# MEHAR ALI KHAN

## 17PWELE5074

**SECTION A**

**ELECTRICAL ENGINNERING DEPARTMENT**

**5$^{TH}$ SEMESTER**

**POWER ELECTRONICS**

**LAB REPORT**

**SIR FAHEEM ALI**

# EXPERIMENT NO [redacted] 1:

## TITLE:
INTRODUCTION TO POWER ELECTRONICS

## POWER ELECTRONICS:

Power electronic deals with the conversion of power from one form to another. Typical application of power electronics include conversion of ac to dc (Rectification), conversion of dc to ac (Inversion) and conversion of an ac power from one frequency & amplitude to another (cyclo-conversion). It is use to control speed of induction motor.

## MAIN OBJECTIVE OF POWER ELECTRONICS:-

The purpose of power electronic circuit is to match load (V & I) to that of the source. Power Electronic circuit convert one level of voltage or current waveform to another and hence are called converters.

## POWER ELECTRONICS CONTROL UNIT PE 481:

It is use in power electronics lab. We implement ~~our~~ power electronics circuit on control unit. It has two positions for inserting other circuits

1) Power module position
2) Control module position

It consist of three ammeters and two voltmeters. We can take constant DC power supply as well as variable. we can also take ac power supply from control unit. The maximum dc output which we can take from this unit is 30V and 2A.

Basically control unit provides platform for the implementation of ckt.

## POWER ELECTRONIC LCR LOAD UNIT PE 481:

Load unit consist of passive elements i-e variable resistor variable inductor and Electrolytic Capacitor. We change the value of resistance and inductance by knob.

## SINGLE THYRISTOR CIRCUITS PE 481A:

This circuit consist of full wave bridge rectifier, sensitive gate thyristor. We insert this circuit in power module position of control unit.

## BASIC TRIGGER CIRCUITS PE 4810:

It is a triggering circuit consist of DIAC characteristic circuit. We insert this circuit in Control module position of control unit. It is use to control other electronic circuits.

# EXPERIMENT NO 2:

**TITLE:** DC Test of SCR
To study switching of an SCR (DC test).

## APPARATUS:

Power Electronics LCR LOAD UNIT PE-482
Single Thyristor circuits PE 481A
Voltmeter
Ammeter
Connecting wires.

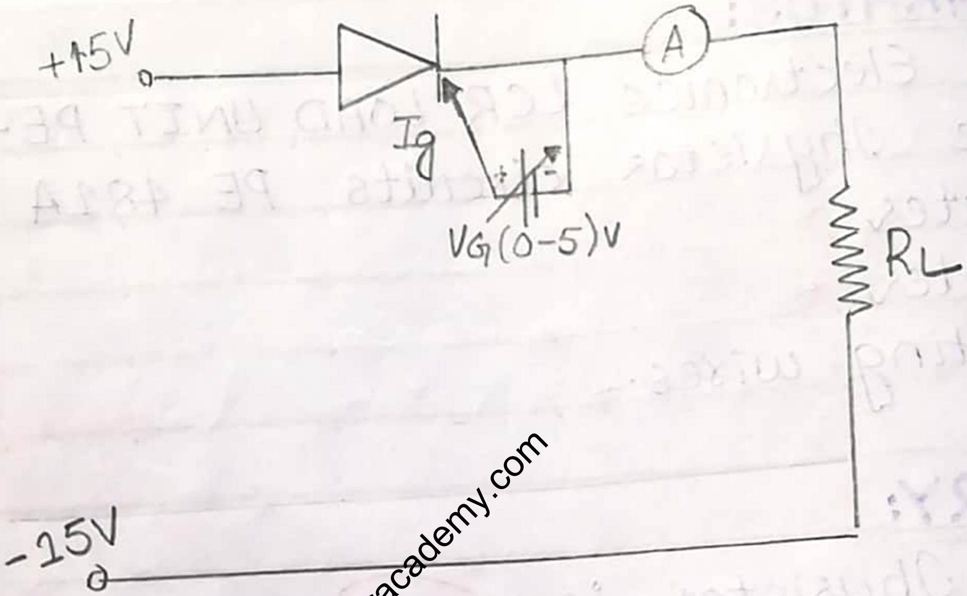
## THEORY:

Thyristor is an electronic switch use in power electronic devices for switching purpose. It is a three terminal device and has three types

a) Silicon Control Rectifier (SCR)
b) Gate turn-off rectifier (GTO)
c) MOS-controlled rectifier (MCT)

Thyristor carry large currents. It has high breakdown voltage. It is use for high power applications. It is not suitable for high frequency because reverse recovery current flows in it for time trr.

## CIRCUIT DIAGRAM



SCR is a type of thyristor, use for switching purpose in power electronic devices.

For SCR to begin to conduct, it must have a gate current applied while it has positive anode to cathode voltage. After conduction is established the gate signal is no longer required to maintain anode current. The SCR will continue to conduct as long as anode current is positive and above a minimum value called the holding level.

SCR can be only turn-ON by providing the gate current.

## PROCEDURE:

To implement the circuit I use Power electronic control unit, single thyristor circuits, Power Electronics LCR load unit, ammeter, voltmeter and connecting wires. I insert single thyristor circuit in PE control unit. Then I implement the circuit according to the circuit diagram.

## OBSERVATION:

| S.No | Ig(mA) | Vg(V) | iL(A) |
|---|---|---|---|
| 1 | 0.02A | 0.634V | 1.55A |
| 2 | 0.02 | 0.634V | 1.3A |
| 3 | 0.02 | 0.634 | 1.1A |

Then I connected voltmeter and ammeter to measure gate current and gate voltage.

## PRECAUTIONS:-

1) Connection must be tight.
2) Properly insert the thyristor ckt in control unit.
3) Take readings accurately.

## CONCLUSION:

I concluded that how we uses SCR for switching purpose. To turn ON SCR two conditions must be fulfilled

1) Anode should be positive with respect to cathode.
2) Short duration gate current.

Once the SCR is turn ON and we remove gate current it will be still turn ON.

# EXPERIMENT NO 3: 5074

## TO STUDY SWITCHING OF AN SCR (AC TEST)

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## APPARATUS:

Power Electronics Control unit PE 481
Power Electronics LCR Load unit PE 481
Single thyristor circuits PE 481A

SCR Characteristics

## THEORY:

Thyristor is an electronic switch use in power electronics. It is a three terminal device and has three types

1. Silicon Control Rectifier (SCR)
2. Gate turn-off transistor (GTO)
3. MOS- controlled rectifier (MCT)

Thyristor carry large currents. It has high breakdown voltage. It is use for high power applications. It is not suitable for high frequency because reverse recovery current flows in it for time trr.

SCR is a type of transistor use for switching purpose in power electronic devices.

For SCR to begin to conduct, it must have a gate current applied while it has positive anode to cathode voltage. After conduction is established the gate signal is no longer required to maintain anode current. The SCR will continue to conduct as long as anode current is positive and above a minimum level called the holding level.

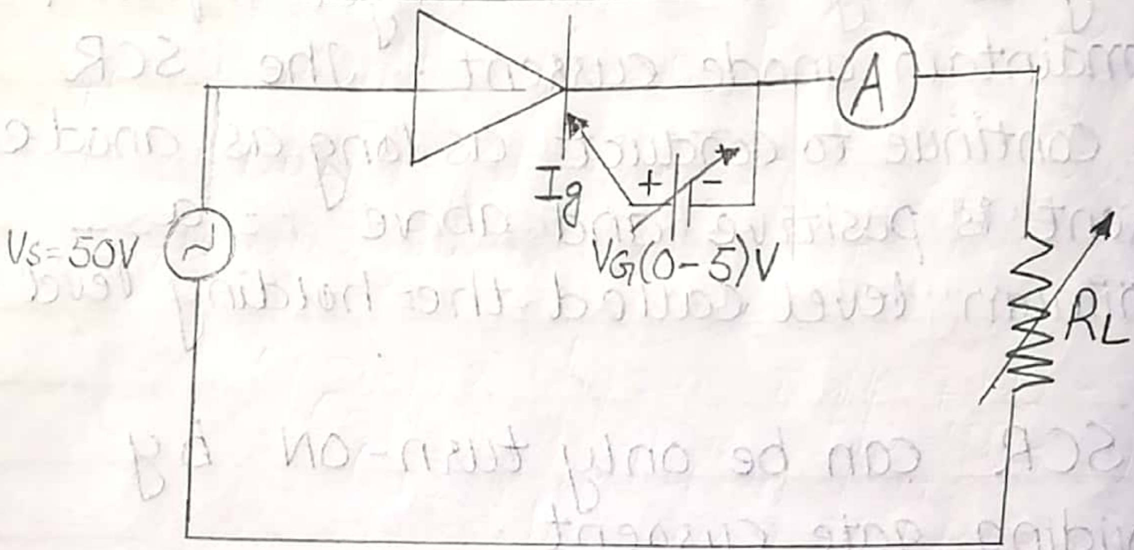
SCR can be only turn-ON by providing gate current.

NOTE:- For SCR to conduct the above mentioned two conditions must be fulfilled. In case of DC test when we apply +ve voltage (i.e anode is positive w.r.t cathode) and provide a gate signal the SCR start conduction if we remove the gate signal the SCR continue to conduct.

In case of AC test when we apply AC voltage to the ckt and gate signal is constantly provided to SCR so we get half wave rectified ~~to~~ at output (across $R_L$). This is because for the positive half cycle of the AC voltage anode is +ve w.r.t cathode & gate pulse is also provided. The SCR will act as short ckt and we get waveform

## CIRCUIT DIAGRAM

### SILICON CONTROL RECTIFIER (SCR)



similar to that of input waveform across $R_L$. ($V_S = V_L$).

For the negative half cycle the first condition does not fulfilled and SCR will be reverse biased although gate pulse is provided, the SCR will act as an open switch and we get nothing at the output.

If gate pulse is constantly provided in case of AC test we get half wave rectified output across $R_L$. If we remove gate pulse we get 0 volts across $R_L$ (as SCR will act as an open switch

## PROCEDURE:

To implement the circuit I use power electronics control unit, single thyristor ckt, power electronics LCR load unit and connecting wires. I insert single thyristor circuit in power electronic control unit Then I implement the circuit according to the circuit diagram

## PRECAUTIONS:

1) Connections must be tight.
2) Properly insert the thyristor circuit in control unit
3) Take readings accurately

# CONCLUSION:

I concluded from this experiment that in case of AC test if we remove the gate pulse the SCR will act as an open switch and we get 0 volt across RL. And if gate pulse is constantly provided we get half wave rectified output across RL

In case of DC test once the SCR is turn ON and we remove gate current it will be still turn ON.

# EXPERIMENT NO 4: 5074

To study single phase control of an SCR (Resistive load)

## APPARATUS:

Power Electronic control unit PE 481.
Power Electronic LCR load unit PE 481.
Single thyristor circuits PE 481A.
Basic trigger circuits PE 4810.

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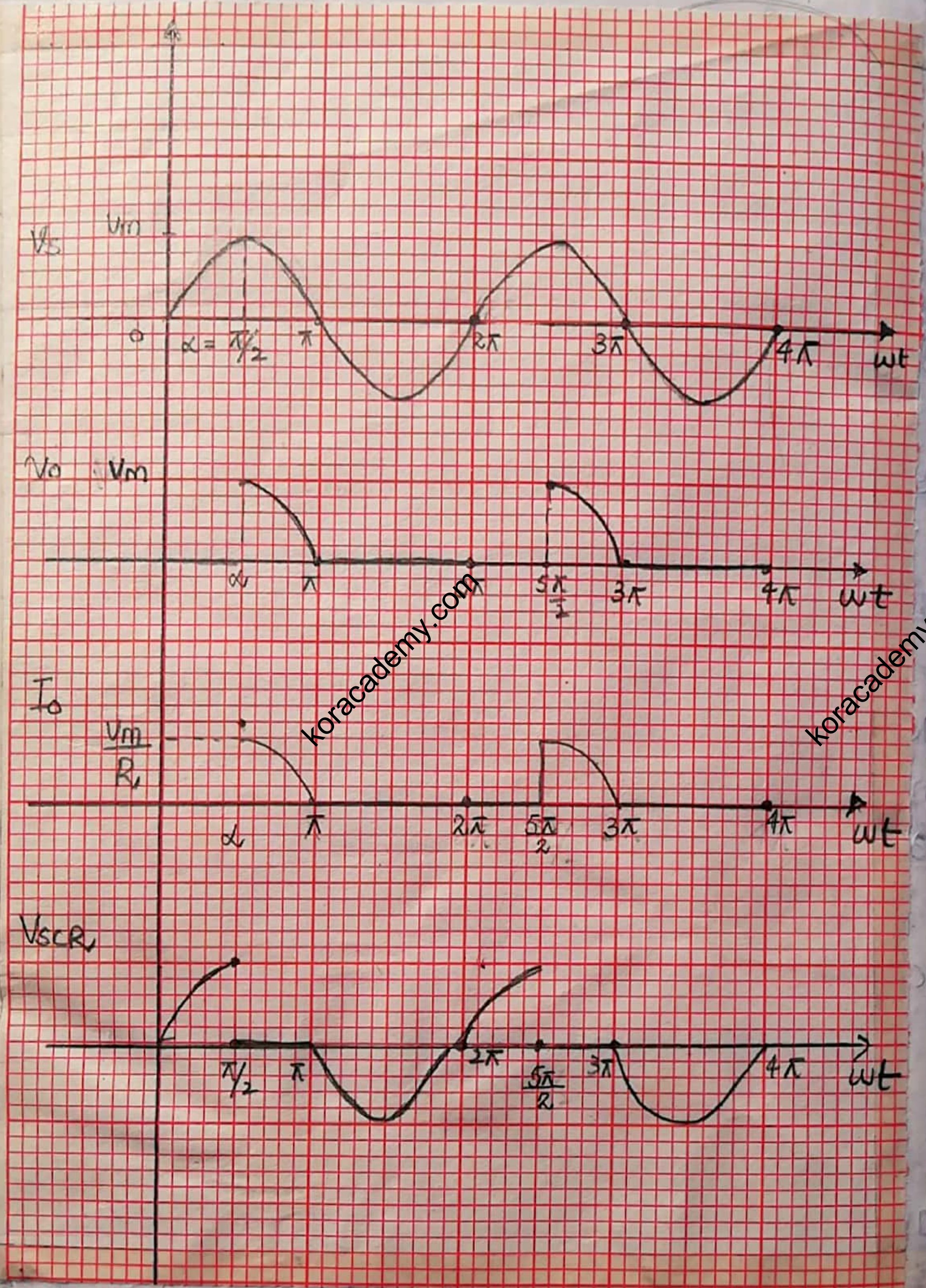
$\alpha_2 + \alpha_3$? incomplete

## THEORY:

We have two types of rectifiers Uncontrolled Half Wave Rectifier and Controlled Half Wave Rectifier. When we uses diode in half wave rectifier so it is uncontrolled half wave rectifier. Its average value is given by

$$V_o = \frac{V_p}{\pi}$$

A way to control output of a half wave rectifier is to use is to use an SCR instead of a diode. Fig Shows a basic controlled half wave rectifier with a resistive load Two conditions must be met before the SCR can conduct




HALF-WAVE CONTROLLED RECTIFIER

VOLTAGE WAVEFORMS

1. The SCR must be forward biased
2. A current must be applied at the gate of SCR.

The average value across the load resistor is

$$V_o = \frac{V_m}{2\pi}(1 + \cos\alpha)$$

In uncontrolled H.W rectifier once the source and load parameters are established, the average value across load is a fixed quantity. But in case of controlled half wave rectifier if we change firing angle ($\alpha$) so the average or dc voltage across load resistor will change.

