GAUTENG DEPARTMENT OF EDUCATION /
GAUTENGSE DEPARTEMENT VAN ONDERWYS
SENIOR CERTIFICATE EXAMINATION /
SENIORSERTIFIKAAT-EKSAMEN

TECHNIKA (ELECTRONICS) SG /
TECHNIKA (ELEKTRONIES) SG

QUESTION 1 / *VRAAG 1*

1.1.1 (a) $X_L = 2\pi FL$
$= 2 \times \pi \times 100 \times 300\ mH$
$= 188,49\ \Omega$

$Xc = \frac{1}{2\pi FC}$
$= \frac{1}{2\pi x100x50\ x10^{-6}}$
$= 31,83\ \Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$
$= \sqrt{(10)^2 + (188,49 - 31,83)^2}$
$= \sqrt{100 + 245,42,36}$
$= \sqrt{24642,35}$
$= 156,99\ \Omega$

$I_T = \frac{V_T}{Z}$
$= \frac{120}{156,99}$

7
$= 0,764$ Amp (9)

1.1.1 (b) $V_L = I_T \times X_L$
$= 0,764 \times 188,49$
$= 144,08$ V (3)

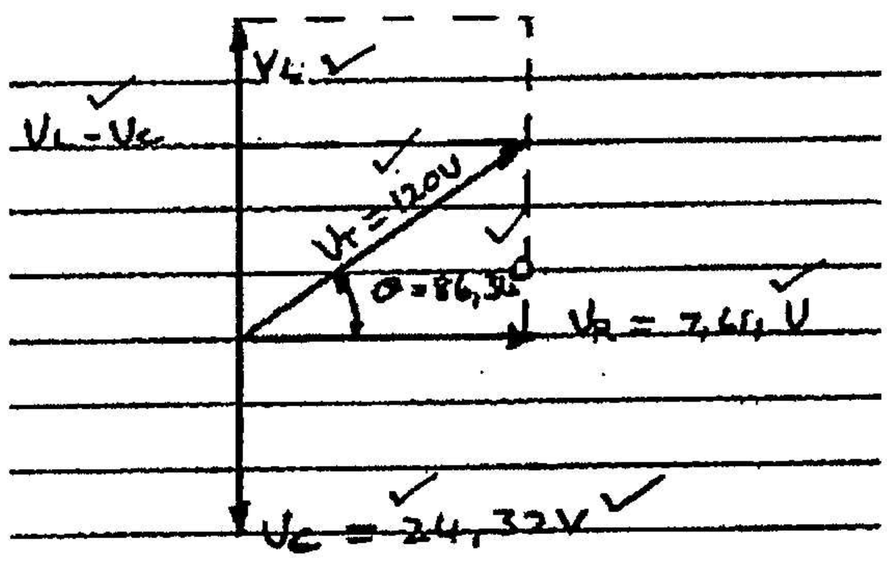
1.1.1 (c) $V_C = I_T \times Xc$
$= 0,764 \times 31,83$
$= 24,32$ V (3)

1.1.1 (d) $V_R = I_T \times R$
$= 0,764 \times 10$
$= 7,64\ V$ (3)

1.1.1 (e) $\text{Cos } \theta = \frac{R}{Z}$
$= \frac{10}{156,99}$
$= 0,0636$
$\theta = 86,34°$ (3) + 2

1.1.1 (f) $\text{Cos } \theta = 0,0636$

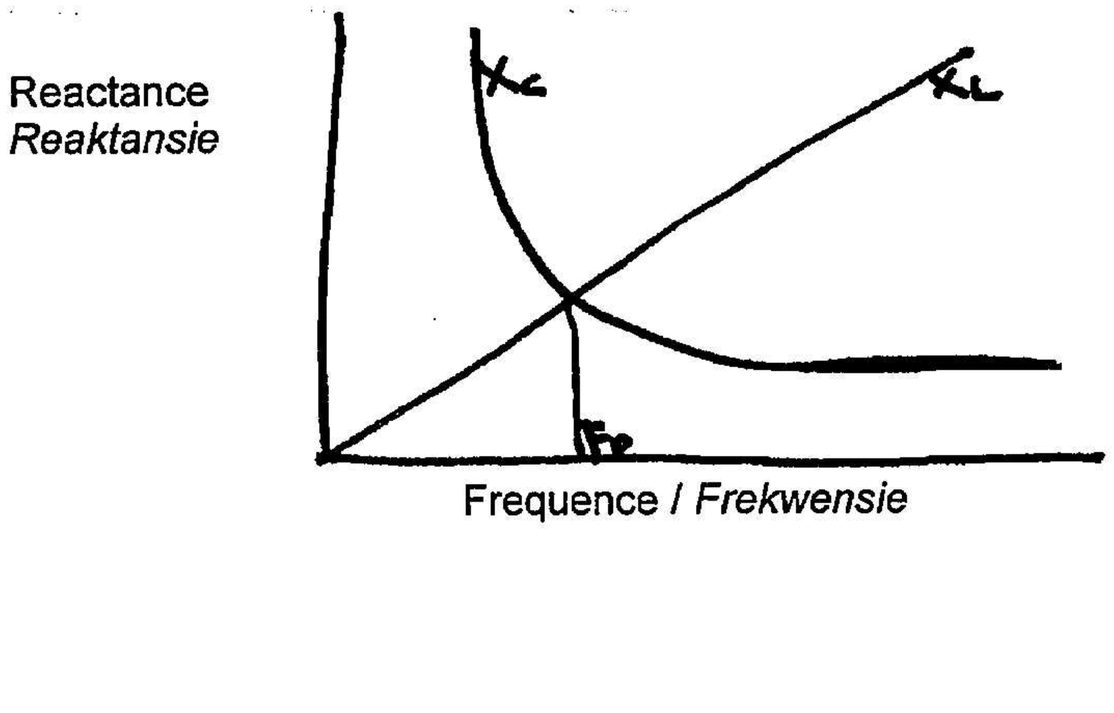
1.1.2 $V_L = 144,08\ V$ (3)



(7)

1.2 By changing either the frequency or the value of the capacitor. / *Deur óf die frekwensie óf die waarde van die kapasitor te verander.* (4)

