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

TECHNIKA (ELECTRICAL)/*TECHNIKA (ELEKTRIES) SG*

QUESTION 1 / *VRAAG 1*

1.1 1.1.1 $X_L = 2\pi fL$ ✓

$= \pi(100)\,0{,}01$ ✓

$= 6{,}283\Omega$ ✓

$X_C = \frac{1}{2\pi fc}$ ✓

$\frac{1}{2\pi\,(100)\,75x10^{-6}}$ ✓

$= 21{,}22\Omega$ ✓

$Z = \sqrt{R^2 + (X_C - X_L)^2}$ ✓

$= \sqrt{5^2 + 14{,}937)^2}$

$= \sqrt{248{,}133}$ ✓

$= 15{,}75\Omega$ ✓

$I = V/Z$ ✓

$= 200/15{,}752$ ✓

$= 12{,}696$ Amp. ✓ (12)

1.1.2 $Tan\,\theta = X_C - X_L/R$ ✓

$= 14{,}937/5$

$\theta = \tan^{-1} 2{,}987$ ✓

$\theta = 71{,}492^\circ$ ✓ (3)

1.1.3 Tension over/*Spanning* oor R = V/I

$V_R = IxR$ ✓

$= 12{,}696x5$ ✓

$= 63{,}48$ volt ✓

$V_L = IxX_L$ ✓

$= 12{,}696x6{,}283$ ✓

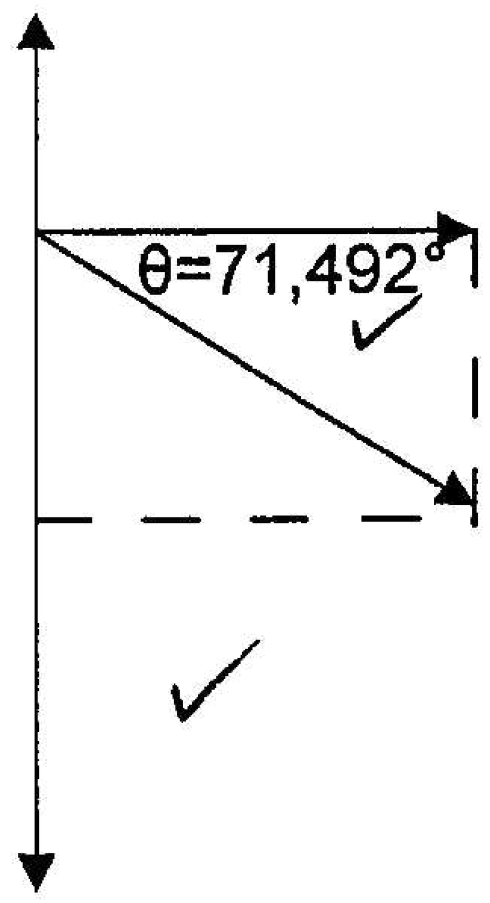
$= 79{,}768$ volt ✓

$V_C = IxX_C$ ✓

$= 12{,}696x21{,}22$ ✓

$= 269{,}409$ volt ✓ (9)

1.1.4 $V_L = 79{,}768\ volt$



$V_R = 63{,}48$ volt.

$V_C - V_L = 189641\,\text{V}$

(6)

1.2 1.2.1 $X_L = 2\pi fL$

$= 2\pi(50)\,0{,}5$

$= 157{,}079\Omega$

$X_C = \dfrac{1}{2\pi(\text{F})c}$

$= \dfrac{1}{2\pi(50)\,100\text{x}10^{-6}}$

$= 31{,}830\Omega$

$I_R = V/R$ $= 110/40$ $= 2{,}75$ Amp.

$I_L = V/X_L$ $= 110/157{,}079$ $= 0{,}7$ Amp.

$I_C = V/X_C$ $= 110/31{,}830$ $= 3{,}455$ Amp.

$I_T = \sqrt{I_{R^2} + (I_C - I_L)^2}$

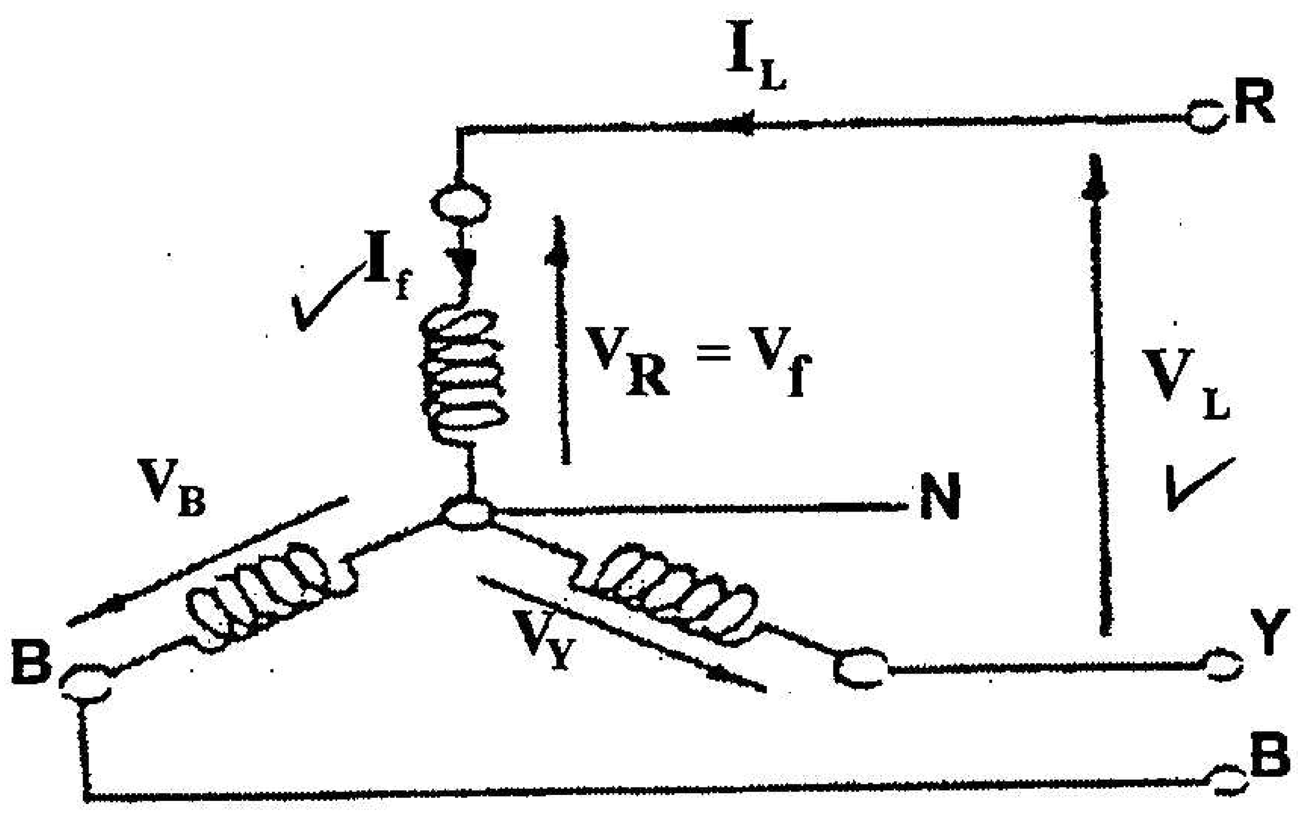
$= \sqrt{2{,}75^2 + (2{,}755)^2}$

$= \sqrt{15{,}15}$

$= 3{,}892\ Amp.$

(10)
[40]

QUESTION/*VRAAG* 2



$V_L = \sqrt{3}\, V_f \Rightarrow V_f = \frac{V_L}{\sqrt{3}}$

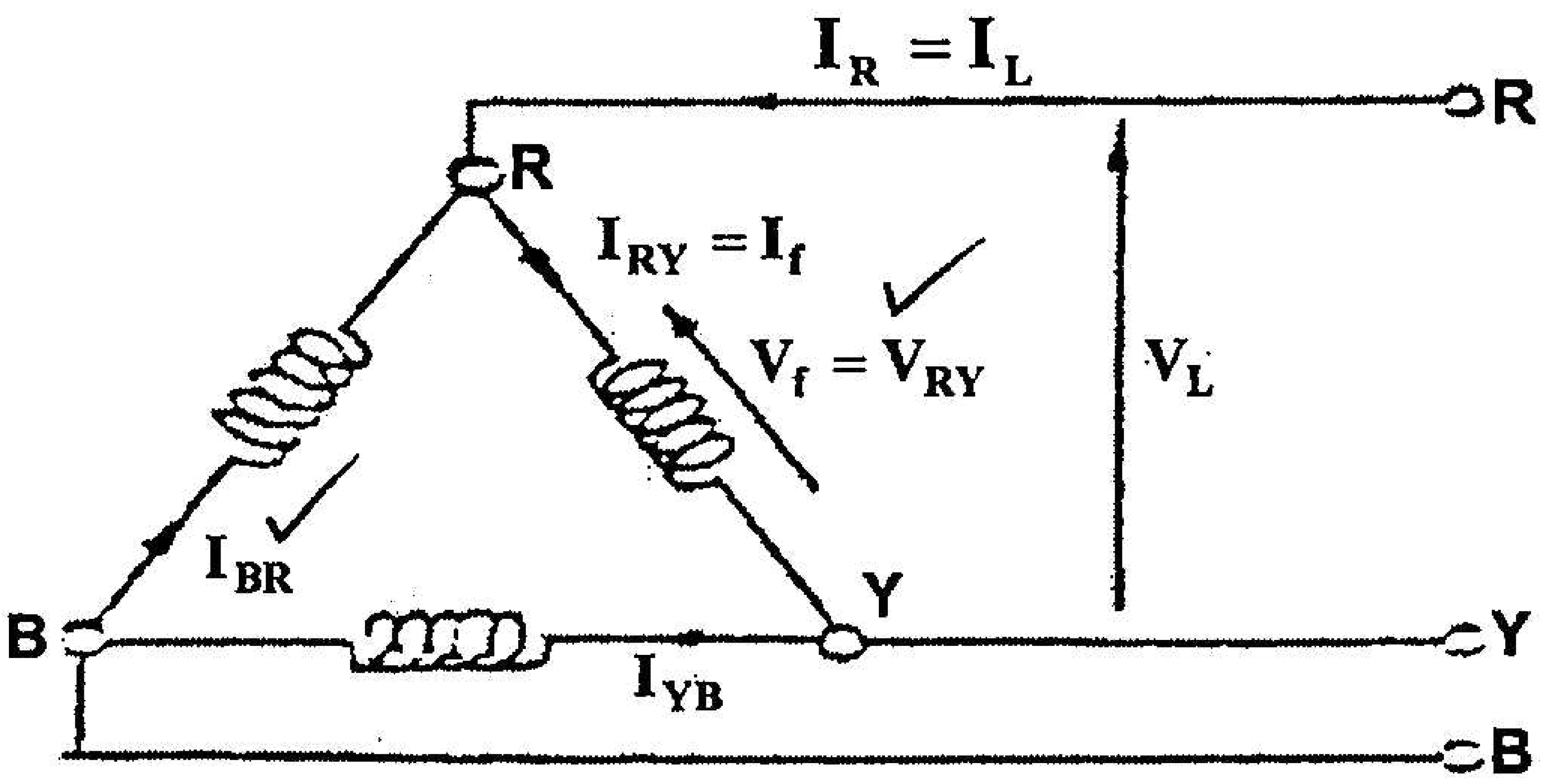
$I_L = I_f$

$= 10A.$

$= \frac{380}{\sqrt{3}}$

$= 219{,}39V$

STAR/*STER*



$V_L = V_f \Rightarrow 380V.$

$I_L = \sqrt{3 I_f}$

$I_f = \frac{I_L}{\sqrt{3}}$

$= 10/\sqrt{3}$

$= 5{,}773$ Amp.

