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.
- A formula sheet (pages 12 – 14) 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 100 Ω. The circuit is supplied from a 220 Volt / 50 Hz supply.

Calculate the

1.1.1 inductive reactance. (3)
1.1.2 capacitive reactance. (3)
1.1.3 impedance. (3)
1.1.4 phase angle. (First sketch a neat, labelled impedance diagram.) (10)

1.2 A series resonant circuit of a radio consists of a coil with an inductance of 400 μH, a capacitor with a capacitance of 305,7 pF and a resistor with a resistance of 100 O. The input signal is 0,2V.

Calculate the

1.2.1 resonant frequency. (3)
1.2.2 Q-Factor. (3)
1.2.3 current value at resonance. (4)

1.3 Calculate the turns ratio required for an impedance matching transformer to satisfy the requirements of a loudspeaker with a 4 Ω voice coil. The transistor needs a 500 Ω load for maximum power transfer. (4)
[33]

QUESTION 2
SEMICONDUCTOR DEVICES

2.1 Identify the following electronic components with reference to the electronic circuit diagram in **Figure 2.1** below. For example: R1 is a 1 MO resistor.

2.1.1	D2	(3)
2.1.2	S1	(2)
2.1.3	T2	(3)
2.1.4	BZ1	(1)
2.1.5	C5	(3)

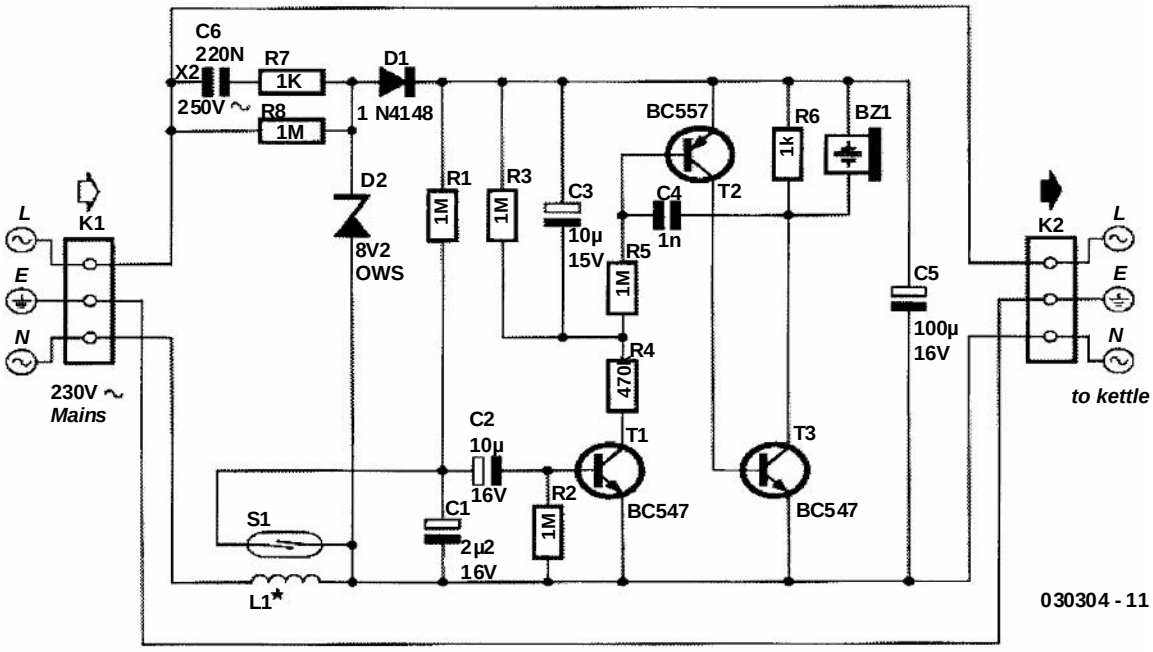


Figure 2.1: Electronic circuit for a Whistling Kettle

2.2 Refer to the electronic circuit in **Figure 2.2** and identify the transistor configuration. Explain by means of a brief description the basic operating principle and characteristics of this configuration. (11)

