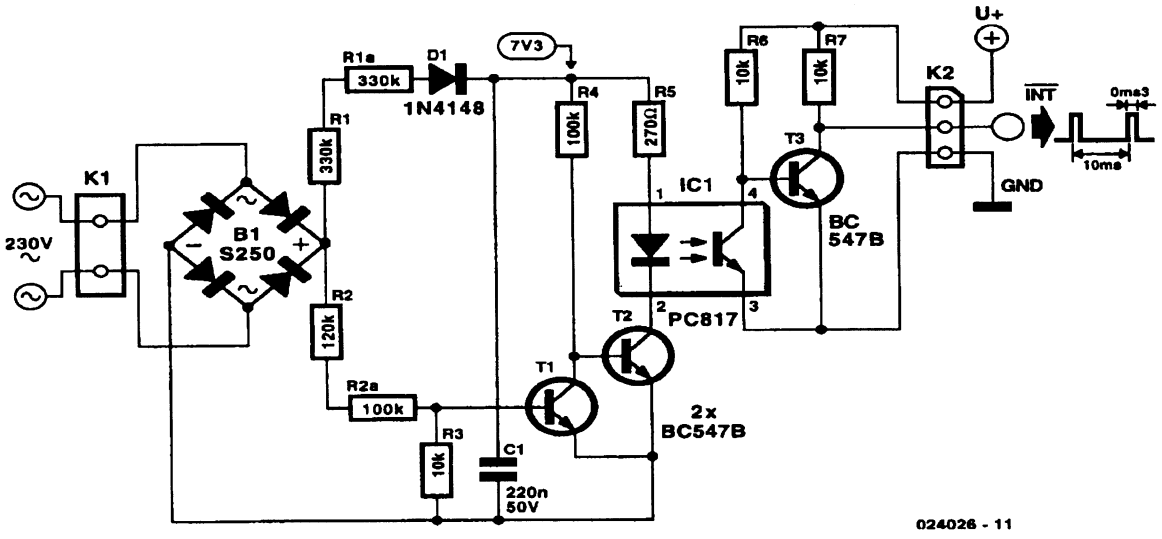
2.1.1 D1 (1)

2.1.2 T1 en T2 gekombineerd (2)

2.1.3 B1 (3)

2.1.4 IC1 (3)

2.1.5 C1 (3)



Figuur 2.1: Kragbron Kringdiagram

2.2 Die veldeffektransistor ("FET") is vanaf 1952 as 'n halfgeleierkomponent gebruik. Verduidelik met behulp van netjies benoemde sketse en kort beskrywings die basiese **samestelling** asook die **funksionele werking** van 'n veldeffektransistor ("FET"). (12)

2.3 Noem VIER voorsorgmaatreëls wat in ag geneem moet word wanneer CMOS-toestelle gesoldeer word. (4)

2.4 Watter groot nadeel van die Diode Brug word oorkom deur in kragbronne van filterkapasitors gebruik te maak? (2)

[30]

1.3 Calculate the turns required for an impedance matching transformer to satisfy the requirements of a loudspeaker with an 8 Ω voice coil. The transistor needs a 500 Ω load for maximum power transfer. (4)

[35]

QUESTION 2
SEMICONDUCTOR DEVICES

2.1 Identify the following electronic components with reference to the power supply circuit in **Figure 2.1**. For example: R6 is a 10 kΩ resistor.

2.1.1 D1 (1)

2.1.2 T1 and T2 combined (2)

2.1.3 B1 (3)

2.1.4 IC1 (3)

2.1.5 C1 (3)

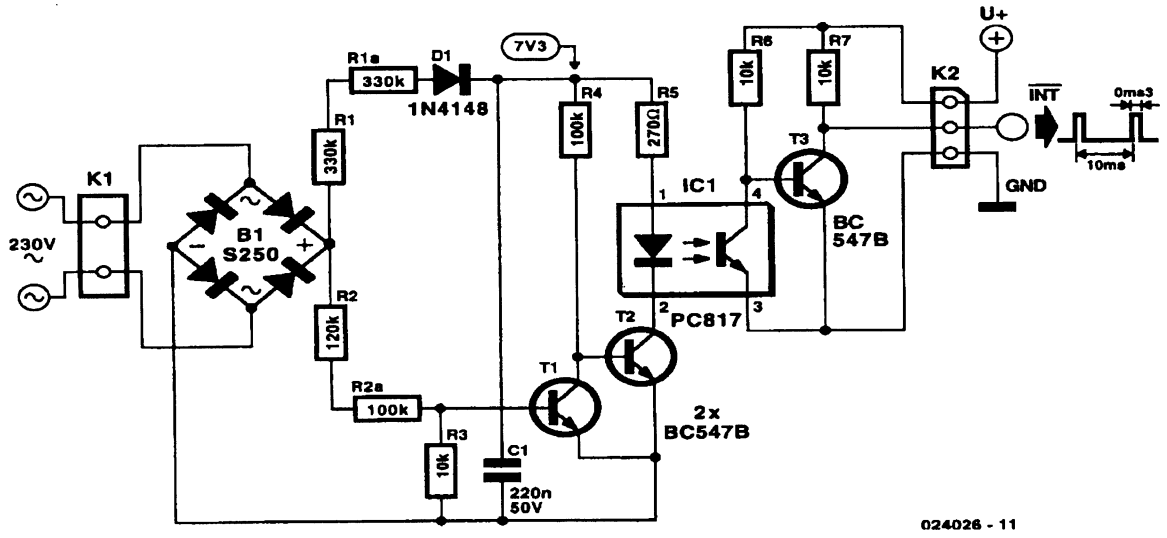


Figure 2.1: Power Supply Circuit

2.2 The field effect transistor (FET) has been used since 1952 as a semi-conductor device. Explain by means of neatly labelled sketches and brief descriptions the basic **construction** and **functional** operation of a field effect transistor (FET). (12)