DELTA

(10)

[10]

QUESTION 3/*VRAAG 3*

3.1 3.1.1 $\frac{V_1}{V_2} = \frac{N_1}{N_2}$ $V_2 \Rightarrow$ can only use fase values but/ *kan slegs fasewaardes gebruik maar* $V_L = V_f = 2200$ Volt

$V_1 = \frac{N_1 x V_2}{N_2}$

$= \frac{10x2200}{1}$

$= 22kV$ Phase voltage/*fasespanning*

$V_{L_1} = \sqrt{3}\, V_{ph1}$

$= \sqrt{3}$ x 22000

$= 38{,}105$ kV

(7)

3.1.2 $KVA = \sqrt{3}\, V_L I_L$ ✓

$$I_{L1} = \frac{KVA}{\sqrt{3} \times V_L}$$ ✓

$$= \frac{300\,000}{\sqrt{3} \times 38{,}105}$$ ✓

$= 4{,}545$ Amp. $I_L = I_{ph} = 4{,}545$ Amp. ✓ (4)

3.1.3 $P = \sqrt{3}\, V_L I_L \cos\theta$ ✓

$= \sqrt{3} \times 38{,}105 \times 4{,}545 \times 0{,}85$ ✓

$= 254{,}973$ kW ✓ (3)

3.2 3.2.1 Eddy current losses:
The iron core of the transformer, as with any iron core of electrical machinery or apparatus which experiences an alternating or pulsating flux, must be laminated in order to reduce eddy currents.

Eddy currents are circulating currents set up by e.m.f.'s which are induced by the alternating or pulsating flux in the core. These circulating currents cause excessive heating and a loss of power.

Werwelstroomverliese:
Die ysterkern van 'n transformator, soos enige ander masjien of apparaat wat 'n ysterkern het waarin daar 'n wissel- of pulseervloed plaasvind, moet gelamelleer word om werwelstrome te beperk.

Werwelstrome word opgestel deur die e.m.k.'s wat deur die wissel- of pulseervloed in die kern geïnduseer word. Hierdie sirkuleerstrome veroorsaak oormatige hitte en 'n kragverlies. (3)

3.2.2 Hysteresis loss:
The iron core of a transformer undergoes continuous magnetic polarity changes while switched on. Before the magnetic polarity can be reversed the residual magnetism in the core has to be forced to zero. The power used in destroying this residual magnetism is converted into heat.

Histereseverlies:
Die ysterkern van 'n transformator ondergaan aanhoudende magnetiese polariteitsveranderings terwyl dit aangeskakel is. Voordat die magnetiese polariteit omgekeer kan word moet die oorblywende magnetisme in die kern na zero gedwing word. Die drywing wat gebruik word om hierdie oorblywende magnetisme te vernietig word in hitte omgesit. (3)

[20]

QUESTION 4/*VRAAG 4*

4.1 **ADVANTAGES OF AC MOTORS**

When compared with DC motors, AC motors have the following advantages:

1. They require less, or in the case of some induction motors, no maintenance. ✓✓
2. They are generally more robust in construction. ✓✓
3. Alternating supply voltages are readily available. ✓✓
4. Except for the universal motor, they have a constant speed. ✓✓
5. They are generally cheaper to manufacture. ✓✓

VOORDELE VAN WS-MOTORS

Wanneer WS-motors met GS-motors vergelyk word, het hulle die volgende voordele:

1. *Hulle benodig minder of in sommige gevalle, geen instandhouding nie.*
2. *Hulle konstruksie is oor die algemeen sterker en stewiger.*
3. *WS-toevoere is gewoonlik oral verkrygbaar.*
4. *Behalwe vir die universele motor, het hulle 'n relatiewe konstante spoed.*
5. *Hulle is oor die algemeen goedkoper om te vervaardig.* (10)

4.2 4.2.1 Insulation resistance test between windings

An insulation resistance tester (megger) is connected between terminals a_1 and b_1 then a_1 and c_1 then b_1 and c_1 and readings of each one taken in turn. The value of resistance should be at least 0,5 megohms, reg. 9.3.1g.

Isolasieweerstand tussen geleiers

'n Isolasietoetser (megger) word tussen a_1 en b_1 dan a_1 en c_1 en dan b_1 en c_1 verbind. Lesings word in elke geval geneem en moet 'n waarde van ten minste 0,5 megohm reg. 9.3.1g hê. (3)

4.2.2 Insulation resistance to earth test

An insulation resistance tester is connected between earth and a_1 then earth and b_1 , then earth and c_1 and readings of each one taken in turn. The value of the resistance should be at least 0,5 megohms, reg. 9.3.1g.

Isolasieweerstand na aarde

'n Isolasietoetser word tussen die raamwerk en a_1 dan die raamwerk en b_1 dan die raamwerk en c_1 verbind. Lesings word in elk geval geneem en moet 'n waarde van ten minste 0,5 megohm reg. 9.3.1g hê. (3)

4.3 To switch on the starter ✓
For safety purposes for man and machine ✓

Should the supply be interrupted, the starter/contactor has to be reactivated by the operator. It will not start by itself. ✓✓

Om die aansitter aan te skakel
Vir veiligheid vir die mens en masjien

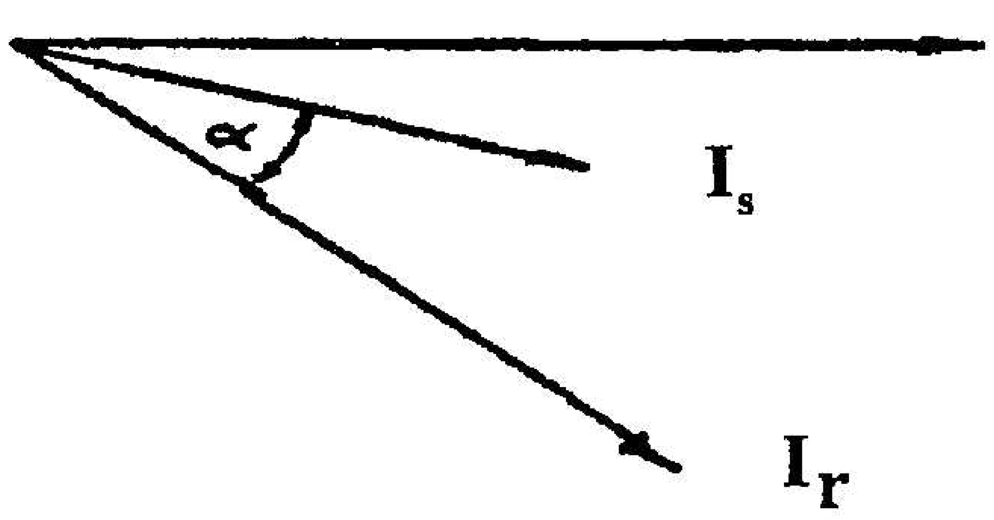
Indien die toevoer onderbreek word, moet die aansitter/kontak reaktiveer word deur die operateur. Dit sal nie self aanskakel nie. (4)

4.4 STARTING OF SPLIT-PHASE INDUCTION MOTORS
Resistance-start split-phase motor

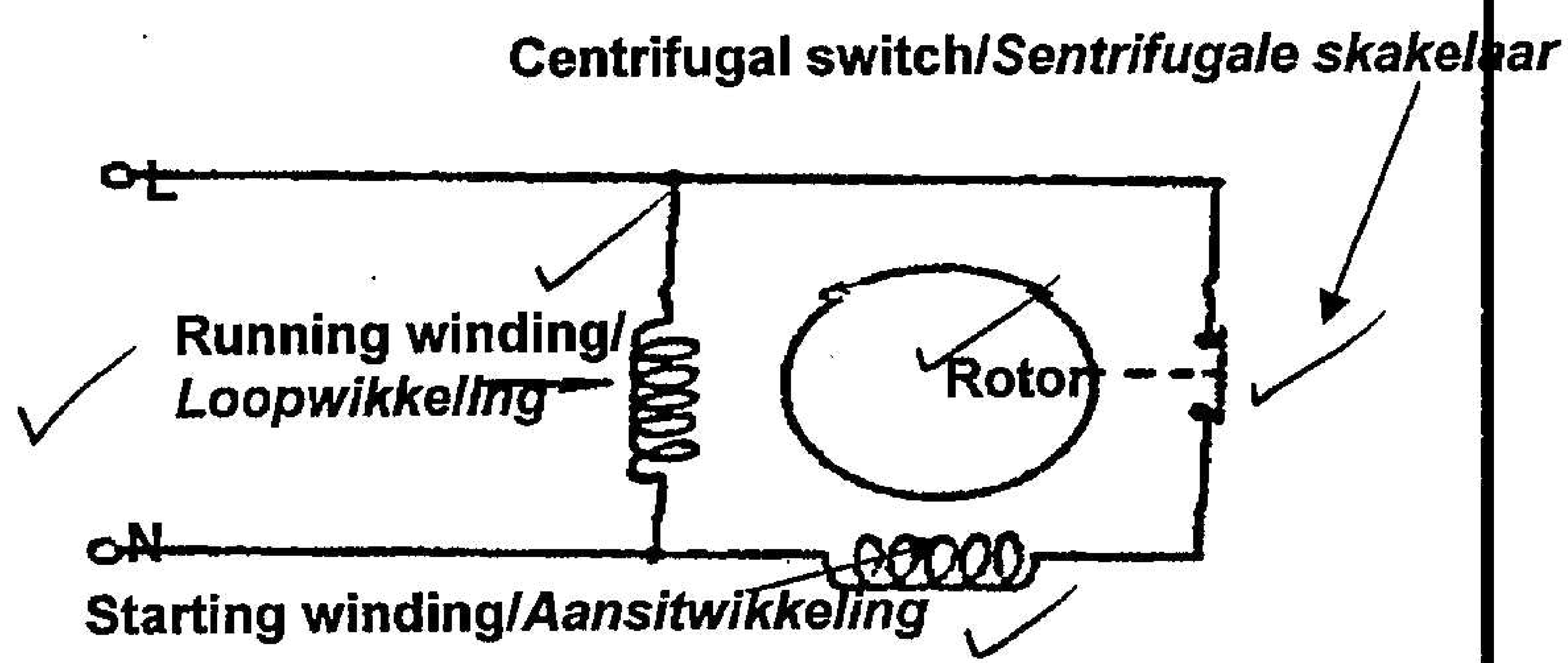
The method just described to make the running winding more inductive and the starting winding more resistive, causes only a small displacement of current between the windings and is in the order of 30°. Since the currents in the two windings are not equal in magnitude, the rotating field is not uniform and the starting torque produced is small.
Uses:
The resistance-start split-phase motor is very widely used for easily started loads. Common applications are for driving washing machines, woodworking tools, grinders and various other low starting-torque applications.
Sizes:
Because of its low starting torque, this motor is seldom used in sizes larger than 0,25 kW. This type of motor is often referred to simply as a split-phase motor.
(Sketch on page 7/*Skets op bladsy 7).*

AANSIT VAN SPLITFASE INDUKSIEMOTOR
Weerstandaansit-splitfasemotor

Die metode wat pas verduidelik is, staan as die weerstandaansit- of soms slegs splitfasemotor bekend. Die faseverskil tussen die strome van die loop- en aansitwikkeling is klein, ongeveer 30°, en die grootte van die twee strome is nie dieselfde nie wat 'n lae aansitwringkrag tot gevolg het.
Gebruike:
Hierdie soort motor word baie gebruik waar die aansitwringkrag wat benodig word laag is. Algemene toepassings is die aandryf van wasmasjiene, houtwerkgereedskap en slypstene.
Groottes:
Weens die lae aansitwringkrag word hierdie motors selde in groottes groter as 0,25 kW vervaardig.