## PROCEDURE:-

To implement the controlled half wave rectifier circuit I insert Basic trigger circuit in control module position of the Power Electronic control unit. I insert the Basic Thyristor circuit power module position. I only

| S No | α degree | Vo (V) | Vrms (V) | Io (A) | Irms (A) | Vo (V) Actual | % Error |
|---|---|---|---|---|---|---|---|
| 01 | 32° | 20V | 33.4V | 0.4A | 0.66A | 19.7 | 1.5% |
| 02 | 42.4° | 18V | 32V | 0.36A | 0.64A | 16.9 | 6.5% |
| 03 | 61.4° | 16V | 32.1V | 0.32A | 0.64A | 16.7 | 4.19% |

Calculation $V_o = \frac{V_m}{2\pi}(1+\cos\alpha)$ — ①

From oscilloscope: 29sd = 360° ⇒ 1sd = 12.41°

$V_m = 34 \times 2 = 68$ V

$\alpha + \pi = 18.5$ div ⇒ $\alpha = 18.5 - 14.5$

⇒ $\alpha = 3.5 \times 12.41$ ⇒ $\alpha = 43.4°$

Put α in ① ⇒ $V_o = 16.9$ volts

$\% \text{ Error} = \frac{V_o(m) - V_o(T)}{V_o(T)} \times 100 = 0.3\%$

Calculations:

| S No | α degrees | Vrms(V) | Io(A) | Irms (A) | Vo(V) Calculated | Vo(V) Actual | Error |
|---|---|---|---|---|---|---|---|
| 1 | 32° | 33.4V | 0.4A | 0.66A | 20V | 19.7V | 1.5% |
| 2 | 47.4° | 32V | 0.36A | 0.64A | 18V | 16.9V | 6.5% |
| 3 | 63.4° | 32.1V | 0.32A | 0.64A | 16V | 16.7V | 4.19% |

connect the ammeter and load to the Basic thyristor circuit. I calculate Vm and $\alpha$ from the oscilloscope and then I calculate the RMS value of voltage, Average value of voltage.

## PRECAUTIONS:

1) Insert basic trigger circuit and basic thyristor ckt properly.
2) Note $\alpha$ carefully from the oscilloscope.

## CONCLUSION:

I concluded from this experiment that once the source and load parameters are established we can change the average or dc voltage across load resistor by changing the firing angle ($\alpha$).

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# LAB NO 5:

To study single phase half wave controlled rectifier (inductive load and without commutating diode.

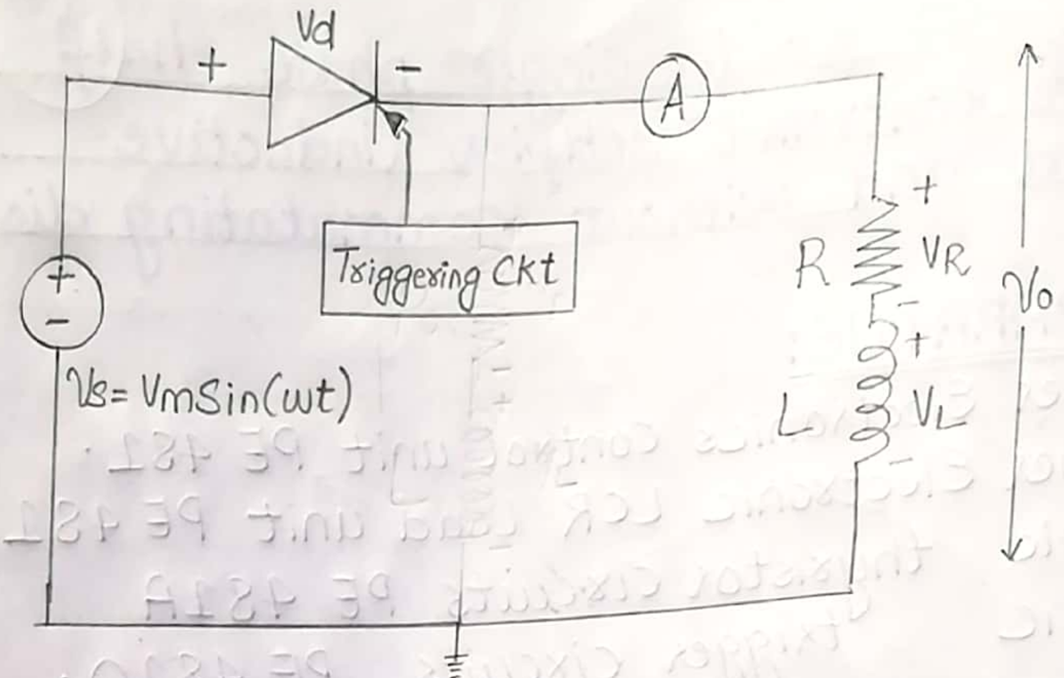
## APPARATUS:

Power Electronics Control unit PE 481.
Power Electronic LCR Load unit PE 481
Single thyristor circuits PE 481A
Basic trigger circuits PE 4810.

## THEORY:

In previous experiment we study single phase half wave controlled rectifier (resistive load) and in this experiment the same rectifier with the inductive load). If we take $\alpha = 0°$ so both the rectifiers i-e having resistive load and inductive load behaves similarly from 0 to $\pi$ rad. Beyond $\pi$ rad the rectifier with resistive load blocks the current resulting in zero voltage drop across $R_L$. But in case of inductive load from $\pi$ to $\beta$ there will be $V_0$. The reason is that in this region the inductor forward biases the diode. So the current will be beyond $\pi$ i-e upto $\beta$

## CIRCUIT DIAGRAM:-




## OBSERVATION AND CALCULATION:-

| Sr No | α | β | Vrms | Vo c (v) | Vo actual | Io Cal | Io Actual | Error % I | Error % V |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 24° | 222° | 35.4° | 17.67 | 0.35 | 0.41 | 18.3 | 11% | 3.8% |
| 2 | 54° | 264.5 | 34.6 | 10.6 | 0.212 | 0.28 | 11.5 | 16% | 7.8% |
| 3 | 80.4° | 264° | 33.8 | 3.2 | 0.64 | 0.091 | 3.46 | 21% | 6.6% |

The purpose of SCR is to control the average value of ~~rectifier~~ o voltage.

$$V_o = \frac{V_m}{2\pi}(\cos\alpha - \cos\beta)$$

The positive value of $\omega t$ that result in zero current is called extinction angle $\beta$. $\alpha$ (alpha) is called the firing angle. The angle $\beta - \alpha$ is called the conduction angle $\gamma$.

$$i(\omega t) = \begin{cases} \frac{V_m}{Z}\left(\sin(\omega t - \theta) - \sin(\alpha - \theta)e^{(\alpha - \omega t)/\omega\tau}\right) & \alpha \le \omega t \le \beta \\ 0 & \text{otherwise} \end{cases}$$

$$i(\beta) = 0$$

## PROCEDURE:

To implement the controlled half wave rectifier circuit & insert basic trigger circuit in control module position of the power electronic control unit. & insert the basic thyristor circuit in power module position & only connect the ammeter and load to basic thyristor circuit.

I calculate $V_m$ and $\alpha$ from the oscilloscope and then I calculate RMS value of voltage, average value of voltage.

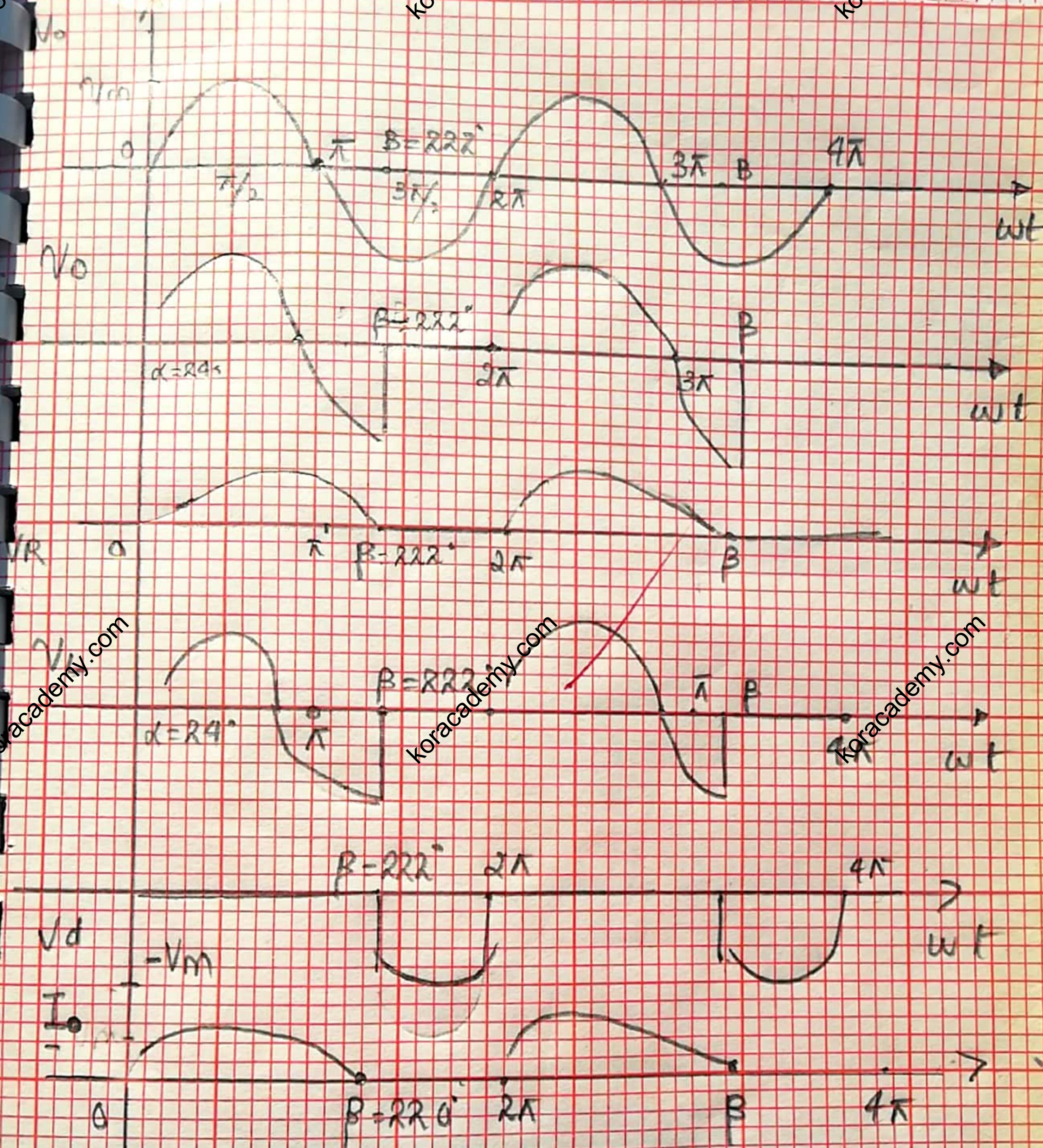
## PRECAUTIONS:

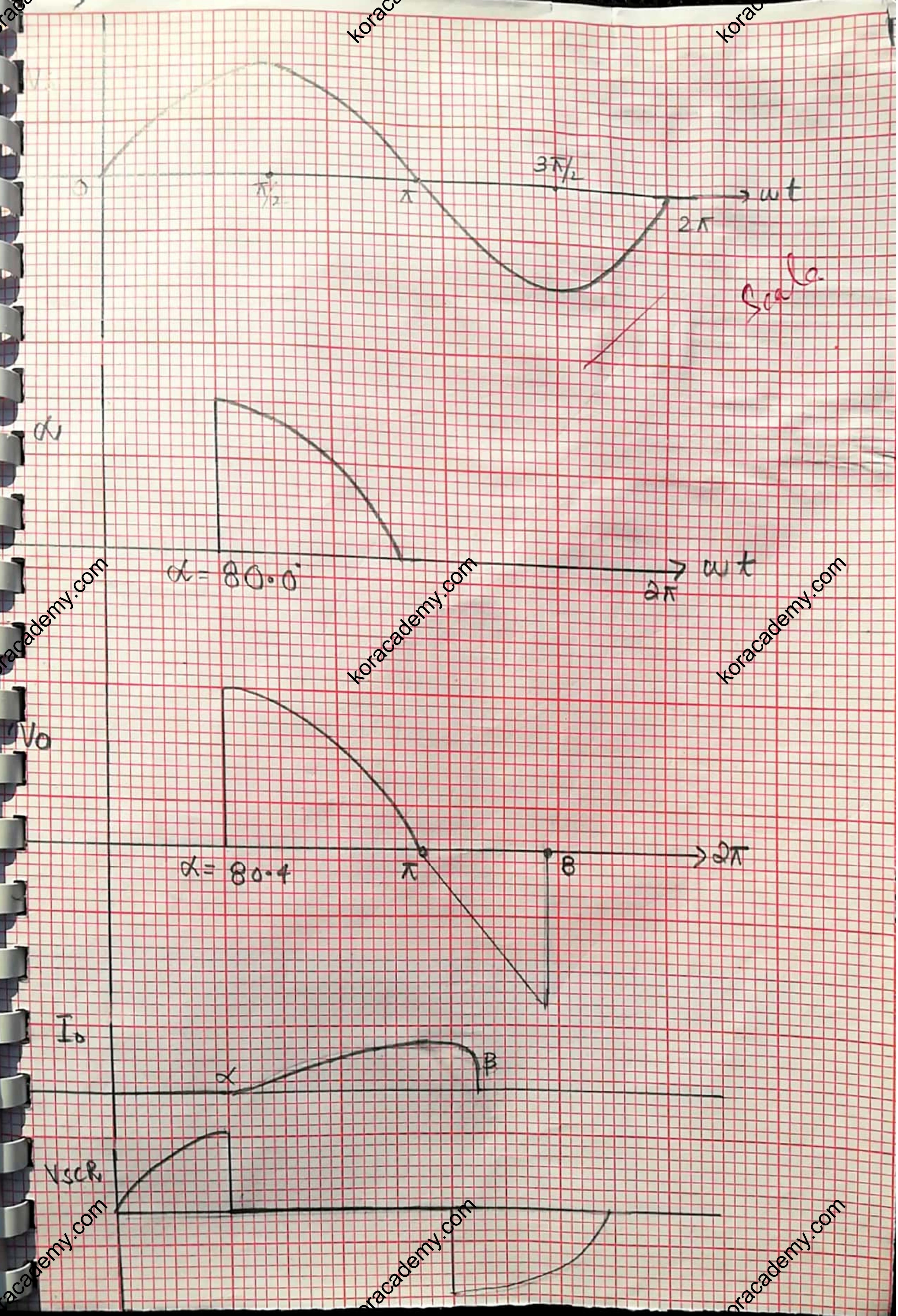
Note the readings carefully.
Insert basic trigger ckt and basic thyristor ckt properly
Note $\alpha$ carefully from oscilloscope.

## CONCLUSION:

We can change the average or dc voltage across load resistor by changing the firing angle $\alpha$.

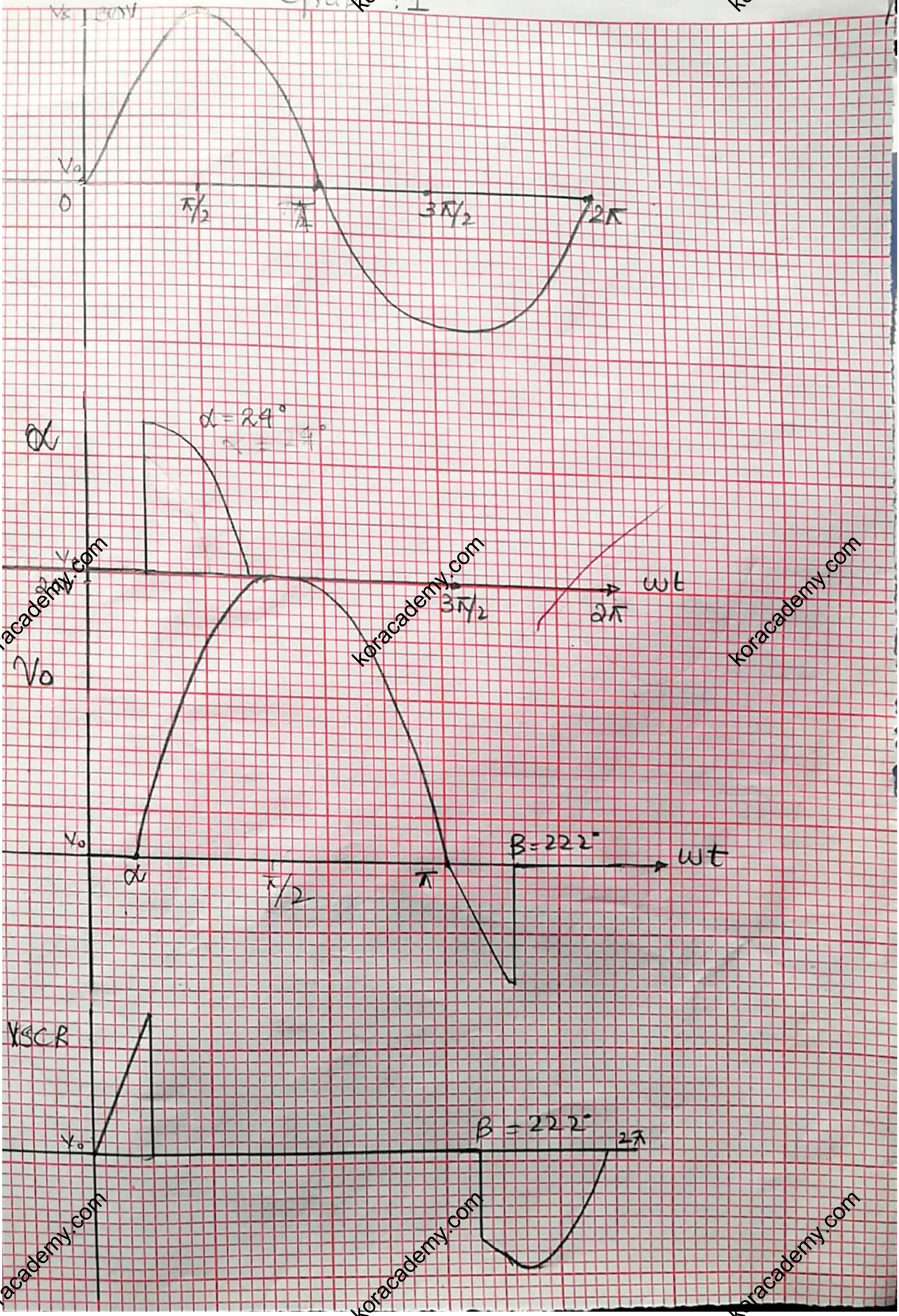
In case of inductive load there will be current from $\alpha$ to $\beta$.
$\alpha$ to $\pi$ because of voltage source as it forward biases the diode and from $\pi$ to $\beta$ because of inductor as inductor forward biases diode in this period.


Vo
Vm
0
π
β=222°
π/2
3π/2
2π
3π
β
4π
ωt
α=24°
VR
Vd
-Vm
Io
β=220°



V
0
π/2
π
3π/2
2π
ωt
Scale
α
α = 80.0°
ωt
2π
Vo
α = 80.4
π
B
2π
Io
α
B
VSCR

Grade: 1



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# LAB NO 6:

To study single phase half wave controlled rectifier (inductive load and with commutating diode)

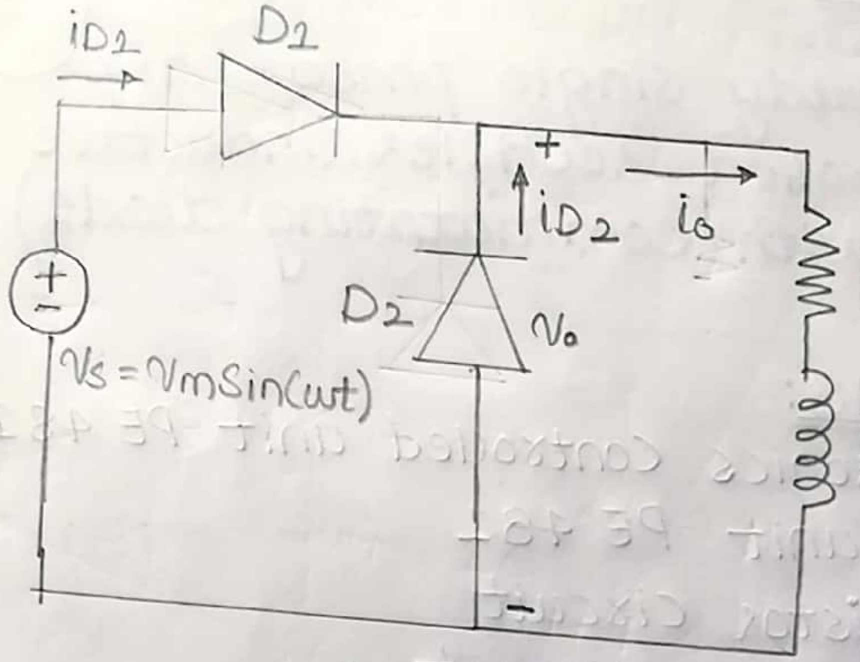
## APPARATUS:

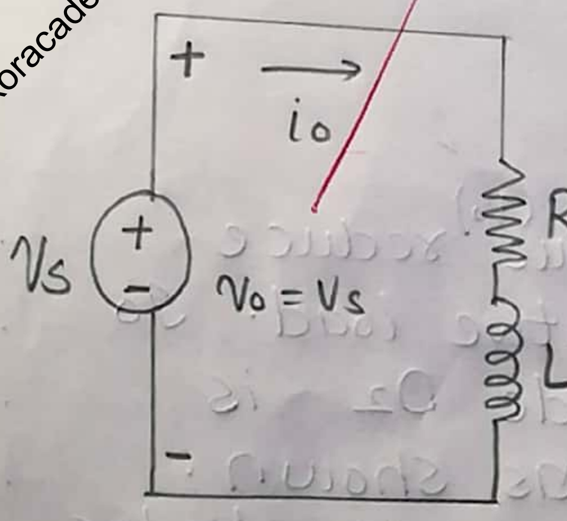
Power electronics Controlled unit PE 481
LCR load unit PE 481
Single thyristor circuit
Basic triggering circuit
Connecting wire
Oscilloscope.

## THEORY:

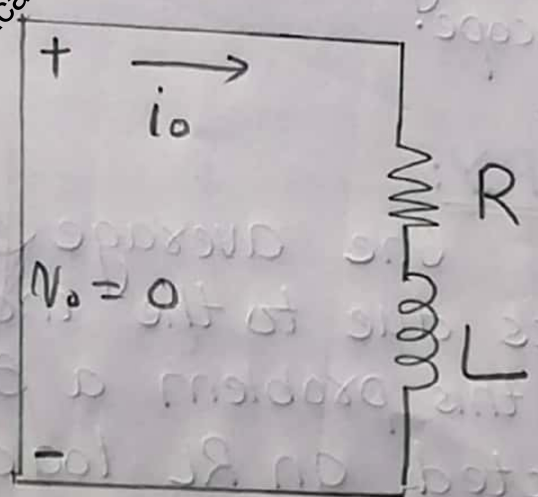
The average value (Vo) reduce reduces due to the inductive load. To tackle this problem a diode D2 is connected an RL load as shown. First it is observed that both diodes cannot be forward biased at the same time.
Diode D1 will be on when the source is positive and Diode D2 will be on when the source is negative

## CIRCUIT DIAGRAM:-




$V_s > 0$




$V_s < 0$

HALF WAVE RECTIFIER WITH FREEWHEELING DIODE

For a positive source voltage
$D_1$ is ON
$D_2$ is OFF (open circuit)
The voltage across RL load is the same as the source.

For a negative source voltage,
$D_1$ is OFF (open ckt)
$D_2$ is ON (short ckt)
The voltage across RL load will be zero.

Since the voltage across the RL load is the same as the source voltage when the source is positive and is zero when the source is negative. The load voltage is **half-wave rectified sine wave**.