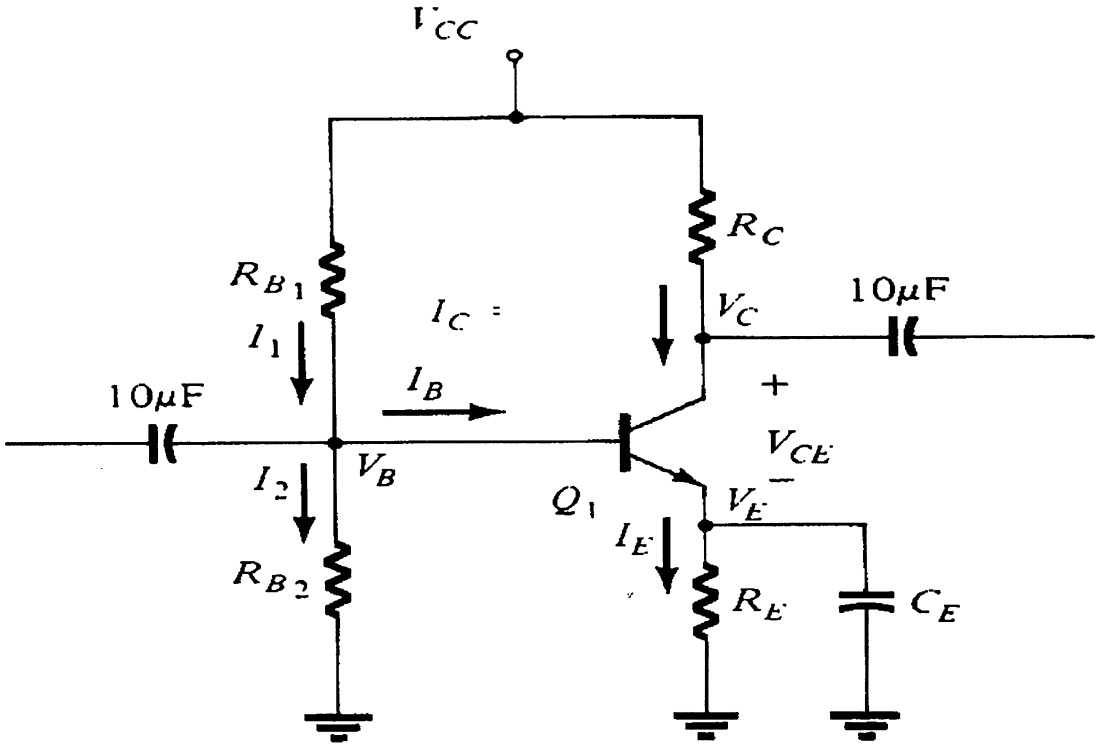
2.3 Name FOUR precautions that must be taken into account when soldering CMOS devices. (4)

2.4 What major disadvantage of the Diode Bridge is overcome with the use of the filter capacitor in power supply units? (2)

[30]

VRAAG 3
VERSTERKERS

3.1 Bereken die weerstandwaardes van Re, Rc en Rb vir 'n transistor-versterkerkring soos aangedui in **Figuur 3.1**. Die spesifikasies van die vervaardiger dui aan dat die stroomwins van die transistor 150 is, teen 'n kollektorstroom van 1 mA. Die toevoerspanning is 16 Volt en Vce = 6 Volt. (23)



Figuur 3.1: Gemeenskaplike Emitterkring

3.2 'n 741 operasionele versterker is in die omkeermodus gekoppel. Dit versterk 'n sein van 5 mV na 1 Volt. Die insetimpedansie is 1 MΩ.

3.2.1 Teken 'n netjies benoemde kringdiagram. (10)

3.2.2 Bepaal die waarde van die terugvoerweerstand deur middel van berekeninge. (7)

[40]

QUESTION 3
AMPLIFIERS

3.1 Calculate the resistor values Re, Rc and Rb for a transistor amplifier circuit as shown in **Figure 3.1**. The manufacturer's specifications state that the transistor has a current gain of 150, at a collector current of 1 mA. The supply voltage is 16 Volt and Vce = 6 Volt. (23)

