UNIVERSITY OF ENGINEERING & TECHNOLOGY PESHAWAR

1980

SALAAR KHAN

17PWELE5087

SECTION A

ELECTRICAL ENGINNERING DEPARTMENT

5TH SEMESTER

POWER ELECTRONICS

LAB REPORT

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Salaar Khan Section A 17PWELE5087

01/10/19

Lab 1

Introduction to Power Electronics lab and apparatuses.

Apparatus

- Power electronics control unit (PE 481)
- Power electronics LCR load unit (PE 481)
- Basic triggering circuits (PE 481D)
- Single thyristor circuit (PE 481A)
- Connecting wires.

Power Electronics Control Unit (PE 481)

It is a trainer used in the lab to implement different power electronic circuits.

It operates on a 220V AC supply.

It contains

- Fixed DC voltage source.
- Variable DC voltage source.
- 2 voltmeters.
- 3 ammeters.

It also has two other positions to adjust external modules on it when implementing a circuit.

Power Electronics LCR load unit. (PE 481)

This device has the following components;

- Fixed resistor.
- Variable resistor.
- Fixed inductor.
- Variable inductor.
- Capacitor.

Single Thyristor Circuit (PE 481A)

It is an external module connected with the control unit consisting of;

- Sensitive gate thyristor.
- Full wave rectifier.
- Flywheel diode etc.

It also has a switch to change it depending on the power provided to it is either external (from the control unit) or not.

Basic Triggering Circuit (PE 481 D)

It is an external module connected with the control unit in the control module position. It is used to control power in other electronic circuits.

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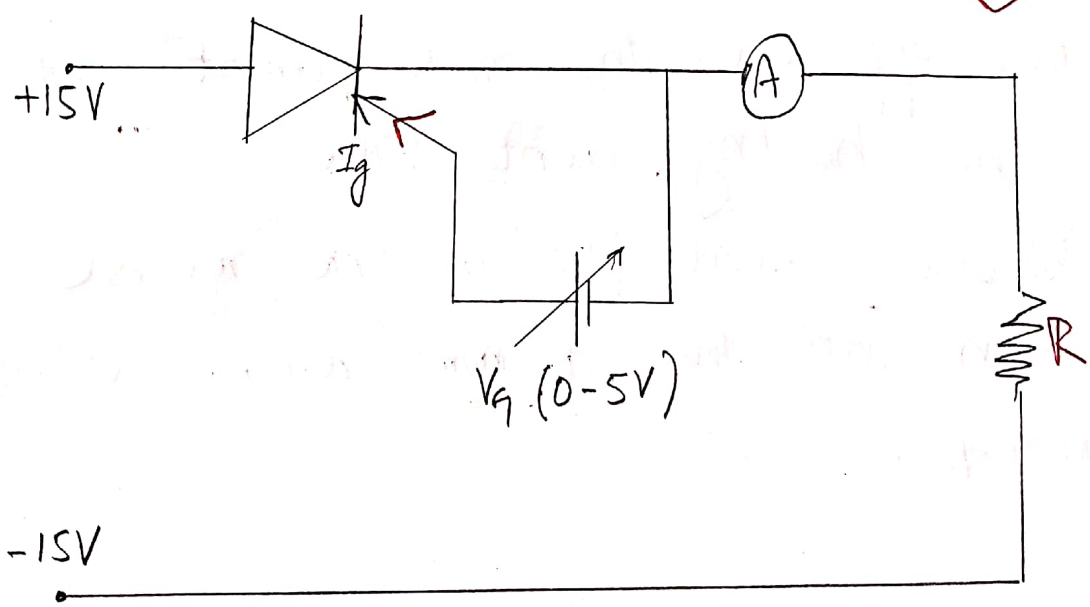
Lab 2   01/10/19

To Study switching of an SCR. (DC Test of Silicon Controlled Rectifier.

Apparatus

- Power electronics control unit (PE 481)
- Single thyristor circuit (PE 481 A)
- Power electronics LCR load unit (PE 481)
- Power supply
- Connecting wires
- Resistor.
- Ammeter

Circuit Diagram



Theory

Thyristor is used as switching or rectifying device. It is also known as silicon controlled rectifier (SCR). It has three terminals ie anode cathode and gate. It allows current in one direction (forward bias) and blocks in the other direction (reverse bias).

The breakover or turn on voltage of an SCR can be adjusted by a current flowing into its gate lead. Breakover voltage drops when the gate current increases.

- A thyristor turns on when the voltage applied to it exceeds breakover voltage and current exceeds latching value.
- It turns off when the anode current drops below the holding current value.
- It blocks current flow in the reverse direction untill the maximum reverse voltage is exceeded.

Procedure

- Make the circuit according to the diagram.
- Apply a variable DC voltage of range (-15V to 15V) to anode w.r.t cathode.
- Apply a variable DC voltage of range (0V to 5V) to gate w.r.t cathode.
- In the absence of gate current, the thyristor will remain off with increase in anode voltage below breakdown voltage.
- With the application of gate voltage, the anode current becomes more than the latching current value and thyristor starts conduction.
- Now remove the gate voltage, the thyristor will still remain ON.
- To turn the thyristor off, anode voltage is removed, the current will drop below the holding current value and as a result thyristor will stop conduction.
- If we apply anode voltage directly again, it will not require gate voltage to make it ON.

Observations.

$I_L = 22.73 mA$

$I_g = 0.01 mA$

$V_g = 0.58 V$

Conclusion

From this experiment we concluded that inorder for the SCR to be ON,

- Anode must be positive with respect to cathode.
- Gate pulse must be provided.

Once the SCR is ON, if we remove the gate pulse, it will still be ON.

But if we remove the power supply it will become off. Now to turn it back ON, you have to give it the power supply plus the gate pulse again.

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Lab 3 08/10/19

To Study Switching of a Silicon Controlled Rectifier Using AC voltage. (AC Test of an SCR)

95

Apparatus

- Power electronics control unit (PE 481)
- Single thyristor circuit (PE 481 A)
- Power electronics LCR load unit (PE 481)
- Power supply.
- Connecting wires.
- Resistor.
- Ammeter.

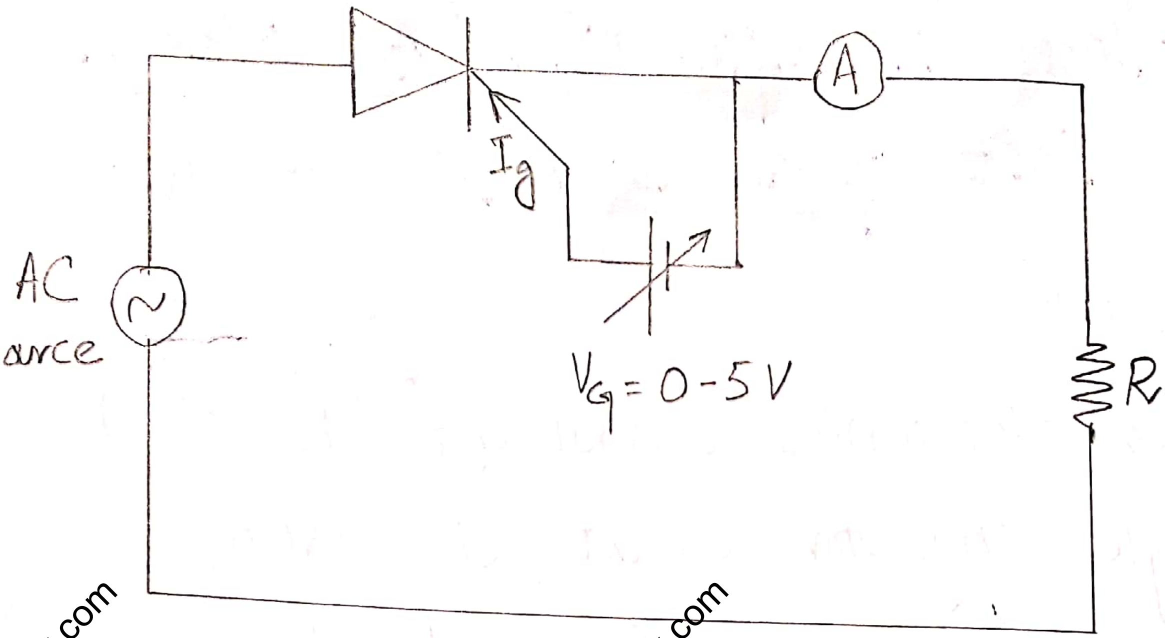
Charac?

Theory

Thyristor is used as switching or rectifying device. It is also known as silicon controlled rectifier (SCR). In this experiment we study its behaviour when an

AC voltage source is applied to it.

Circuit Diagram



Procedure

- Make the circuit acurding to the diagram.
- Apply an AC voltage source at the cathode and anode terminals.
- Apply a variable DC voltage source (0-5 V) at the gate terminal.
- In the absence of gate current, the thyristor will remain off with increase in anode voltage below breakdown voltage.

With the application of gate voltage,

the anode current becomes more than the latching current value and the thyristor starts conduction.

- Now if we remove the gate voltage, the thyristor will turn off.
- This is because the negative cycle of source signal has arrived making the diode reverse biased.

Conclusion.

In the AC test, when AC signal and gate pulse is constantly provided, we get a half wave rectified at output ie the voltage across load (R_L).

This is because anode is positive with respect to cathode in the positive cycle so the SCR will act as short circuit and $V_S = V_L$.

For the negative half cycle, the anode is negative w.r.t cathode and hence the SCR is reverse biased and acts as an open circuit and thus we get nothing at the output ie $V_L = 0V$, although the gate pulse is provided.

Observations.

$V_g = 2.75\ V$

$I_g = 1.5\ mA$

$I_L = 27\ mA$

Lab 4 15/10/19 5087

To study the single phase control of an SCR (with resistive load).

Apparatus

- Power electronics control unit PE 481.
- Power electronics LCR load unit PE 481.
- Single thyristor circuit PE 481 A
- Basic triggering circuit PE 481 D.

95

Theory

A silicon controlled rectifier is basically a switch which can be used in rectifier circuit. We have two types of rectifiers,

(i) Controlled
(ii) Uncontrolled

If a diode is used in the circuit it is uncontrolled whereas the use of SCR makes it a controlled half wave rectifier. as turn ON of the SCR is controlled.

Inorder for the SCR to conduct;

- Anode must be positive w.r.t cathode.
- Gate pulse must be provided.