1.3

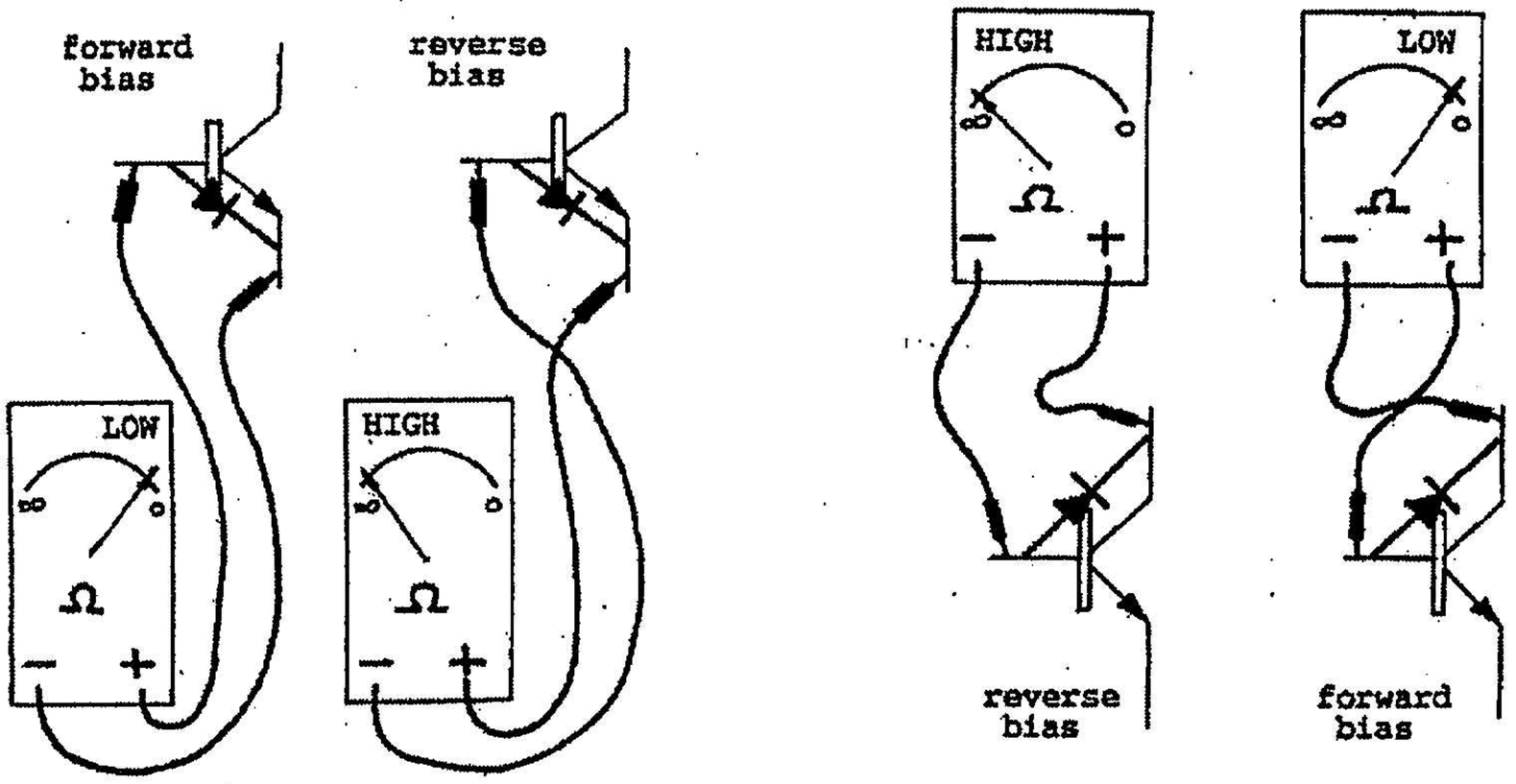


(5)

QUESTION 2 / *VRAAG 2*

2.1.1 82-k Ω-resistor (3)
2.1.2 PNP Transistor (2)
2.1.3 0,1 μF Capacitor Electrolitic / *Elektrolitiese kapasitor* (2)
2.1.4 Diode PN (2)
2.1.5 NPN Transistor (2)

2.2

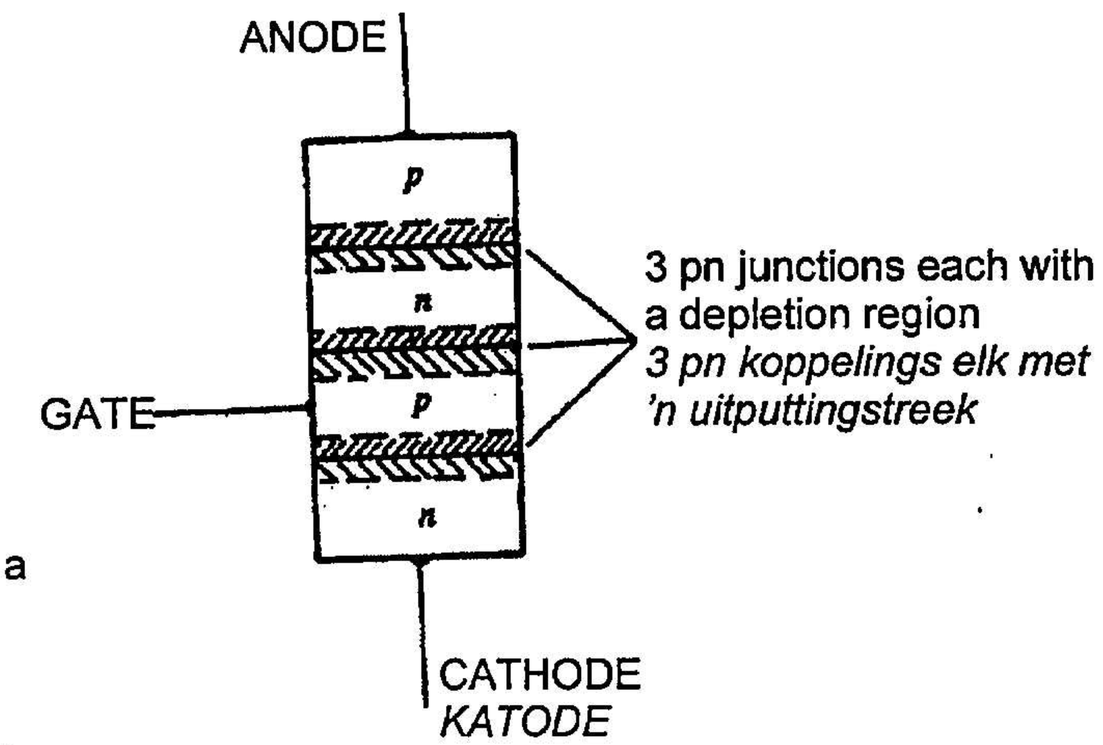


(10)

2.3 **SCR OPERATION**

As an SCR is a half-wave rectifying device, similar to a diode, it will only conduct in the forward direction. But it will only conduct once a signal is applied to its gate terminal.
'n BSG is 'n halfgolf gelykrigtings toestel, sortgelyk aan 'n diode, maar sal slegs in die voorwaartse rigting en slegs as 'n sein op su hekkerminaal toegepas word.

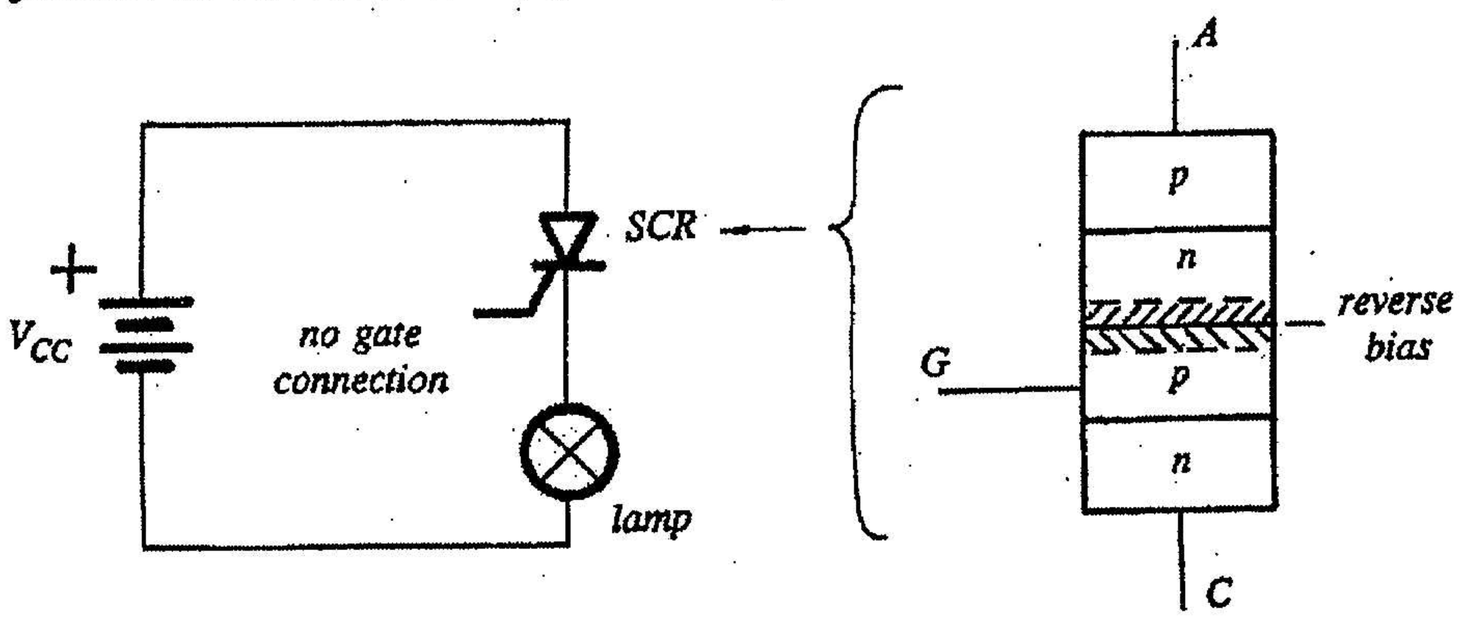
As the SCR has four silicon layers of n-p-n-p semiconductor it then has three separate pn junctions
Aangesien die BSG vier silicone van n-p-n-p halfgeleier het, het dit drie aparte pn-koppelings.