**PROCEDURE:**

I implement the circuit according to the circuit diagram I just connected diode $D_2$ across the load. I note $V_m$, $V_{rms}$ and $V_o$ from oscilloscope

OBSERVATION AND CALCULATION:-

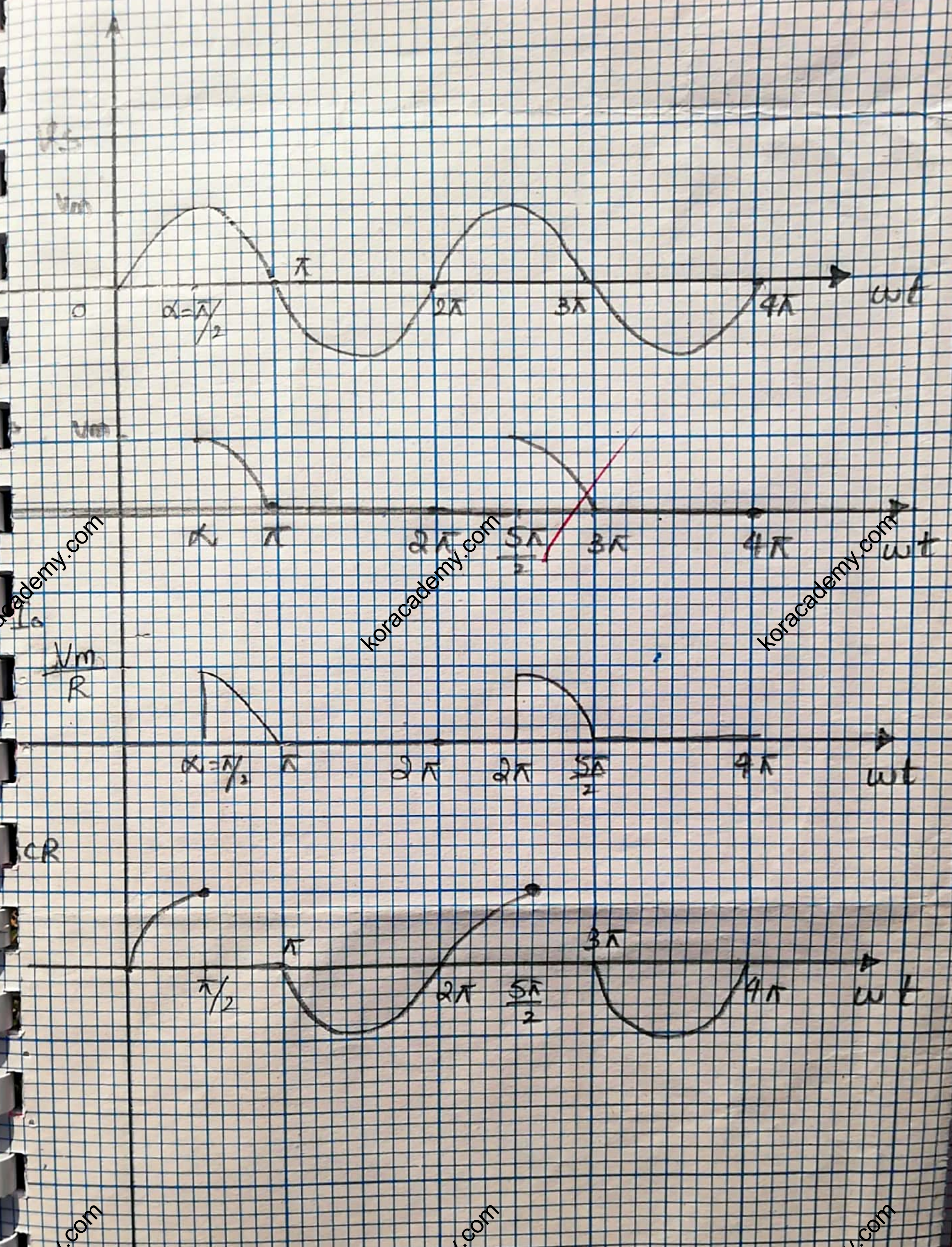
| Sr No | $\alpha$ | Vrms (V) | $V_o$ cal (V) | $V_o$ act (V) | $I_o$ act (A) | $I_o$ cal A | Error $I_o$ | Error $V_o$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 24° | 33.92 | 20 | 22 | 0.4 | 0.47 | 11% | 9.1% |
| 2 | 54° | 30.7 | 16 | 17.4 | 0.32 | 0.43 | 19% | 8.04% |
| 3 | 80.4° | 26.1 | 12.44 | 13.52 | 0.25 | 0.297 | 13% | 8% |

# PRECAUTIONS:-

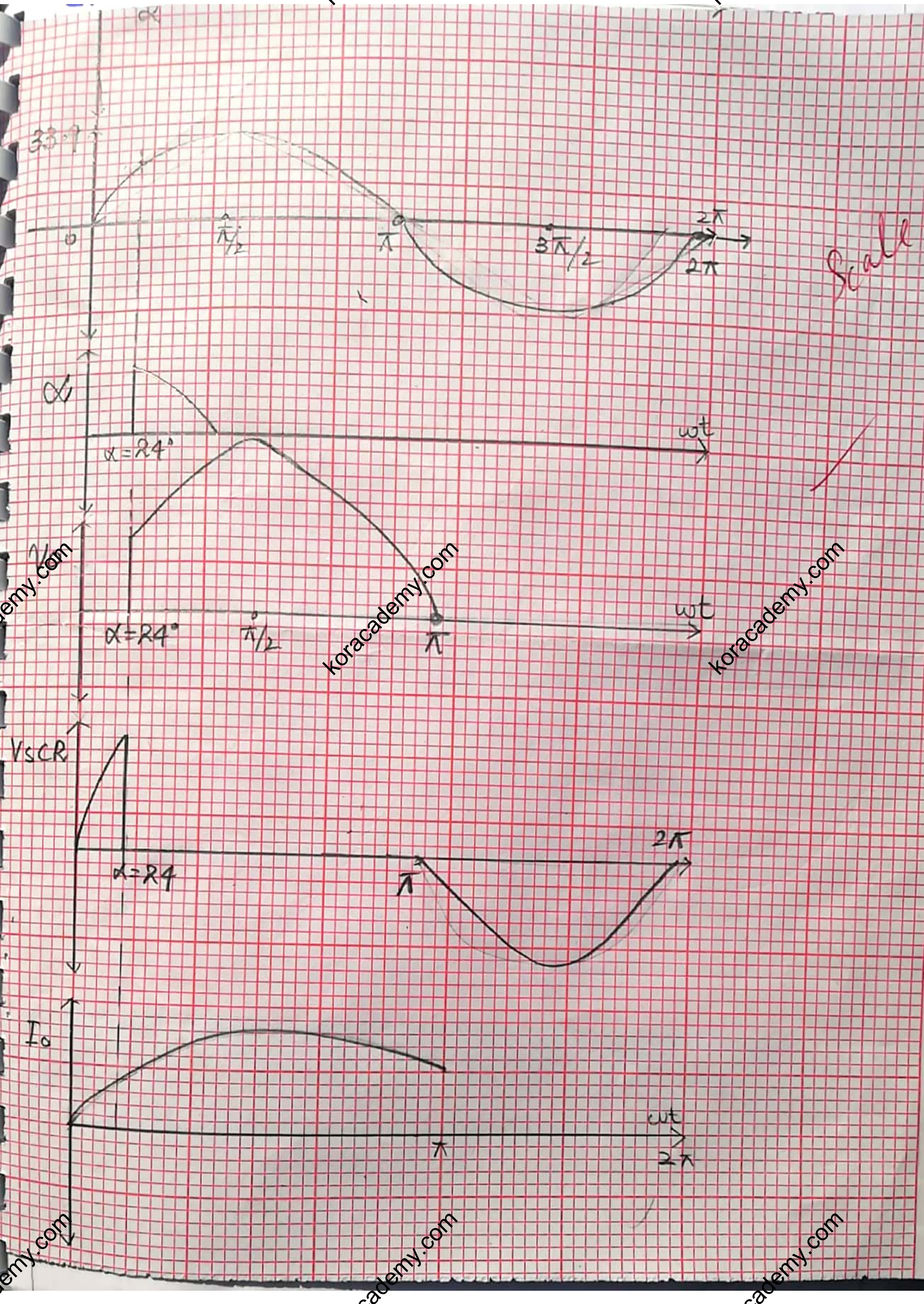
1) Note the readings carefully
2) Insert ckts properly

# CONCLUSION:

I concluded from this experiment that by just connecting Diode $D_2$ parallel to load we get half wave rectified sine wave at the output.



Vs
Vm
o
α=π/2
π
2π
3π
4π
ωt
Vm
α
π
2π
5π/2
3π
4π
ωt
Vm/R
α=π/2
π
2π
2π
5π/2
4π
ωt
π/2
π
2π
5π/2
3π
4π
ωt


33.9
0
π/2
π
3π/2
2π
Scale
α
ωt
α=24°
VSCR
α=24
Io

5074

LAB NO 7:

To study single phase full wave uncontrolled rectifier with resistive load.

Graphs Missing
Title

**APPARATUS:**

Power electronics controlled unit PE 481.
LCR load unit PE 482
Single thyristor circuit
connecting wires
Oscilloscope

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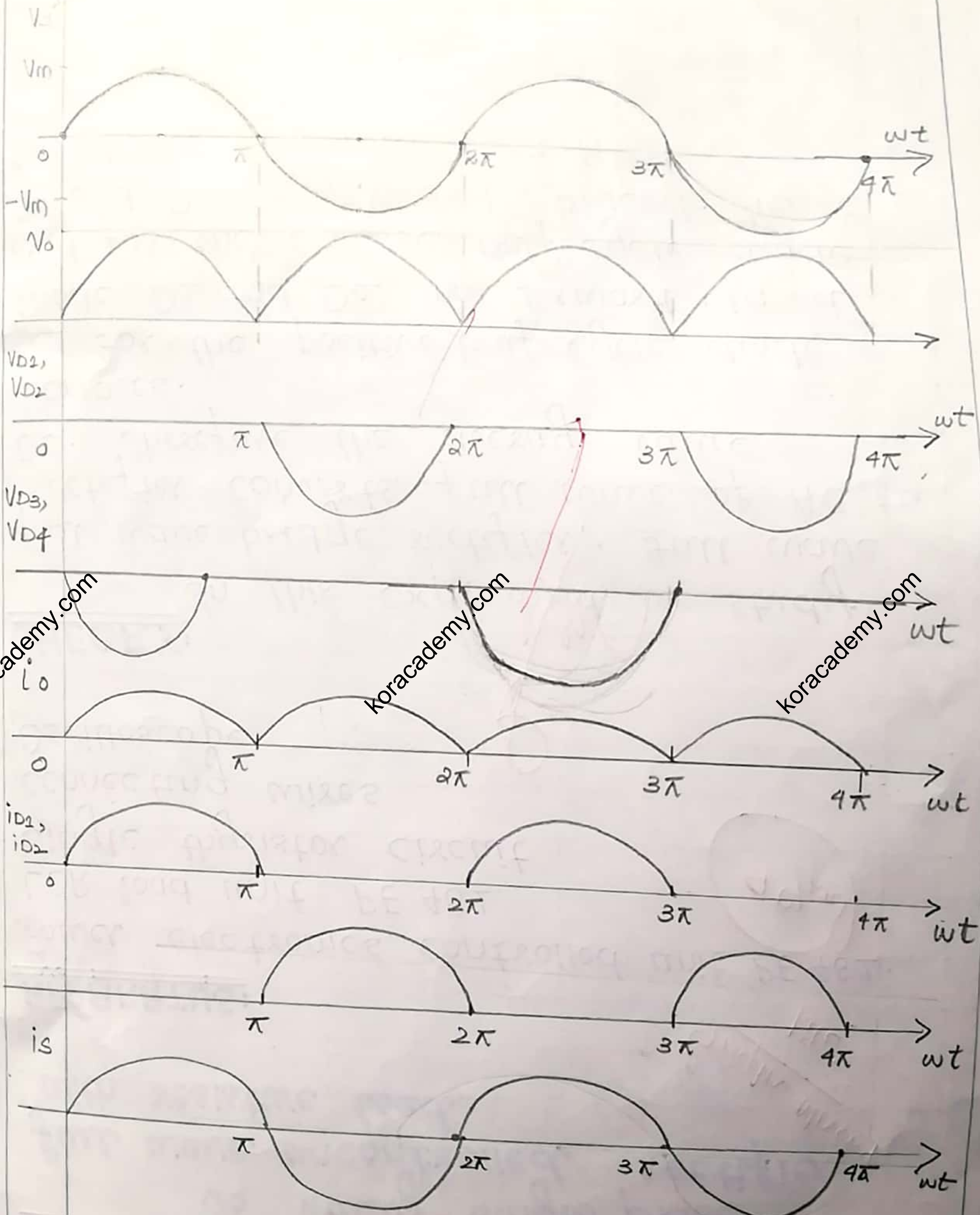
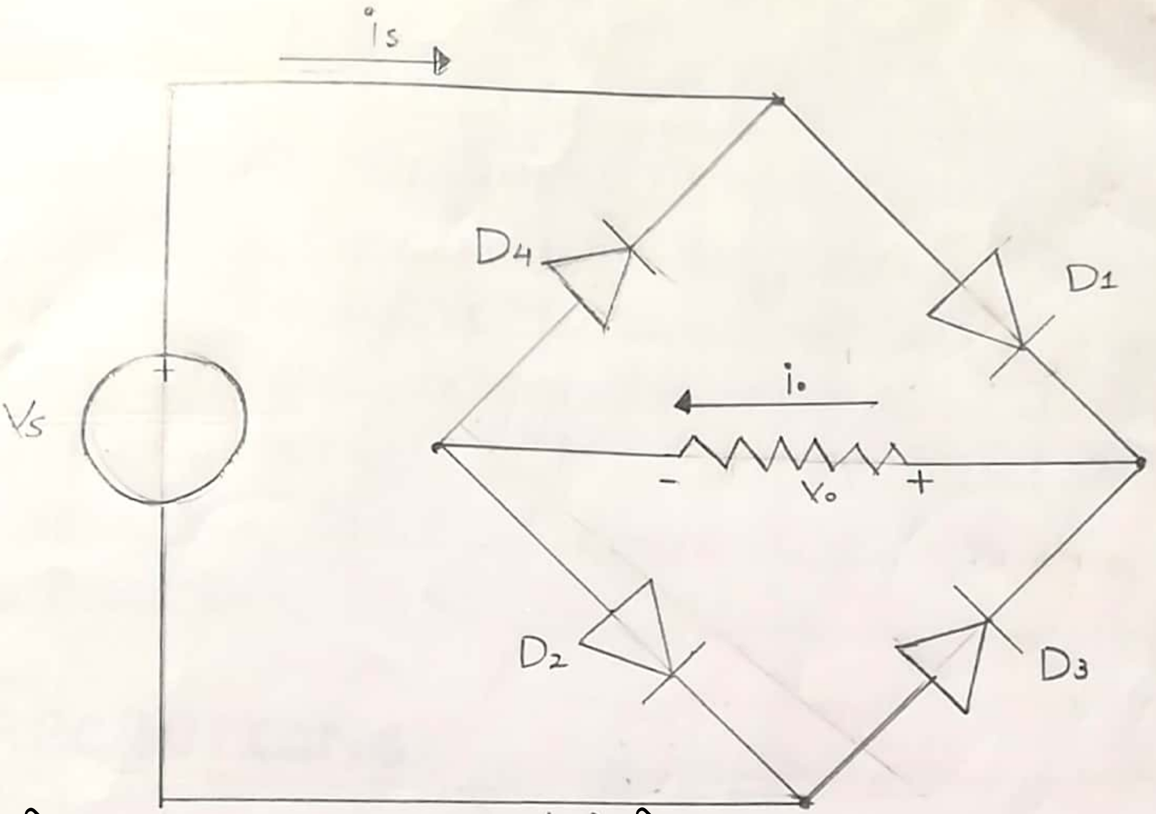
**THEORY:**

In this experiment we study full wave bridge rectifier. Full wave rectifier converts full wave of AC to DC. Therefore the average value increases.