In uncontrolled rectifiers once the load and source parameters attain a certain value, the average values of voltage and current across the load are fixed. whereas in controlled rectifier by changing the firing angle (α), the average values of voltage and current across the resistive load will change.

The average value of voltage across the load resistor is;

$$V_0 = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \sin\omega t \, d\omega t$$

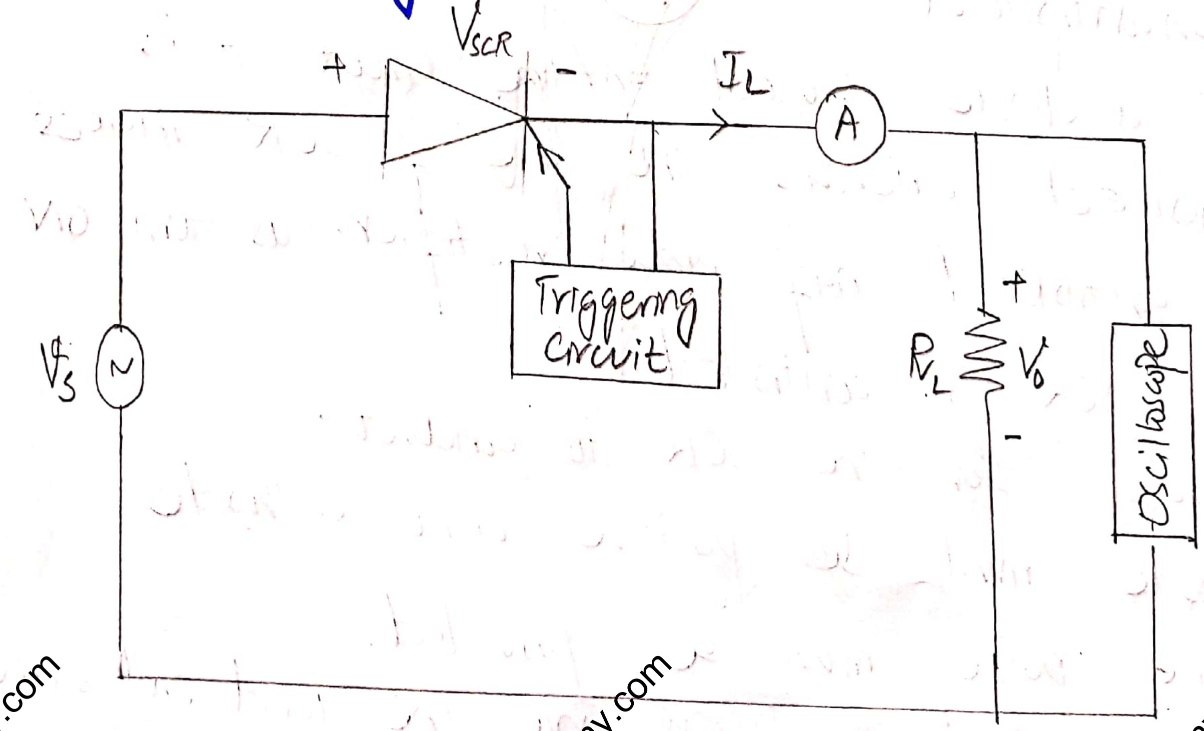
$$\Rightarrow V_0 = \frac{V_m}{2\pi}(1+\cos\alpha)$$

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

$$\Rightarrow V_{rms} = \frac{V_m}{2}\sqrt{1-\frac{\alpha}{\pi}+\frac{\sin 2\alpha}{2\pi}}$$

$$I_0 = V_0/R \qquad I_{rms} = \frac{V_{rms}}{R}$$

Circuit Diagram



Procedure

- The circuit is made according to the circuit diagram as,
  - Insert the basic triggering circuit in the control module position of the power electronics control unit.
  - Insert the basic thyristor circuit in the power modules position.
  - Connect the ammeter and load to the basic thyristor circuit.
- Observe V_m and α from the oscilloscope.
- Calculate the Rms and average values of load voltage for different values of α.

Observations And Calculations

1 cycle = 28.5 small blocks.

$\Rightarrow 28.5\ sb = 360°$

$\Rightarrow 1\ sb = \dfrac{360°}{28.5} = 12.63°$

Also $\pi = \dfrac{360°}{2} \Rightarrow \pi = \dfrac{28.5}{2} = 14.25\ sb.$

Now $\alpha + \pi = 18\ sb.$

$\Rightarrow \alpha = 18 - 14.25 = 3.75$

$\Rightarrow \alpha_1 = 3.75 \times 12.63$

$\Rightarrow \alpha_1 = 47.36°$

Similarly

$\alpha + \pi = 20 \Rightarrow \alpha = 20 - 14.25 = 5.75$

$\Rightarrow \alpha = 5.75 \times 12.63 \Rightarrow \alpha_2 = 73.6°$

(3) $\alpha + \pi = 19 \Rightarrow \alpha = 19 - 14.25 = 4.75$

$\Rightarrow \alpha = 4.75 \times 12.63 \Rightarrow \alpha_3 = 68.8°$

Conclusion

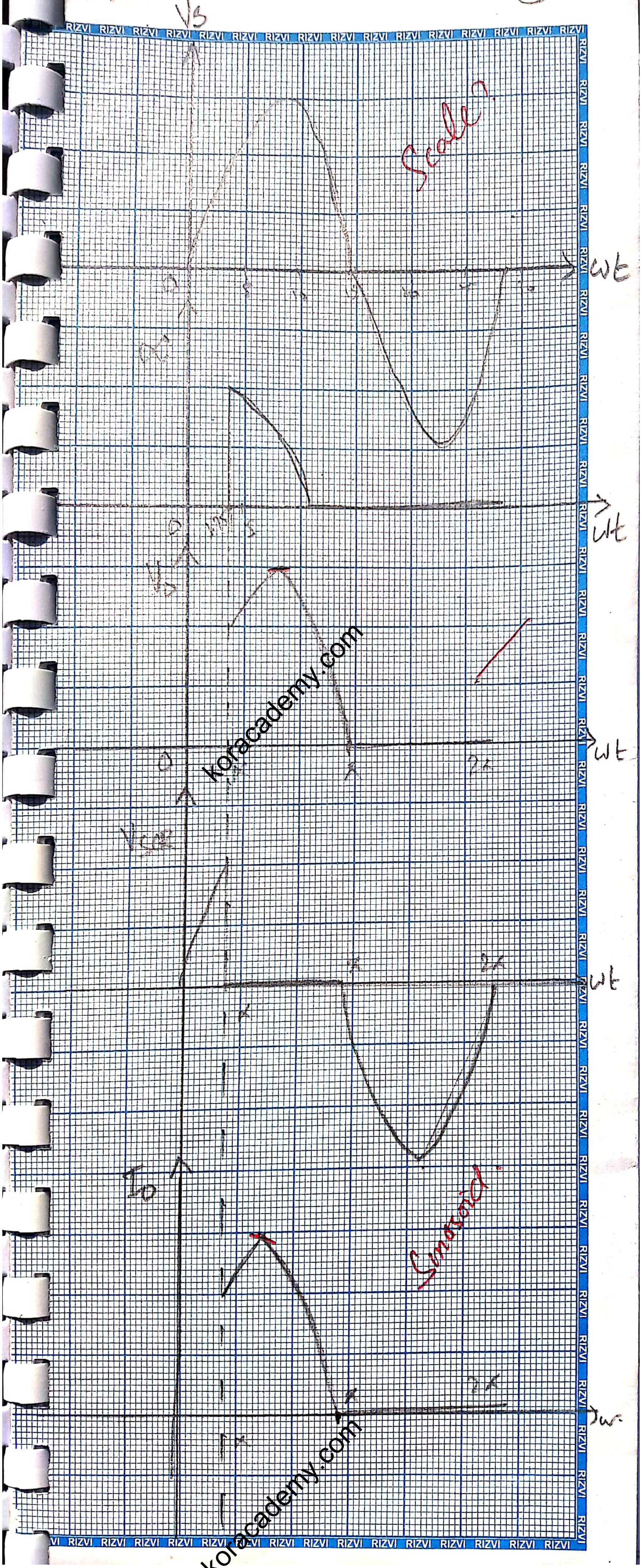
From this experiment, we conclude that by changing the firing angle (α), the values of output voltages and current changes.

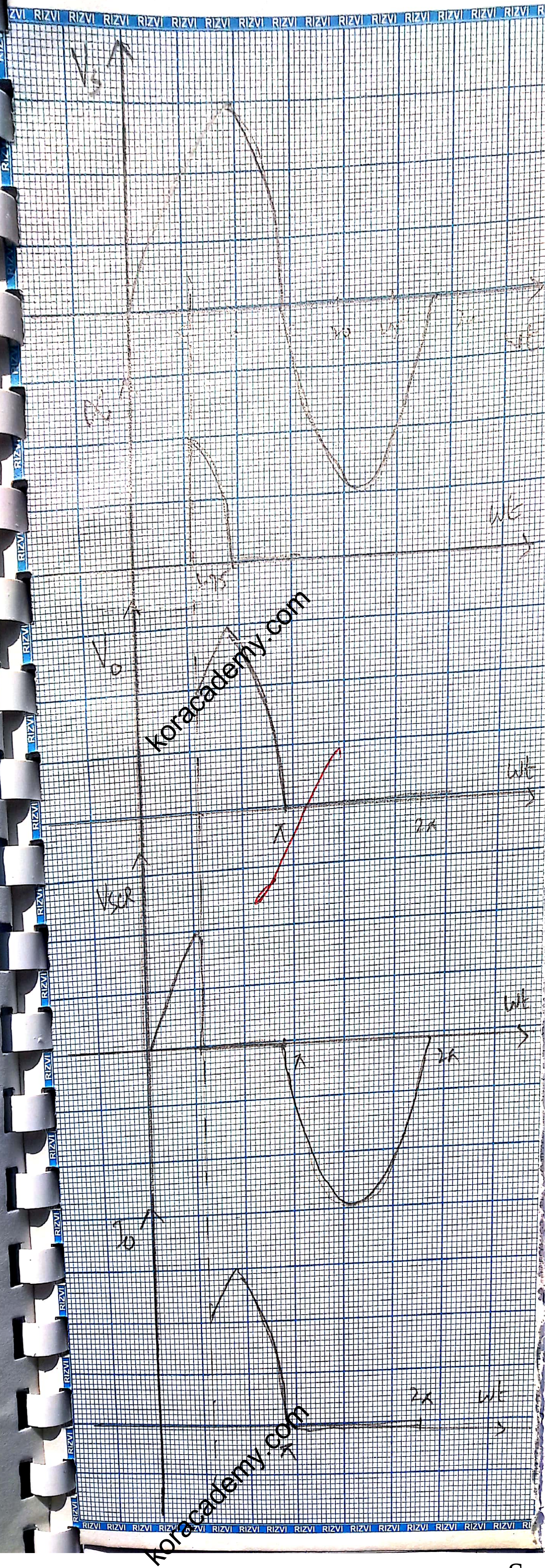
SNo	α	V_m (V)	V_o (V) calculated	V_o (V) measured	V_{rms} (V)	I_o (mA)	I_{rms} (mA)	% error
1	47.3°	68	18.55	17.5	32.17	350	693	3.7%
2	73.6°	68	18.88	14.8	27.98	296	559	6.2%
3	60.8°	68	16.11	16.81	30.36	336	607	4.16%