PHASE RELATION/
FASEVERHOUDING



SPLIT-PHASE MOTOR/*SPLITFASEMOTOR*

(10)

[30]

QUESTION 5/*VRAAG 5*

THE TRIAC
This device is correctly called a "bi-directional triode thyristor" which has been shortened to TRIAC. It consists of two back-to-back coupled SCR's which enable it to conduct in both directions, overcoming the disadvantages of a single SCR and so allowing for the full 360° cycle of supply to be passed to a load, under constant control. This makes the TRIAC ideal for a wide range of uses in ac control circuits. A further advantage is that the TRIAC can be triggered into condition with either a protective or a negative gate pulse, no matter what the polarity of the supply to the device.

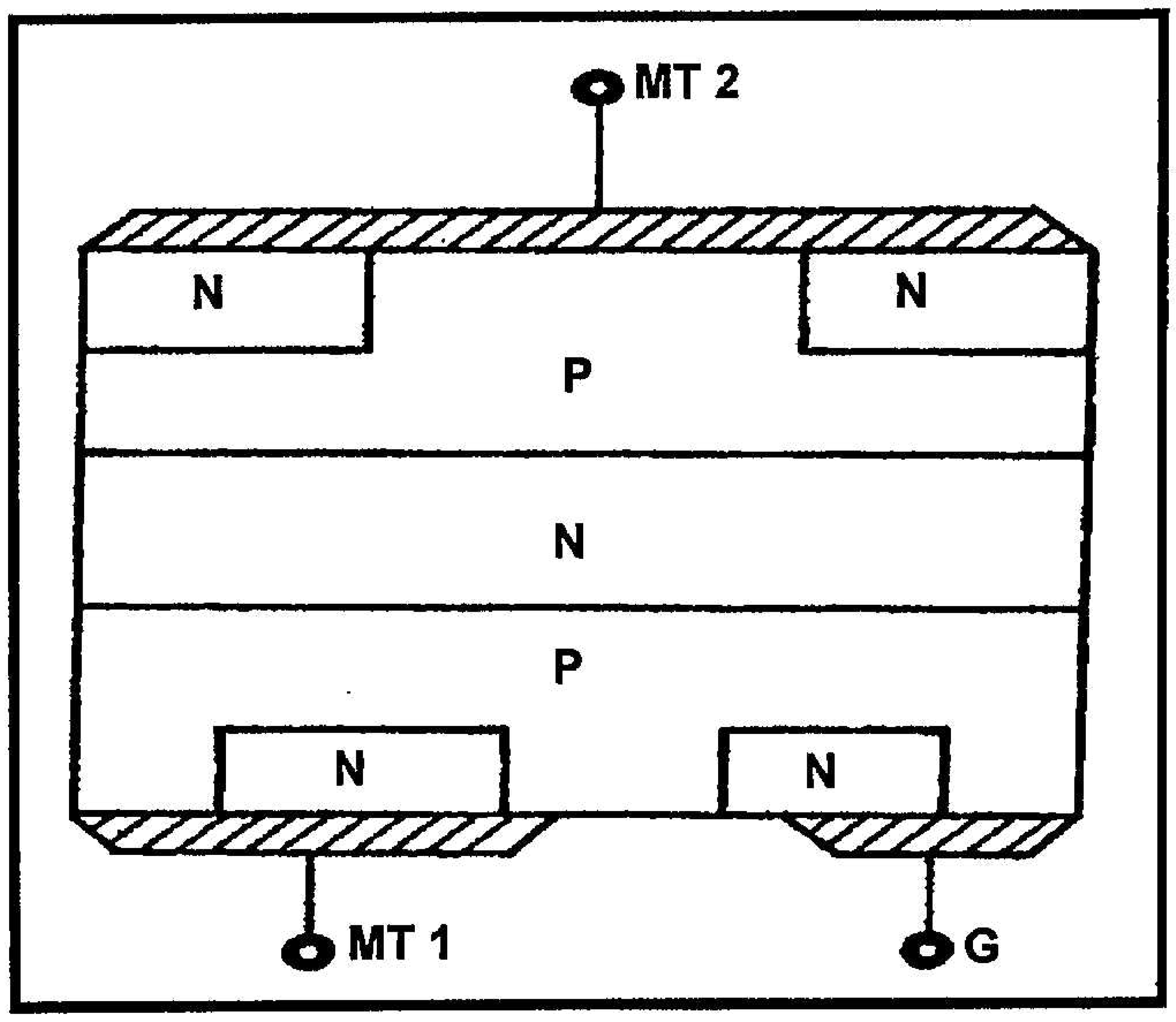
DIE TRIAK
Hierdie toestel se korrekte benaming is 'n "tweerigtingtriodetiristor" wat verkort is na TRIAK. Dit bestaan uit twee rug-aan-ruggekoppelde BSG's wat in staat is om in albei rigtings te gelei, wat die probleme van 'n enkel BSG oorkom en dus die volledige 360°C-siklustoevoer aan 'n las voorsien, onder konstante beheer. Dit maak die TRIAK ideaal vir 'n wye verskeidenheid aanwendings in WS-beheerkringe. 'n Verdere voordeel is dat die TRIAK in geleiding van 'n positiewe of 'n negatiewe hekpuls geaktiveer kan word, ongeag die toevoer van die toestel.

TRIAC CONSTRUCTION
A TRIAC is a modification of a standard SCR with two opposite regions of p-n doped silicon sharing a common central p region connected to the gate terminal. A portion of the outer ends of each side are n doped regions sharing a common connecting lead with the larger p region. The connecting leads, being bi-directional are named main terminal $1\,MT_1$ and main terminal $2\,MT_2$.

BOU VAN DIE TRIAK
'n TRIAK is 'n aanpassing van 'n standaard BSG met twee teenoorgestelde streke van 'n p-n gebalanseerde silikoon met 'n gedeelde p-streek wat aan die hekterminaal verbind is. Gedeelte van die buitenste dele van elke kant is gedeelde n-streke wat 'n gemeenskaplike leiding met die groter p-streek deel. Die gelei leidings is tweerigting, genaamd hoofterminaal $1\,MT_1$ *en hoofterminaal* $2\,MT_2$.

Construction of a TRIAC/
Konstruksie van 'n TRIAC

TRIAC SYMBOL/
TRIAC SIMBOOL



The TRIAC symbol clearly represents the two diodes with arrows facing in opposite directions, sharing a common gate lead.

TRIAC OPERATION
Following the constructional diagram above, each case is considered in turn.
When terminal M_2 is positive, the doped layers $n_4\ p_1\ n_1$ and p_2. A positive signal on the gate will turn the device on.
With terminals M_2 negative and M_1 positive, the main conduction path becomes doped layers $n_2\ p_2\ n_1$ and p_1.

Die TRIAK-simbool verteenwoordig die twee diodes duidelik met twee pyltjies wat in teenoorgestelde rigtings wys en 'n gemeenskaplike hekleiding deel.
TRIAK-WERKING
Volgens die bostaande diagram van die konstruksie, word elke geval beurtelings oorweeg.
Wanneer terminaal M_2 positief is, is die gemeenskaplike lae $n_4\ p_1\ n_1$ en p_2. 'n Positiewe sein van die hek af, sal die toestel aanskakel.

Met terminale M_2 negatief en M_1 positief, word die hoofgeleidingsroete gemeenskaplike lae $n_2\ p_2\ n_1$ en p_1

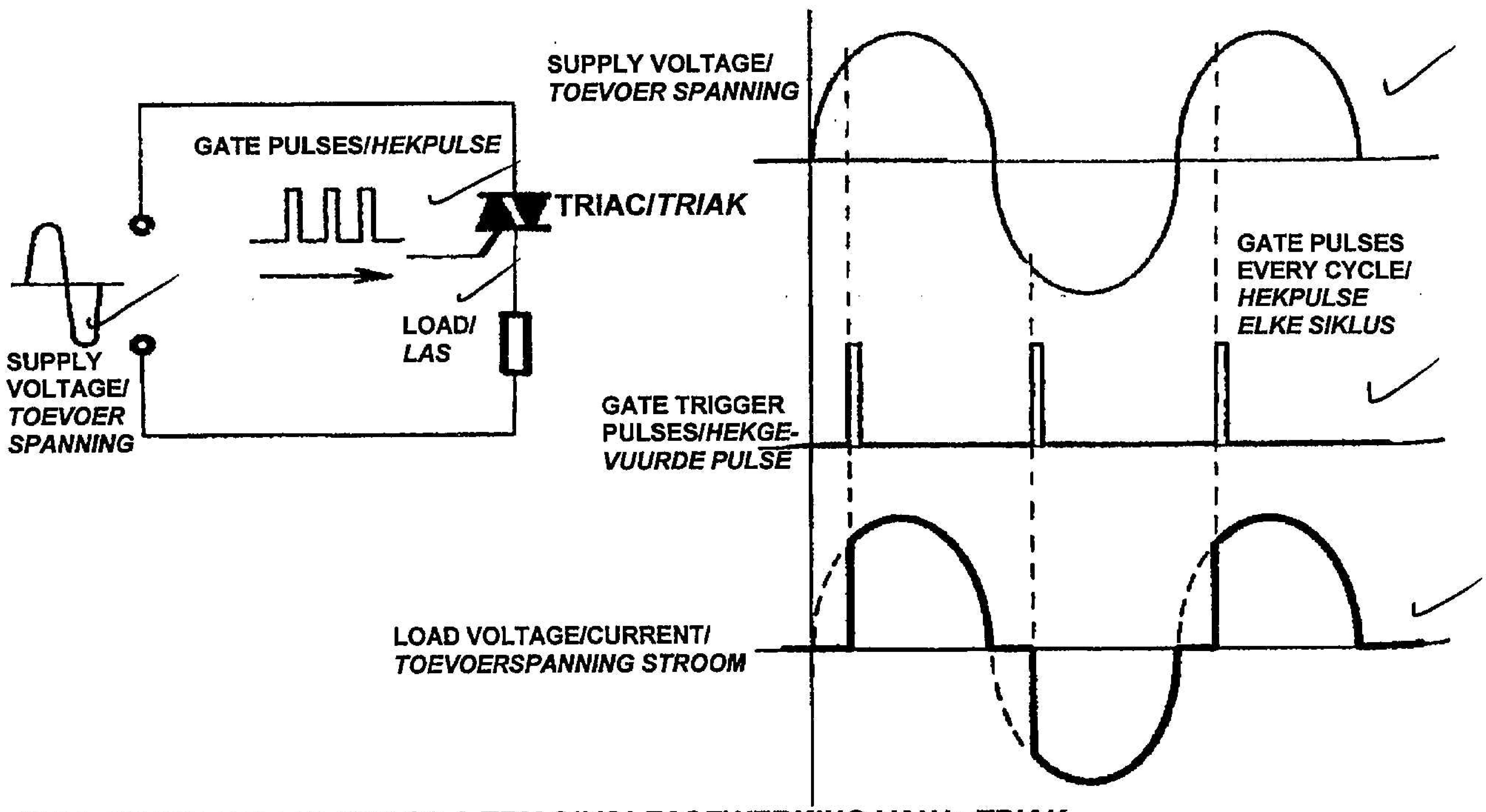
During operation, the three metallic connectors coupling to different n and p layers, each form either npn or pnp transistors in each direction.
Although the TRIAC will conduct irrespective of positive or negative gate signals, it is more sensitive in different directions. Manufacturers have constructed TRIAC's to have preferred connections for minimum heat loss with the following connections:

- In the first half cycle, as M_2 becomes positive, the gate signal is made positive with respect to M_1.
- In the second half cycle, as M_2 is negative, the gate signal is made negative with respect to M_1.

