GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRONICS) HG

OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005

TIME: 3 hours

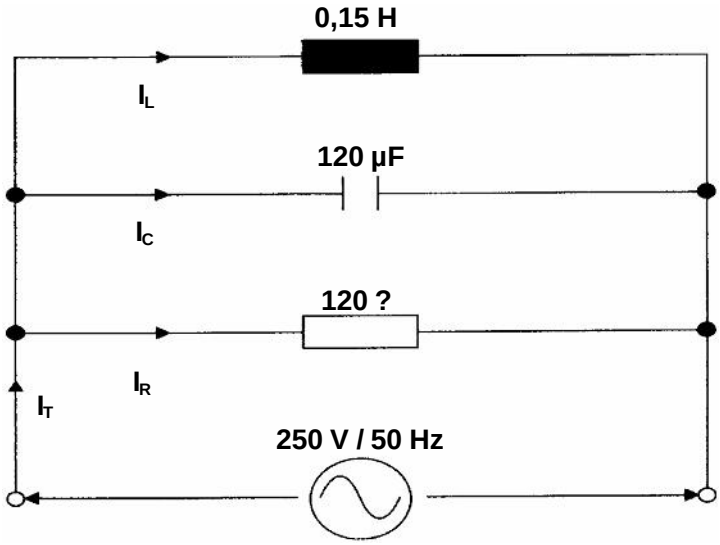
MARKS: 300

INSTRUCTIONS:

- Answer ALL the questions.
- Sketches and diagrams must be large, neat and labelled.
- All calculations must be shown.
- Answers must be clearly numbered, according to the numbering used on the question paper.
- A formula sheet (pages 13 – 15) is provided at the end of the paper.

QUESTION 1
ELECTRIC CURRENT THEORY

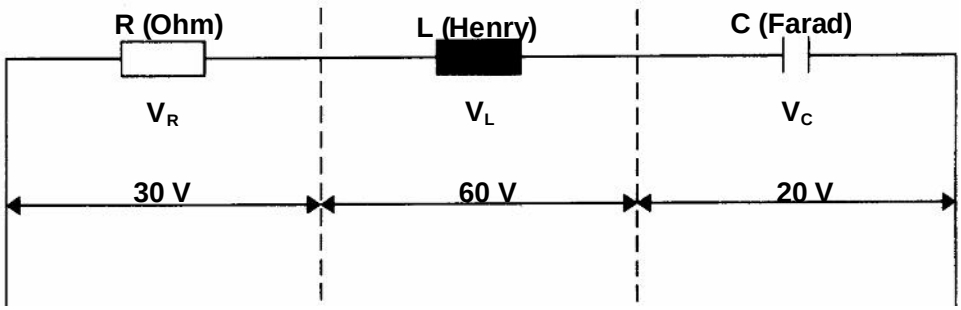
1.1 Refer to **Figure 1.1** and calculate the total current of the circuit.



(18)

Figure 1.1 Parallel RLC Circuit

1.2 Draw a neat labelled phasor diagram of the RLC circuit in **Figure 1.2** to a scale of your choice. Make use of the phasor diagram to determine (measure) the total voltage.



(8)

Figure 1.2

1.3 In the transfer of maximum power from a source to a load, the load impedance must equal the internal impedance of the source. Calculate the effective resistance (internal impedance) of the source if the impedance-matching transformer has a turn-ratio of 20:1 and is connected to an output load of 8 ?. (5)
[31]

QUESTION 2
SEMICONDUCTOR DEVICES

2.1 Identify the following electronic components with reference to the electronic circuit diagram in **Figure 2.1**. For example: R1 is a 3k3 ? resistor.