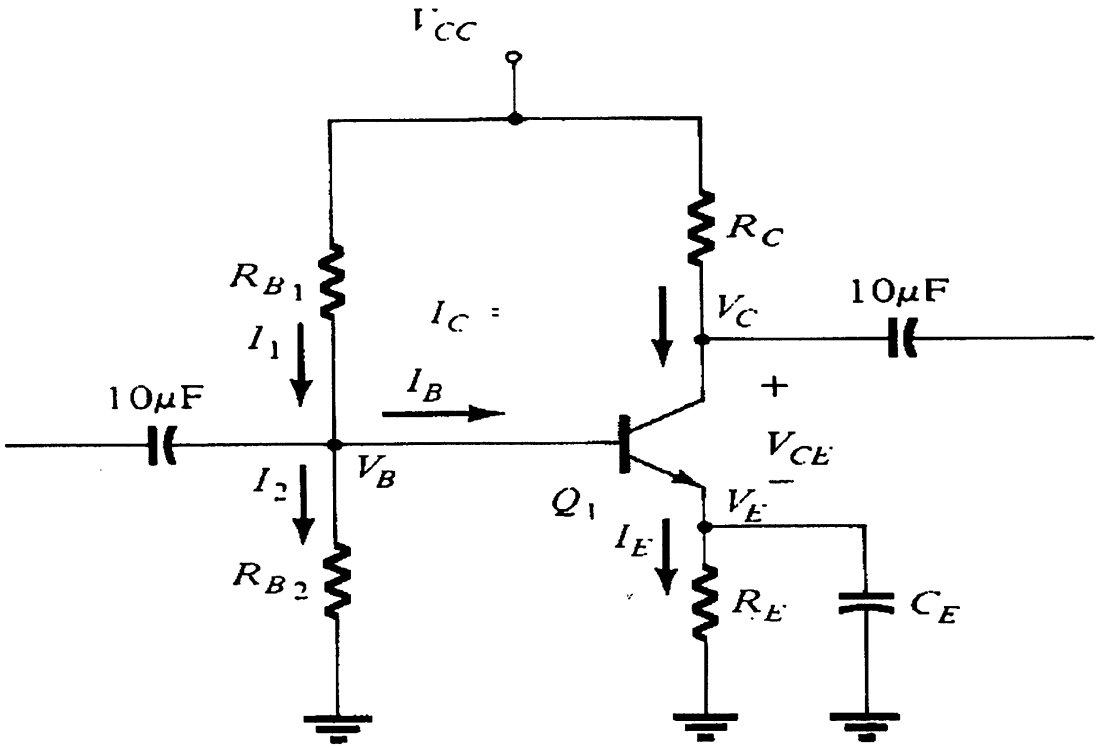


Figure 3.1: Common emitter circuit

3.2 A 741 operational amplifier is connected in the inverting mode. It amplifies a signal of 5 mV to 1 Volt. The input impedance is 1 MΩ.

3.2.1 Draw a neatly labelled diagram of the circuit. (10)

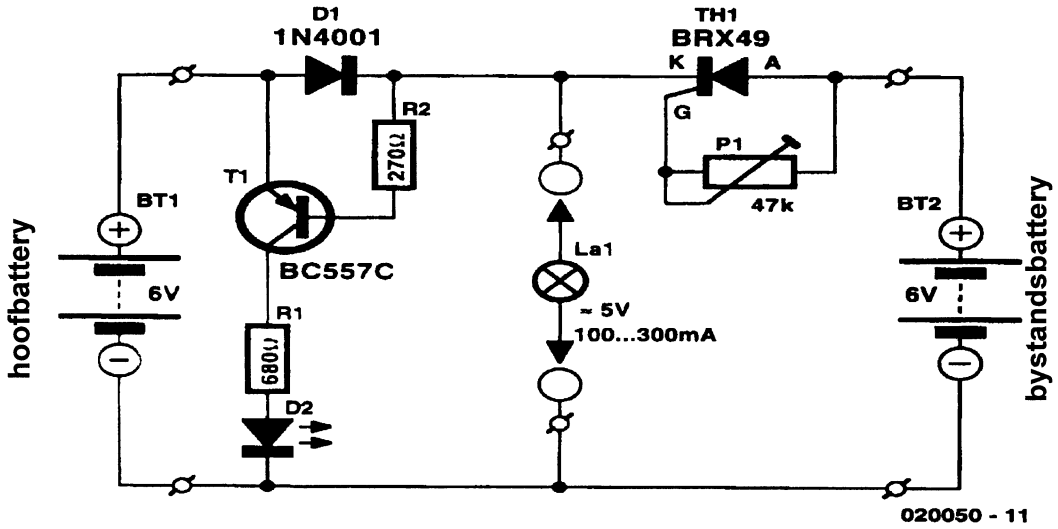
3.2.2 Determine the value of the feedback resistor by means of calculations. (7)

[40]

VRAAG 4
SKAKEL- EN BEHEERKRINGE

4.1 Teken 'n netjies benoemde kringdiagram van 'n A-stabiele Multivibrator. Jy het die keuse om van diskrete komponente of operasionele versterkers gebruik te maak. Dui alle relevante inset- en uitsetgolfvorms aan. (10)

4.2 Die elektroniese stroomkring in **Figuur 4.1** is ontwerp deur gebruik te maak van 6 Volt herlaaibare batterye, en is van outomatiese oorskakeling na 'n sekondêre (bystand) battery voorsien indien die primêre battery ontlaai het. Verduidelik die werkbeginsel van hierdie stroomkring. (Neem asseblief kennis dat die oorskakeling spanningsafhanklik en verstelbaar is). (12)