Scale

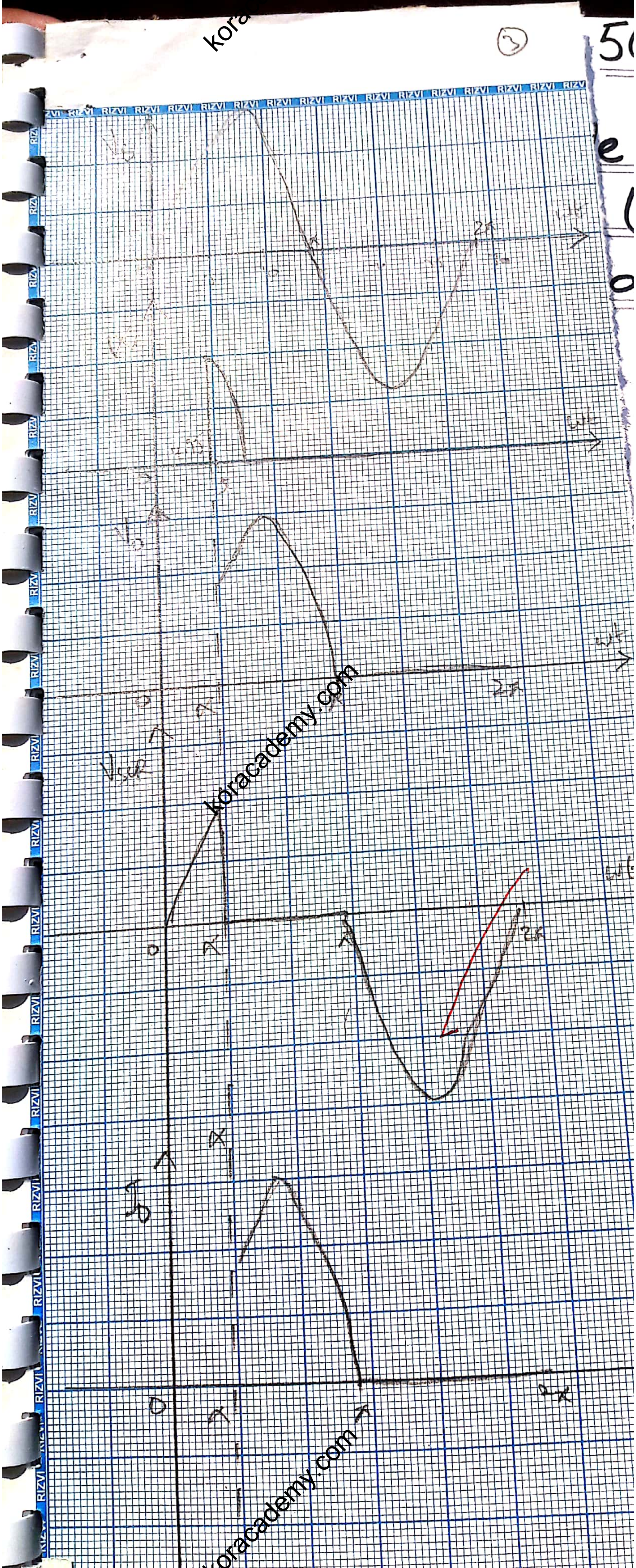
Along y axis 3 big squares = 68 V.

Along x axis 1 big square = 5 divisions of oscilloscope


Vs
ωt
Scale?
0
ωt
Vo
ωt
0
π
2π
Vscr
π
2π
ωt
Io
Sinusoid.
2π



V_s
wt
V_o
π
2π
V_{SCR}
I_o



ωt
2π
Vo
VSCR
Io

5087 22/10/19

Lab 5

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

100/100

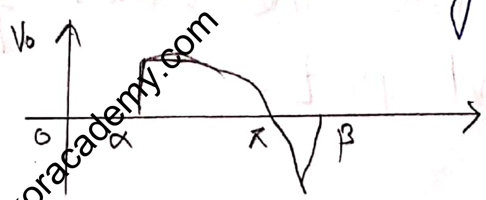
Apparatus

- Power electronics control unit PE 481.
- Power electronics controlled LCR load unit PE 481.
- Single thyristor circuit PE 481 A.
- Basic triggering circuit PE 481 C.
- Multimeter
- Oscilloscope.

Theory

An SCR is a four layer solid state current controlled device. The layers are made of two P type and two n type materials with three junctions and three terminals.

SCR allows current if the anode is made positive wrt cathode and a gate pulse (α) is applied.

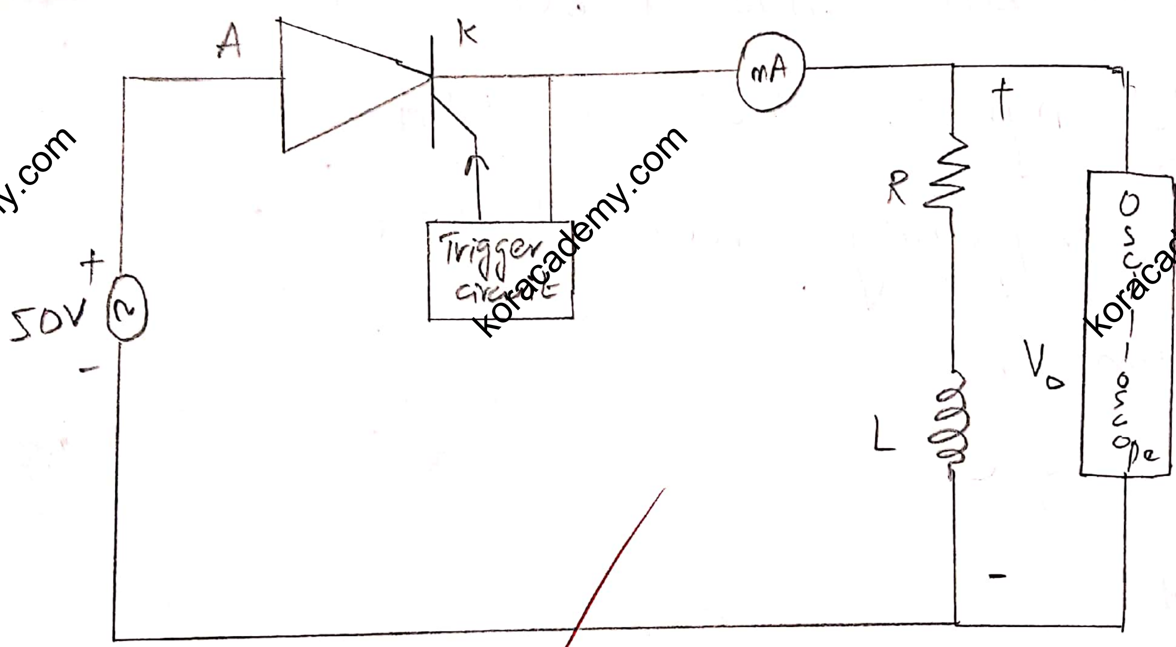


The inductor stores energy that generates voltage when there is negative cycle of the source signal.

At negative cycle the voltage develops across inductor, forward biases SCR and maintain its conduction till β.

There is no conduction from β to 2π.

Circuit diagram



Procedure

- The circuit is designed according to the shown circuit diagram.
- By changing the triggering unit we can control α, π and β.
- Then calculate the values of α, β, V_o, I_o, V_{rms}, I_{rms} and plot.

Observation

By changing the triggering value, the value of α changes; hence changing the conducting portion ie α to β.

Calculations

$$V_0 = \frac{1}{2\pi}\int_{\alpha}^{\beta} V_m \sin\omega t \, d\omega t = \frac{V_m}{2\pi}\left(-\cos\omega t\right|_{\alpha}^{\beta}$$

$$\Rightarrow - V_0 = \frac{V_m}{2\pi}\left(\cos\alpha + \cos\beta\right)$$

- $I_0 = V_0 / R.$

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

$$= \sqrt{\frac{V_m^2}{2\pi}\int_{\alpha}^{\beta}\left(\frac{1-\cos 2\omega t}{2}\right) d\omega t}$$