2.1.1 T2 (2)
2.1.2 LDR 1 (2)
2.1.3 VR1 (3)
2.1.4 D1 (1)
2.1.5 N.O. Relay (2)

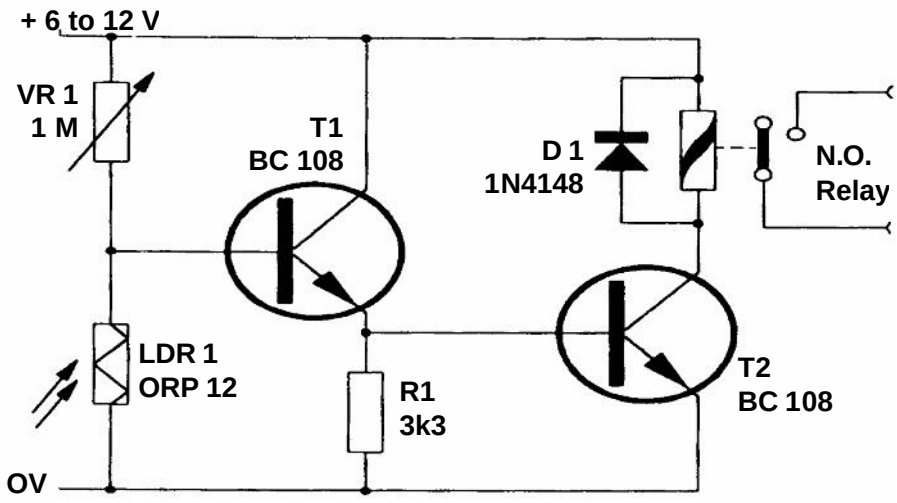


Figure 2.1: Light-sensitive Switch

2.2 Explain by means of neat, labelled sketches and a brief explanation, the basic **construction** and **functional** operation of the Silicon Controlled Rectifier (SCR). Your explanation should include a characteristic curve. (15)

2.3 What is the maximum voltage range to be applied to a CMOS logic circuit? (3)

2.4 Interpret the characteristic curve in **Figure 2.2** and name the semiconductor device that it represents.

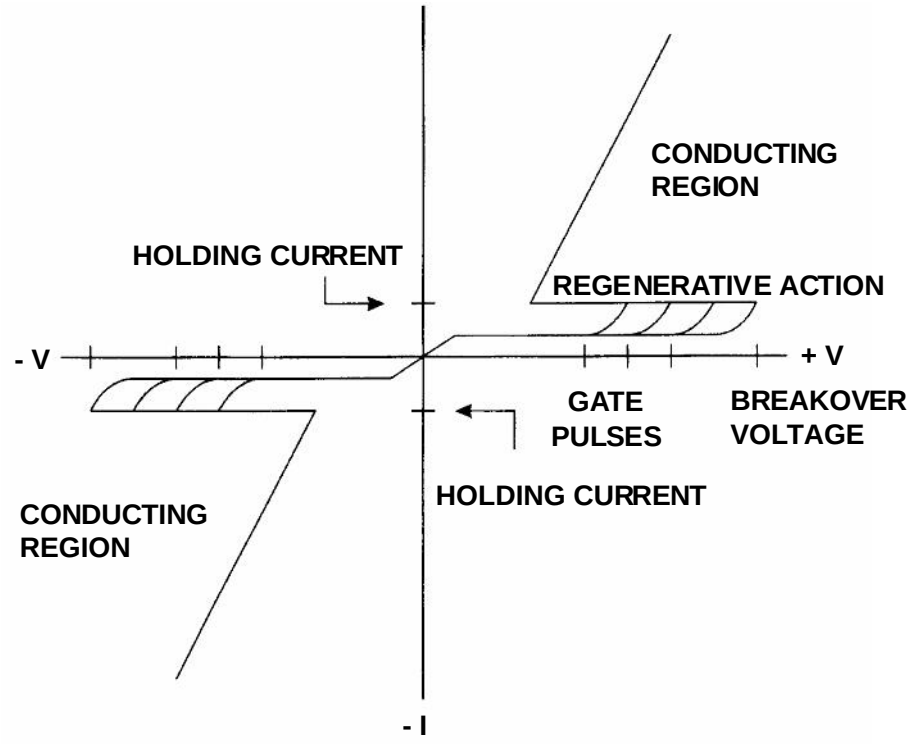


Figure 2.2: Characteristic Curve (10)

[38]

QUESTION 3
AMPLIFIERS

3.1 Design a DC bias circuit for an amplifier as in **Figure 3.1**. The manufacturer's specifications state that the transistor has a current gain of 150, typical, at a collector current of 1 mA, and a supply voltage of 16 volt. (20)