Gedurende werking, word die drie metaalverbinders aan verskillende n en p lae gekoppel, van 'n npn of 'n pnp-transistor in elke rigting. Al gelei die TRIAK – ongeag of dit 'n positiewe heksein ontvang, is dit sensitief in albei rigtings. Vervaardigers het TRIAKS gemaak met die volgende voorkeurverbindings om die minimum hitte te verloor:

- *In die eerste halfsiklus, soos wat* M_2 *meer positief raak, word die heksein positief ten opsigte van* M_1 *gemaak*
- *In die tweede halfsiklus, soos wat* M_2 *negatief word, word die heksein negatief gemaak ten opsigte van* M_1.

TRIAC AC OPERATION
Control is achieved by firing the TRIAC with gate signals at the same point in both the positive and the negative half cycles (i.e. the same firing angle). Just like the SCR, the TRIAC resets and switches off when the supply voltage changes direction. To get the TRIAC to again conduct, another trigger signal must be fed to the gate.
TRIAK WS-WERKING
Beheer word bewerkstellig deur die TRIAK met hekseine op dieselfde punt in die positiewe en die negatiewe halfsiklusse te stimuleer (d.i. teen dieselfde vuurhoek). Net soos die BSG, herstel die TRIAK en skakel af wanneer die toevoerspanning van rigting verander. Om die TRIAK weer te laat gelei, moet nog 'n pulssein aan die hek gestuur word.



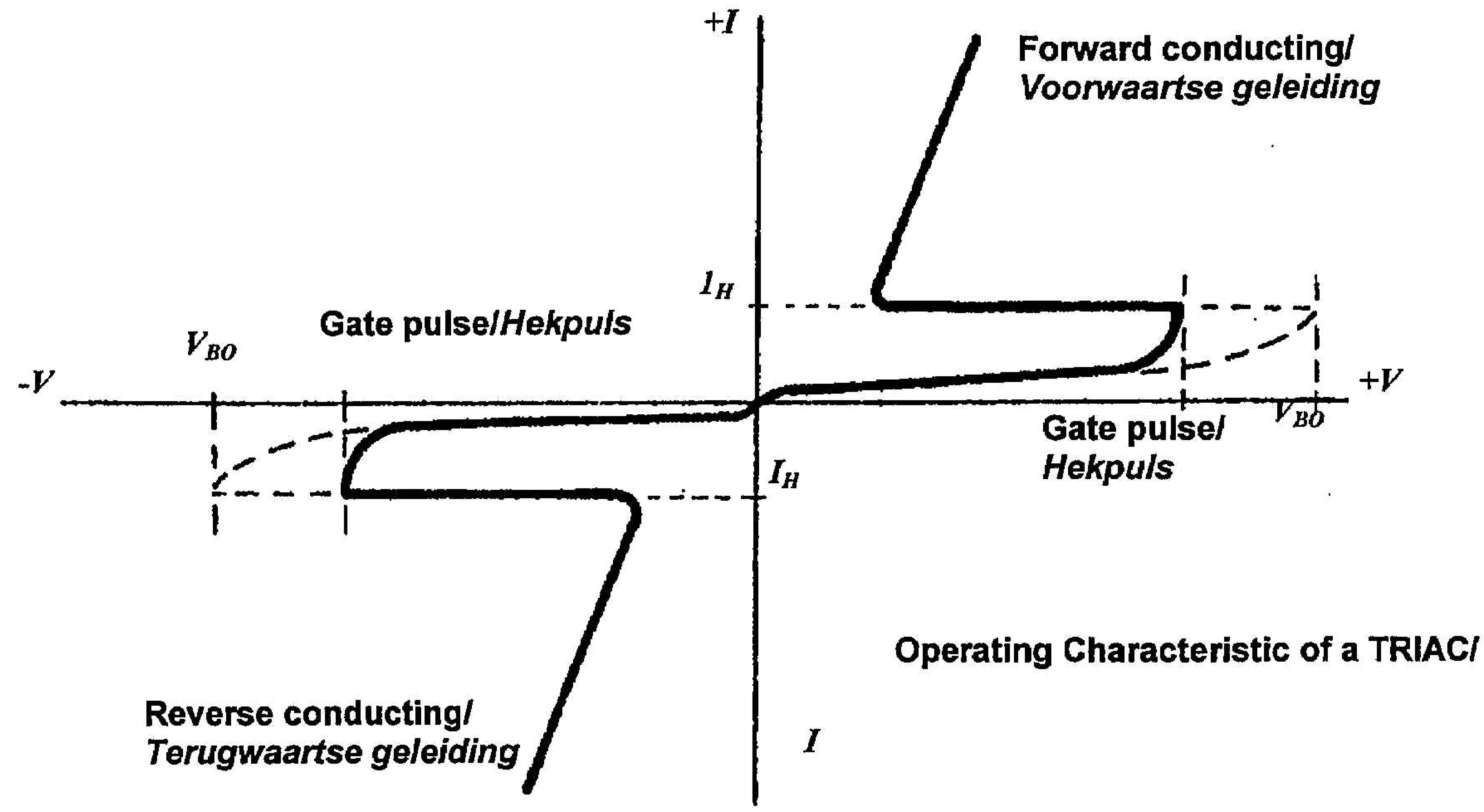
FULL PHASE OPERATION OF A TRIAC/*VOLFASEWERKING VAN 'n TRIAK*

(10)

TRIAC CHARACTERISTIC CURVE
As the TRIAC is a back-to-back SCR, its characteristic curve is identical to two SCR's, each conducting in opposite directions. They each have a forward breakdown voltage V_{BO} and with the appearance of a gate pulse, they will each conduct at that point.

KENMERKENDE KROMME VAN 'N TRIAK

Aangesien die TRIAK rug-aan-rug met die BSG werk, is sy kenmerklike kromme identies aan twee BSG's, wat elk in twee teenoorgestelde rigtings gelei. Hulle het 'n voorwaartse afbreekspanning V_{BO} *en met die verskyning van 'n hekpuls, sal hulle van gedrag verander op hierdie punt.*



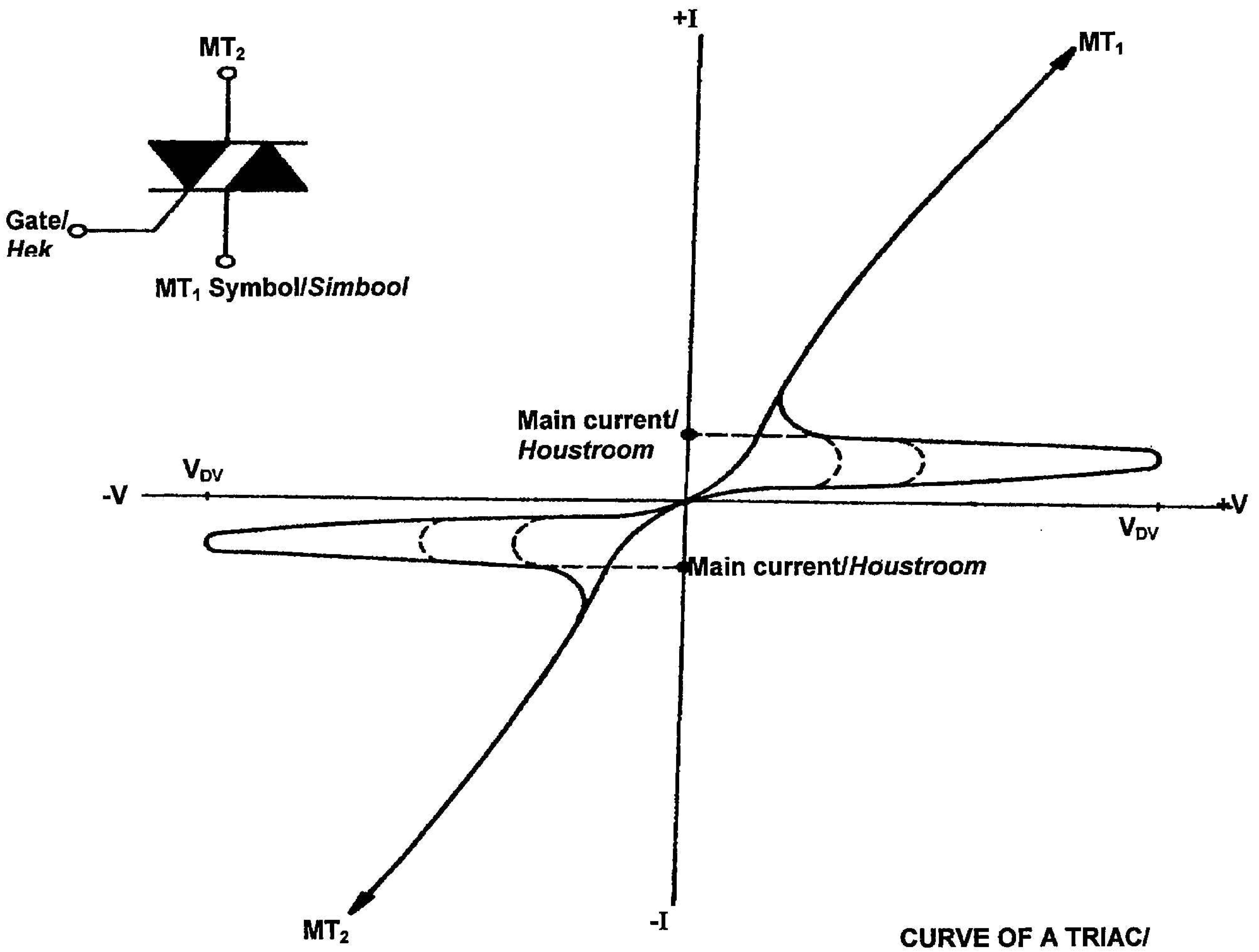
The device operates identically in either direction/*Die toestel tree identies op in albei rigtings*

A TRIAC is considered diac with an additional electrode or gate controlling the on-condition in both directions and differs from a SCR in respect that it can react to a positive or a negative gate signal.