Figuur 4.1: Outomatiese Batteryoorskakel-stroomkring

QUESTION 4
SWITCHING AND CONTROL CIRCUITS

4.1 Draw a neatly labelled circuit diagram of an A-stable Multivibrator. You may use discrete components or operational amplifiers. Show the relevant input and output waveforms. (10)

4.2 The electronic circuit in **Figure 4.1** is designed for use with 6 Volt rechargeable batteries, and provides automatic switchover to a reserve battery when the main battery approaches the fully discharged level. Explain the working principle of this circuit (please note that the actual switchover is voltage-dependent and adjustable). (12)

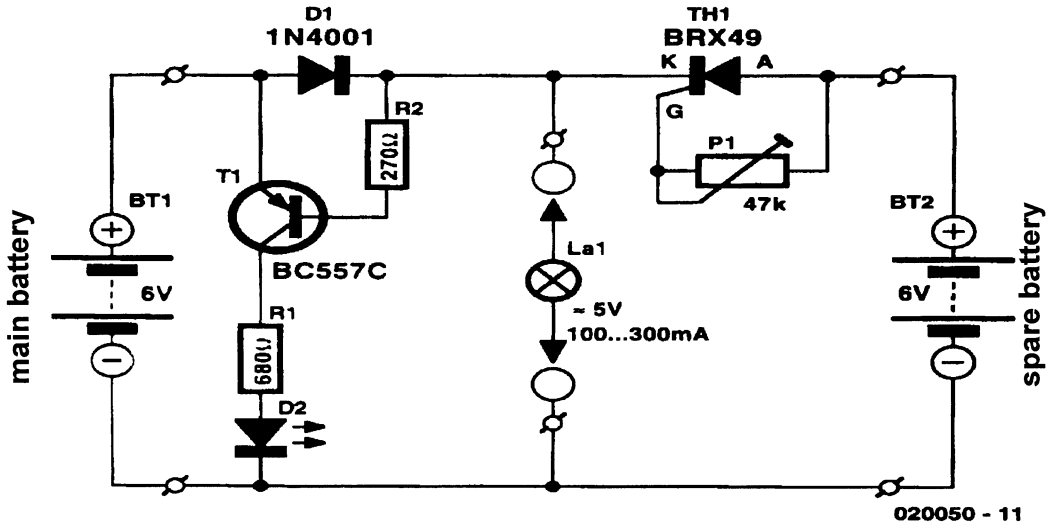
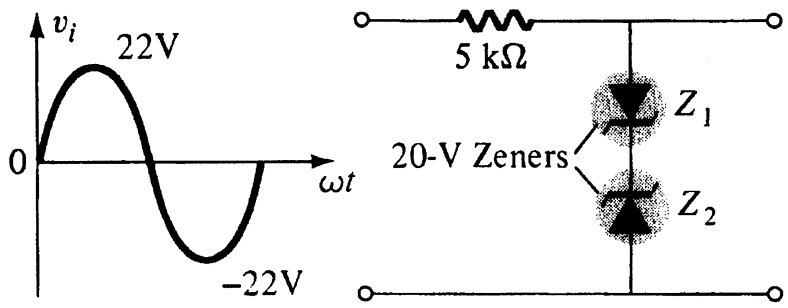


Figure 4.1: Automatic Battery Switchover Circuit

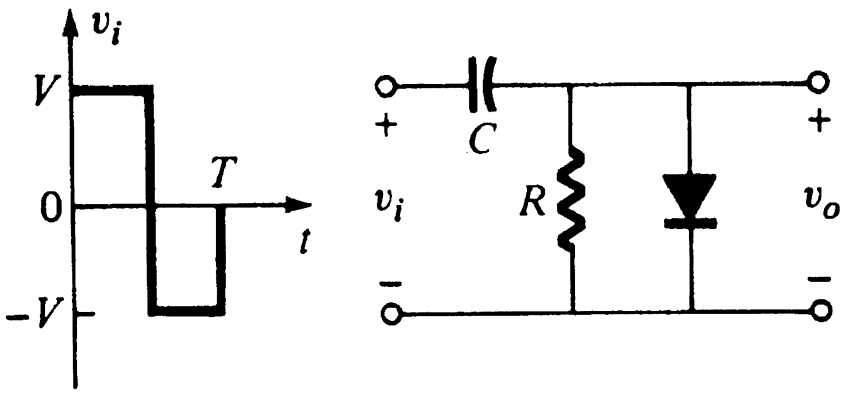
4.3 Vasklem- en afkapstroombane is diodegolfvormingskringe wat sekere gedeeltes van golwe deurlaat en ander dele weer tot 'n vooraf bepaalde waarde beperk om byvoorbeeld die gehalte van die beeld op die televisieontvangs te verseker. Bepaal die uitsetgolfvorms van die afkap- en vasklemkringe met verwysing na **Figuur 4.2**. (Skets slegs die uitsetgolfvorms in jou antwoordboek.)