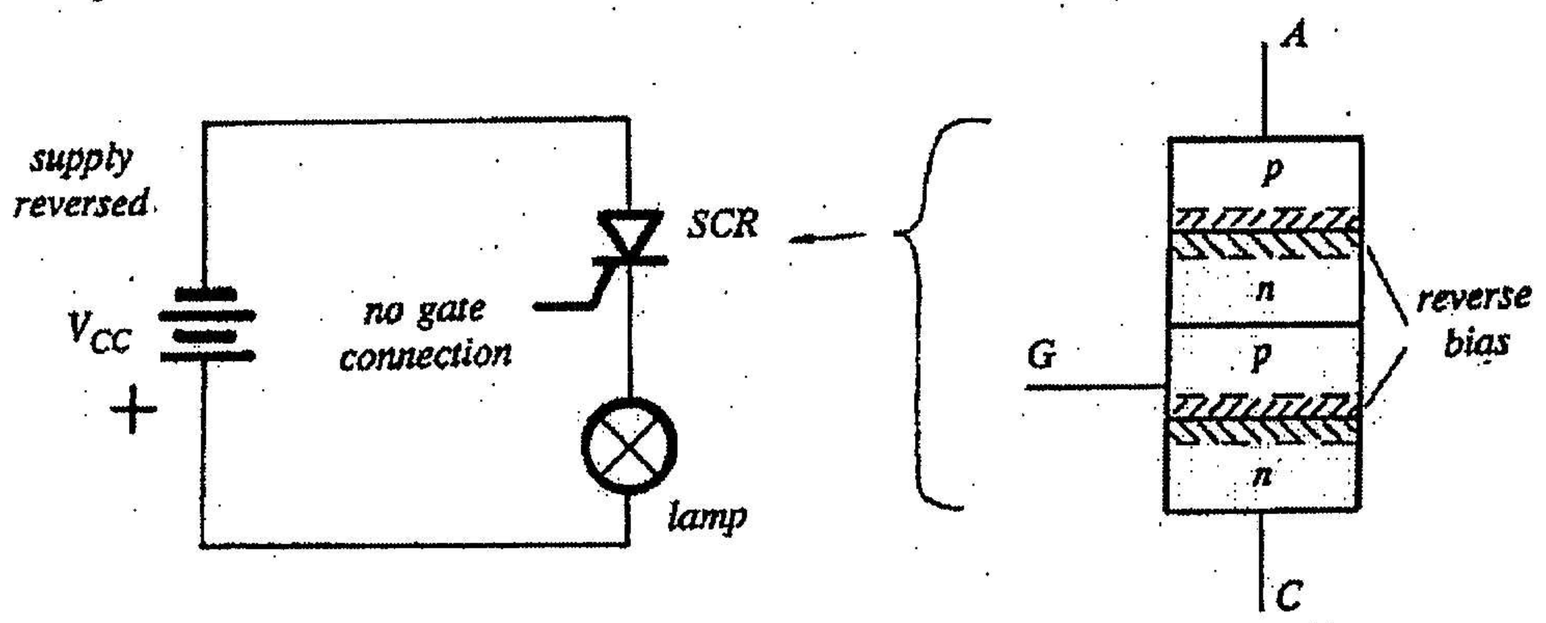
A half rectifying device similar to a diode will only conduct when a signal is applied to the gate
'n Halfgolf gelykrigtertoestel soortgelyk aan 'n diode wat slegs sal gelei as 'n sein op die hek toegepas word.

With no voltage signal on the gate terminal the SCR can be either forward or reverse biased and there will be no conduction in either direction. *Met geen spanning op die*

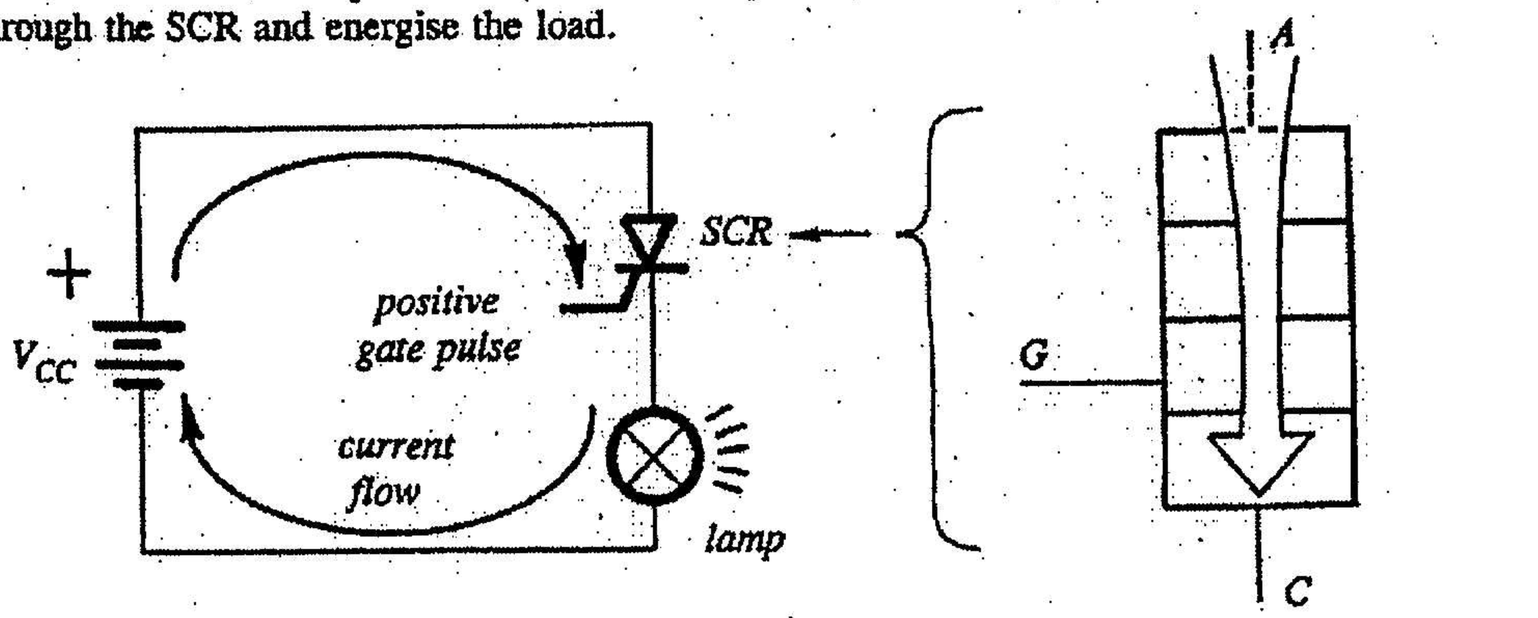
1. In the forward direction, with the anode positive and the cathode negative, the two outer pn junctions are forward biased while the centre junction is reverse biased. **No conduction.**