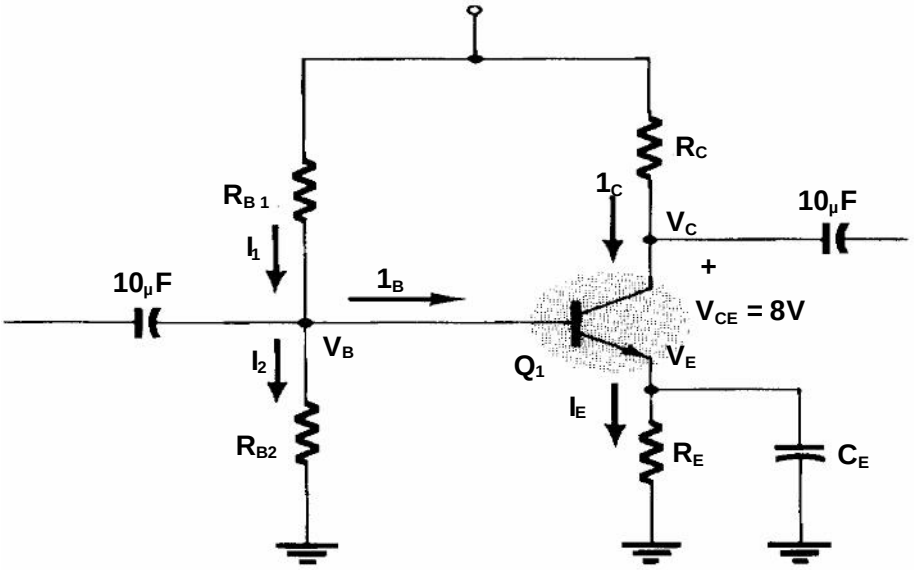


Figure 3.1: Common-emitter Amplifier

3.2 Explain the concept **thermal runaway** and how it may be overcome. (5)

3.3 Draw a neatly, labelled diagram of an op-amp used as a summing amplifier with the following sets of input voltages and resistors. Also calculate the output voltage.

Rf = 1 M?

V1 = -2 Volt, V2 = + 3 Volt, V 3 = + 1 Volt

R1 = 200 k?, R2 = 500 k?, R3 = 1M? (12)

[37]

QUESTION 4
SWITCHING AND CONTROL CIRCUITS

4.1 **Figure 4.1** illustrates a motor speed controller. Explain the working principle of this circuit, with specific reference to the output waveform across the load and SCR. (10)

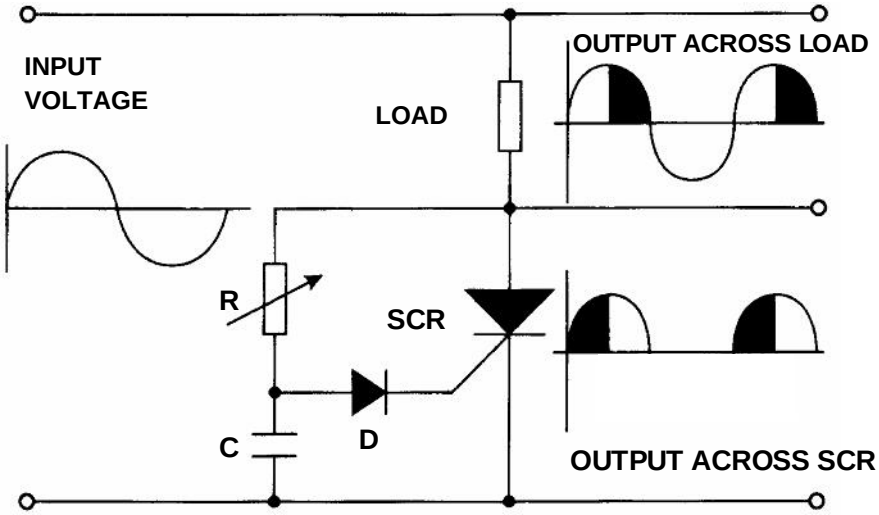


Figure 4.1: Motor Speed Controller

4.2 The electronic circuit in **Figure 4.2** illustrates a headlight delay unit that will keep a car's headlights switched on for a predetermined period, to light up the driveway after the driver has left the car. Explain the working principle of this circuit. (10)