4.3.1



(3)

4.3.2



(3)

Figuur 4.2: Golfvormingskringe

4.4 Verduidelik die werksbeginsel van **ENIGE** elektroniese eksperiment **OF** model wat jy hierdie jaar gebou/ontwerp het. Neem kennis dat jou verduideliking 'n netjies benoemde kringdiagram of blokdiagram met 'n kort verduideliking moet insluit. Alle relevante golfvorms moet getoon word. Neem verder kennis dat die beskrywing verband moet hou met jou kringdiagram. Jy mag nie enige kringbane en vrae wat in hierdie vraestel voorkom, herhaal nie. (15)

[43]

VRAAG 5
OSSILLATORS

5.1 Teken 'n netjies benoemde kringdiagram van 'n kristalbeheerde Collpits-Ossillator. (10)

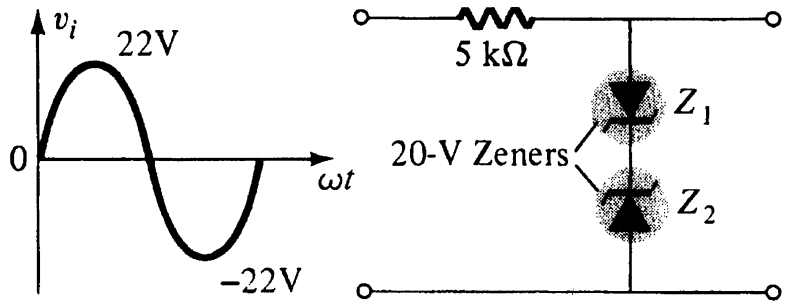
5.2 Verduidelik die **piësoelektriese effek** met verwysing na die kwartskristal. (4)

5.3 Teken 'n netjies benoemde grafiek om die effek wat resonante frekwensie op die impedansie van 'n kristal het, te illustreer. (4)

[18]

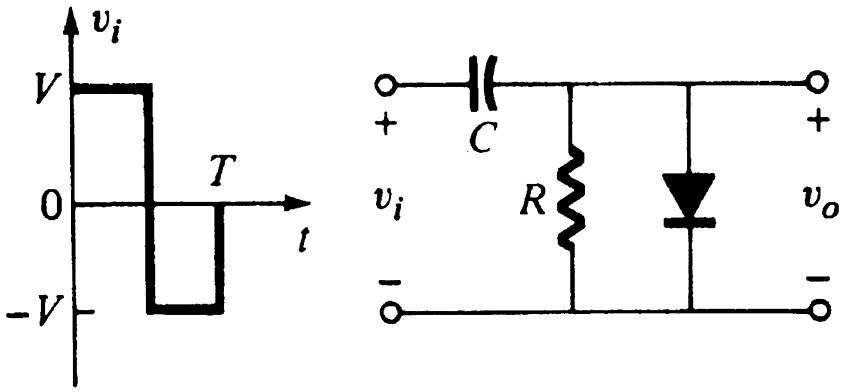
4.3 Clippers and clampers are diode waveshaping circuits transmitting parts of waveforms and suppressing others to a predetermined value to ensure for example satisfactory pictures in television receivers. Find the output voltage wave shape for the inputs shown in **Figure 4.2**. (Only sketch the output voltage wave shape in your answer book.)

4.3.1



(3)

4.3.2



(3)

Figure 4.2: Waveshaping circuits

4.4 Explain the working principle of **ANY** electronic experiment **OR** model that you have built/designed this year. Take note that your explanation should include a neatly-labelled circuit diagram or block diagram with a brief description. All wave forms should be included where applicable. Please note that the description should directly link to your circuit diagram. You are not allowed to replicate a question already covered in this question paper. (15)

[43]

QUESTION 5
OSCILLATORS

5.1 Draw a neatly labelled circuit diagram of the crystal controlled Collpits-Oscillator. (10)

5.2 Explain the **piezoelectric effect** with reference to the quartz crystal. (4)

5.3 Draw a neatly labelled graph to illustrate the effect resonant frequency has on the impedance of a crystal. (4)

[18]

VRAAG 6
REKENAARBEGINSELS

6.1 Ontwerp 'n NEN-heknetwerk vir die volgende Boole-vergelyking (A, B en C is direkte insette):

$F = A.B.C + A.B + A.C$ (6)

6.2 Bewys deur van Boole-algebra gebruik te maak dat:

$\overline{A}.B + A.\overline{B} = (A + B)\,\overline{A.B}$ (7)

6.3 ABC Bank versoek jou om 'n stroomkring te ontwerp wat 'n alarm by die plaaslike Suid-Afrikaanse Polisiediens sal aktiveer indien die volgende voorskrifte nie nagekom word wanneer die bankkluis oopgemaak word nie. Die bankkluis mag slegs gedurende normale werksure oopgemaak word, en slegs in die teenwoordigheid van enige van die volgende twee persone:

- Die Bankbestuurder
- Die Senior Rekenmeester
- Die Hoofsekuriteitsbeampte

6.3.1 Teken 'n waarheidstabel vir hierdie situasie. (8)

6.3.2 Verteenwoordig die vergelyking van die alarmfunksie (F) in terme van A, B, C en D. (4)

6.3.3 Vereenvoudig die vergelyking en ontwerp 'n logikakring om die versoek te bevredig. (10)

6.4 Bereken die som van die volgende twee desimale getalle in binêr:

20,375

\+ 10

(4)