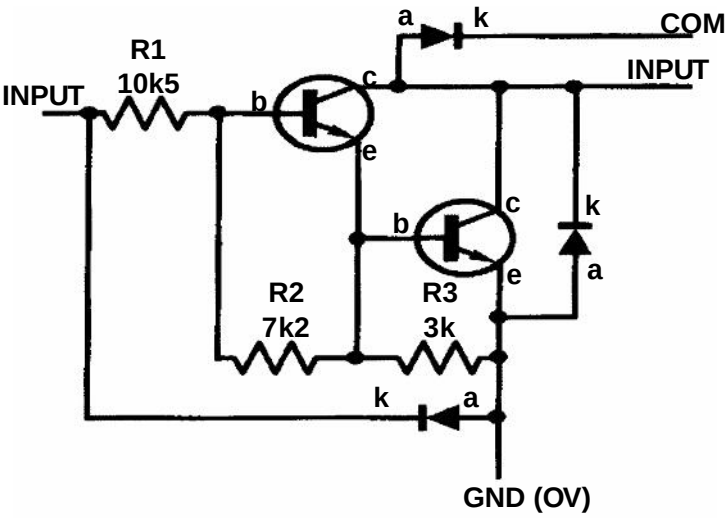


Figure 2.2: Electronic Circuit

2.3 The field effect transistor (FET) has been used since 1952 as a semiconductor device. Explain by means of neat, labelled sketches and brief descriptions, the basic **construction** and **functional** operation of a field effect transistor (FET). (12)

2.4 What major disadvantage of the diode bridge is overcome when filter capacitors are used in power supply units? (2)

[37]

QUESTION 3
AMPLIFIERS

3.1 Design a dc bias circuit for the amplifier in **Figure 3.1**. The manufacturer's specifications state that the transistor has a current gain of 120, at a collector current of 10 mA, and a supply voltage of 12 Volt. (20)

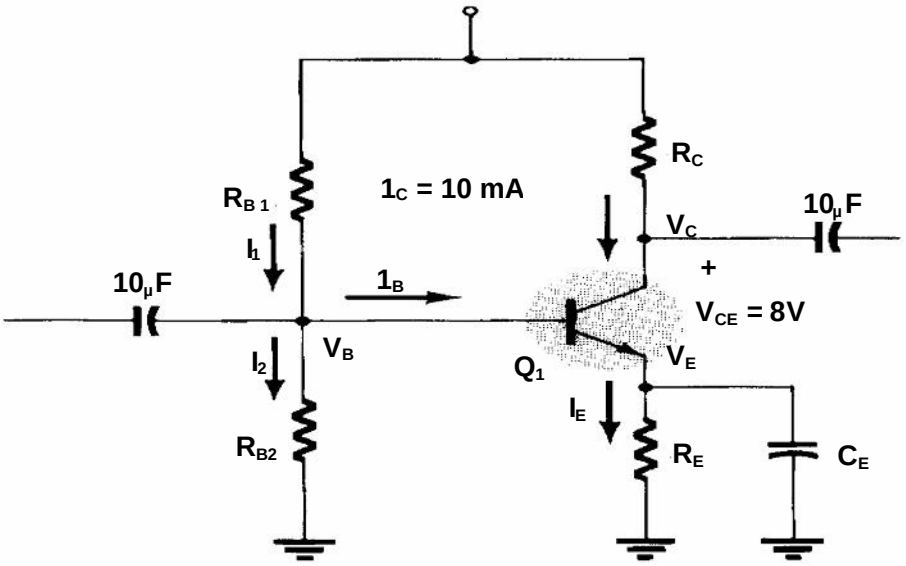


Figure 3.1: Common-emitter amplifier

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 MO.

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

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

3.3 Calculate the dB increase in power if the input frequency to a certain filter increases from 10 kHz to 20 kHz and the output power rises from 50 mW to 100 mW. (4)

[41]

QUESTION 4
SWITCHING AND CONTROL CIRCUITS

4.1 Draw a neat, labelled circuit diagram of an astable multivibrator. You may use discrete components or operational amplifiers in your circuit. Relevant input and output waveforms should be indicated. (15)

4.2 The electronic circuit in **Figure 4.1** illustrates an Infra-red Control Extender used to extend the range of the available controller, receiving the Infra-red Signal (IR-signal) from your remote control and re-transmitting it, for example around a corner into another room. Explain the working principle of this circuit. (12)