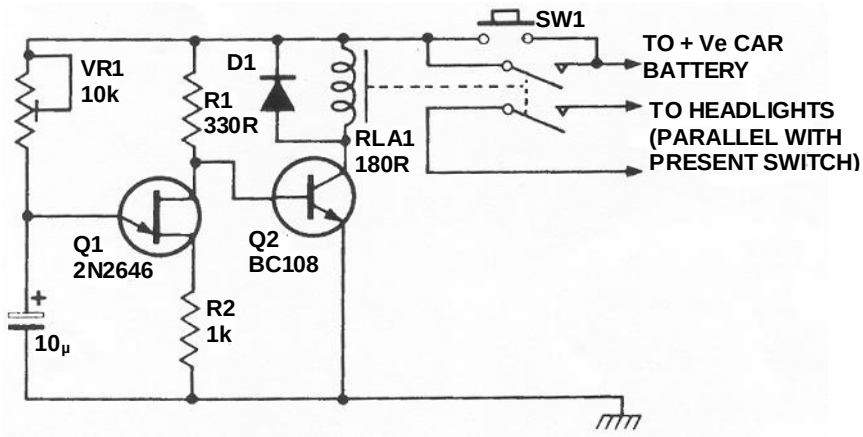
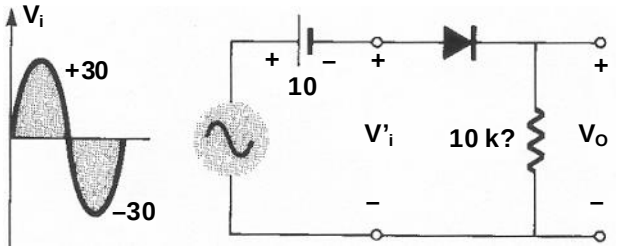


Figure 4.2: Headlight Delay Unit

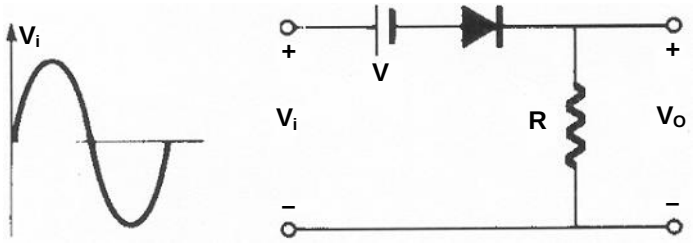
4.3 Clippers and clampers are diode wave-shaping circuits transmitting parts of waves and suppressing others to a predetermined value. Find the output-voltage wave shapes for the input waves shown in the circuits in **Figure 4.3**. (Only sketch the output-voltage wave shapes in your answer book.)

4.3.1



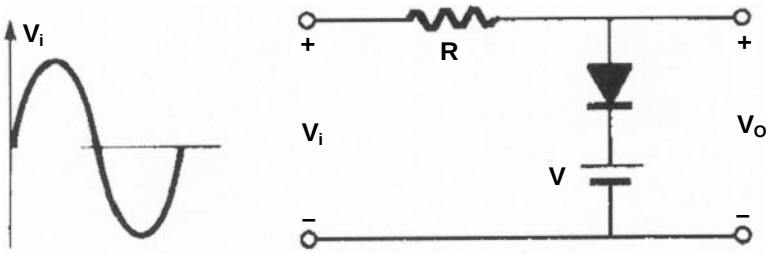
(4)

4.3.2



(3)

4.3.3



(3)

Figure 4.3: Wave-shaping Circuits

4.4 Explain the working principle of **ANY** electronics experiment **OR** model that you have built / designed this year. 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 any question or circuit already covered in this question paper. (15)

[45]

QUESTION 5
OSCILLATORS

5.1 Explain with the aid of a neat, labelled circuit diagram and brief description, the operating principle of a Colpits Oscillator. (12)

5.2 Calculate the oscillating frequency (fo) of the circuit in Question 5.1 if the following values for the tank circuit are known:

L = 40 microhenry

C1 = 750 pF

C2 = 2 500 µH (6)

[18]

QUESTION 6
COMPUTER PRINCIPLES

6.1 Refer to **Figure 6.1** and determine the truth table for the logic circuit. Identify the logic circuit.

Note: 74LS00 is an inverter.