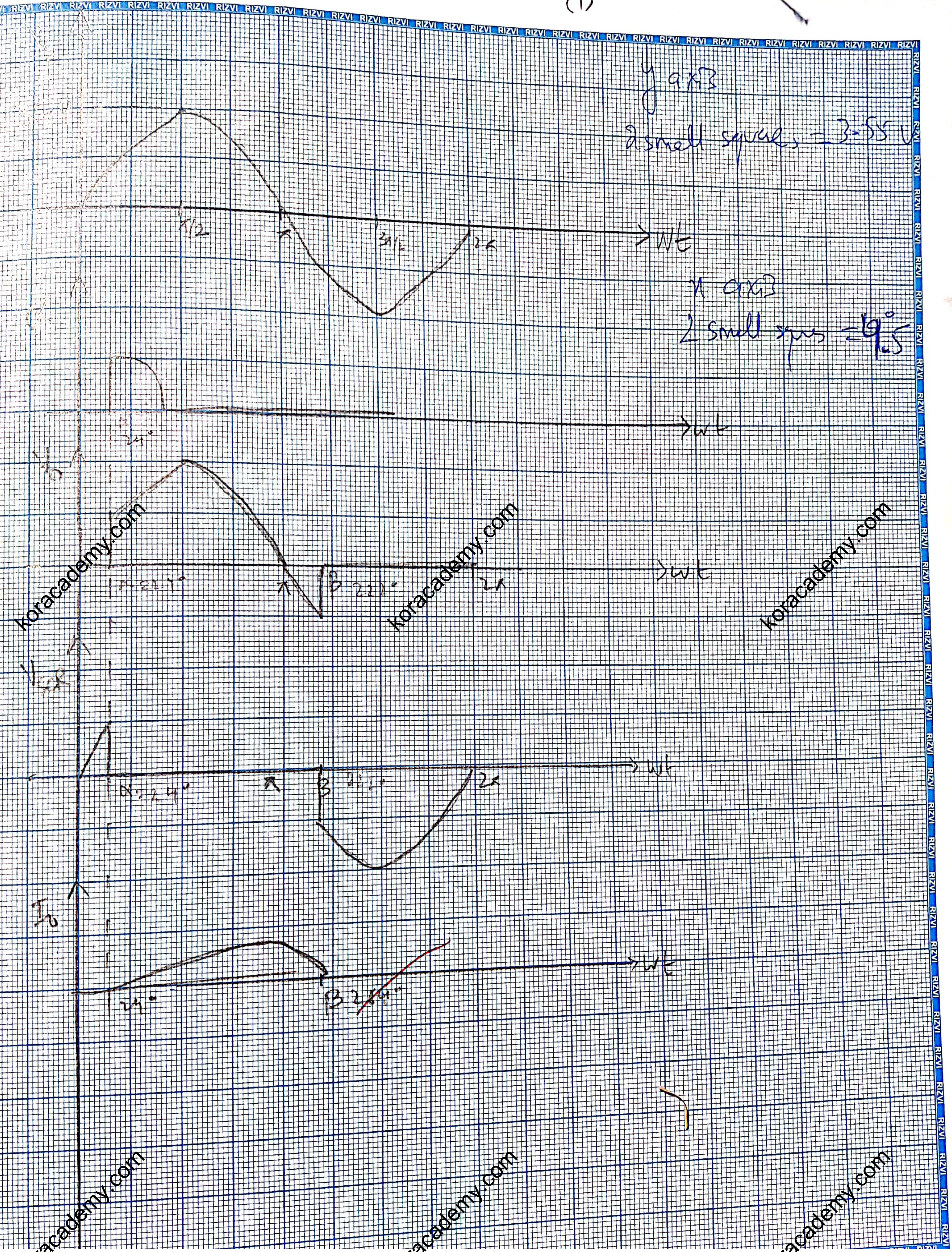
$$\Rightarrow V_{rms} = \sqrt{\frac{V_m^2}{4\pi}(\beta - \alpha)}$$

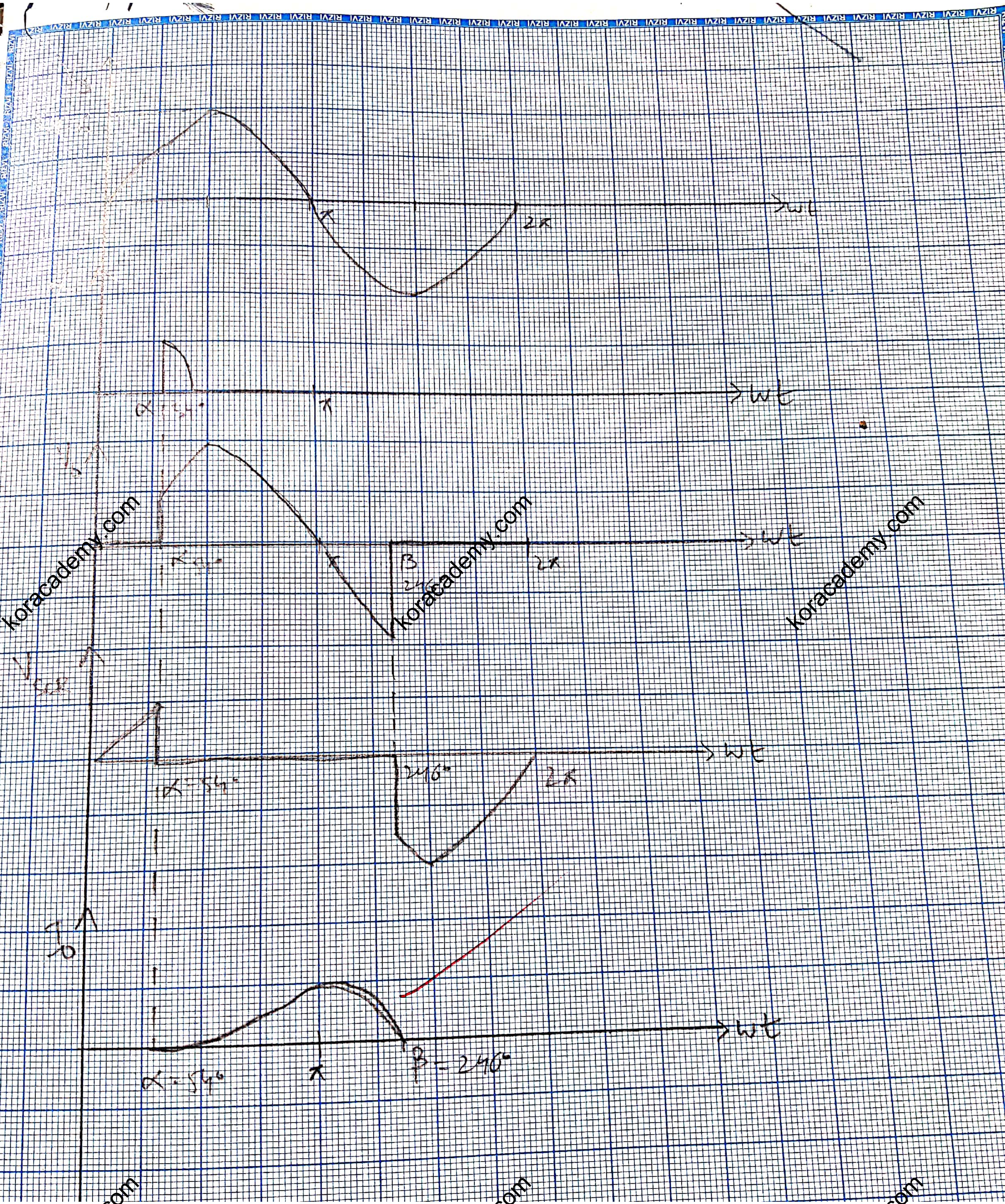
- $I_{rms} = \frac{V_{rms}}{R}$

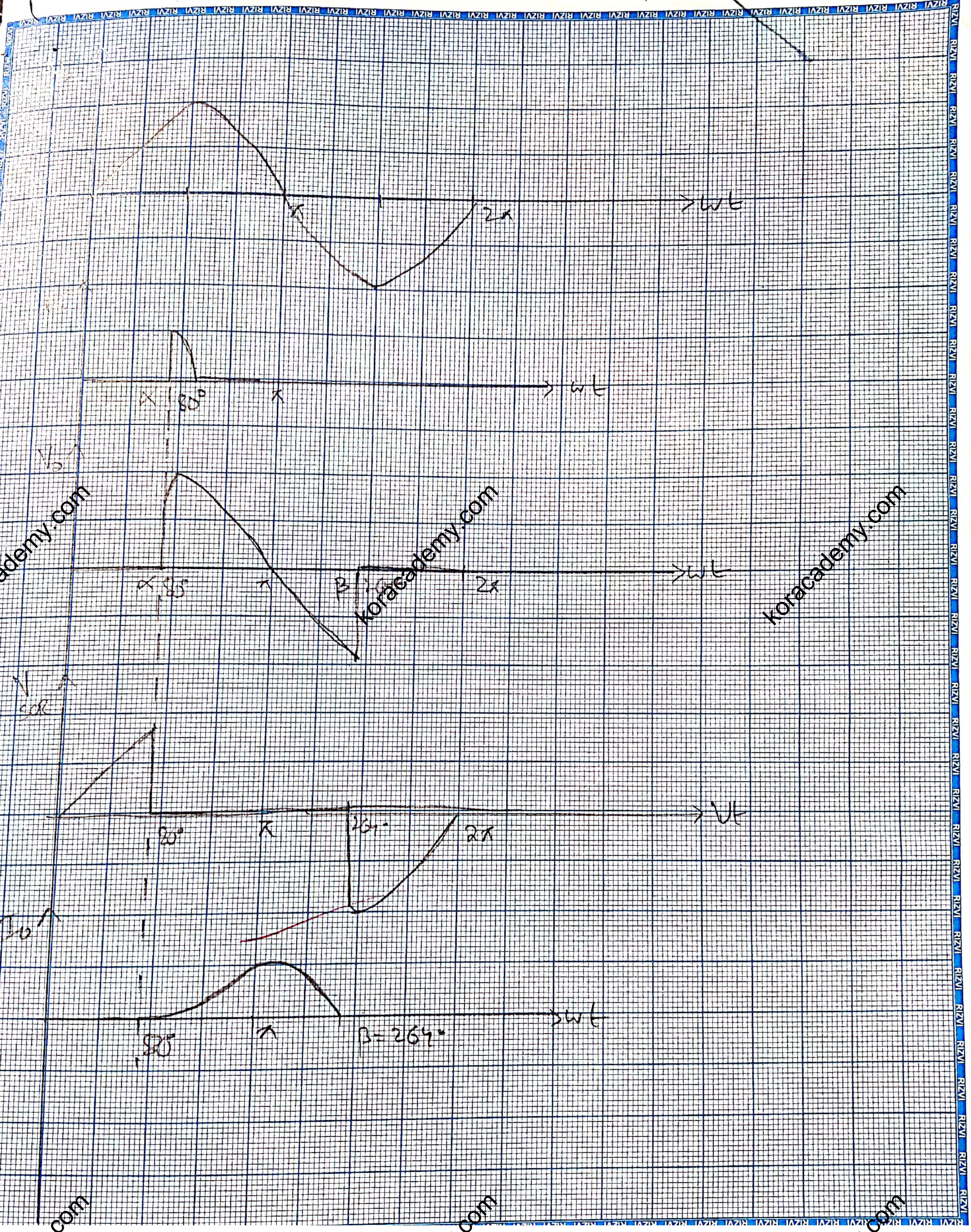
S.No	$\alpha°$	$\beta°$	Vrms (Vs)	V_o (V) calculated	V_o expt	I_o(A) calculated	I_o (A) Actual	Error V_o (%)	Error I_o (%)
1	24°	222°	35.4	17.67	18.3	0.35	0.41	3.8	11
2	54°	246°	34.6	10.6	11.5	0.42	0.28	7.8	16
3	80.4°	264°	33.8	3.2	3.46	0.064	0.091	6.6	21