The terminals are referred to as MT_1 *and* MT_2 *(main terminal 1 and 2) and not anode and cathode as in the case of a SCR.*

'n TRIAC kan beskou word as 'n diak met 'n addisionele elektrode of hek wat die aan toestand beheer in beide rigtings, en verskil van 'n SBG in die opsig dat dit kan reageer op 'n positiewe en negatiewe hek sein.

Die terminale word verwys na as MT_1 *en* MT_2 *(hoof terminal 1 en 2) en nie na anode en katode soos in die geval van 'n DBG nie.*



CURVE OF A TRIAC/
KENKROMME VAN 'N TRIAK (1(

[5(

QUESTION 6/*VRAAG 6*

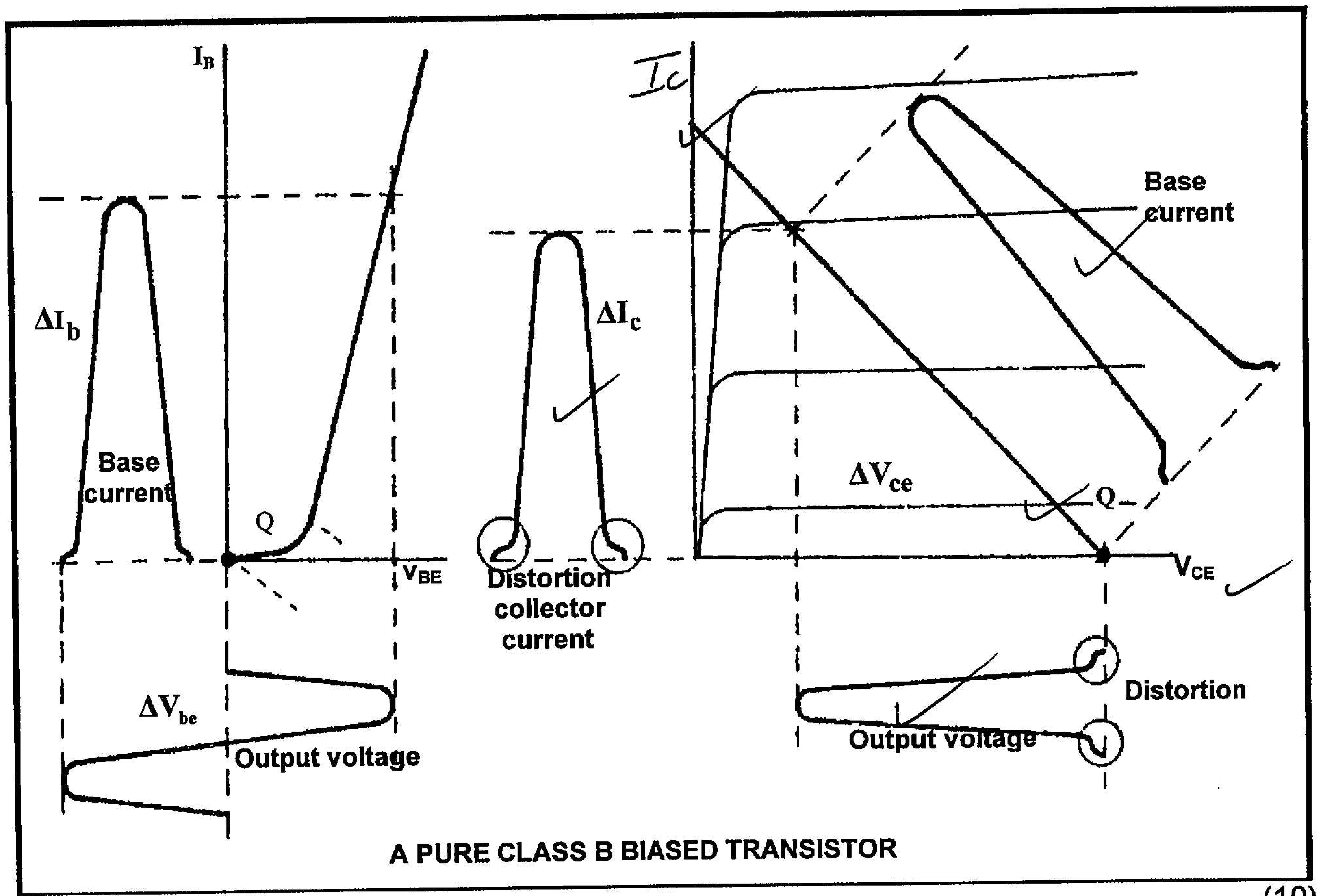
6.1 CLASS B BIASING

In this class of biasing, the transistor is biased with the Q point right at the bottom of the load line right at the cut-off point. It is purposely held off with no base current flowing.

Only when a large enough input signal is introduced, can it forward bias the transistor and the circuit can operate. A sinusoidal input will only be able to energise the transistor into operation in its positive half cycles because the negative halve cycles will not be able to activate the transistor into operation. Each negative half cycle will actually end up holding the transistor off. Therefore the conduction angle Ø of a Class B biased circuit is 180°.

The advantages of this class of biasing is that the transistor remains in its cut-off region drawing no biasing current for as long as no input signal in introduced. It will only go into its active region, drawing current when necessary, this improves its efficiency to 78,5%.

6.1 *KLAS B*



(10)

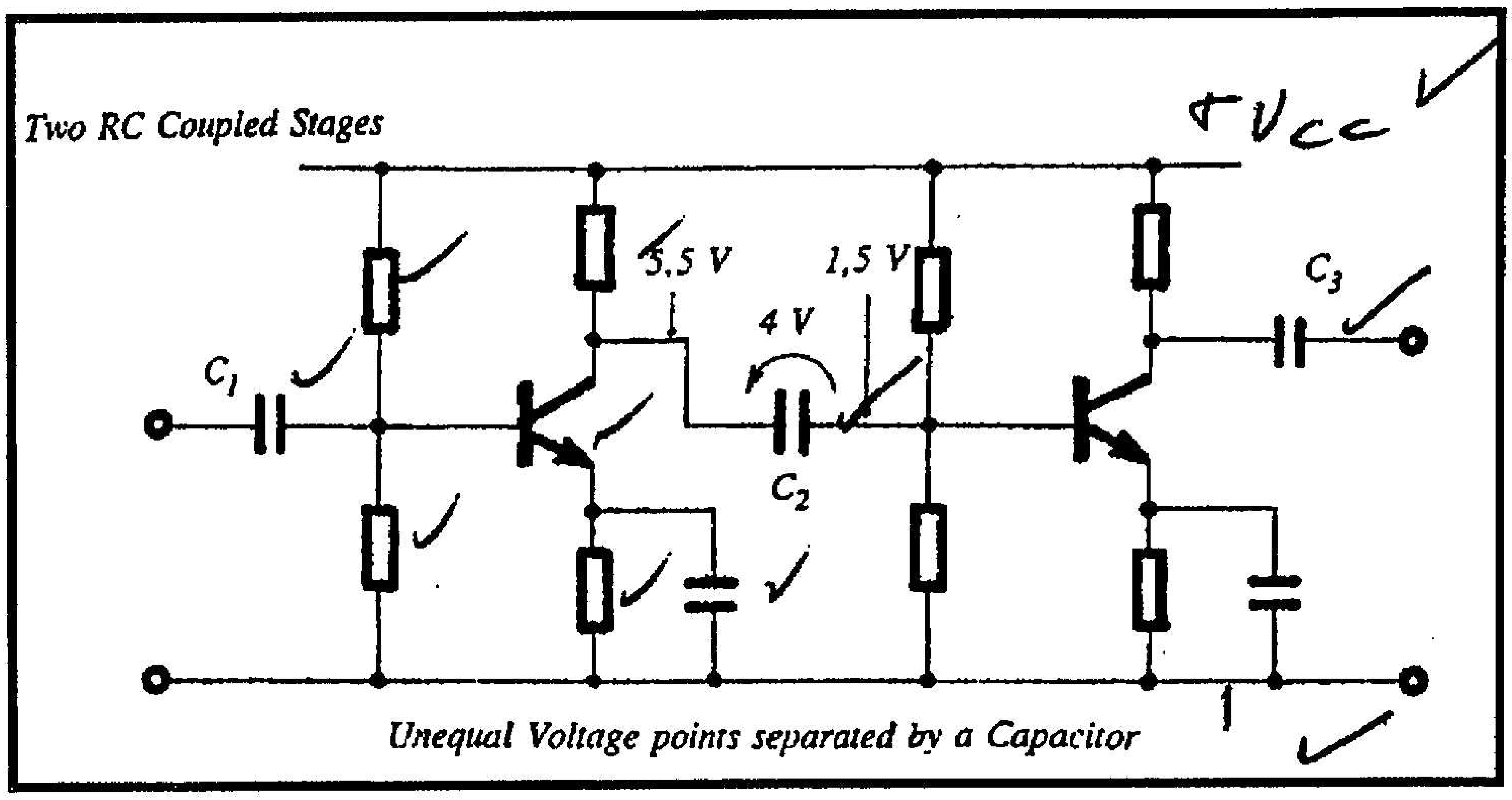
There are two disadvantages of class B biasing

1. as it can only amplify one half of a waveform (180°) it cannot successfully amplify an audio input signal by itself
2. as the transistor is biased in its cut-off region, the first 0,6V of any input signal must overcome the depletion region of the emitter-base junction before the transistor will begin operating. This is in the non-linear part of the transistors characteristic which causes a distortion of the signal which is immediately evident to the human ear as a "blurred" sound to that normally expected. As the ear is so sensitive to these distortions, it is important that audio amplifiers are designed to overcome this distortion.