74LS08 is an AND gate.

74LS32 is an OR gate. (7)

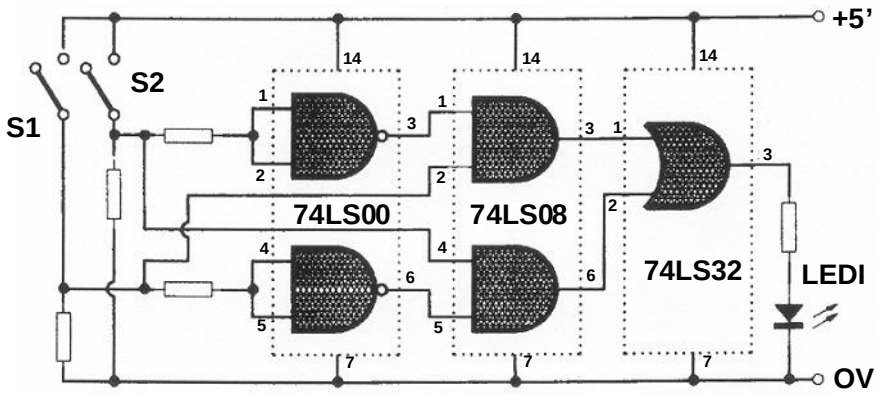


Figure 6.1: Logic Circuit

6.2 Prove with Boolean algebra that:

$$\overline{AB} + \overline{(A + B)} = \overline{AB} \quad (5)$$

6.3 Design a warning system for your car to sound an alarm when the headlights are left switched on and the key is removed from the ignition switch. The alarm should only be activated when the door is open and the headlights are on or when the key is removed from the ignition switch and the headlights are on. The system uses the following normally open switches:

Headlight switch is closed when lights are on and open when lights are off.

Ignition switch is closed when the key is in the lock and open when the key is removed from the lock.

Door switch is closed when the door is open and open when the door is closed.

6.3.1 Draw up a truth table for this situation and represent the alarm function **F** in terms of **A**, **B** and **C**. (8)

6.3.2 Simplify the function and design a practical logic circuit. (8)

6.4 Add the following two numbers in binary:

28,375

\+ 5,00

(4)

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

1010

\+ 111

(16)

6.6 Explain the term **high positive logic**. (2)

6.7 Explain the term **low positive logic**. (2)

[52]

QUESTION 7
INFORMATION TRANSFER

7.1 Illustrate the principle of operation of the amplitude modulation (AM) transmitter using a neat, labelled block diagram and a brief explanation. (15)

7.2 Name THREE advantages of optical fibre systems. (3)

7.3 Explain the importance of correctly joining optical-fibre cables. (6)

7.4 Explain by means of a neat, labelled block diagram the basic working principle of a typical fibre optic communication link. (12) **[36]**

QUESTION 8
MEASURING INSTRUMENTS

8.1 Illustrate by means of a neat, labelled sketch and explanation how electromagnetic deflection takes place in television (TV) receivers. (10)