Conclusion

From this experiment we concluded that by changing the triggering value, the value of α changes due to which the conducting portion of the graph of circuit changes.


y axis
2 small squares = 3.55 V
x axis
2 small squares = 9.5°
ωt
π/2
π
3π/2
2π


wt
π
2π
α=54°
wt
π
wt
α=54°
π
β 246°
2π
wt
α=54°
246°
2π
I_o
wt
α=54°
π
β=246°


ωt
π
2π
α
80°
ωt
π
α
80°
π
β
2π
ωt
80°
π
264°
2π
ωt
80°
π
β = 264°
ωt

Lab 06

22/10/19

5087

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

99/100

Apparatus

- Power electronics control unit PE 481.
- Power electronics controlled LCR load unit PE 481.
- Single thyristor circuit PE 481 A.
- Basic triggering circuit PE 481 C.
- Multimeter.
- Oscilloscope

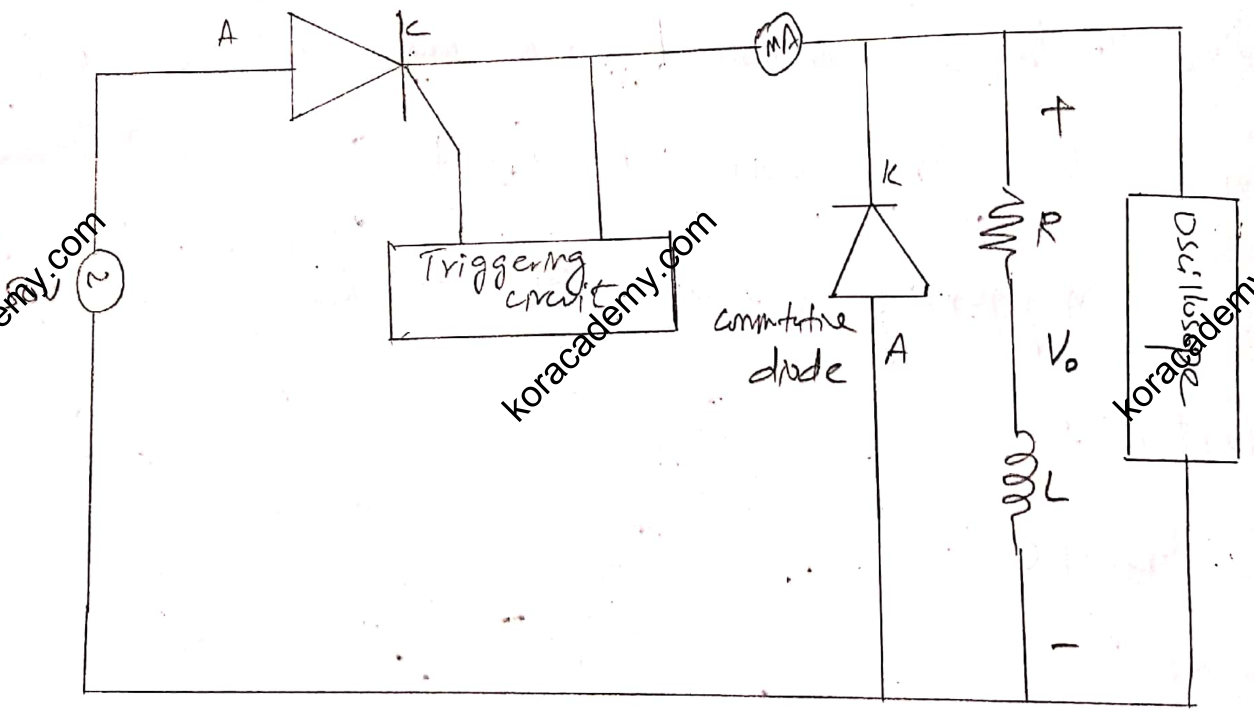
Theory

An SCR is a four layer solid state current controlled device. The layers are made of two P type and two N type materials with three junctions and three terminals.

SCR allows current through it if anode is positive w.r.t cathode and a gate pulse α is applied

The inductor stores energy that generates voltage when the cycle is negative. This voltage developed across the inductor forward biases the SCR and it maintains its conduction till π.

Circuit diagram



Procedure

- The circuit is made according to the shown circuit diagram.
- By changing the triggering value, we can control α.
- Calculate the values of α, β, I_o, V_o, I_{rms} and V_{rms} and plot.

Observations

We observe that by changing the triggering value, the value of α changes. And also that due to commutative diode there will be no conduction after π.

Calculations

$$V_o = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \sin\omega t \, d\omega t = \frac{V_m}{2\pi}\left(-\cos\omega t\right|_{\alpha}^{\pi}$$

$$= \frac{V_m}{2\pi}\left(\cos\alpha - \cos\pi\right)$$

$$\Rightarrow V_o = \frac{V_m}{2\pi}\left(1+\cos\alpha\right), \quad I_o = V_o/R$$

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

$$= \sqrt{\frac{V_m^2}{2\pi}\int_{\alpha}^{\pi}\left(\frac{1-\cos 2\omega t}{2}\right)d\omega t}$$

$$= \frac{V_m}{2}\sqrt{\frac{1}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha - \sin 2\pi}{2}\right)}$$

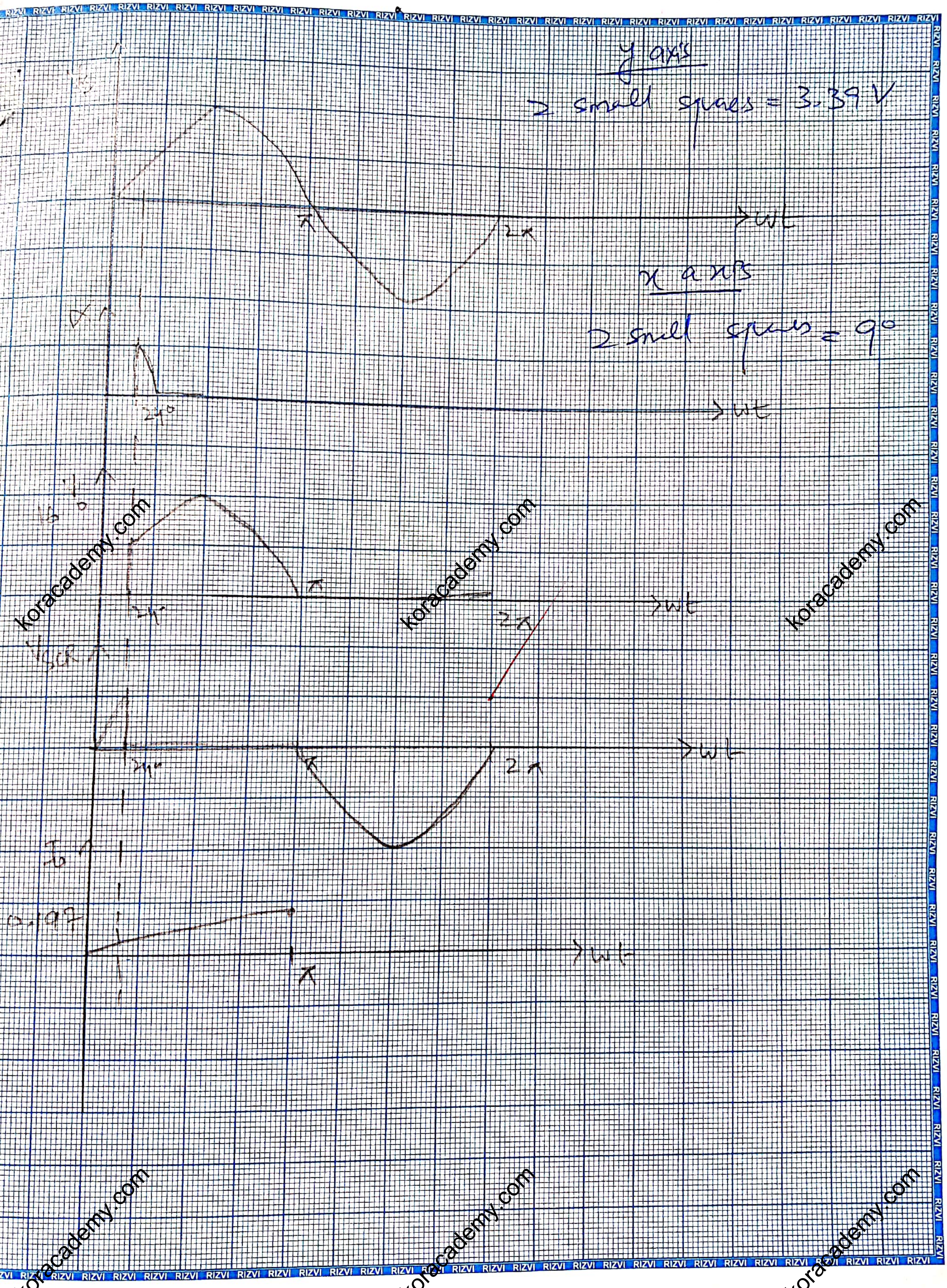
$$\Rightarrow V_{rms} = \frac{V_m}{2}\sqrt{1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2}}$$