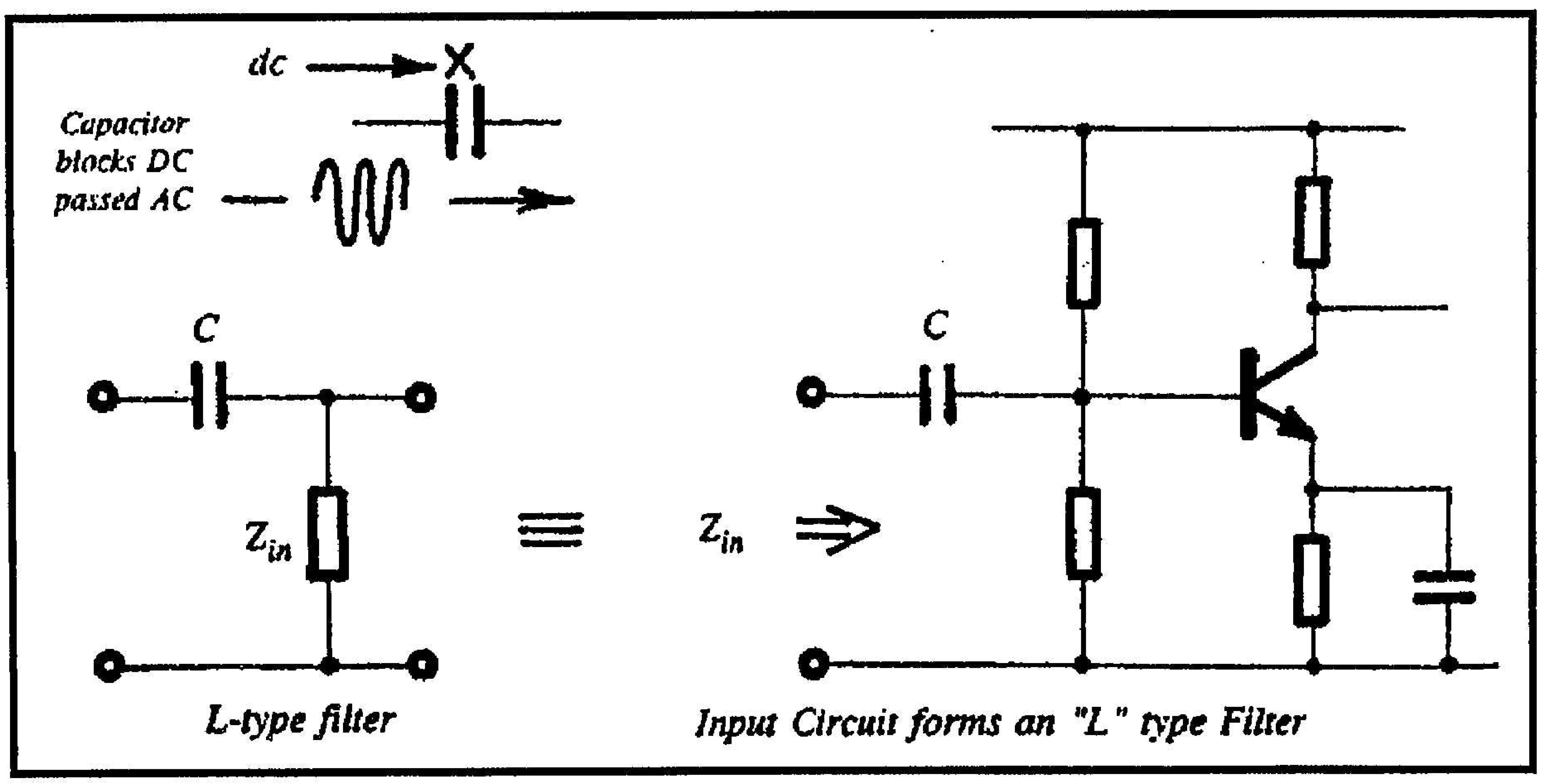
   This class of amplifier is not widely used for audio amplifier purposes because of the non-linear distortion it causes but it does find use in DC servo motor amplifiers. (10)

6.2 Resistor-capacitor (RC) coupling

This is the most common and most 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.



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 5,5V while the other connected to the next transistors base, sits at about 1,5V. Therefore the capacitor stores a charge of 4V between its plates, absorbing the difference in voltage between the stages. When a 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.



The coupling capacitor, together with the input impedance Z_{in} of the following stages forms 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 1Nf at video frequencies quite common. These values are still comparatively quite small. (12)

[22]

QUESTION/*VRAAG* 7

DIE WAARDE VAN DIE SERIERESISTOR

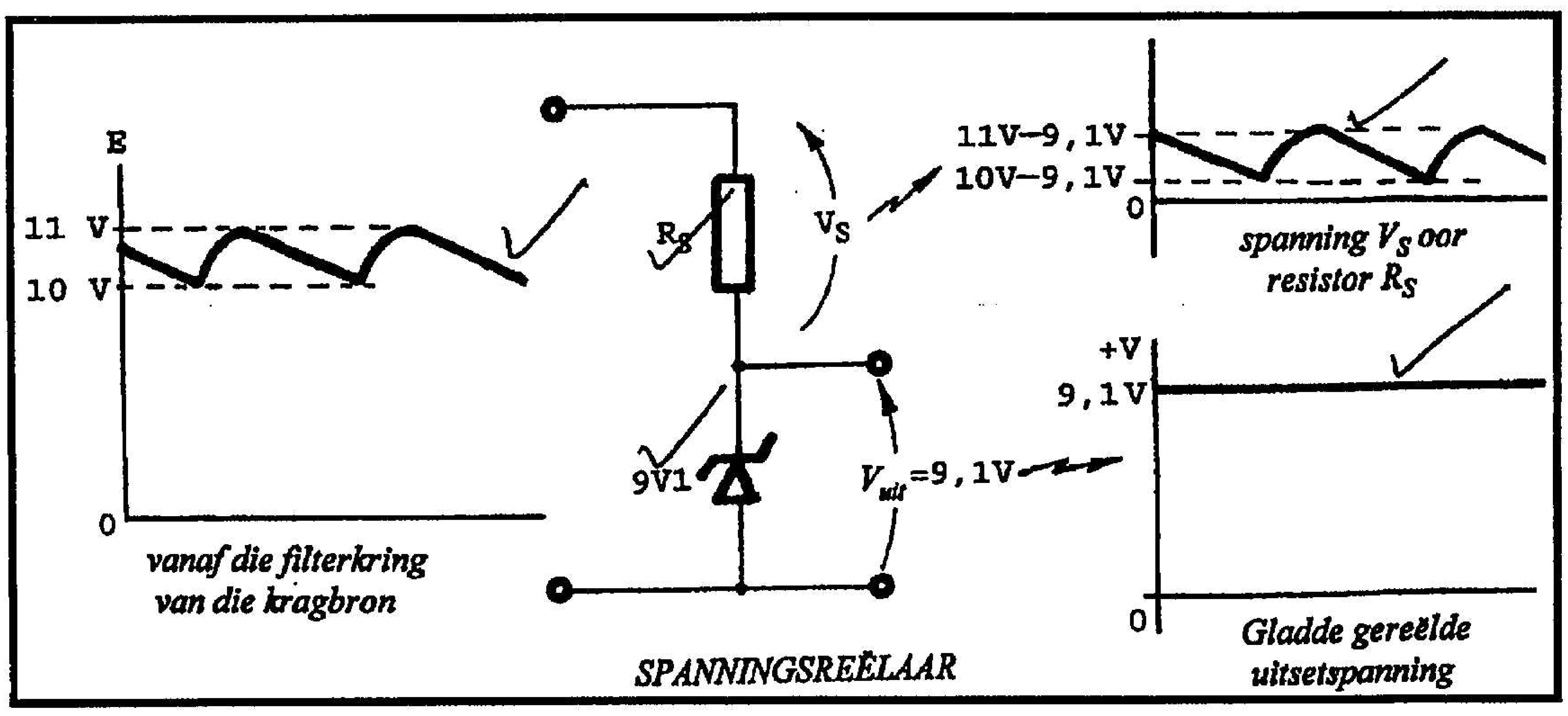
In die ontwerp van 'n zenerdiode-reëlaar moet die waarde van die serieresistor so gekies word sodat die aanslag van die zenerdiode nie oorskry word nie.

Dit is duidelik dat die spanning wat die kragbron voorsien 'n minimum waarde (insluitend die rimpel) moet hê wat groter is as die zenerspanning van die diode, anders kan die diode nie in die konstante spanning gedeelte "in geforseer" word nie.

Die serie resistor R_s word so gekies dat die werkpunt van die zenerdiode in die deurslag omgewing is. Die stroom is gewoonlik laag, ± 10mA, en is genoeg om die zener by die deurslag punt te hou.

DIE ZENERDIODE-REëLAAR

Met die insluiting van die serieresistor, R_{s1}, vorm die kring 'n basiese zenerdiode-sjuntreëlaar. Die kring verskaf 'n konstante uitsetspanning met variërende insetspanning. Enige variasie in die uitset spanning van die kragbron word deur die zenerkring geabsorbeer en lewer 'n konstante spanning oor die uitsetterminale. Die verskil in die kragbron uitsetspanning, E, en die konstante zenerspanning, V_2 word deur die serieresistor "geabsorbeer", V_s.



Beide die lasstroom en die zenerstroom vloei deur die serie resistor, R_s. Die waarde van R_s moet só gekies word sodat genoegsame stroom sal vloei om die zenerdiode by sy deurslagpunt te hou terwyl die nodige stroom deur die las moet vloei. Indien die lasstroom vermeerder, sal die zenerstroom verminder. Die terminaalspanning bly konstant solank as wat die zener by sy deurslagpunt bly. Die kring maak dit nou moontlik om enige verandering in die lasstroom insetspanning te hanteer.

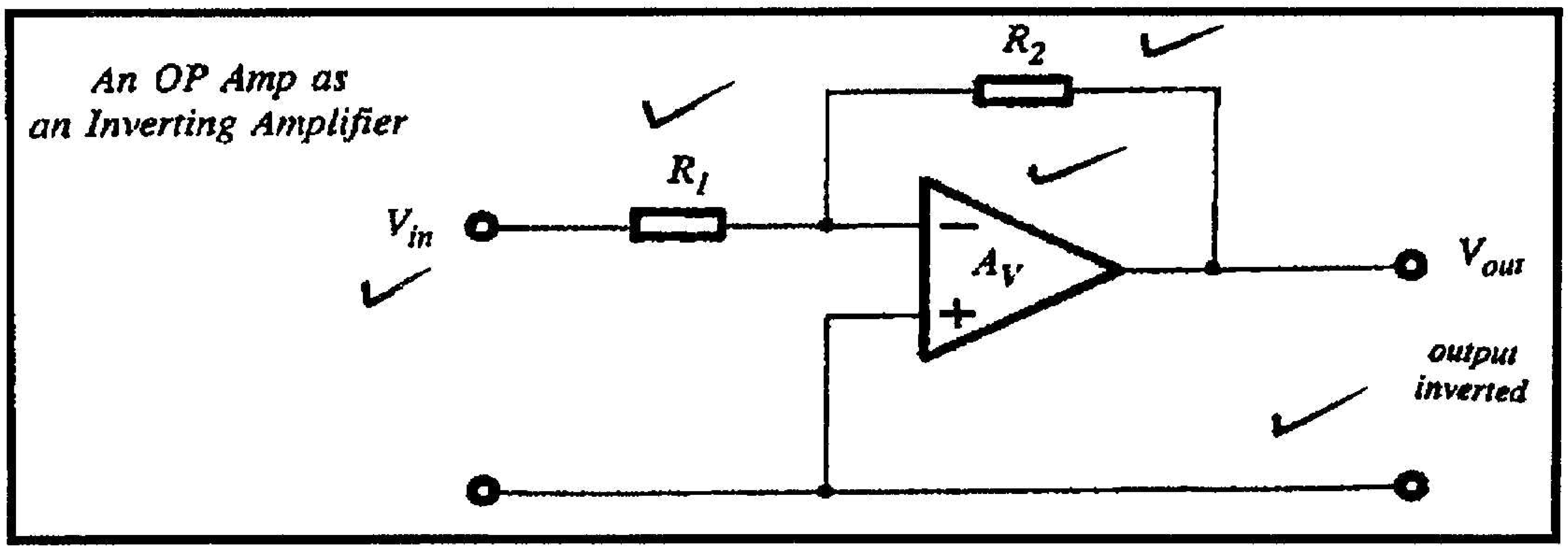
Die nadeel van hierdie kring is dat die maksimum stroom wat dit aan enige las kan lewer beperk is tot die maksimum stroom wat die zener kan dra. (15)

[15]