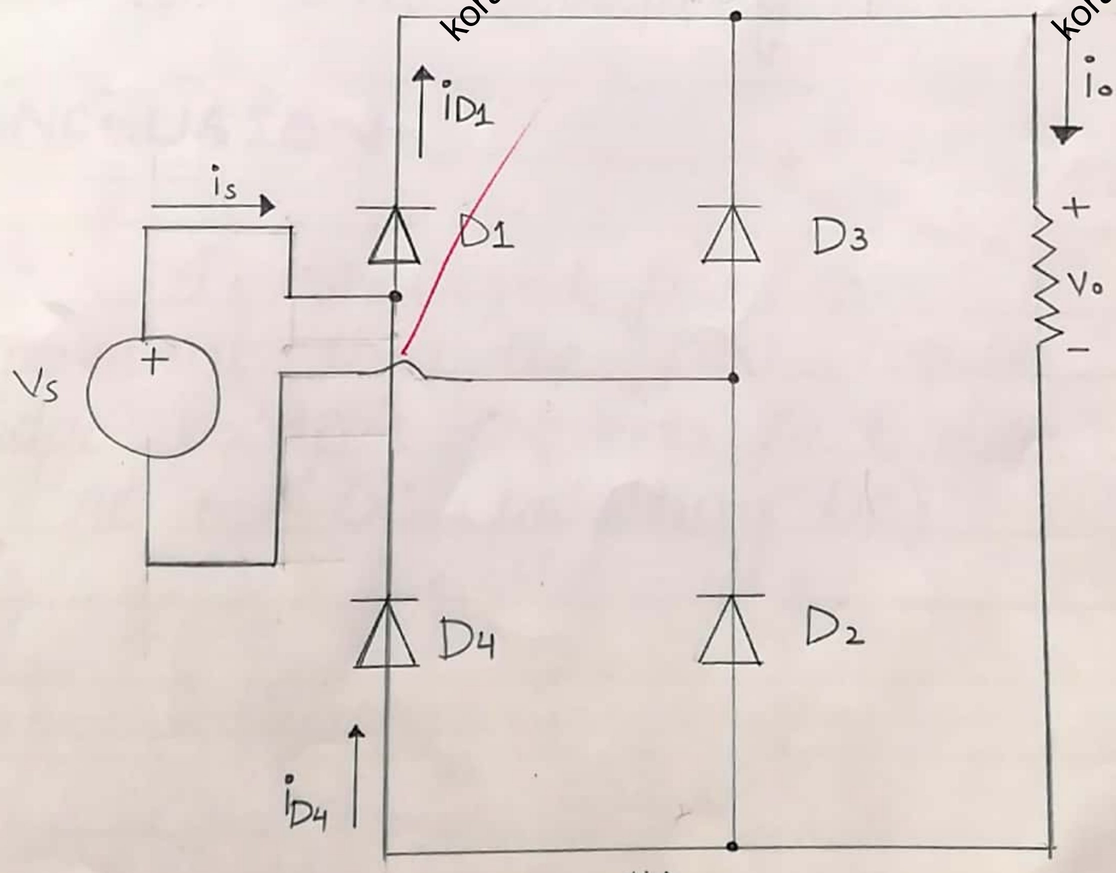
For the positive half cycle diode Diode $D_1$ and $D_2$ are forward biased and for the reverse half cycle diode $D_3$ and $D_4$ are forward biased. Hence two diodes conducts at a time




Voltages & Currents waveforms.




(a)




(b)

Full-Wave bridge rectifier (a) Circuit Diagram
b) Alternative representation

## PROCEDURE:

I implement the circuit according to circuit diagram. The bridge rectifier was already there on the triggering circuit. I just connect it with load and across the load I connect the oscilloscope.

## PRECAUTIONS:

Calculate the average value carefully
Insert the ckts properly

## CONCLUSION:

I concluded from this experiment that the full wave bridge rectifier converts full wave of AC to DC (pulsating DC)

## EXPERIMENT NO 8: 5074

Bi-phase half wave fully controlled rectifier (Resistive load and Inductive load)

## OBJECTIVE:

To observe local voltage waveform for bi-phase half-wave fully controlled rectifier.

## APPARATUS:

Power Electronics control unit PE-481
Power Electronics LCR load unit PE-481
Full wave thyristor circuits PE-481-B
Oscilloscope CRO GS-1040 and connecting wires.

## THEORY:

In this experiment we use a a center-tapped transformer which divides the input voltage into $V_1$ and $V_2$ which are out of phase by 180°

## PROCEDURE:

1) Make the connections as shown in fig.
2) Connect the oscilloscope across the load.
3) Apply gate pulse to thyristers $Th_1$ and $Th_2$ from $Tp_1$ and $Tp_2$ of uni-junction

## OBSERVATION AND CALCULATIONS:-

Vertical divisions = 5.2

Volt per division = 1V/div

Amplification factor = 10

$V_m = 5.2 \times 1 \times 10 \Rightarrow$ $\boxed{V_m = 52 \text{ volts}}$

$\pi = 20$ div and conduction upto 13 divisions

So $\alpha = \pi - 13 = 20 - 13 = 7$ div

1 div/cycle $= 9° \Rightarrow \alpha = 7 \times 9 \Rightarrow \alpha = 63°$

For resistive load (R)

$V_o$(calculated) $= \frac{V_m}{\pi}(1+\cos\alpha) = 15.7V$

$V_o$(actual) $= 16.7V$

$V_{rms}$(calc) $= V_m \sqrt{\left(\frac{\pi}{2\pi} - \frac{\alpha}{2\pi} + \frac{\sin 2\pi}{4\pi}\right)}$

$= 15$ Volts.

For inductive Load (RL):-

$\beta = \alpha + \pi \Rightarrow \beta = 7 + 20 = 27$ divisions

$\beta = 9 \times 27 \Rightarrow \boxed{\beta = 243°}$

transistor triggering circuit.

4) From center tapped transformer get $V_1$ and $V_2$ which are 180° out of phase.

) During positive half cycle, thyristor $Th_1$ start conduction as gate pulse is applied.

) Similarly, $Th_2$ thyristor starts conduction during positive half cycle of $V_2$ when gate pulse is applied.

Observe the load voltage using oscilloscope and measure "α".

## CONCLUSION:

I concluded from this experiment that when we increase delay angle α the mean voltage across the load decreases and vice versa. As it is also evident from the formula of mean load voltage and also from the this experiment I concluded the mean voltage depends on delay angle(α).

$V_{o\,(calc)} = 24.02V$

$V_{rms\,(actual)} = 21V$

2 For $\alpha = 25°$

## Resistive Load:-

$V_{o\,calc} = 20.8V$ $V_{o\,(actual)} = 21V$

$V_{rms\,calc} = 14V$ $V_{rms\,(actual)} = 12.1V$ $I_o = 0.4A$

## Inductive Load:-

$V_{o\,cal} = 19.9V$ $V_{o\,(actual)} = 20V$

$V_{rms\,cal} = 44V$ $V_{rms\,(actual)} = 46V$ $I_o = 0.3A$

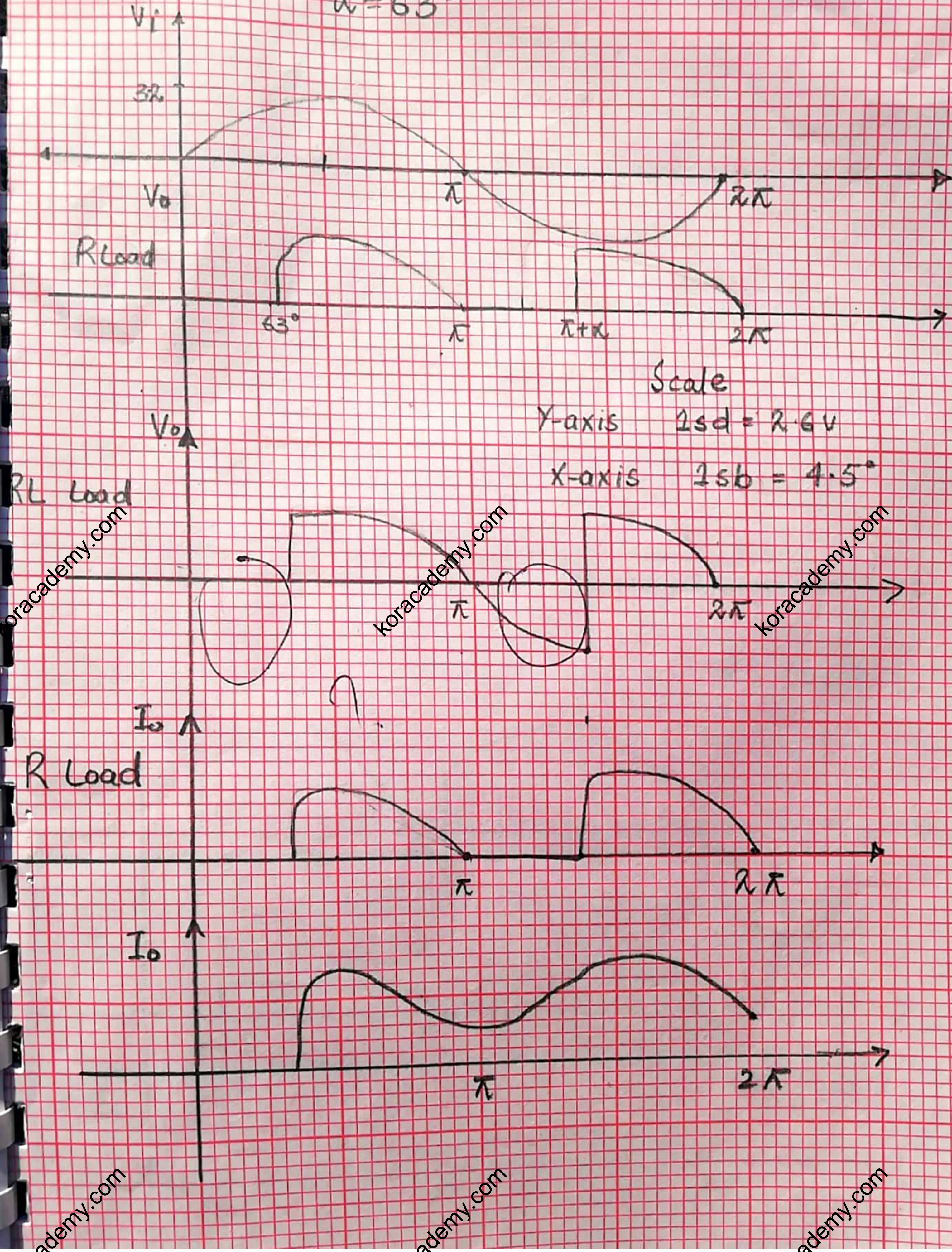
$\alpha = 63°$

| Load | Vo(V) calc | Vo(V) actual | Error in Vo | Vrms(V) calc | Vrms(V) | Error | Io(A) |
|---|---|---|---|---|---|---|---|
| R | 15.7 | 16.7 | 5% | 15 | 14.2 | 6% | 0.33 |
| RL | 10 | 12 | 11% | 24.01 | 21 | 10% | 0.24 |

$\alpha = 22.5°$

| Load | Vo(V) calc | Vo(V) actual | Error x Vo | Vrms(V) calc | Vrms(V) actual | Error | Io(A) |
|---|---|---|---|---|---|---|---|
| R | 20.8 | 21 | 15% | 14 | 12.1 | 8% | 0.4 |
| RL | 19.9 | 20 | 4% | 44 | 46 | 5% | 0.3 |

$\alpha = 63°$


Vi
32
Vo
π
2π
R Load
63°
π
π+α
2π
Scale
Y-axis 1sd = 2.6V
X-axis 1sb = 4.5°
Vo
RL Load
π
2π
Io
R Load
π
2π
Io
π
2π