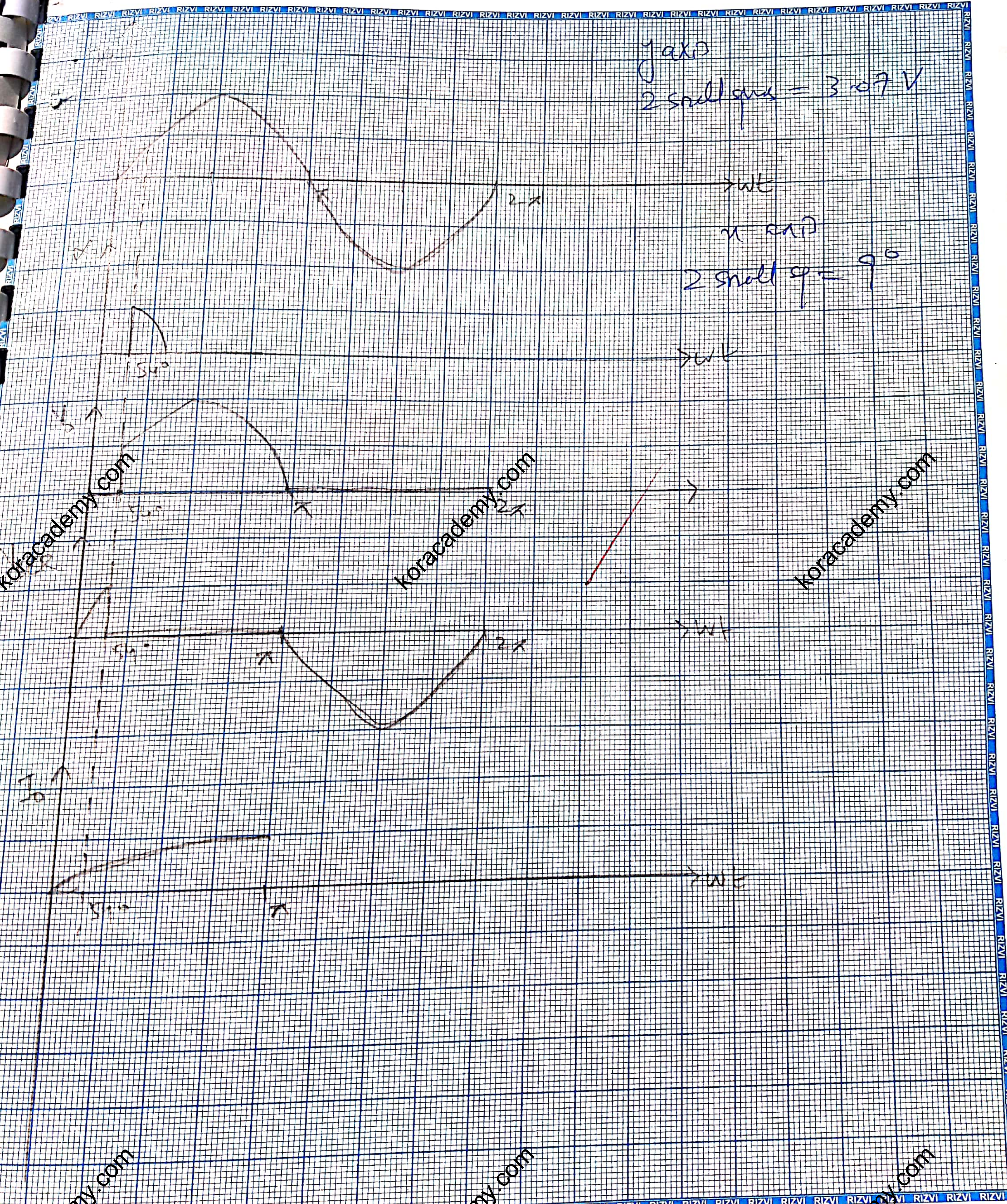
$$I_{rms} = \frac{V_{rms}}{R}$$

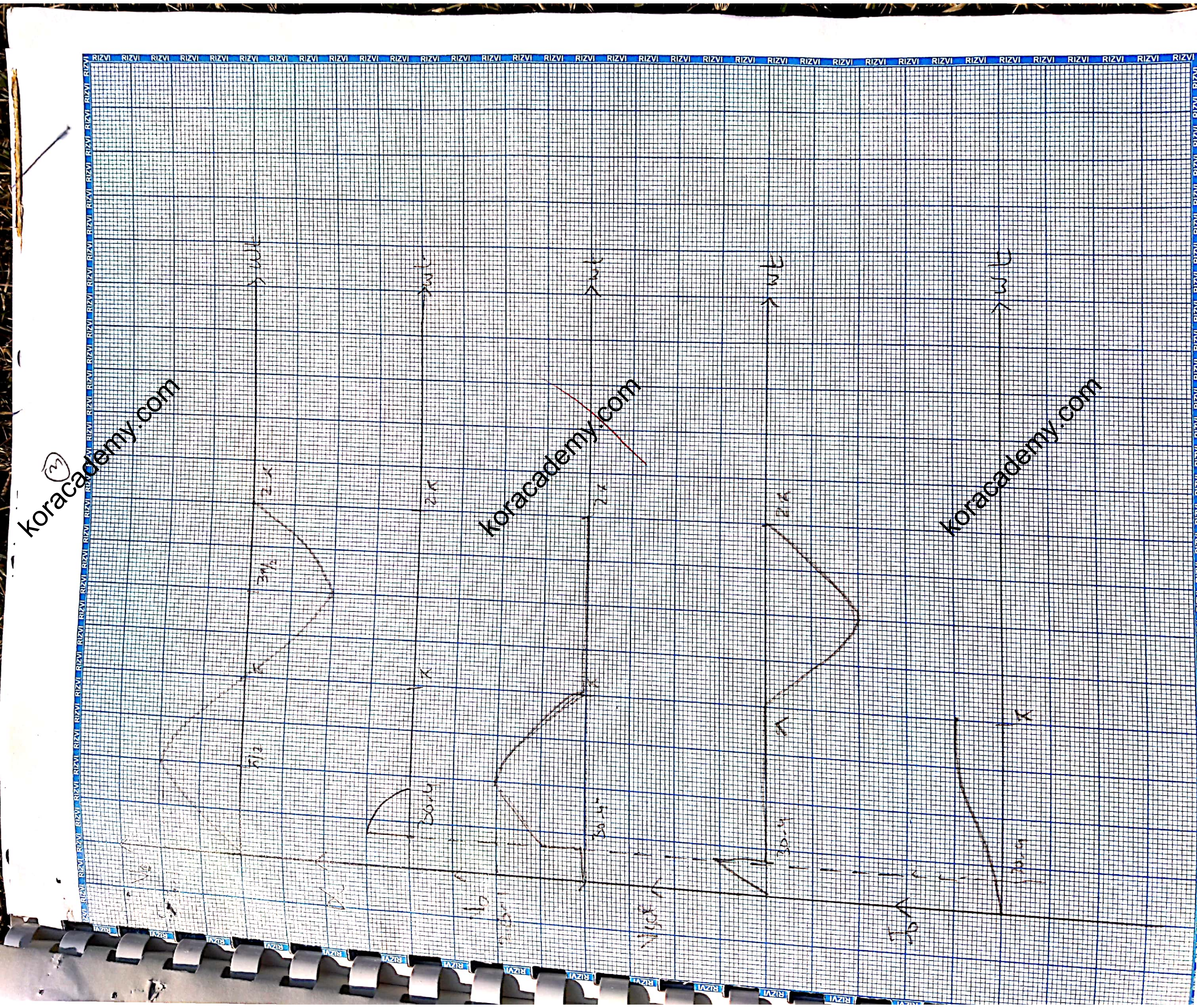
S No	α	V_{rms} (V)	V_0 actual (V)	V_0 calculated (V)	I_0 (A) actual	I_0 (A) calculated	Error I_0 %	Error % V
1	24°	33.9	22	20	0.47	0.4	11%	9%
2	54°	30.7	17.4	16	0.43	0.32	19%	8.64%
3	39.5	26.1	13.52	12.4	0.197	0.25	13%	8%

Conclusion

From this experiment we conclude that by changing the triggering value the value of α changes and due to commutative diode the conduction portion changes i.e there will be no conduction after π.


y axis
2 small squares = 3.39 V
x axis
2 small squares = 9°
wt
π
2π
24°
wt
24°
π
2π
wt
24°
π
2π
wt
0.197
π
wt


y axis
2 small squares = 3.07 V
x axis
2 small sq = 9°
ωt
2π
π
54°



Salaar Khan 17PWELE5087 29-10-19

Lab 07

To study single phase unctrolled bridge rectifier.

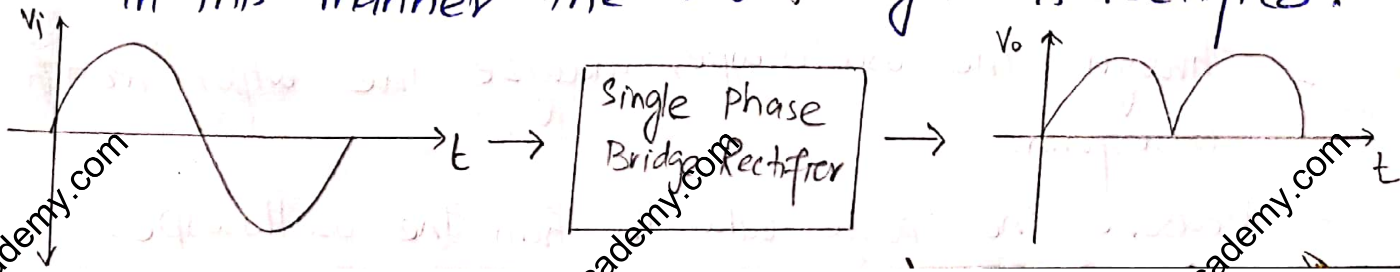
Apparatus

- Power electronics control unit PE481.
- Power electronics LCR load unit PE481
- Single thyristor circuit PE 481 A.
- Basic triggering circuits.
- Connecting wires

Theory

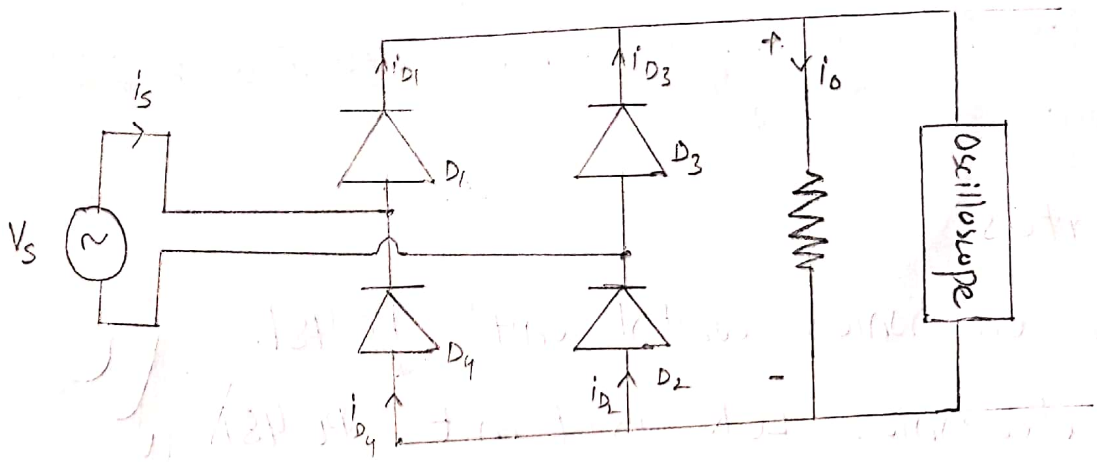
Bridge rectifier is an arrangement of diodes such that the output signal is DC. This arrangement consists of four diodes and are connected in such a way that only two diodes conduct at a time ie two for positive half cycle and the other two for the negative half cycle.