QUESTION 8/*VRAAG 8*

8.1 THE INVERTING AMPLIFIER

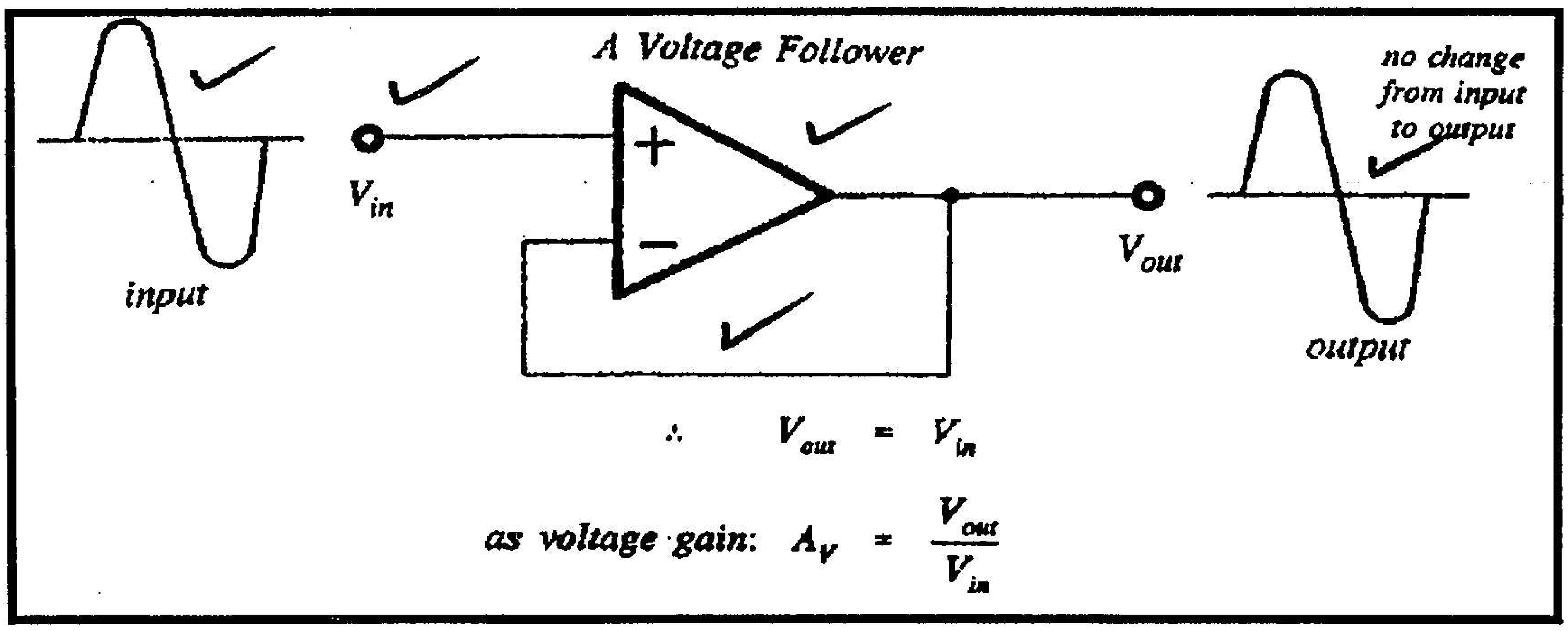
This circuit will invert and amplify any input signal. The amount of amplification experienced by die input signal is determined solely on the ratio of the two external resistors R_1 and R_2.



(5)

8.2 THE VOLTAGE FOLLOWER

This circuit uses a feedback loop of 100% where all the voltage appearing at the output voltage is fed around back to the inverting (-) input terminal:

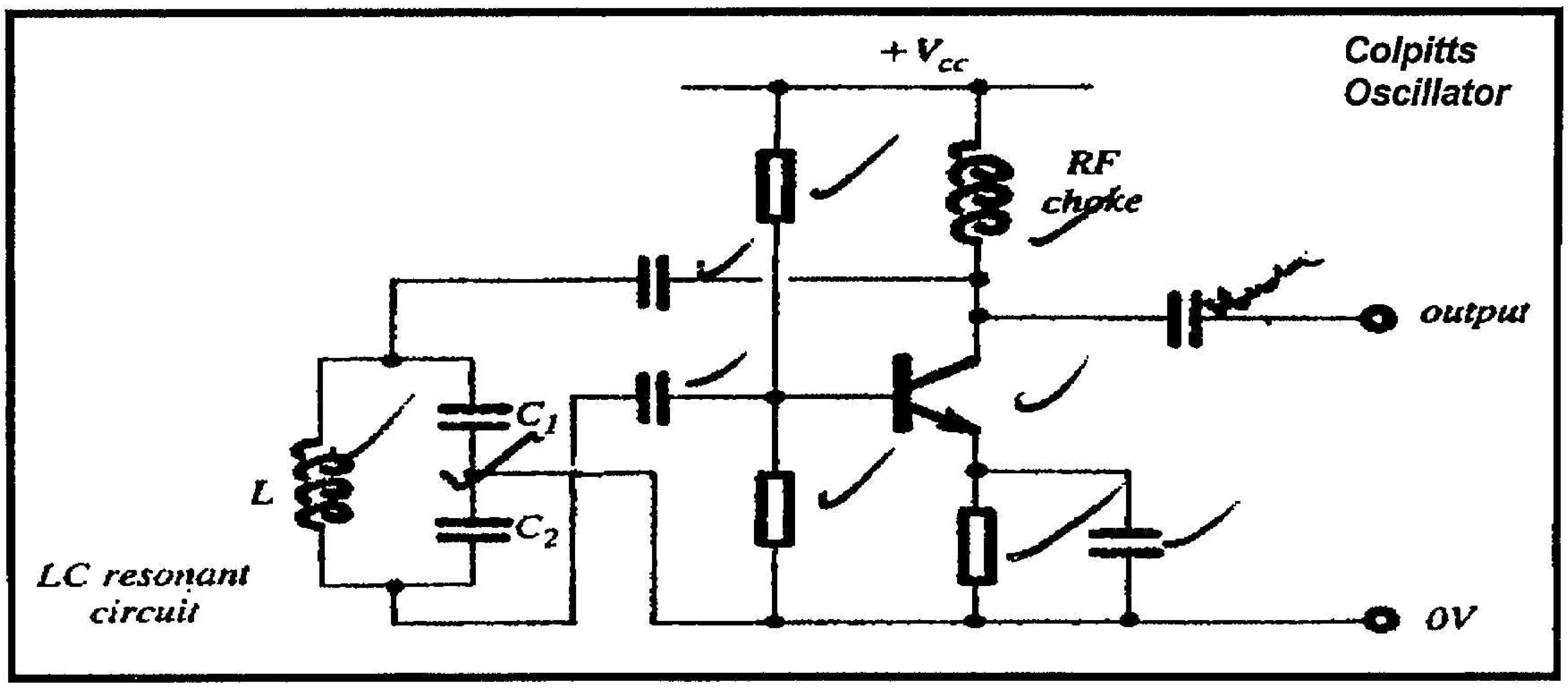


(5)
[10]

QUESTION 9/*VRAAG 9*

9.1 COLPITTS OSCILLATOR

The Colpitts oscillator is similar to the Hartley circuit except that the components in its resonant tank circuit are reversed. The Colpitts tank circuit consists of two capacitors and one inductor, with the common point between the capacitors coupled to the emitter terminal. The tank circuit resonates at the desired frequency of oscillation and, like the Hartley oscillator, it is very frequency selective so it discriminates against all other unwanted frequencies. This circuit is widely used in signal generator circuits above 1 MHz because of its good frequency stability.



(10)

The circuit's attention can be shown to be:

$$\beta = \frac{C_2}{C_1}$$

with its resonant frequency being:

$$f_o = \frac{1}{2\pi\sqrt{LC_T}\ H_Z}$$

where the total series capacitance:

$$C_r = \frac{C_1 C_2}{C_1 + C_2}$$

Like the Hartley oscillator, this circuit also makes use of an RF choke in the collector line to increase the AC impedance of the collector circuit. It also uses coupling capacitors between the tank circuit and the amplifier to act as a DC block, allowing only the RF signal to pass back into the amplifier.

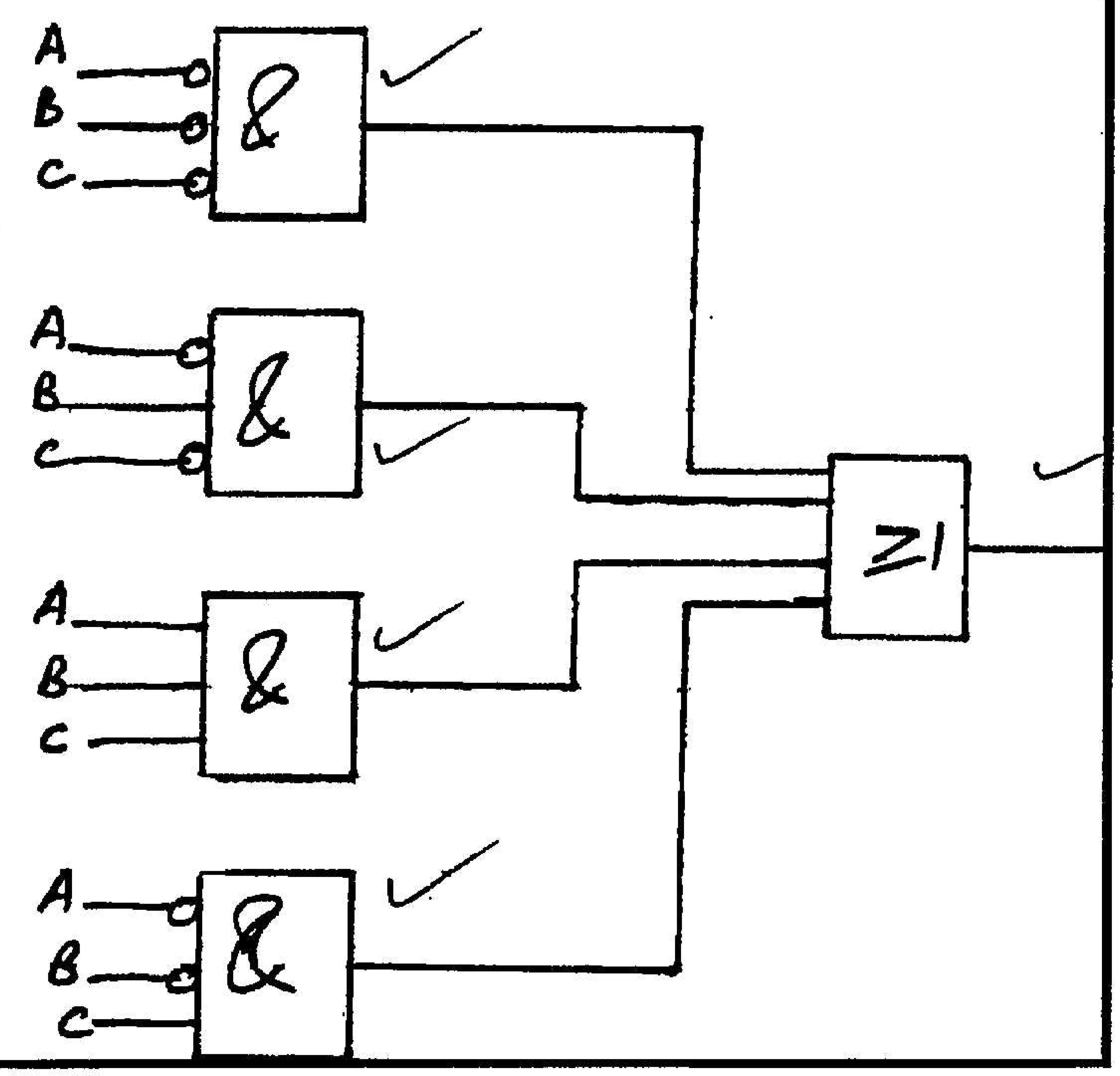
Other circuits which operate on the same oscillating tank principle are the:

1. Clapp oscillator (which is a modified Colpitts circuit).
2. Crystal oscillator which relies on a resonating crystal which, at resonance, takes on all the properties of an LC tank circuit.