6.5 Illustreer deur middel van 'n netjies benoemde blokdiagram die werkbeginsel van 'n voloptellerkring deur die volgende binêre getalle bymekaar te tel:

1010

\+ 1010

(16)

6.6 Verduidelik die doel van die EPROM- geheue met verwysing na rekenaars. (4)

[59]

QUESTION 6
COMPUTER PRINCIPLES

6.1 Design a NAND gate network for the following Boolean expression (A, B and C are direct gate inputs.):

$F = A.B.C + A.B + A.C$ (6)

6.2 Prove by means of Boolean-algebra that:

$\overline{A}.B + A.\overline{B} = (A + B)\,\overline{A.B}$ (7)

6.3 ABC Bank requests that you design a circuit that will sound an alarm at the local South African Police Services if the following conditions are not met when opening the Bank's safe. The safe may only open during normal working hours when any two of the following persons are present:

- The Bank Manager
- The Senior Accountant
- The Chief Security Officer

6.3.1 Draw up a truth table for this situation. (8)

6.3.2 Represent the alarm function (F) in terms of A, B, C and D. (4)

6.3.3 Simplify the function and design a practical logic circuit for this request. (10)

6.4 Add the following two numbers in binary:

20,375

\+ 10

(4)

6.5 Illustrate by means of a neatly labelled block diagram of a full adder circuit, how the following binary numbers will be added:

1010

\+ 1010

(16)

6.6 Explain the purpose of the EPROM memory with reference to computers. (4)

[59]

VRAAG 7
INFORMASIE-OORDRAG

7.1 Frekwensies word volgens frekwensiebande geklasifiseer, wat elk hul onderskeie gebruike bevat. Verwys na **Tabel 7.1** en voltooi die tabel. Skryf die nommers onder mekaar in jou antwoordboek neer en daarnaas die antwoord. (6)

BAND	TERM	GEBRUIKE
7.1.1	Lae Frekwensie (LF)	Langafstand-kommunikasie
300 kHz – MHz	7.1.2	Mediumgolf-kommunikasie
3 MHz – 30 MHz	Hoë Frekwensie (HF)	7.1.3
30 MHz – 300 MHz	Baie Hoë Frekwensie ("VHF")	7.1.4
7.1.5	Ultra Hoë Frekwensie (UHF)	TV-kanale, Mnet, E-TV
Meer as 3 GHz	7.1.6	Radar, Satellietkommunikasie, Optiese Vesel

Tabel 7.1

7.2 Noem VIER voordele van optiesevesel-stelsels. (4)

7.3 Verduidelik, deur gebruik te maak van 'n netjiese benoemde blokdiagram, die basiese werkbeginsel van 'n tipiese optiesevesel-kommunikasiestelsel. (6)

7.4 Noem DRIE hoofoorsake van seinverlies in optiesevesel-kabels. (8)

7.5 Verduidelik deur gebruik te maak van 'n netjiese benoemde blokdiagram die basiese werkbeginsel van 'n FM-ontvanger. Alle golfvorms moet getoon word. (13)
[37]

QUESTION 7
INFORMATION TRANSFER

7.1 Frequencies fall into frequency bands, each with different uses. Refer to **Table 7.1** and complete the table. Write the question numbers below each other in your answer book and next to it, only the answer. (6)

BAND	TERM	USES
7.1.1	Low Frequency (LF)	Long distance communication
300 kHz – MHz	7.1.2	Medium-wave broadcasting
3 MHz – 30 MHz	High Frequency (HF)	7.1.3
30 MHz – 300 MHz	Very High Frequency (VHF)	7.1.4
7.1.5	Ultra High Frequency (UHF)	TV bands, Mnet, E-TV
Above 3 GHz	7.1.6	Radar, Satellite communication, Fibre-optic

Table 7.1

7.2 Name FOUR advantages of optic fibre systems. (4)

7.3 Explain by means of a neatly labelled block diagram the basic working principle of a typical fibre-optic communication link. (6)

7.4 Name THREE major causes of signal losses in fibre-optic cables. (8)

7.5 Explain by means of a neatly labelled block diagram the working principle of an FM receiver. All waveforms have to be indicated. (13)
[37]

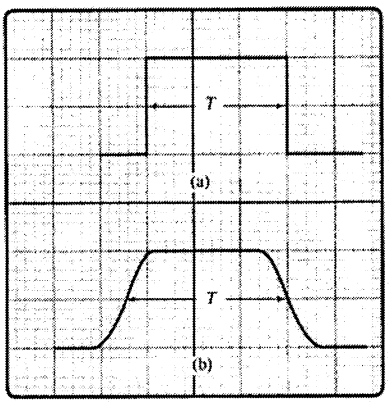
VRAAG 8
MEETINSTRUMENTE

8.1 Verduidelik die werkbeginsel van 'n digitale multimeter met behulp van 'n netjies benoemde blokdiagram. (10)

8.2 Bestudeer **Figuur 8.1** wat twee pulse vertoon op die skerm van 'n ossilloskoop vertoon. (KSO). Bepaal die volgende:

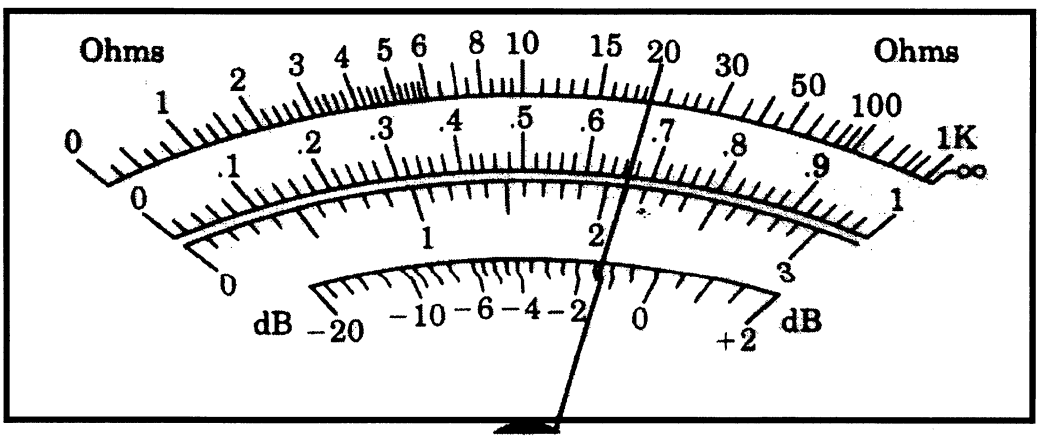
8.2.1 Die duur van puls A indien die Tyd/Divisie-skakelaarverstelling van die ossilloskoop op 10msek/Div gestel is. (3)

8.2.2 Die maksimum waarde van puls B indien die Spanning/Divisie-verstelling op 5 mV/Div gestel is. (3)



Figuur 8.1: Elektroniese puls

8.3 Bestudeer **Figuur 8.2** en bepaal die lesing van die multimeter indien die skakelaarverstelling op X 1K gestel is. (2)



Figuur 8.2 Multimeterlesing **[18]**

QUESTION 8
MEASURING INSTRUMENTS

8.1 Explain the working principle of a digital multimeter by means of a neat, labelled block diagram. (10)

8.2 Examine **Figure 8.1** showing two pulses on the screen of an oscilloscope (CRO). Determine the following:

8.2.1 The duration of pulse A if the Time/division setting of the oscilloscope is set to 10 ms/Div. (3)

8.2.2 The maximum value of pulse B if the CRO (the Voltage/division setting of the oscilloscope) is set to 5 mV/Div. (3)

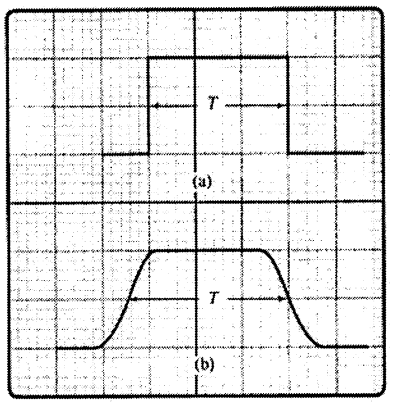


Figure 8.1: Electronic pulse

8.3 Determine with reference to **Figure 8.2** the reading of the multimeter if the range switch is on X IK. (2)

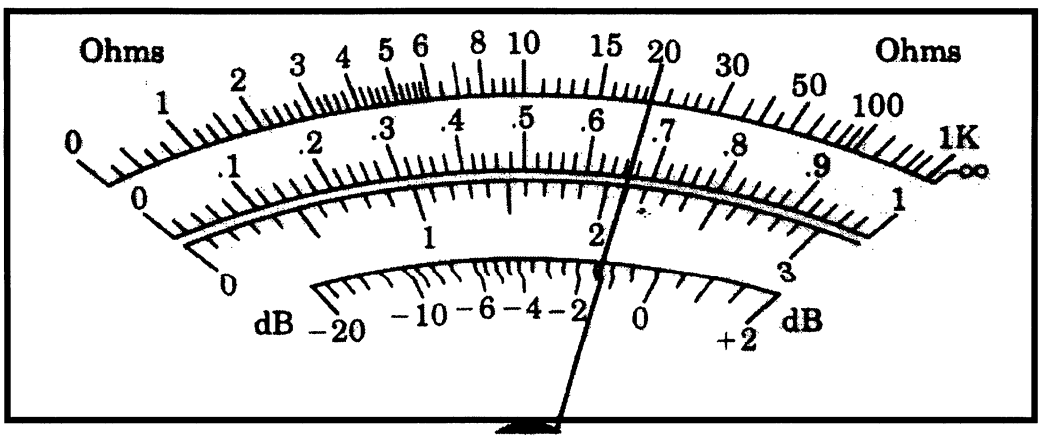


Figure 8.2 Multimeter reading. **[18]**

VRAAG 9
VEILIGHEID

9.1 Noem VYF voorsorgmaatreëls wat toegepas moet word wanneer daar met 'n multimeter gewerk word. (5)

9.2 Verduidelik hoe jy 'n elektriese vuur sal blus. (2)

9.3 Beantwoord die volgende vrae. Skryf slegs WAAR of ONWAAR in jou antwoordboek teenoor die toepaslike vraagnommer.

'n Persoon kan VIGS kry deur

9.3.1 'n persoon te soen wat MIV-positief is. (1)