2. In the reverse direction with the anode negative and the cathode positive, the two outer pn junctions are reverse biased and the centre junction is now forward biased. **No conduction.**



For **conduction** to occur the anode-cathode must first be forward biased just like a normal diode. Then a trigger signal is applied to the gate. This trigger voltage must be large enough to break down the middle reverse bias junction. Once all three junctions are forward biased anode current will flow through the SCR and energise the load.



Once the SCR goes into conduction the gate is no longer needed and it looses all further control over the SCRs operation. (12)

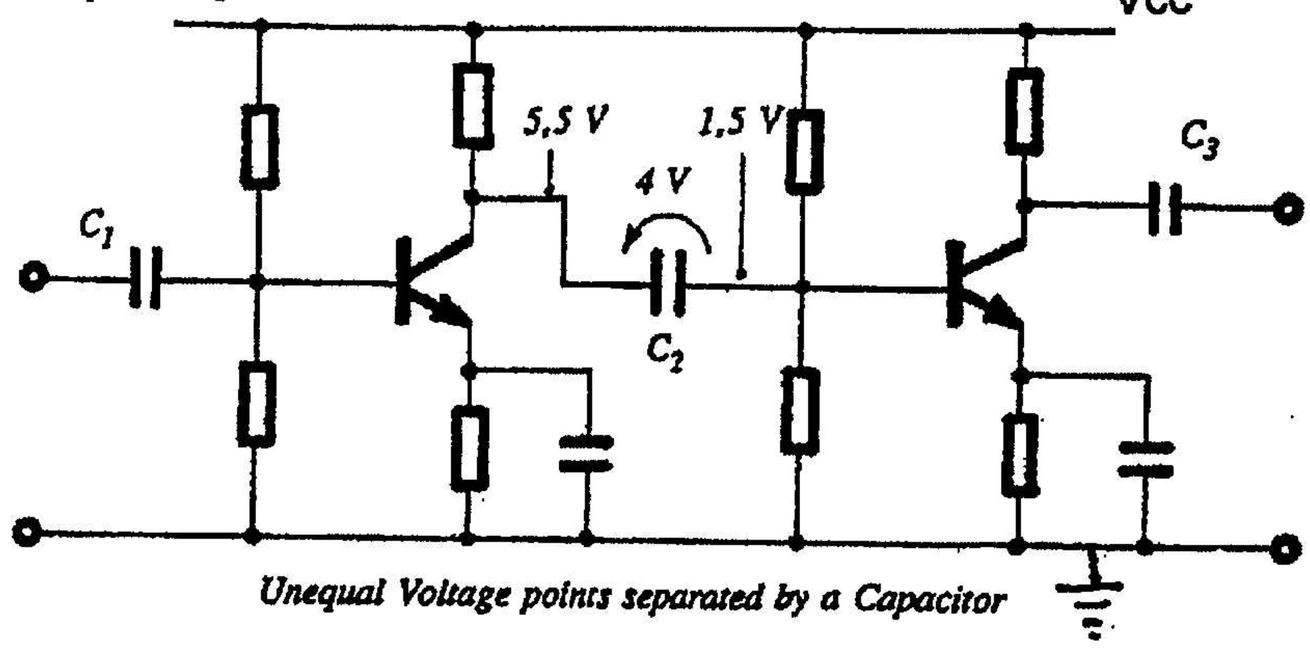
2.4
- Speed control Motors (DC)
- Light dimming circuits (2)

QUESTION 3 / *VRAAG 3*

3.1 RESISTOR-CAPACITOR (RC) COUPLING

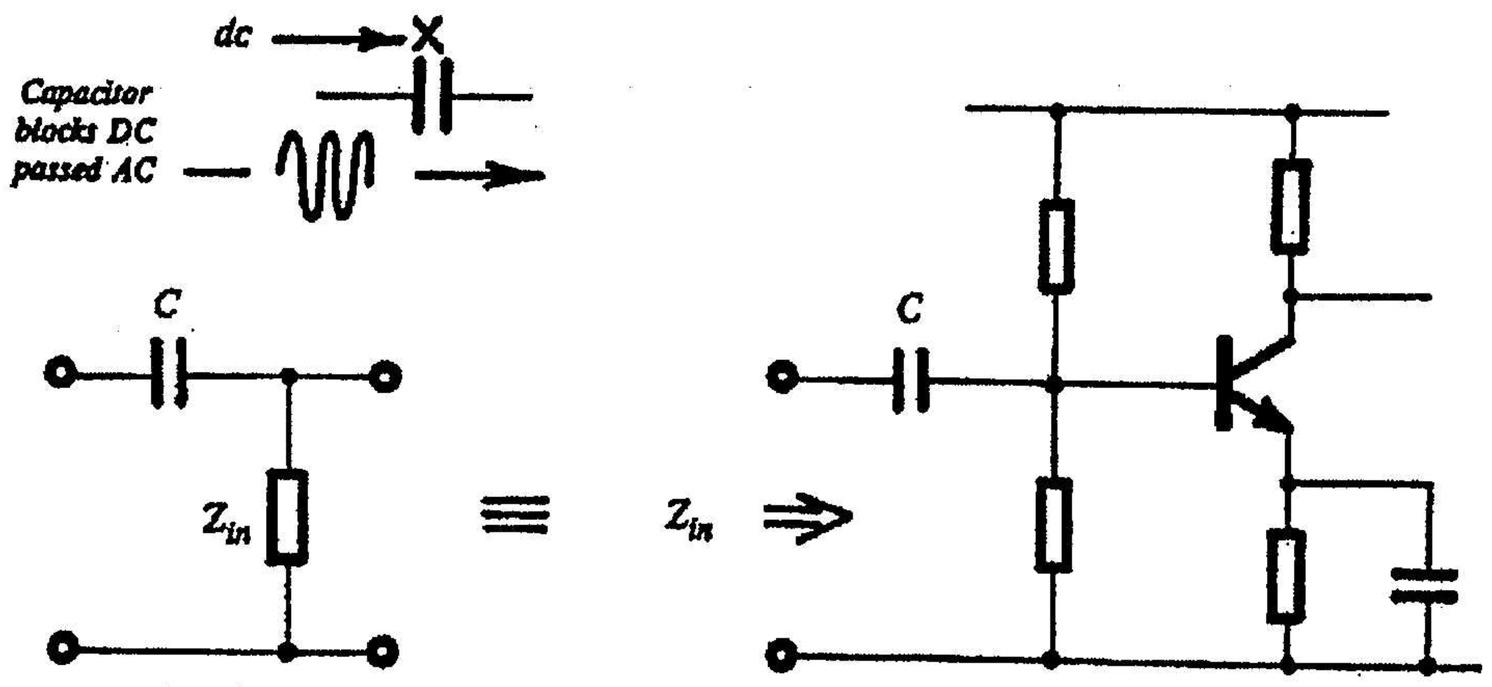
This is the most common and widely used method of coupling between stages. It uses a capacitor coupled from the output of the first stage to the input of the next, shown below as capacitor C_2. Capacitors C_1 and C_3 also act as coupling capacitors between the signal source and output load.