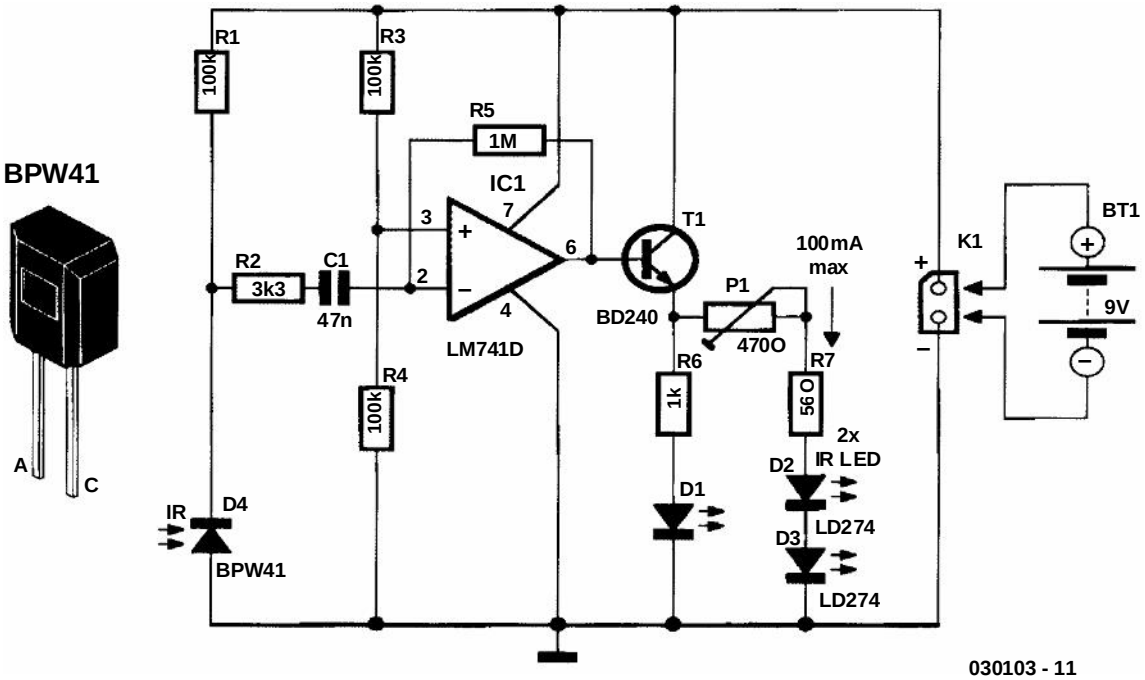
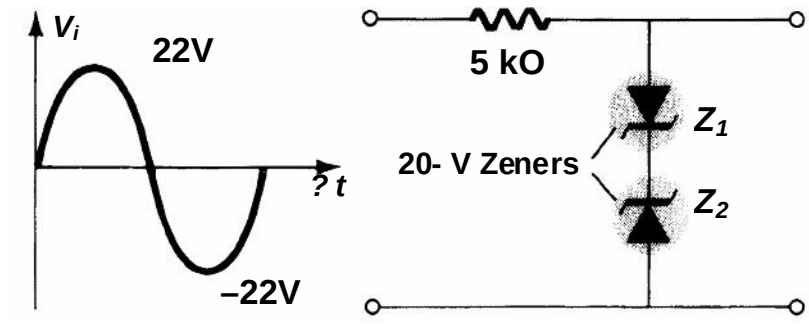


Figure 4.1: Infra-red Control Extender

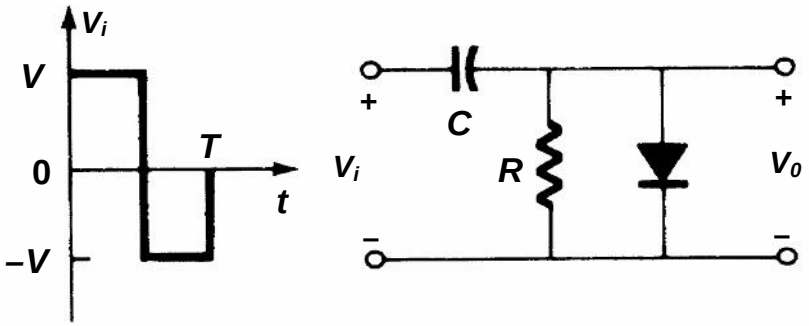
4.3 Clippers and clampers are diode waveshaping circuits transmitting parts of waveforms and suppressing others to a predetermined value. Find the output voltage wave shape for the inputs shown in **Figure 4.2**. (Only sketch the output voltage wave shape in your answer book.)