9.3.2 saam met 'n persoon te werk wat MIV-positief is. (1)

9.3.3 bloed te skenk. (1)

9.3.4 'n bloedoortapping. (1)

9.3.5 dieselfde toiletgeriewe te deel met 'n persoon wat MIV-positief is. (1)

9.3.6 seks te hê met 'n persoon wat MIV-positief is. (1)

9.3.7 dieselfde eetgerei te gebruik as 'n persoon wat MIV-positief is. (1)

9.4 Skryf die VIGS-kontaknommer in jou antwoordboek neer. (1)

9.5 Noem VYF onveilige toestande in 'n werkwinkel. (5)
[20]

TOTAAL: 300

QUESTION 9
SAFETY PRECAUTIONS

9.1 Name FIVE precautions that should be taken into account when handling a multimeter. (5)

9.2 Explain how you would extinguish an electrical fire. (2)

9.3 Answer the following questions. Only write TRUE or FALSE next to the appropriate question in your answer book.

A person can get AIDS from

9.3.1 kissing a person infected with HIV. (1)

9.3.2 working with a person infected with HIV. (1)

9.3.3 donating blood. (1)

9.3.4 a blood transfusion. (1)

9.3.5 sharing the same toilet facilities with a person infected with HIV. (1)

9.3.6 having sex with a person infected with HIV. (1)

9.3.7 using the same cutlery as a person infected with HIV. (1)

9.4 Write down the AIDS hotline number in your answer book. (1)

9.5 Name FIVE unsafe conditions in a workshop. (5)
[20]

TOTAL: 300

INFORMATION SHEET / *INLIGTINGSBLAD*

ELECTRIC CURRENT THEORY / *ELEKTRIESE STROOMTEORIE*

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

$$P = V \times 1 \text{ WATT}$$

$$t = \frac{1}{F} \text{ seconds / } \textit{sekondes}$$

$$V_{ave./\,gem.} = V_m \times 0{,}637$$

$$V_{mms./\,wgk.} = V_m \times 0{,}707$$

STAR / *STER*

$$V_L = \sqrt{3} \times V_P$$

$$I_L = I_P$$

DELTA

$$I_L = \sqrt{3} \times I_P$$

$$V_L = V_P$$

$$X_C = \frac{1}{2 \times \pi \times f \times C}$$

$$f_r = \frac{1}{2 \times \pi \times \sqrt{LC}}$$

$$X_L = 2 \times \pi \times f \times L$$

$$f_r = \frac{1}{2 \times \pi} \times \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$V_T = \sqrt{V_R^{\,2} + V_C^{\,2}}$$

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

$$V_T = \sqrt{V_R^{\,2} + V_L^{\,2}}$$

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

$$V_T = \sqrt{V_R^{\,2} + V_X^{\,2}}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$V_X = V_L - V_C$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

$V_C = I_T \times X_C$

$V_L = I_T \times X_L$

$V_R = I_T \times R$

$V_T = \sqrt{V_R^2 + V_X^2}$

$V_X = V_C - V_L$

$I_T = \sqrt{I_R^2 + I_X^2}$

$I_X = I_C - I_L$

$\frac{N_1}{N_2} = \sqrt{\frac{Z_1}{Z_2}}$

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

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

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

$X_X = X_L - X_C$

AMPLIFIERS / *VERSTERKERS*

$I_e = I_c + I_b$

$V_{cc} = V_{Rc} + V_{ce}$

$I_c = \frac{V_{cc}}{Rc}$

DECIBEL RATIOS / *DESIBELVERHOUDINGS*

$$G_I = 20 \text{ LOG } \frac{I_2}{I_1}$$

$$G_V = 20 \text{ LOG } \frac{V_2}{V_1}$$

$$G_P = 10 \text{ LOG } \frac{P_2}{P_1}$$

OPERATIONAL AMPLIFIERS / *OPERASIONELE VERSTERKERS*

$$A_V = -\frac{R_F}{R_1}$$

$$V_{OUT} = A_V \times V_I$$

$$A_V = 1 + \frac{R_F}{R_1}$$

$$V_{OUT} = A_V \times V_I$$

$$V_{OUT} = \frac{1}{RC} \int V_1 \, dt$$

$$V_{OUT} = -RC \frac{dv}{dt}$$

$$V_{OUT} = -\left(V_1 \frac{R_F}{R_1} + V_2 \frac{R_F}{R_2} + V_3 \frac{R_F}{R_3}\right)$$

COMPUTER PRINCIPLES / *REKENAARBEGINSELS*

$A.B = B.A$
$A + B = B + A$

$A.(B.C) = (A.B).C$
$A + (B + C) = (A + B) + C$

$A.(B + C) = AB + AC$
$A + (B.C) = (A + B) + (A + C)$

$A(A + B) = A$
$A + (AB) = A$

$A + 0 = A$
$A + 1 = 1$
$A.0 = 0$
$A.1 = A$
$A + \underline{A} = A$
$A + A = 1$
$A.\underline{A} = A$
$A.A = 0$

END / *EINDE*