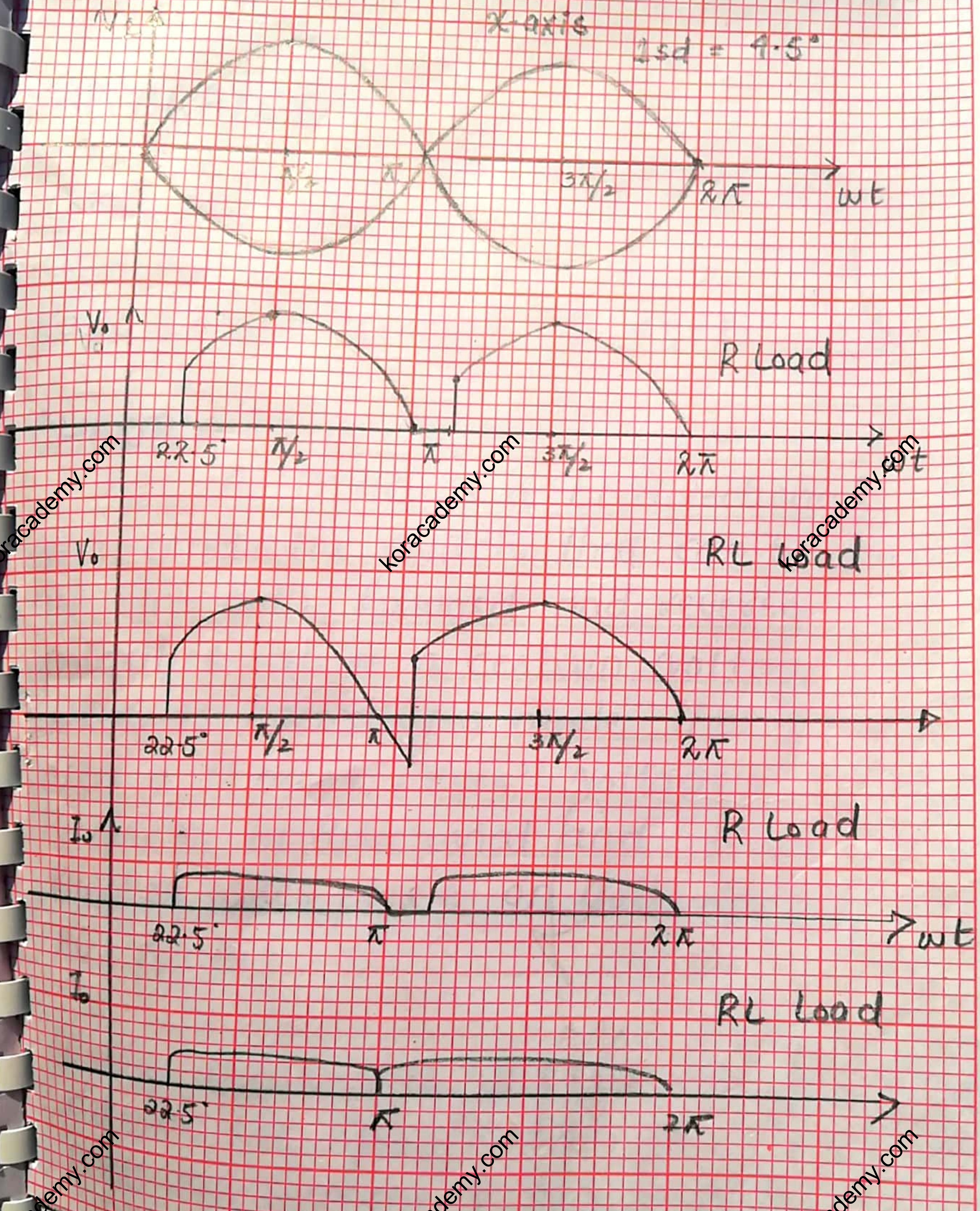
Scale:-

y-axis

$\alpha = 22.5^\circ$ 1sd = 2.6v

x-axis

1sd = 4.5°



# EXPERIMENT NO 9 5074

To study characteristic of "DIAC"

## APPARATUS:

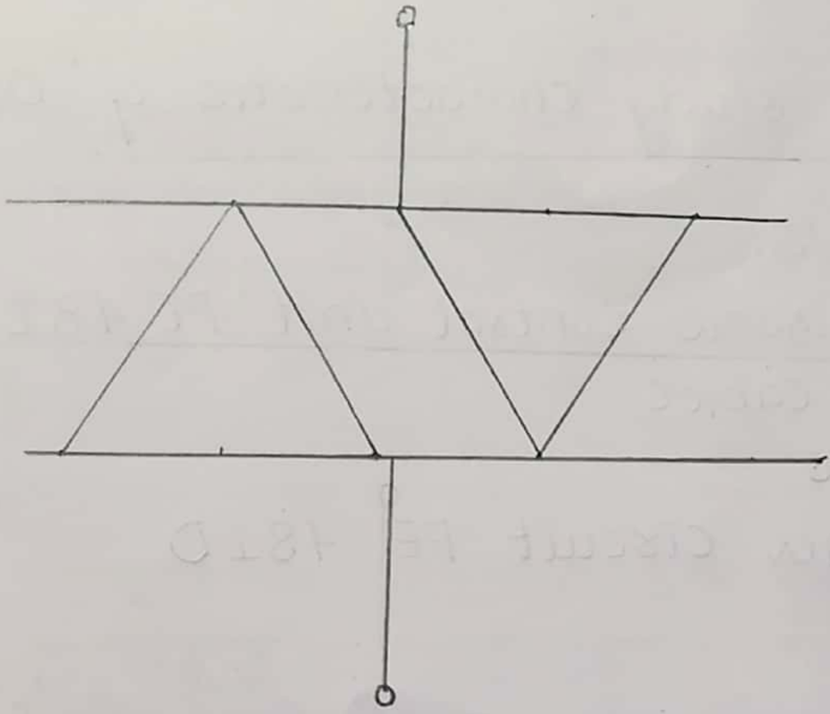
Power electronic control unit PE 481
Connecting cables
Oscilloscope
Basic trigger circuit PE 481D

98/100

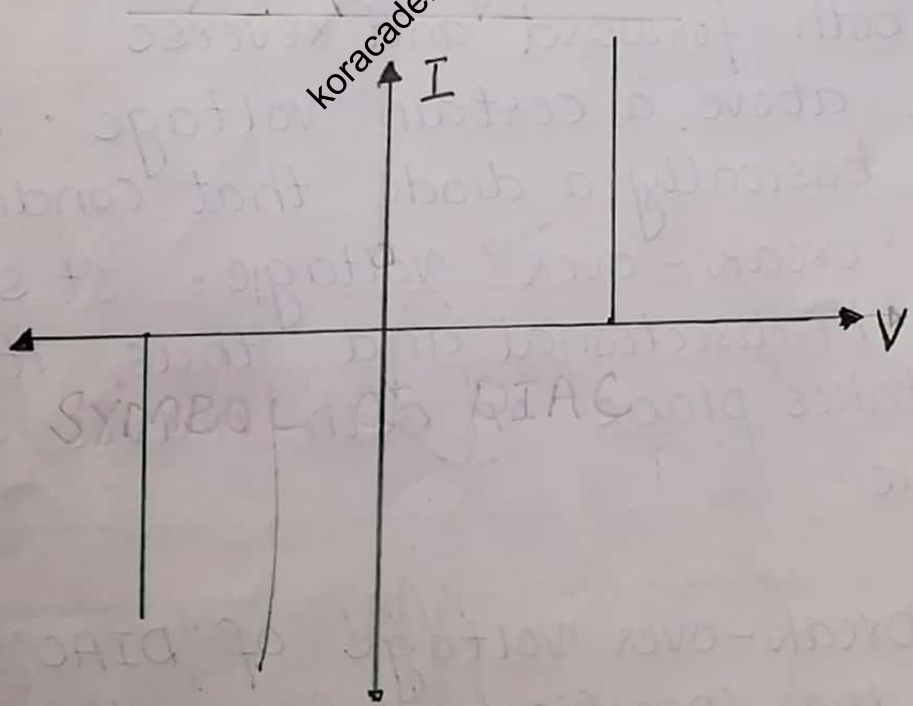
## THEORY:

A DIAC is a bi-directional semi-conductor switch that can be turned ON in both forward and reverse polarities above a certain voltage. The DIAC is basically a diode that conducts after a "break-over" voltage. Its behaviour bi-directional and thus its function takes place on both halves of an AC cycle.

The break-over voltage of "DIAC" depends the specification for the particular component type. When the DIAC break over voltage occur, the resistance of the component decreases



DIAC SYMBOL




VI CHARACTERISTIC OF DIAC

Unlike simple diodes DIAC conduct in both forward and reverse directions if a voltage higher than the break-over voltage is applied whereas the simple diode starts conduction in only forward direction.

## PROCEDURE:

I connected the DIAC with oscilloscope to analyze the current & voltage across the DIAC. From 0 I started increasing the input voltage

When voltage become greater than break-over voltage, the current started flowing through the device.

## CONCLUSION:

I concluded from this experiment that DIAC is a special type of switch that is used to make the current flow in both forward and backward directions when the break-over voltage is reached.

5074

# EXPERIMENT NO 10:

"To study the switching characteristic of a triac"

95/100

## APPARATUS:

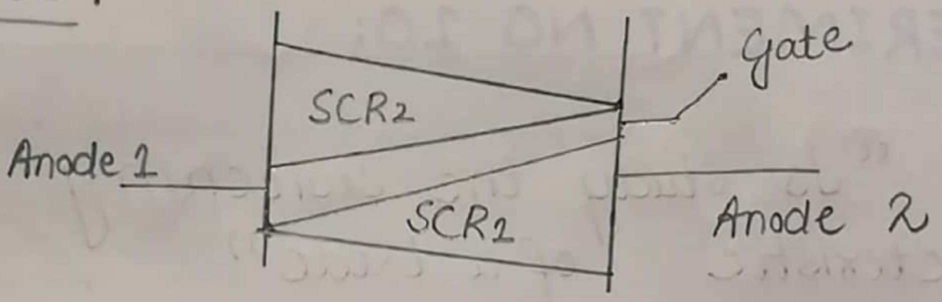
1) Power Electronic control unit PE 4810.
2) AC thyristor circuit PE 4810
3) Power Electronic LCR load unit PE-481.

## THEORY:

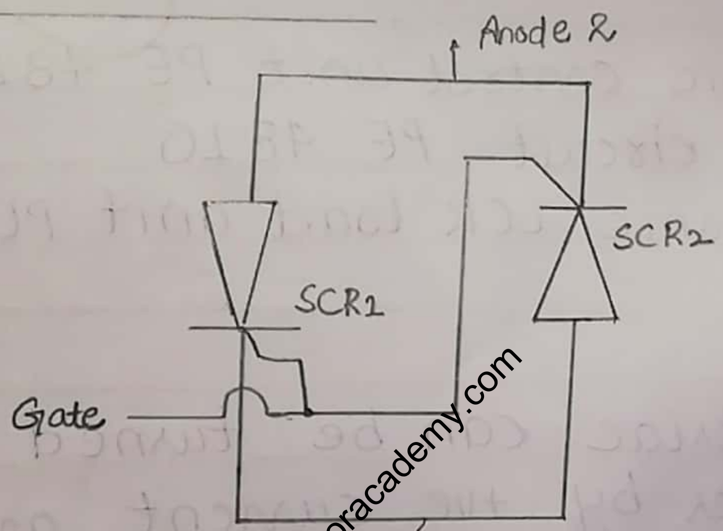
The triac can be turned on by either by +ve current or -ve current pulse applied at its gate terminals. However in practice triac's with -ve gate pulse are usually used.

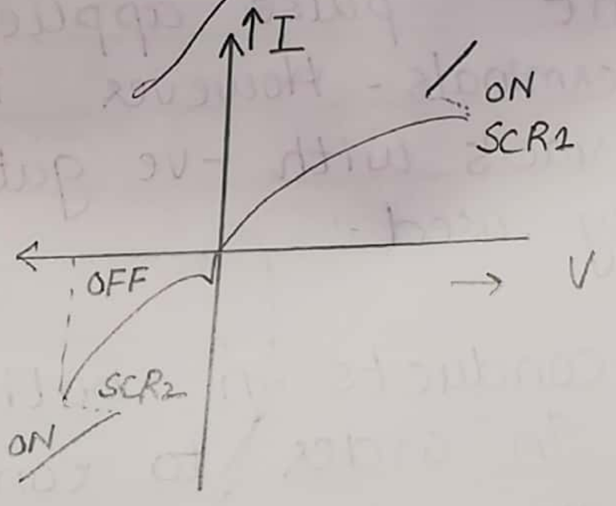
The triac conducts in both directions. In order to conduct gate pulse must be provided When Anode 1 is +ve SCR conducts because of forward biasing same case with $SCR_2$ if anode 2 is +ve. Hence it would conduct if sufficient gate pulse is provided.

## SYMBOL :




## Equivalent circuit:-




## OBSERVATION

$\alpha = 89.6^\circ$  $V_{rms\ actual} = 22V$  $V_{rms}(cal) = 21.22V$

$\alpha = 125.5^\circ$  $V_{rms\ actual} = 13V$  $V_{rms\ cal} = 11.55V$

It is a five layered device having PNPN. It allows the current in either direction.

**CONCLUSION:**

In this experiment we studied about TRIAC, its voltage waveform and found out RMS voltage for different values of $\alpha$.

# EXPERIMENT NO 11 :-

To study voltage regulation using triac in phase control mode

100/100

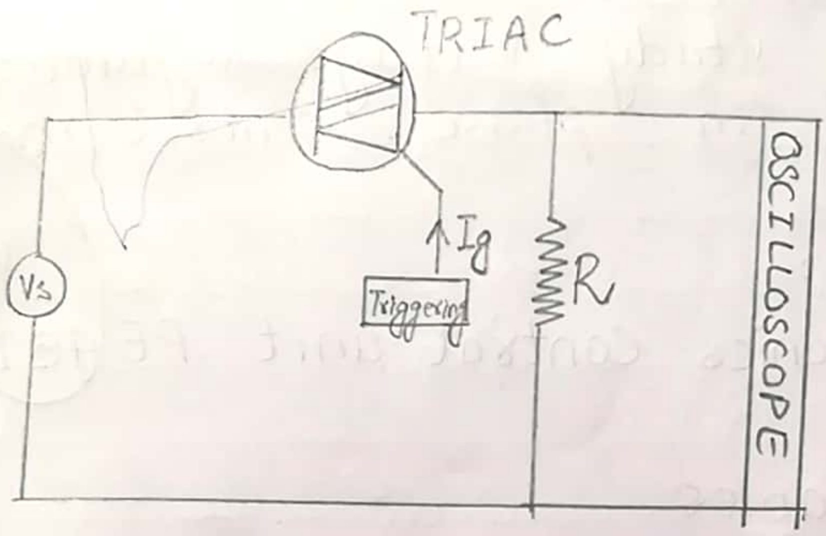
## APPARATUS:

Power Electronics control unit PE 482
Oscilloscope
Connecting cables
Power electronics LCR load units PE 482
Basic trigger circuit PE 481D

## THEORY:

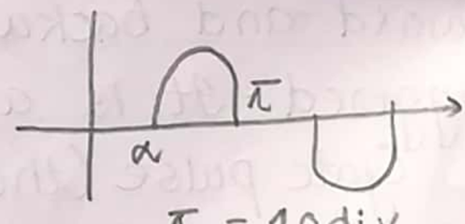
Triac is a bi-directional semi-conductor device that conducts current in both forward and backward directions when triggered. It is a three terminal device. Gate pulse (the firing angle) is applied at the gate terminal of a triac to make it trigger. In AC thyristor circuits PE 481C module, we already have a triac circuit, to which AC input 50V signal is applied and we use this triac in our circuit.