Two RC Coupled Stages



Unequal Voltage points separated by a Capacitor

The coupling capacitor allows each stage to operate completely free of the next as it blocks any dc interference between stages. Each of the capacitor's plates sits at different voltages, in the example below that connected to the collector terminal sits at about 5,5 V while the other connected to the next transistors base sits at about 1,5 V. Therefore the capacitor stores a charge of 4 V between its plates, absorbing the difference in voltage between the stages. When an ac signal is introduced for amplification, the coupling capacitor behaves like a low impedance path, allowing the ac signal to pass with no obstruction at all.

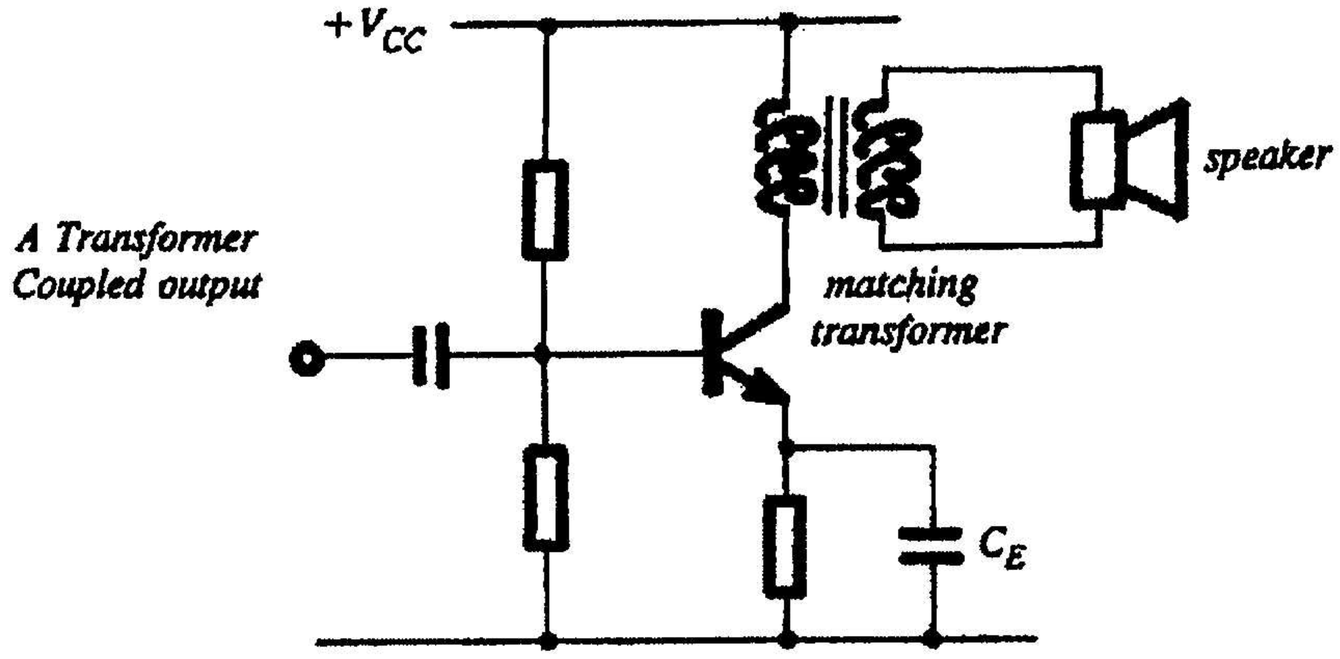


L-type filter *Input Circuit forms an "L" type Filter*

The coupling capacitor, together with the input impedance Z_{in} of the following stage fonns an "L" type filter which has a marked negative loading effect on the stage's frequency range especially the lower frequency range extending down to dc. To overcome this, coupling capacitors are purposely selected to be as large as possible for the range of frequencies required to be handled, with values of 10 µF at audio frequencies and 1 nF at video frequencies quite common. These values are still comparatively quite small.

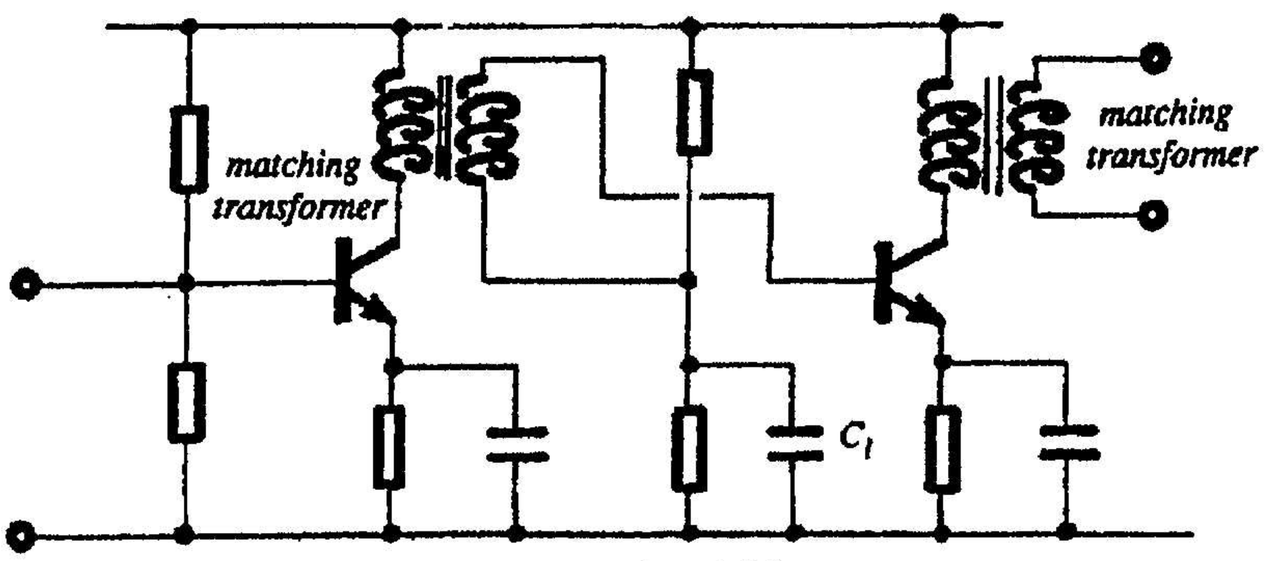
TRANSFORMER COUPLING

This method of coupling makes use of the inductive coupling properties of a transformer to couple two stages together. The advantage is that both its primary and secondary number of turns can be varied allowing it to act as either a step-up or a step-down device. This will correctly match two different impedances while at the same time separating their dc circuits, acting as what is called a **buffer**. The chief use of this impedance matching property is in matching an audio amplifier with a low impedance loudspeaker which has a typical impedance of only 8 Ω.



Because they are made from coils of copper wire, the resistance of transformer windings is very low. When used as the collector load in a transistor amplifier this creates a very steep (almost vertical) load line on the output characteristic, which creates very-high-current currents with a small voltage output. This is useful for driving low-impedance loads such as relays, loudspeakers and motors.