In this manner the whole cycle is rectified.

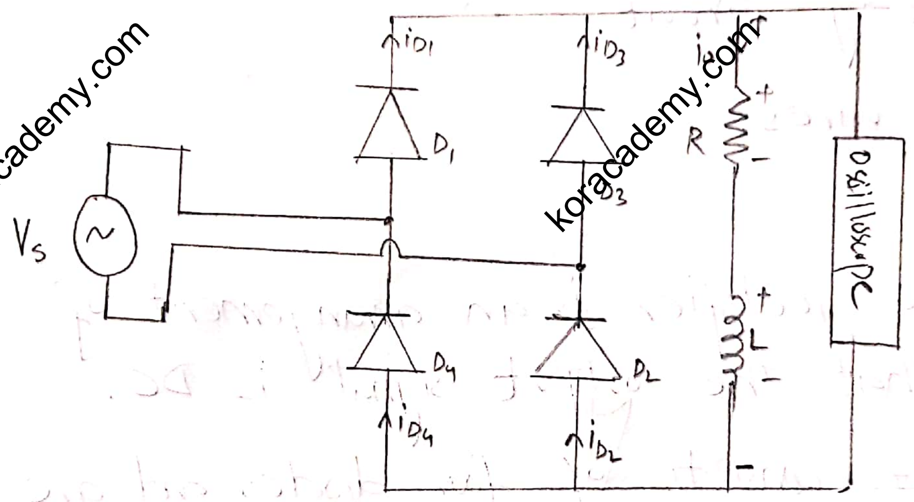


Circuit diagram

(i) Resistive load.



(ii) Inductive load.



Procedure

- Make the circuit according to the shown diagram.
- First analyze it for resistive then for inductive load.
- Give the input such that one terminal is connected to D_1 and other to D_3.
- Through the oscilloscope, analyze the output rectified wave form.
- Measure the peak value V_m from the oscilloscope.

- Measure the V_{avg}, V_0 and V_{rms} values across the load using a voltmeter (multimeter).
- Calculate V_0 and V_{rms} using peak value through the formula.

Observation

In this experiment we observed that both negative and positive half cycles are rectified to get a pulsating DC at the output.

Calculations.

Peak = 3.2 divisions of oscilloscope.

$\Rightarrow V_m = 3.2 \times 10 \times 2 \Rightarrow \boxed{V_m = 60.4\ V}$

Measured Values.

$V_{DC} = V_{0\,measured} = 39.3\ V$

$V_{AC} = V_{rms\,measured} = 43.9\ V$

calculated values

$$V_0 = \frac{1}{\pi}\int_0^{\pi} V_m \sin\omega t \, d\omega t = \frac{V_m}{\pi}\left(\cos\omega t\right|_0^{\pi} = \frac{2V_m}{\pi}$$

$$= \frac{2(60.4)}{\pi} \Rightarrow \boxed{V_0 = 38.47\ V}$$

$$V_{rms} = \sqrt{\frac{1}{\pi}\int_0^{\pi} V_m^2 \sin^2\omega t \, d\omega t} = \frac{V_m}{\sqrt{2}} \Rightarrow \boxed{V_{rms} = 42.7\ V}$$

% error

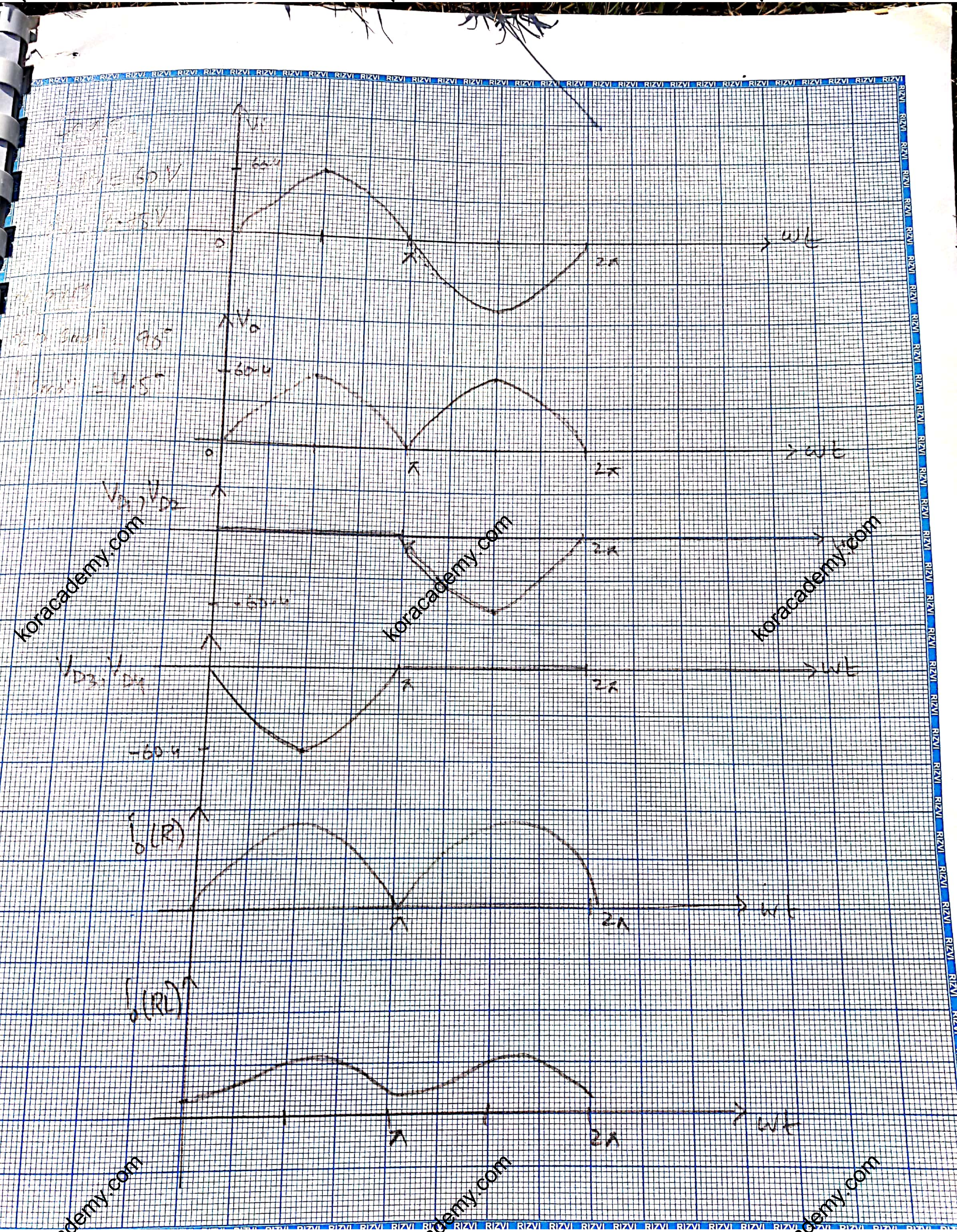
$$\%\ error_0 = \frac{39.3 - 38.47}{39.3} \times 100\% = \boxed{2.1\%}$$

$$\% \text{ error}_{rms} = \frac{43.9 - 42.7}{43.9} \times 100\% = \boxed{2.7\%}$$

Conclusion

From this experiment, we concluded that full wave bridge rectifier both half cycles of AC are rectified into pulsating DC unlike half wave rectifier. And the current i_o decreases in presence of inductive load as compared to resistive load.

$$i_o \text{ (resistive)} = 0.4\ A$$
$$i_o \text{ (inductive)} = 0.136\ A$$


Vi
60V
0
ωt
π
2π
Vo
60V
0
ωt
π
2π
VD1, VD2
2π
60V
VD3, VD4
ωt
π
2π
-60V
io(R)
ωt
π
2π
io(RL)
ωt
π
2π

Salaar Khan 17PWELE5087 05-11-19

Lab 08

To study the operation and characteristics of biphase half wave rectifier.

(i) Resistive load (ii) Inductive load.

Apparatus

- Power electronics control unit PE 481.
- Single thyristor circuit PE 481A.
- Uni junction Thyristor triggering circuit PE 481 E.
- Oscilloscope.

Theory

Biphase half wave rectifier consists of two SCRs, both are connected with phases and used for conversion of AC to DC, which is controlled.

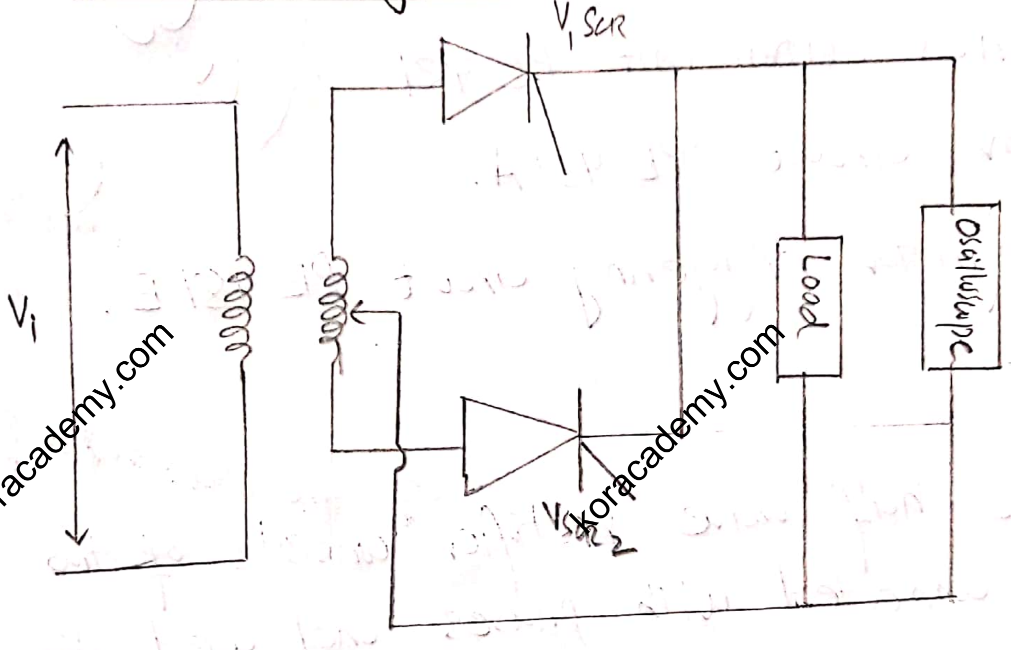
The connected provides two voltages V_1 and V_2 in an antiphase relation to the neutral N, connected to the load.