4.3.1



(4)

4.3.2



(4)

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 neat, labelled circuit diagram or block diagram with a brief description. All wave forms, where applicable, should be included. 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)

[50]

QUESTION 5
OSCILLATORS

5.1 Draw a neat, labelled circuit diagram of the crystal controlled Colpitts Oscillator. (10)

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

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

[18]

QUESTION 6
COMPUTER PRINCIPLES

6.1 Design a NOR gate network for the following Boolean expression (A, B, C and D are direct gate inputs.):

F = (A.B) + (C.D) (7)

6.2 Observe the following Boolean expression and complete the questions below:

F = (A.B)' + (A' + B)'

6.2.1 Simplify the Boolean expression above. (4)

6.2.2 Draw a logic gate circuit for the simplified circuit. (3)

6.3 You have been contracted by a leading electronics company to design a logic system that will satisfy the following needs:

An electric light is to be controlled by three switches. The light is to be ON whenever switches **A** and **B** are in the same position; when **A** and **B** are in different positions, the light is to be controlled by switch **C**.

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

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

6.3.3 Simplify the function and design a practical logic circuit. (4)

6.4 Refer to **Figure 6.1** and draw a truth table that will satisfy the possible solution of this logic circuit. (9)

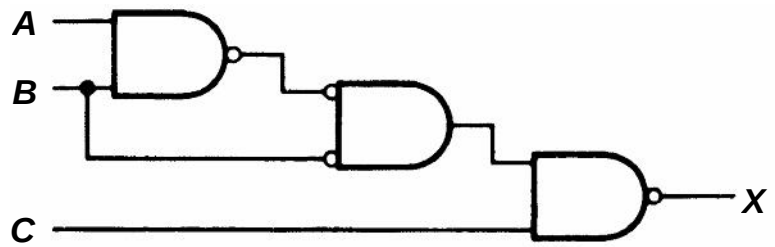


Figure 6.1: Logic circuit

6.5 Illustrate by means of a neat, labelled logic circuit and a Boolean expression, the Full Adder with SUM and CARRY. (16)

[55]

QUESTION 7
INFORMATION TRANSFER

7.1 All frequencies above the range of human hearing (>20kHz) are called radio frequencies (RF). These frequencies fall into frequency bands, each with different uses. Refer to **Table 7.1** and complete the table. Write each answer in your answer book next to the appropriate number. (6)

BAND	TERM	USES
7.1.1	Low Frequency (LF)	Long-distance communication
300 kHz – 3 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, M-Net, e.tv
Above 3 GHz	7.1.6	Radar, Satellite communication, Fibre optic

Table 7.1

7.2 Name TWO advantages of fibre optic systems. (2)

7.3 Explain by means of a neat, labelled block diagram the basic working principle of a typical fibre-optic communication system. (12)

7.4 Explain the purpose of the repeater with reference to Question 7.3. (5)

7.5 Name the major causes of signal losses in fibre optic cables. (8)

[33]

QUESTION 8
MEASURING INSTRUMENTS

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

8.2 Examine **Figure 8.1** and determine the reading of the multimeter if the range switch is on X 1M. (2)

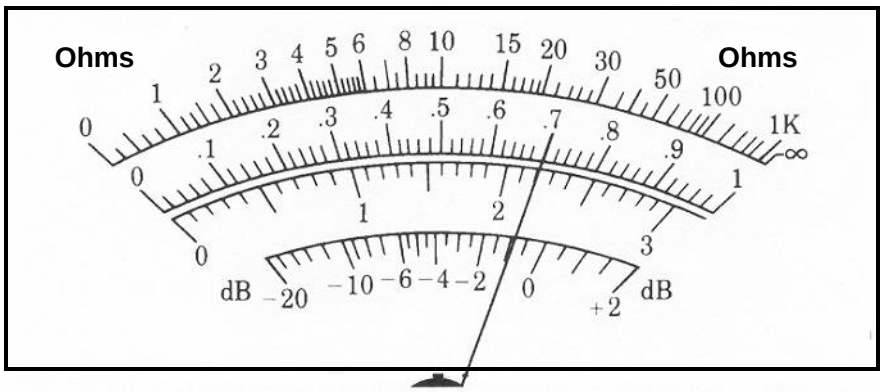


Figure: 8.1 Multimeter reading

8.3 Examine the sine waveform in **Figure 8.2** and

8.3.1 determine the peak-to-peak voltage of the wave if the Volts/Division switch is on 2 mV/Division. (3)