When used as an interstage coupling a slightly different bias arrangement is needed. The junction where the transformer feeds the bias voltage onto the base is decoupled to ground via capacitor C_1. This will maintain a fixed dc operating point on the base which remains unaffected by any ac input signal.



Two Transformer Coupled Stages

A transfonner coupled circuit is expensive to build, large in size but easy to design. It is often used in circuits requiring large current outputs or where two phase-split outputs are required as in a push-pull amplifier (see later). It is more efficient than RC coupling as the primary coil's resistance (which replaces the collector resistance) has a much lower value and therefore causes less dc power loss for the stage.

OR

Transformer coupling is also a widely used between RF amplifier stages. (20)

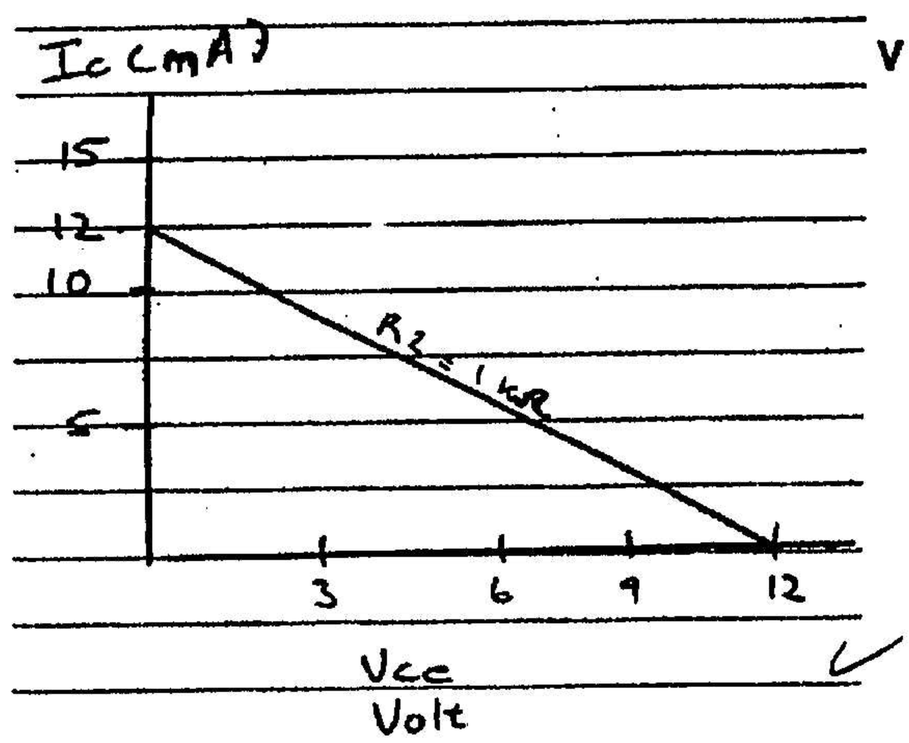
3.2 Rc = 1 000 Ω
Vcc = 12 V

Vce = Vcc
Vce = 12 V

Ic max = $\frac{Vcc}{Rc}$

= $\frac{12\,V}{1000\,\Omega}$

= 12 mA



(10)

3.3 <u>Negative Feedback</u>

- Output is 180° out of Phase with input
- Result in gain is unity or less than maximum gain. Gain is effectively reduced.
- More stable in terms of gain and temperature
- Less noise
- Broader hand width (4)

3.4 1. $A_v \approx \alpha$: infinite open loop voltage gain
(they have more gain than necessary which can be sacrificed using feedback and in return improve a number of other properties).

2. $Z_{in} \approx \alpha$: infinite input impedance (Z_{in})
(this will not "load down" a high-impedance signal source).

3. $Z_{out} \approx 0$: zero output impedance (Z_{out}),
(they are able to deliver a signal to a low impedance source).

4. Bandwidth ≈ α : infinite bandwidth,
5. unconditionally stable,
6. differential inputs (ie: two inputs).
7. Common mode rejection (this gives them the ability to reduce hum and noise). (5)

3.5.1 **COMMON MODE**

If **identical signals** are presented to **both input** terminals, then the conduction of both transistors will rise and fall simultaneously. Therefore the voltage changes at both collector resistors will be the same causing both outputs to fall and rise in unison. As both branches of the circuit are identical then the two outputs will also be the same causing the **difference** between the two outputs to be zero. (2)