QUESTION 10/*VRAAG 10*

10.1

A	B	C.	F.
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



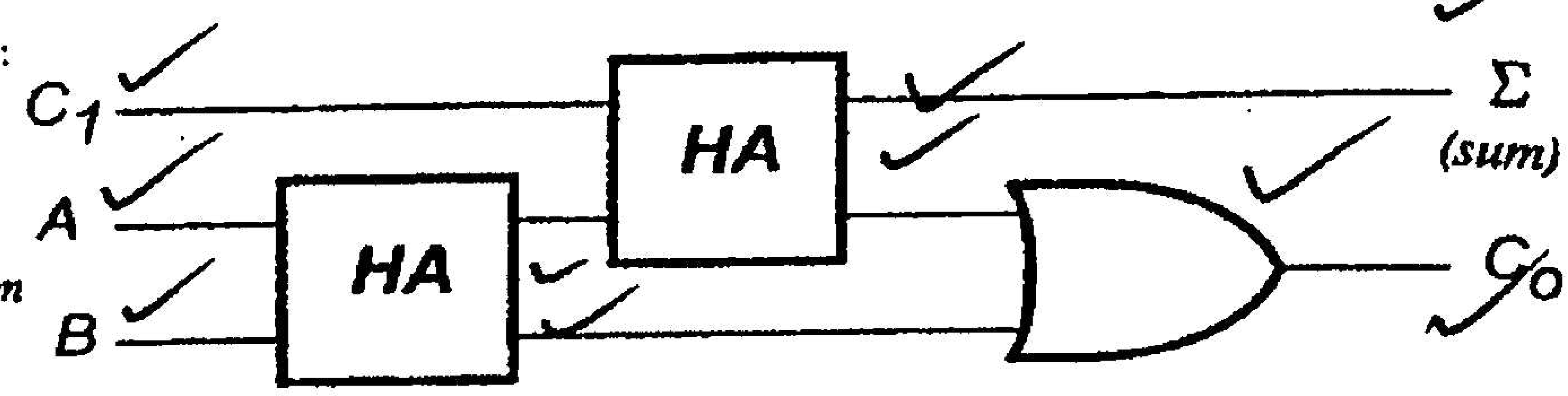
(8)

THE FULL ADDER

This logic circuit must be able to add three bits at a time. It is an extension of the half adder circuit which also is able to take into account a carry-over from a previous circuit. It has three inputs, the two binary inputs A and B, as well as the carry-over C_o. The circuit consists of two half adders which feed their results into an OR gate. To achieve the sum Σ of all inputs, they must be EXORred together through the two half adders.

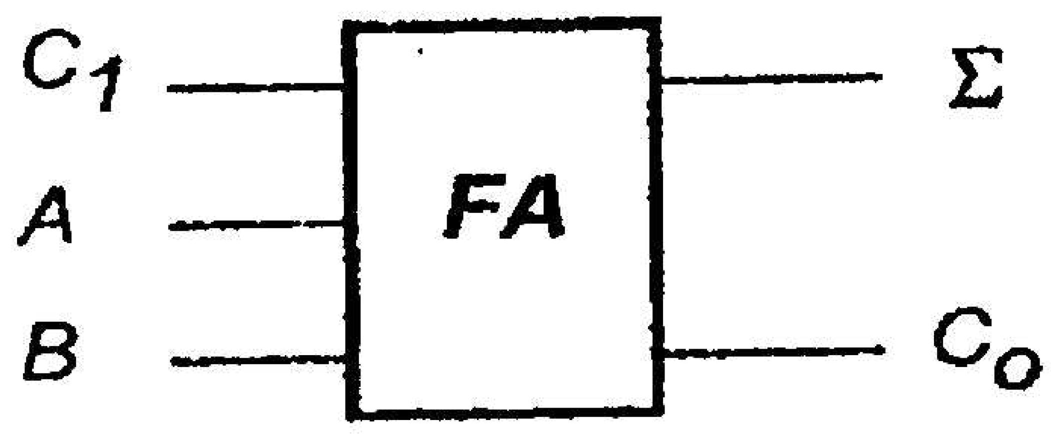
The expression for the sum result will be: $\Sigma = A \oplus B \oplus C_0$
The expression for a carry-over bit is: $C_0 = A \cdot B + C_0 \cdot (A \oplus B)$

A simplified circuit is:



Simplified Block Diagram of a Full Adder

The logic symbol is:

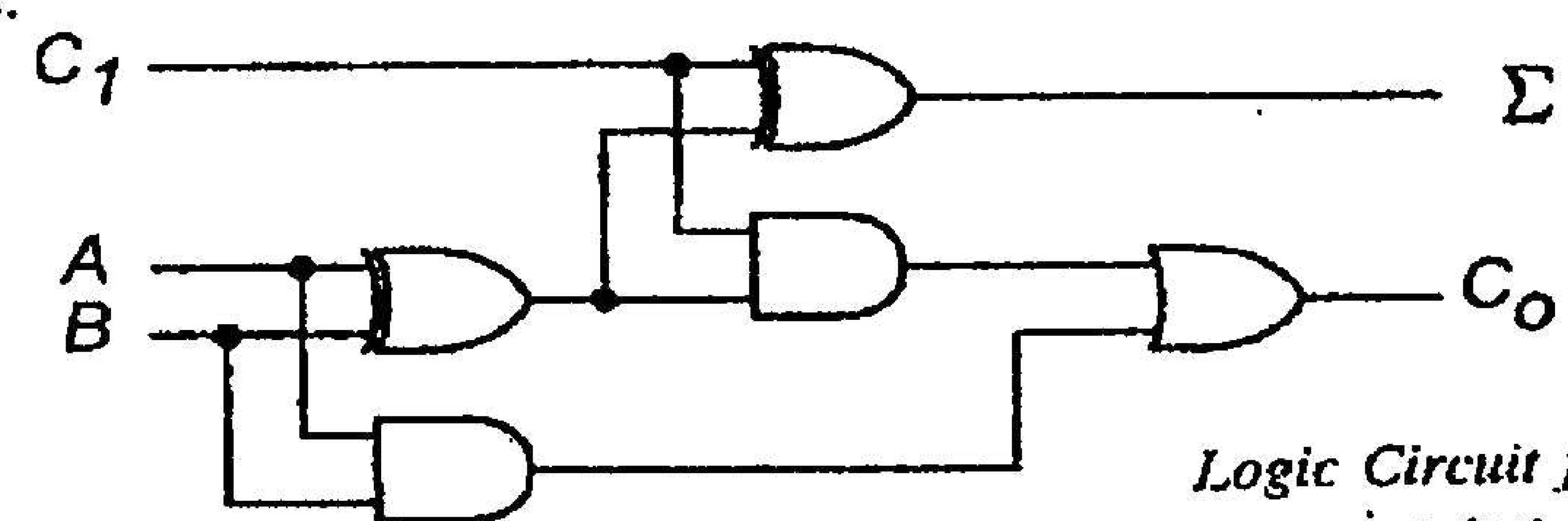


Full Adder Logic Symbol

The truth table for this circuit shows the three inputs including the carry-over C_0 from a previous stage. The two outputs reflect the sum of the three inputs (Σ) and a carry-over output C_0.

INPUTS			OUTPUTS	
C_1	A	B	Σ	C_0
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

One version of the complete logic circuit is shown below. There are other versions which make use of different logic gates.



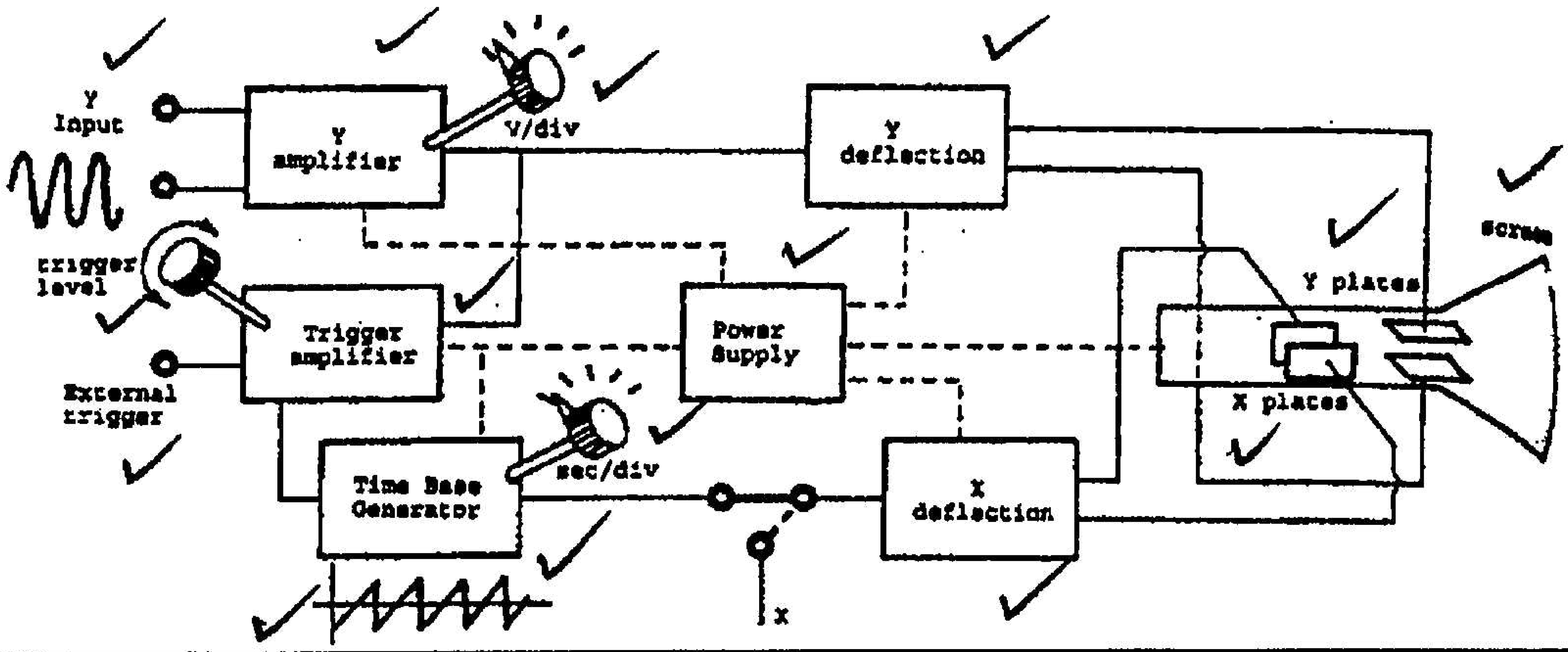
Logic Circuit for a Full Adder using two Half Adders

[18]

QUESTION 11/*VRAAG 11*

7.9.4 BLOCK DIAGRAM OF AN OSCILLOSCOPE

The internal circuitry of an oscilloscope can be simplified by representing the operation of each section by a block. The block diagram of the oscilloscope is shown below.



(15)

TOTAL/*TOTAAL:* 200