8.3.2 determine the frequency if the Time/Division switch of the oscilloscope is set at 50µsec/Div. (6)

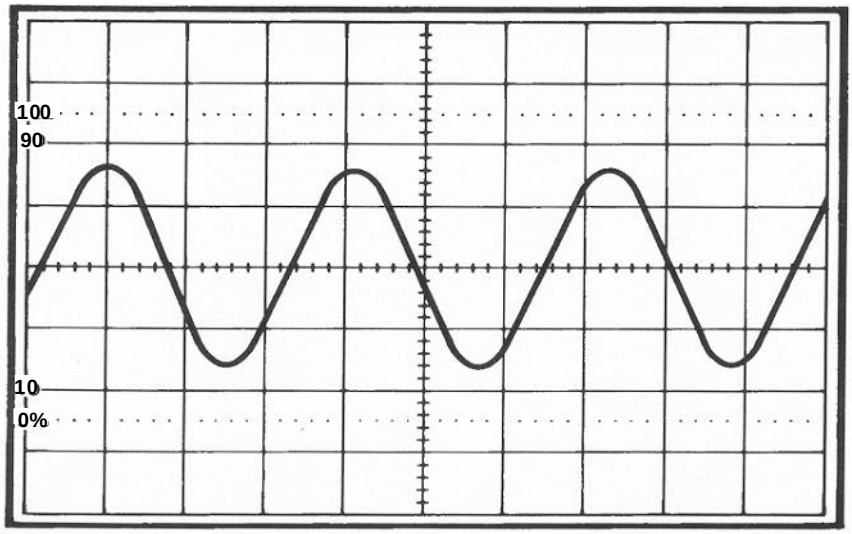
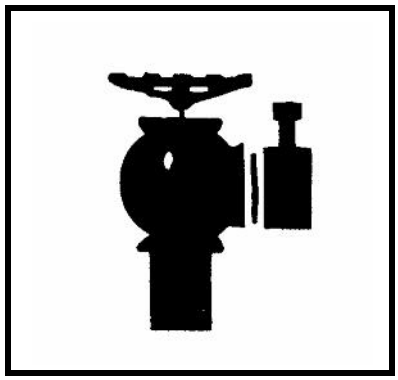


Figure 8.2: Waveform **[21]**

QUESTION 9
SAFETY PRECAUTIONS

9.1 Name FOUR housekeeping rules that you have applied in your workshop this year. (4)

9.2 Identify the following safety sign: (1)



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

9.3.1 You will not be given a life insurance policy if you tested positive with HIV. (1)

9.3.2 It is a criminal offence if you do not disclose your HIV status to your sexual partner. (1)

9.3.3 You will be excluded from employment if you are HIV positive. (1)

9.4 Name ONE law that will protect your rights in the workplace. (1)

9.5 Explain the term **window period** with reference to HIV/Aids testing. (3)

[12]

TOTAL: 300

INFORMATION SHEET / *INLIGTINGSBLAD*

ELECTRIC CURRENT THEORY / *ELEKTRIESE STROOMTEORIE*

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

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

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

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

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

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

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

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

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

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

$$V_X = V_L - V_C$$

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

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

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

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

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

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

$V_C = I_T \; x \; X_C$

$V_L = I_T \; x \; X_L$

$V_R = I_T \; x \; R$

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

$V_X = V_C - V_L$

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

$I_X = I_C - I_L$

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

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

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

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

$X_X = X_L - X_C$

AMPLIFIERS / *VERSTERKERS*

$I_e = I_c + I_b$

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

$V_e \cong \frac{1}{10} V_{cc}$

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

DECIBEL RATIOS / *DESIBEL-VERHOUDINGS*

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

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

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

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*