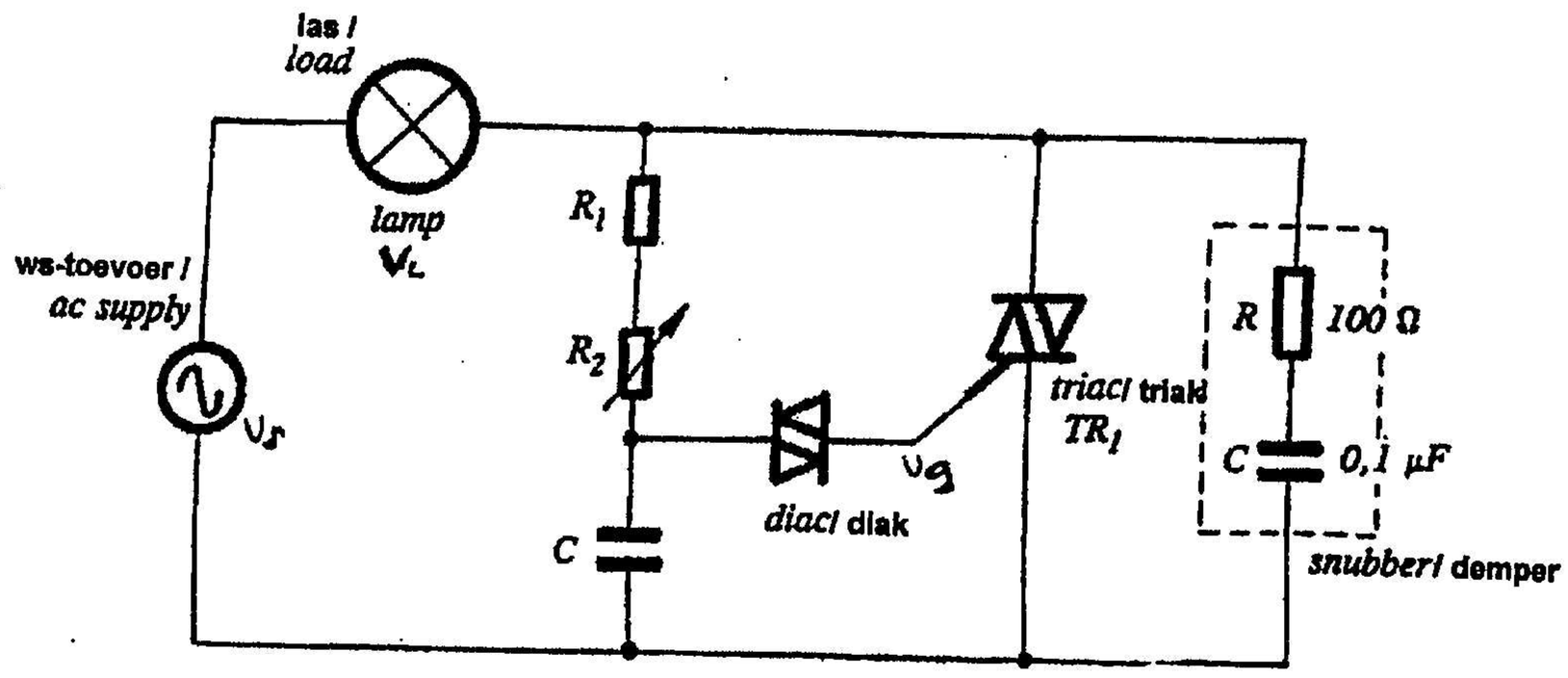
3.5.2 **DIFFERENTIAL MODE**

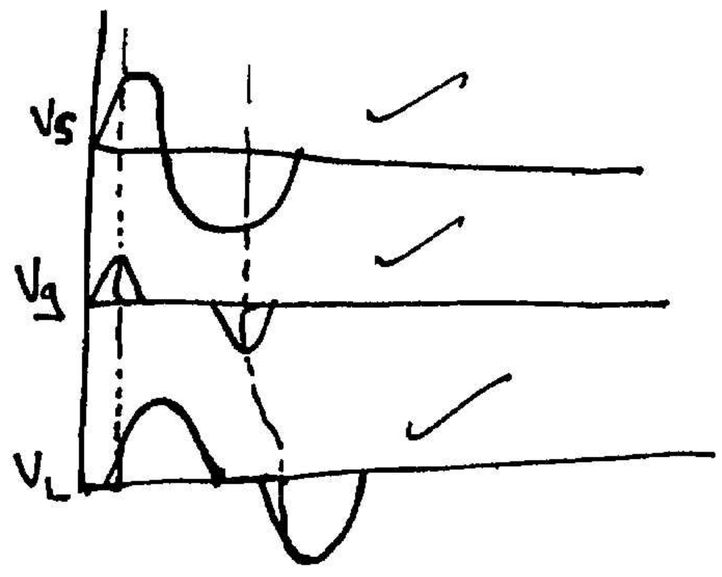
Therefore a differential output signal will not contain any part of a signal which is common to both inputs, i.e: a common-mode signal. This is particularly useful in the elimination of hum or noisy signals. By feeding the signal onto both inputs of a differential amplifier, the circuit will cancel any common-mode noise. This is one of the (2)

major advantages of the differential amplifier.

QUESTION 4 / *VRAAG 4*

4.1





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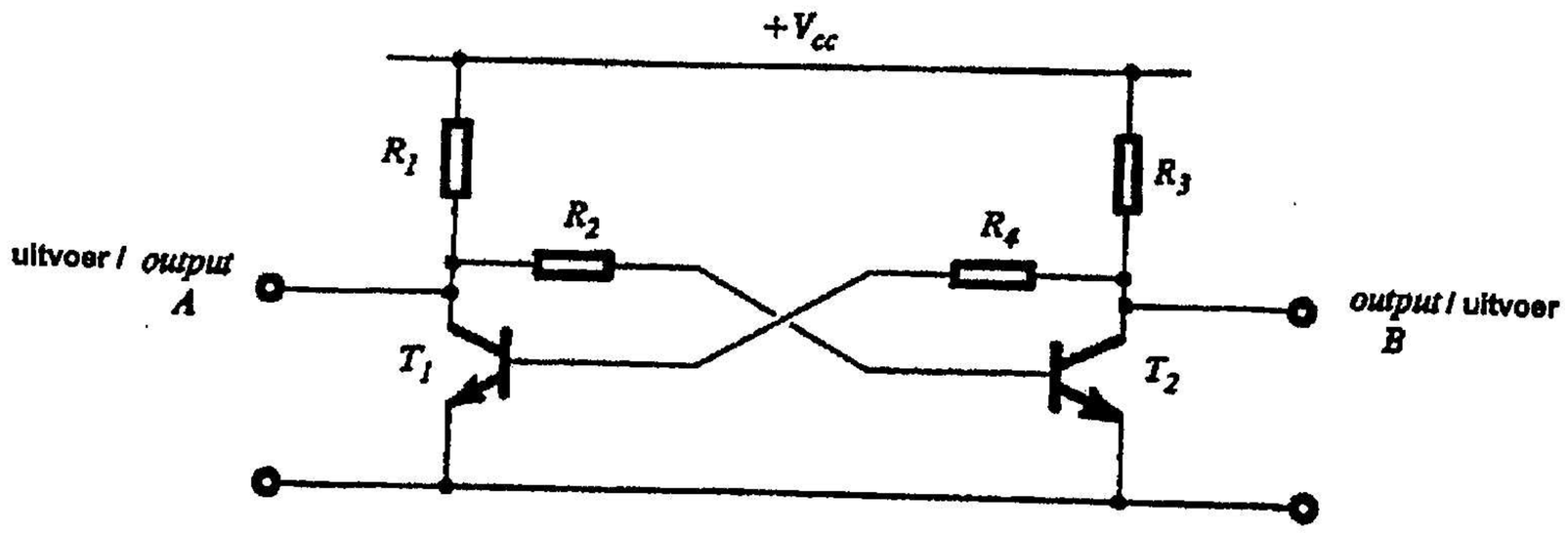
4.2