8.2 List FOUR typical adjustment controls on a cathode-ray oscilloscope (CRO). (4)

8.3 Examine **Figure 8.1**. What voltage is indicated on the analogue-meter if the range selector switch is on 10? (2)

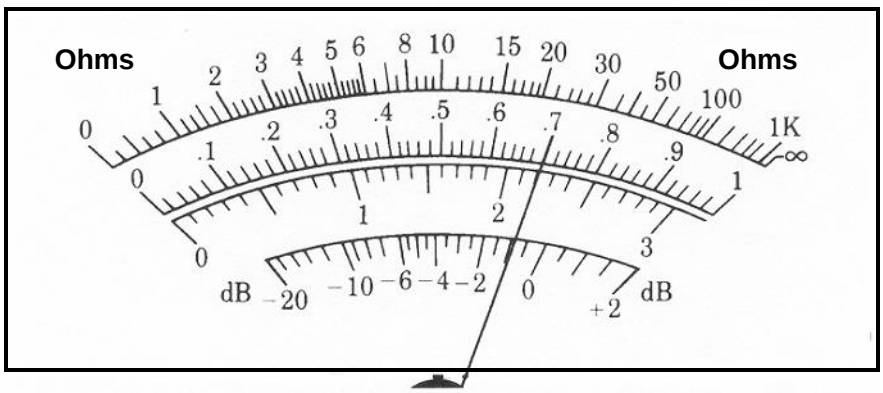


Figure: 8.1 Analogue-meter Reading

8.4 Examine **Figure 8.2**.

8.4.1 Determine the peak-to-peak voltage of the wave if the Volts / Division switch is on 10 mV/Division. (3)

8.4.2 Determine the frequency if the Time / Division setting of the oscilloscope is set at 50 µSec/Div. (6)

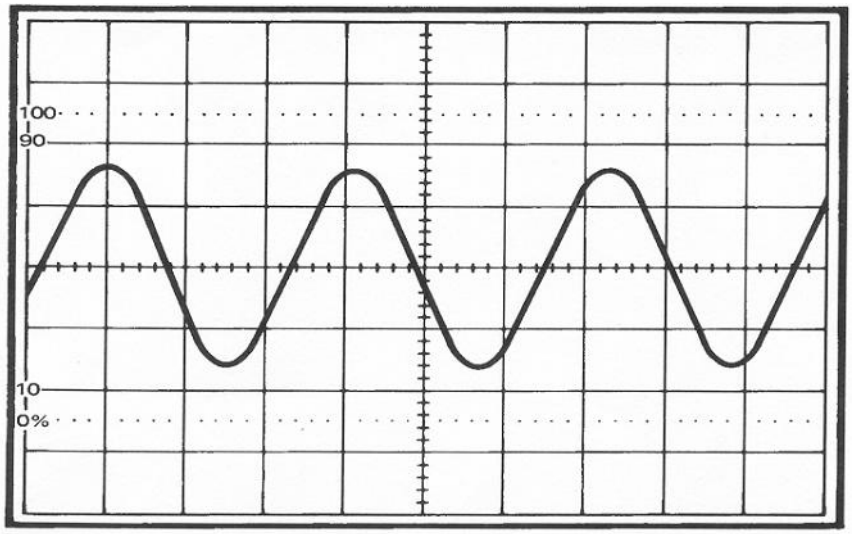


Figure 8.2: Waveform **[25]**

QUESTION 9
SAFETY PRECAUTIONS

9.1 Name FIVE housekeeping rules that you have applied in your workshop this year. (5)

9.2 What is **NOSA**? (3)

9.3 List THREE main causes of fire. (3)

9.4 For each class of fire listed in the table below, write down only the question number and the appropriate type of fire extinguisher to be used for that class of fire. (3)

CLASS OF FIRE	TYPE OF FIRE EXTINGUISHER
Wood, paper, coal, grass and other organic materials	9.4.1
Flammable liquids and greases. e.g. alcohol, benzene, oil, paraffin, petrol	9.4.2
Fires occurring in the presence of live electrical installations	9.4.3

9.5 Answer the following questions by writing only TRUE or FALSE next to the appropriate question number in your answer book.

A person can contract Aids by

9.5.1 donating blood. (1)

9.5.2 sharing the same toilet facilities with a person who is infected with HIV. (1)

9.5.3 having unprotected sex with an HIV infected person. (1)

[17]

TOTAL: 300

INFORMATION SHEET / *INLIGTINGSBLAD*

ELECTRIC CURRENT THEORY / *ELEKTRIESE STROOMTEORIE*

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

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

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

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

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

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

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

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

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

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

$$V_X = V_L - V_C$$

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

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

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

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

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

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

$V_C = I_T \times X_C$

$V_L = I_T \times X_L$

$V_R = I_T \times R$

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

$V_X = V_C - V_L$

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

$I_X = I_C - I_L$

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

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

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

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

$X_X = X_L - X_C$

AMPLIFIERS / *VERSTERKERS*

$I_e = I_c + I_b$

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

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

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

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*