Circuit Diagram:-




OBSERVATIONS:-

$$20\,\text{div} = 2\pi$$
$$\pi = 10\,\text{div}$$
$$1\,\text{div} = 18^\circ$$
$$\alpha + 7 = 10\,\text{div} = \pi$$
$$\alpha = 3\,\text{div}$$
$$\alpha = 54^\circ$$




Now:

$$V_{rms} = \sqrt{2\left(\frac{1}{2\pi}\int_{\alpha}^{\pi} V_m^2 \sin^2\omega t \, d\omega t\right)}$$

$$= V_m \sqrt{\frac{1}{2\pi}(1-\cos 2\omega t \, d\omega t)}$$

$$V_{rms} = 39.75 \text{ volts}$$

**PROCEDURE:**

I made the circuit practically according to the ckt diagram.

I applied the firing angle from the basic trigger circuit

I connected the output of load with oscilloscope to analysis the output voltage across the load.

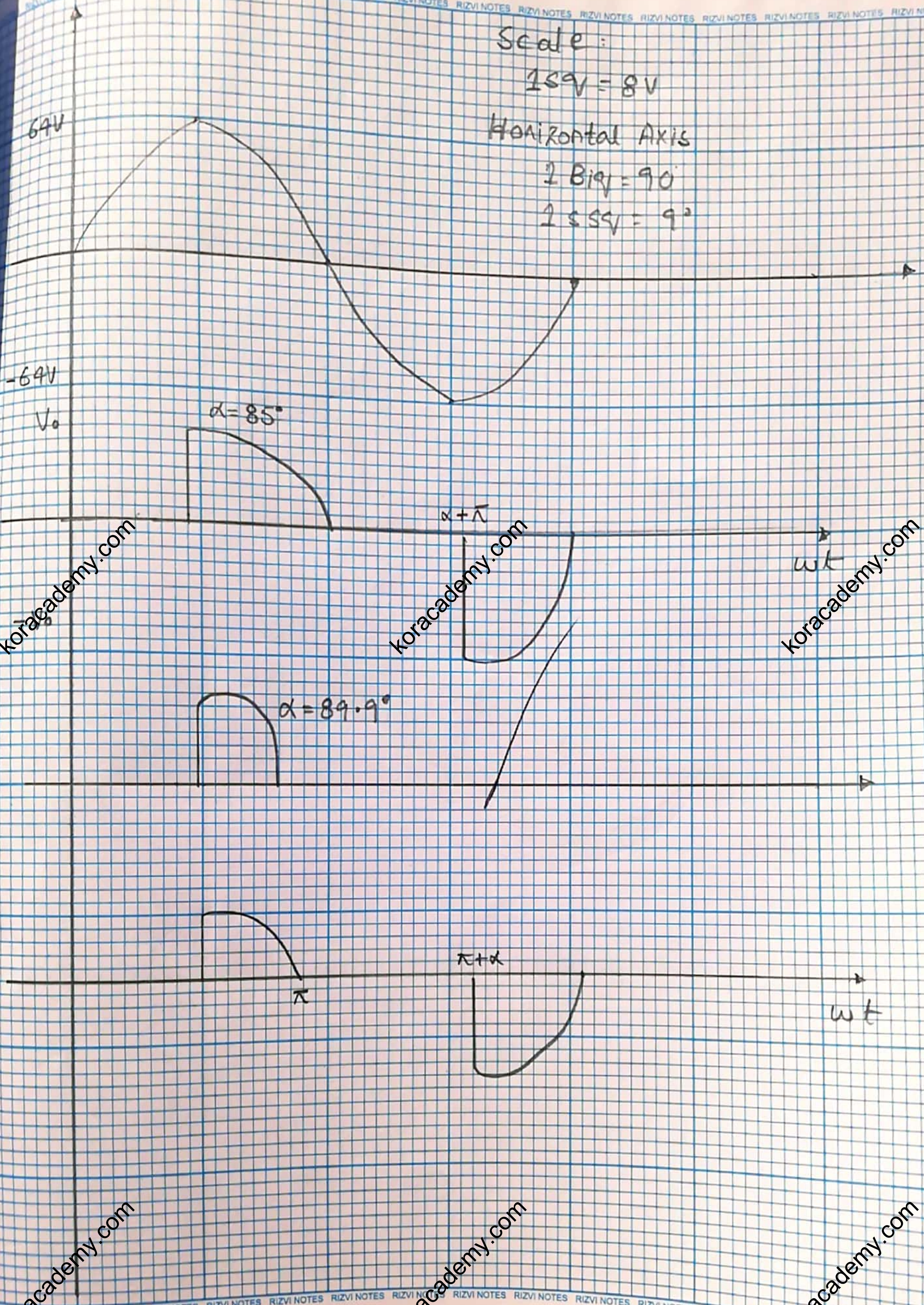
For different values of firing angle $\alpha$ I calculated the rms value of voltage

Changing triggering angle change the voltage waveform.

**CONCLUSION:**

From this experiment I concluded that triac does not conduct at all voltages. It starts conduction at a certain level of gate voltage.

Ref:


Scale :
1sq = 8V
Horizontal Axis
1 Big = 90
1 ssq = 9°
64V
-64V
Vo
α = 85°
α + π
ωt
α = 89.9°
π + α
π
ωt

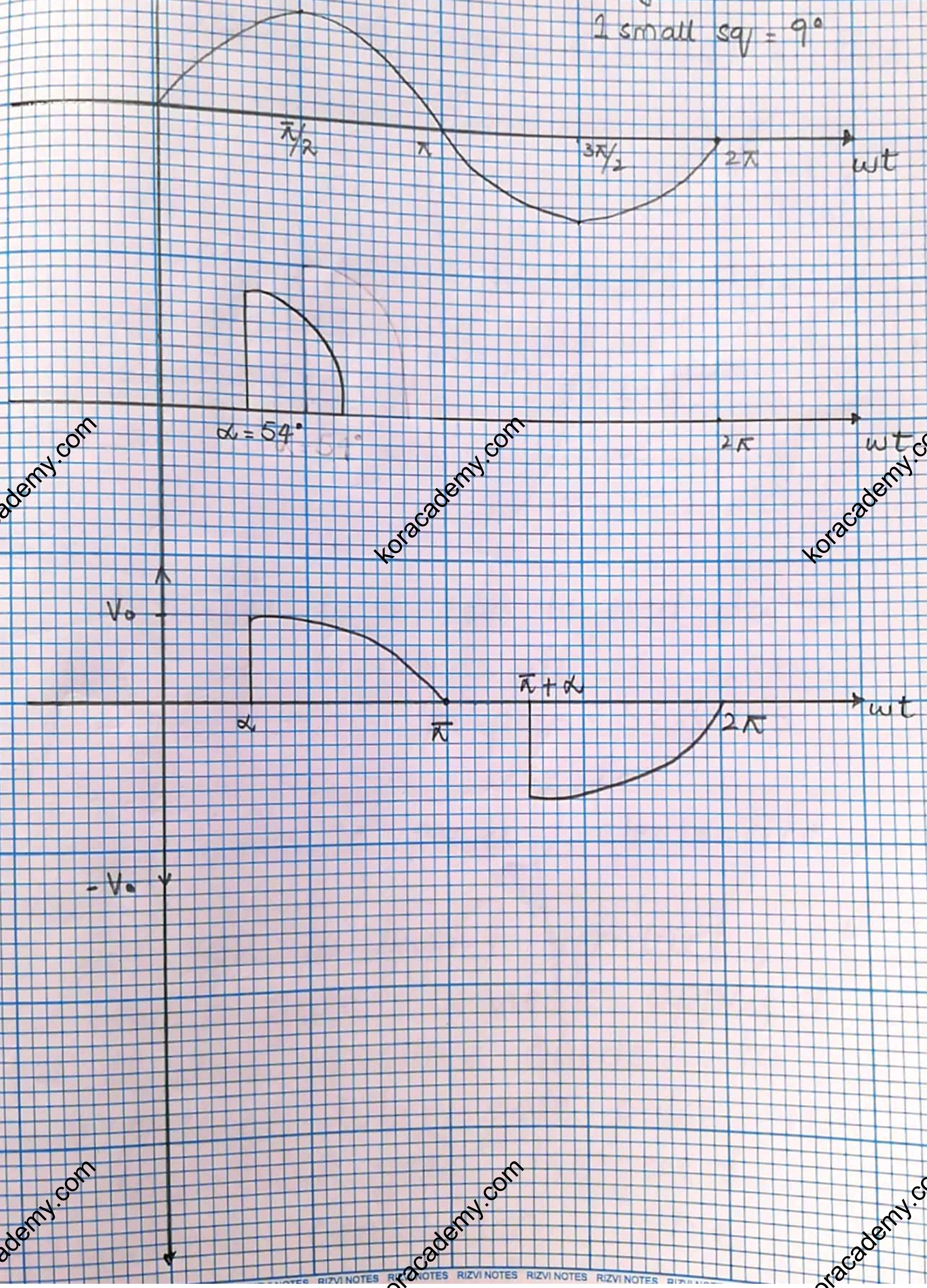
Ref:

Scale:

Horizontal Axis

1 big sq = 90°

1 small sq = 9°



5074

# EXPERIMENT NO 12:

## TITLE:

To study dynamic characteristics of SCR

9.6/10

## APPARATUS:

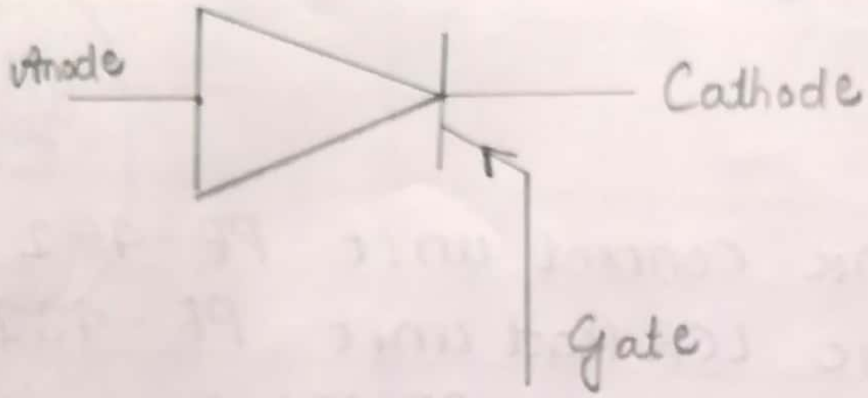
Power Electronic control unit PE-481
Power electronic LCR load unit PE-481
Single thyrister circuit PE 481-A
Oscilloscope (CSO-1030) etc

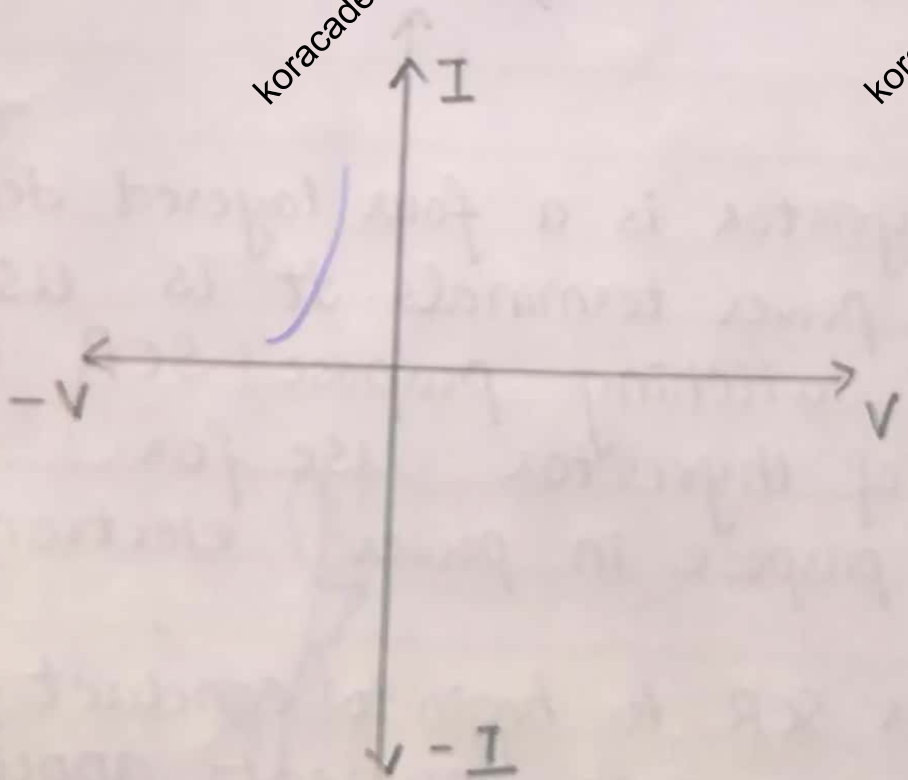
## THEORY:

Thyristor is a four layered device with two power terminals. It is use for the switching purpose. SCR is a type of thyristor use for switching purpose in power electronic devices.