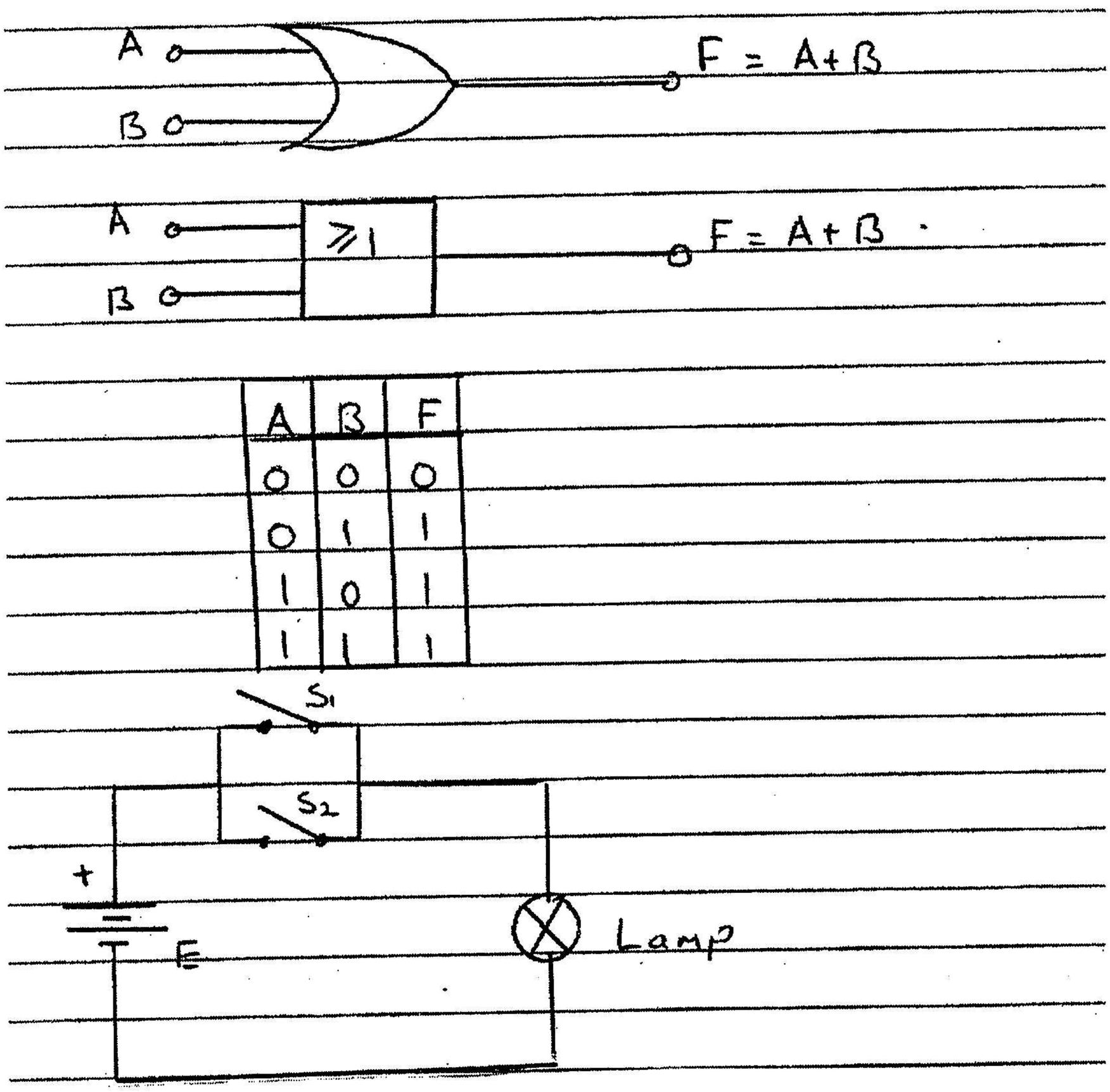


A Bistable Multivibrator
'n Bistabiele Multivibrator

(10)

QUESTION 5 / *VRAAG 5*

5.1



(12)

5.2 $A + B(A.\overline{B}) = A$

$A + AB\overline{B} = A$ $\quad B.\overline{B} = 0$

$A + A.- = A$ $\quad A.0 = 0$

$A = A$

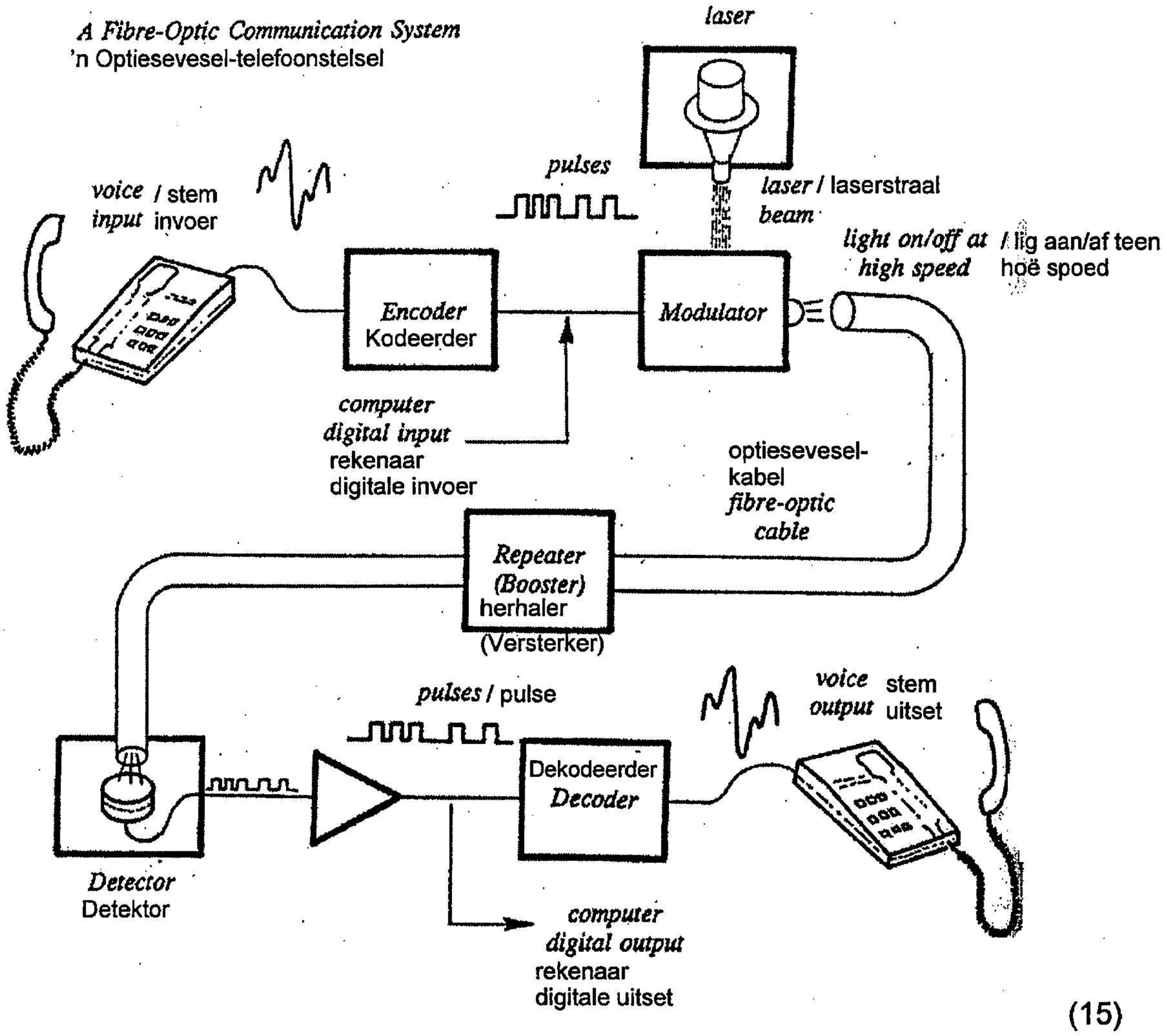
$LK = RK$

(10)

QUESTION 6 / *VRAAG 6*

6.1

A Fibre-Optic Communication System
'n Optiesevesel-telefoonstelsel



(15)

QUESTION 7 *VRAAG 7*

7.1.1 10 DIV

T/DIV = 2 ms

Time = 10 x 2 ms
= 20 ms

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

$= \frac{1}{20\,ms}$

= 50 Hz (2)

7.1.2 4 DIV

V/DIV = 3 V

EM = 4 x 3 V
= 12 V

E average = Em x 0,637
= 12 x 0,637
= 7,644 V (2)

7.1.3 Erms = Em x 0,707
= 12 x 0,707
= 8,48V (2)

7.1.4 Erms = Em x 0,707
= 12 x 0,707
= 8,48 (2)

QUESTION 8 / *VRAAG 8*

8.1 You can get AIDS from

Having unprotected sex with an infected person.
Sharing a needle for intravenous drug use with an HIV-infected person
Infected blood entering the body through broken skin
From an infected mother to an unborn child

Dra te alle tye latekshandskoene wanneer 'n persoon gehelp word wat enige oop wonde aan hom/haar het. (3)

8.2 1. Let the person lie on his / her back.
2. Pull the person's head backward to ensure airway is open.
3. Make sure that the person's tongue does not block his/her airway. (6)
4. Practice mouth-to-mouth respiration.
5. Apply heart massage in-between.

8.3 * *Verseker dat alle draagbare toerusting buigsame kernbedrading het.*
* *Alle verbindingspunte moet meganies en elektries korrek wees.*
* *Isolasie moet in goeie toestand wees en aan regulasies voldoen.*
* *Verseker dat die gronddraad die regte kleur is.*
* *Verseker dat die gronddraad goeie kontak maak met die metaaldele van die apparaat.*
* *Koppel die regte kleure op die regte plekke :* (4)

(E) Grond = *groen en geel*
(N) Neutraal = *blou*
(L) Lewendig = *bruin*

8.4 any acceptable answers.

10111
082911
084124
112 (cellphones) (2)

TOTAL: 200
TOTAAL: 200