For SCR to begin to conduct, it must have a gate current applied while it has positive anode to cathode voltage. When gate pulse is given the SCR gets triggered and starts conduction. The minimum gate current that must

SYMBOL



be to SCR to make the current flow through the device is called latching current. The minimum current that must be maintained through the device is called holding current.

**PROCEDURE:**

Change oscilloscope mode to x-y mode so we can analyze both voltage & current through SCR simultaneously on oscilloscope.

x-axis is for voltage.

y-axis is for current through the device

Connect SCR with oscilloscope

Analyze the output VI characteristics from oscilloscope.

**CONCLUSION:**

In this lab I observed the dynamic characteristics of SCR. We can obtain the V-I curve using oscilloscope and we can control the output by changing the firing angle.

5074

# EXPERIMENT NO 13

To study voltage regulation using inverse parallel Thyristor

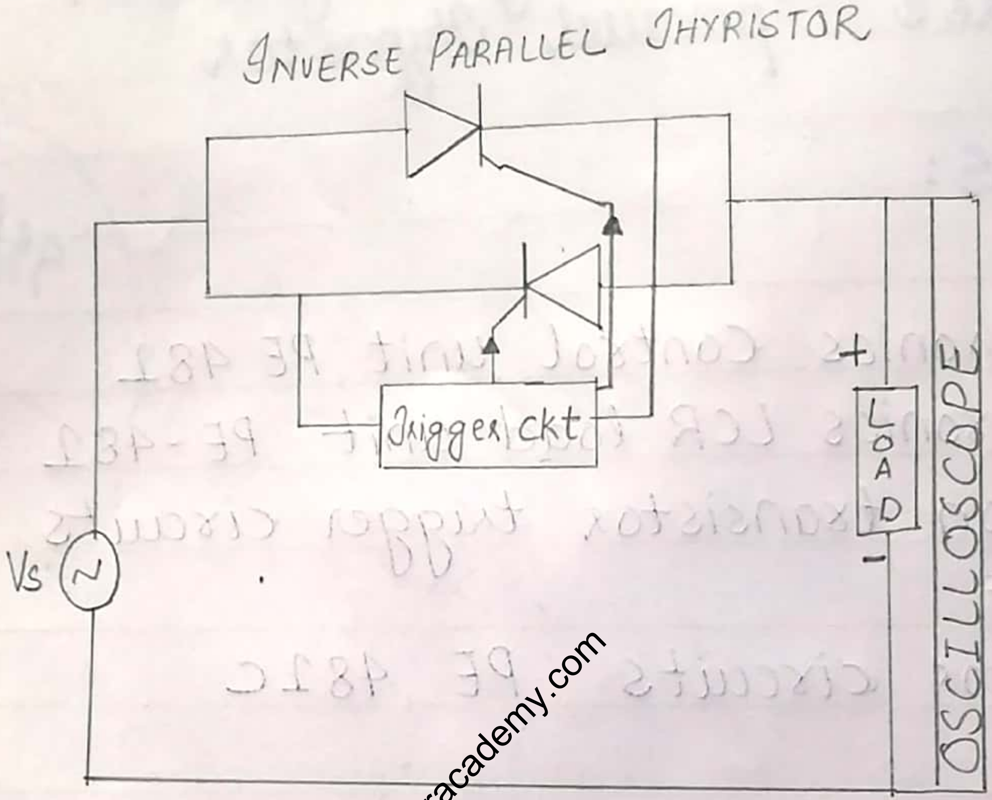
99/10

## APPARATUS:

Power electronics control unit PE 481
Power electronics LCR load unit PE-481
uni-junction transistor trigger circuits PE 481E
AC Thyristor circuits PE 481C
Oscilloscope

## THEORY:

A thyristor is a solid state semi-conductor device with four layer of P and N type material. It acts exclusively as a bi-stable switch conducting when the gate receives a current trigger. An SCR is a type of thyristor that in which turn off of the device is in our control. SCR starts conduction when anode of the SCR is positive with respect to cathode and when a gate pulse is given to the gate terminal to make it trigger




# CIRCUIT DIAGRAM

when two SCRs are connected in Anti-parallel manner it is called inverse parallel thyristor.

## PROCEDURE:

I made the circuit practically according to the circuit diagram using the mentioned apparatuses.
Input signal is applied
Firing angle is given to the SCR.
For positive half cycle one thyristor is forward biased and it starts conduction when it receives gate pulse while 2nd SCR is reverse biased.
For -ve half cycle we still have O/P voltage because 2nd SCR becomes forward biased and it conducts when receives gate pulse while 1st SCR is reverse biased.

I analyzed the output voltage across the load using oscilloscope

For different values of firing angle I analyzed the circuits and plotted the graphs.

## OBSERVATION AND CALCULATION:

Horizontally:

$$20 \text{ div} = 360°$$

$$1 \text{ div} = \frac{360}{20} = 18°$$

$\alpha_1 = 2 \text{ div} = 2 \times 18° = 36°$

$\alpha_2 = 3 \text{ div} = 3 \times 18° = 54°$

$\alpha_3 = 6 \text{ div} = 6 \times 18° = 108°$

Vertically:- $V_m = 10 \text{ div}$

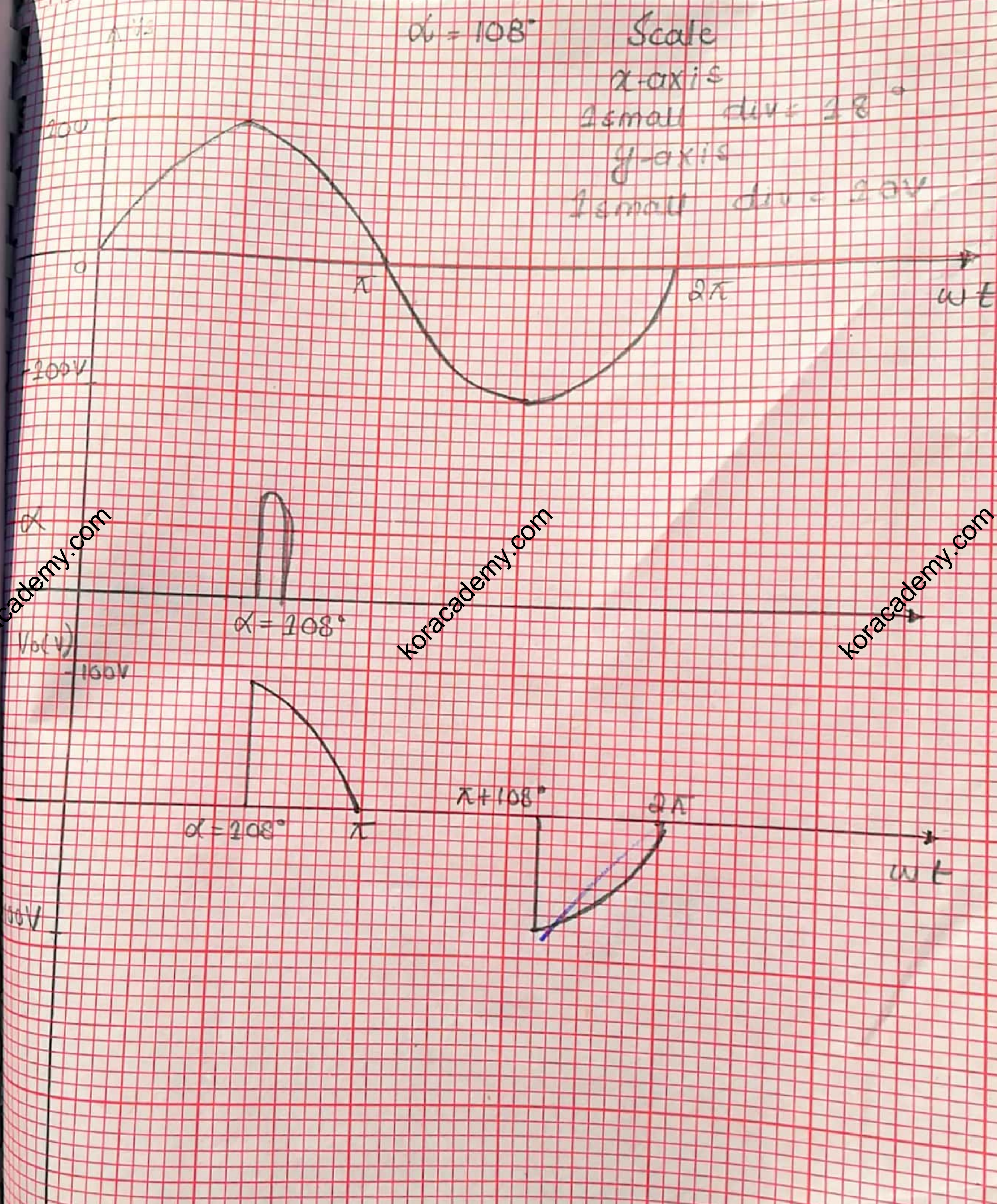
$$V_m = 10 \times 10 = 100V$$

| $\alpha$ | $V_{o\,rms}$ (actual) | $V_{o\,rms}$ (calculated) | % Error |
|---|---|---|---|
| 36° | 43.19V | 41.21V | 4.8% |
| 54° | 40.61V | 40.05 | 1.39% |
| 108° | 28.28V | 26.18 | 8.02% |

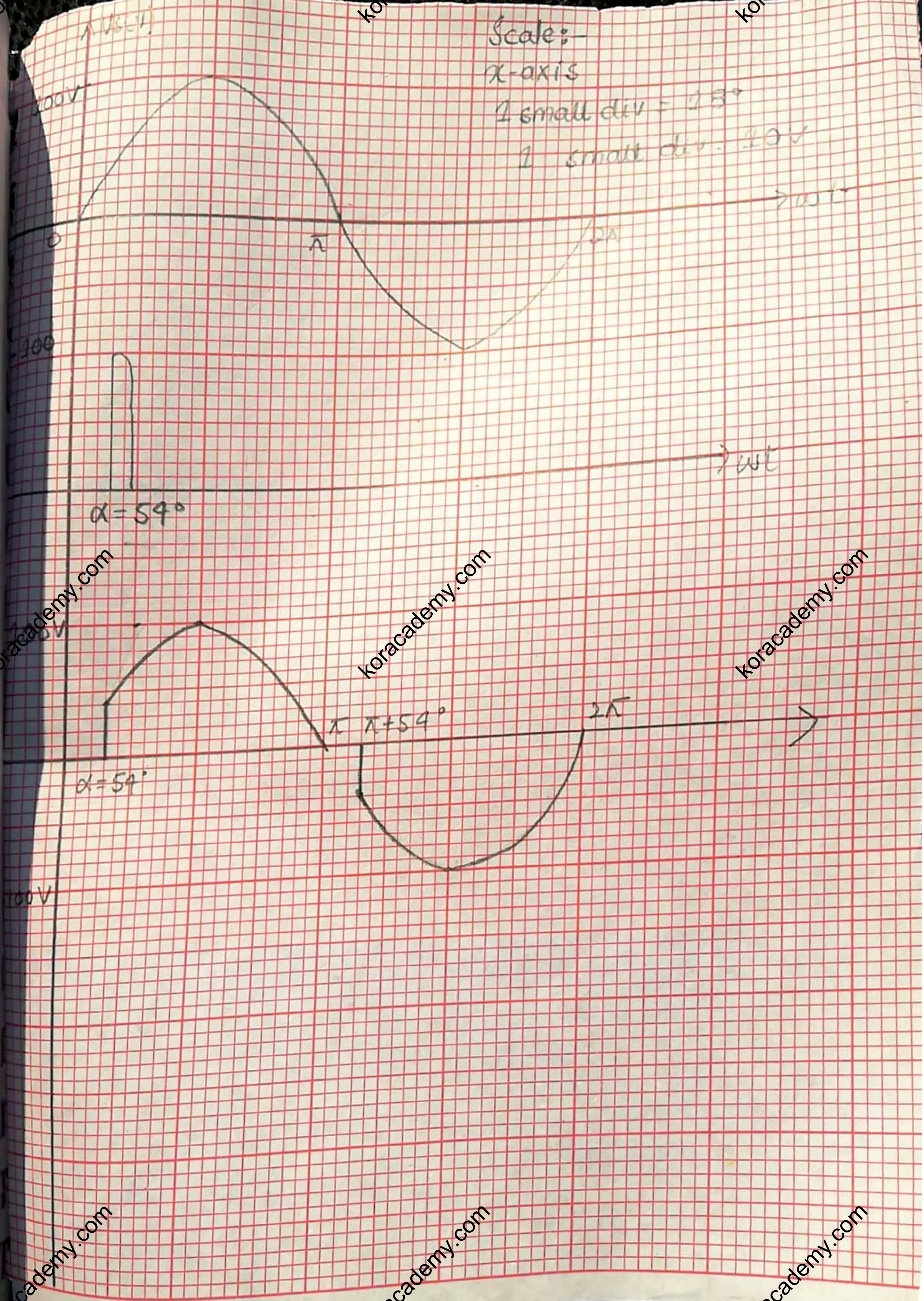
# CONCLUSION:

In lab I observed that inverse parallel thyrister circuit we have output voltage for both +ve and -ve cycles of input voltage and can be controlled by firing angle ($\alpha$).

Scale:-



α = 108°
Scale
x-axis
1 small div = 18°
y-axis
1 small div = 20V
200
0
π
2π
ωt
-200V
α
α = 108°
Vo(V)
100V
α = 108°
π
π+108°
2π
ωt
100V


Scale:-
x-axis
1 small div = 18°
1 small div = 10V
100V
0
π
2π
ωt
-100
α = 54°
ωt
100V
π
π+54°
2π
α = 54°
100V