Procedure

- Make the circuit according to the diagram shown.
- Connect the oscilloscope across the load.
- Apply the triggering angle with the help of uni junction transmission triggering circuit.

- From centre tapped transformer, we get V_1 and V_2.
- SCR 1 conducts for the half cycle (first) and SCR2 conducts for the second half cycle.
- Using oscilloscope, find α and V_m, and then calculate the Rms values.

Circuit Diagram



Observations

Vertical divisions = 5.2

Volt per division = 1 V/div

Amplification factor = 10

$\Rightarrow V_m = 5.2 \times 1 \times 10 \Rightarrow \boxed{V_m = 52\,V}$

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

So $\alpha = \pi - 13 = 20 - 13 = \boxed{7\,div}$

1 div/cycle = 9° $\Rightarrow \alpha = 7 \times 9 \Rightarrow \boxed{\alpha = 63^\circ}$

For resistive load (R)

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

V_o (actual) $= 16.7\,V$.

V_{rms} (calc) $= V_m \sqrt{\left(\frac{\pi}{2\pi} - \frac{\alpha}{2\pi} + \frac{\sin 2\alpha}{4\pi}\right)} = 15\,V$

V_{rms} (actual) $= 14.2\,V$

For inductive load (RL)

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

$\Rightarrow \beta = 9 \times 27 \quad \Rightarrow \boxed{\beta = 243^\circ}$

V_o (calc) $= \frac{V_m}{2}(\cos\alpha - \cos\beta) = 10\,V$

V_o (actual) $= 12\,V$

V_{rms} (calc) $= 24.01\,V$

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

2

For $\alpha = 25^\circ$

Resistive load

V_o calc $= 20.8\,V$ $\quad$ V_o actual $= 21\,V$

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

Inductive load

V_o cal $= 19.9\,V$ $\quad$ V_o actual $= 20\,V$

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

$\alpha = 63°$

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

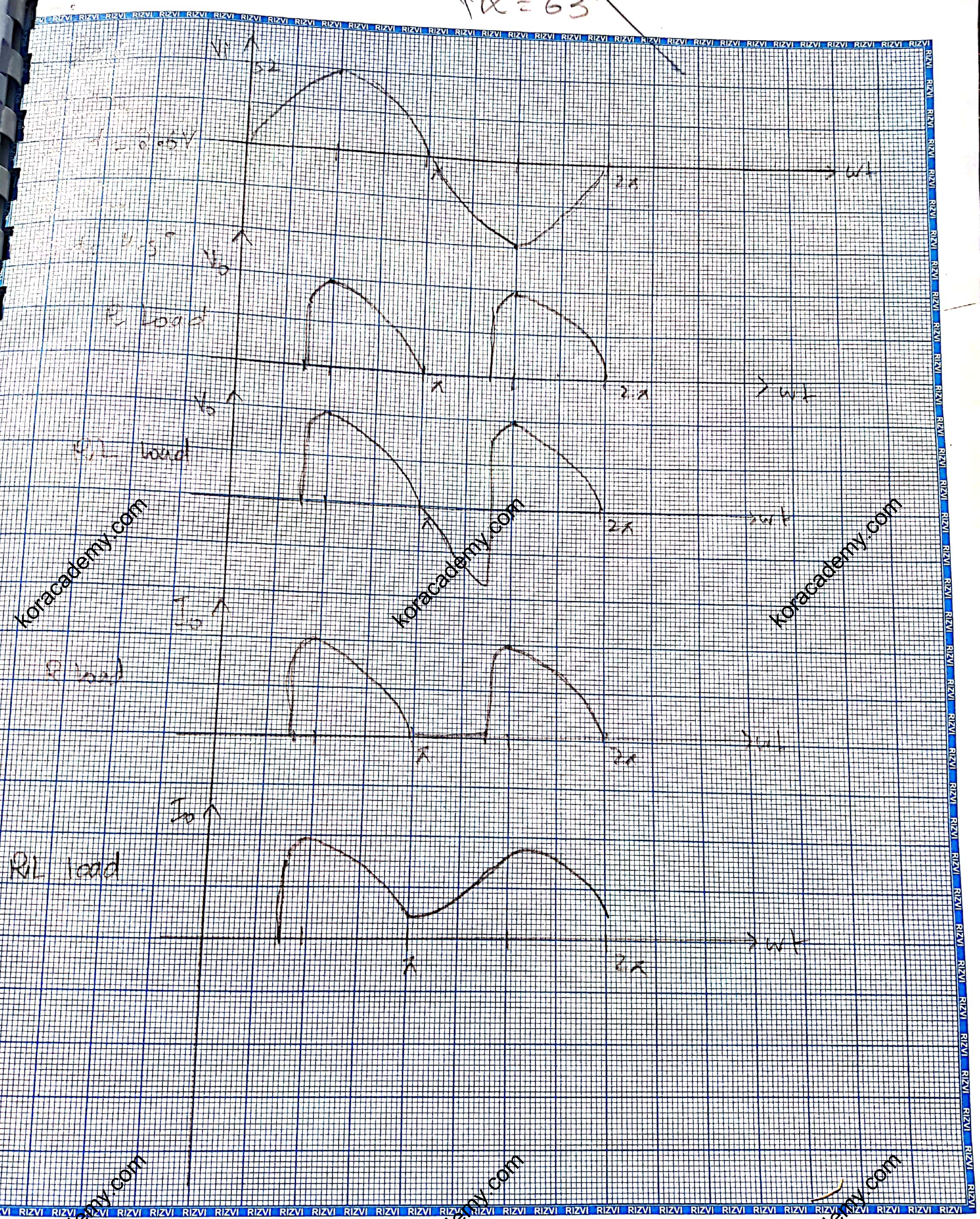
$\alpha = 22.5°$

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

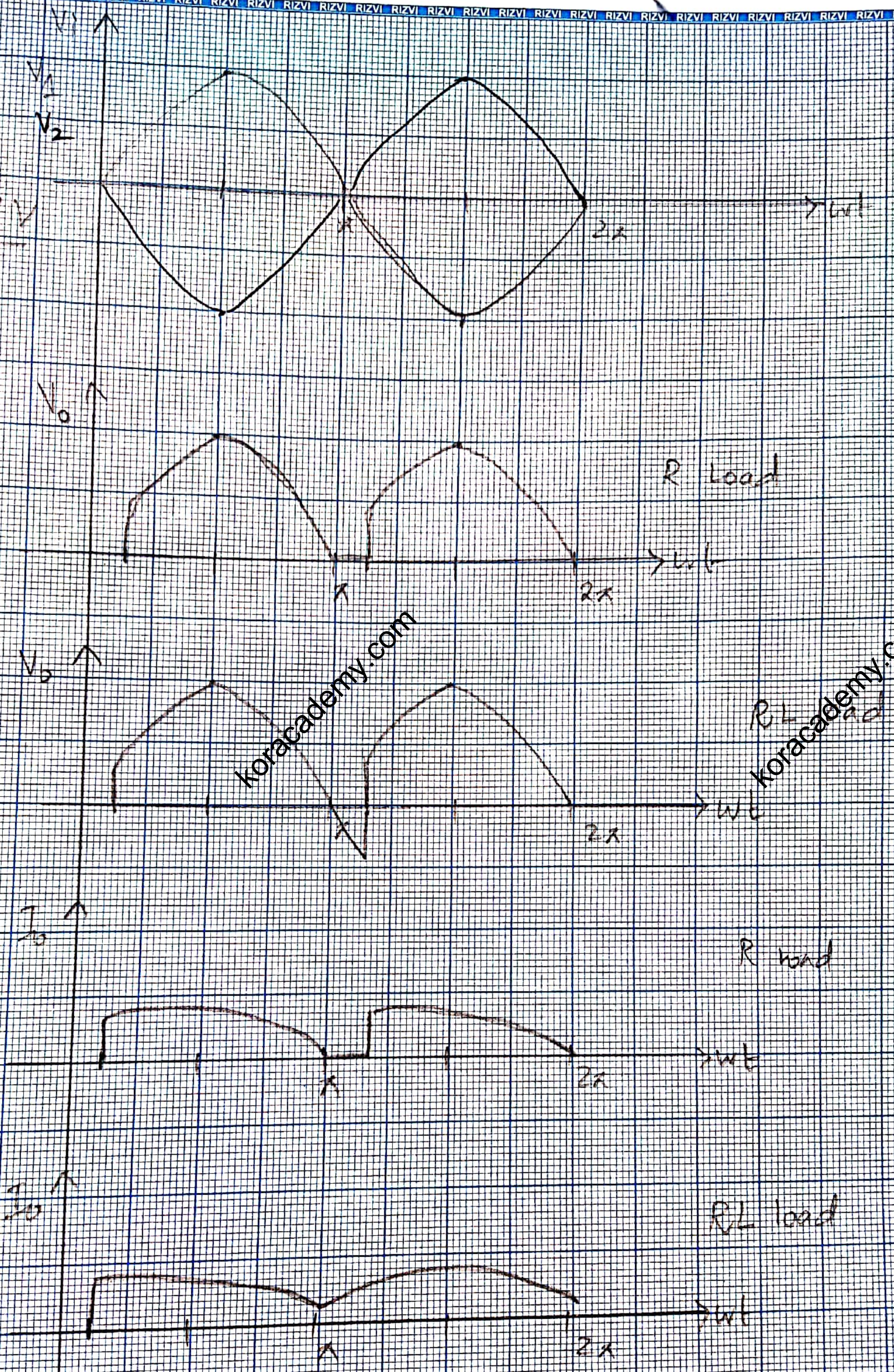
Conclusion.

From this experiment, I conclude that we can change the output voltage by changing the value of triggering circuit.

$\alpha = 63$



For $\alpha = 22.5°$



Salaar Khan 17PWELE5087 26-11-19

Lab 09

To study Dynamic characteristics of DIAC.

Apparatus

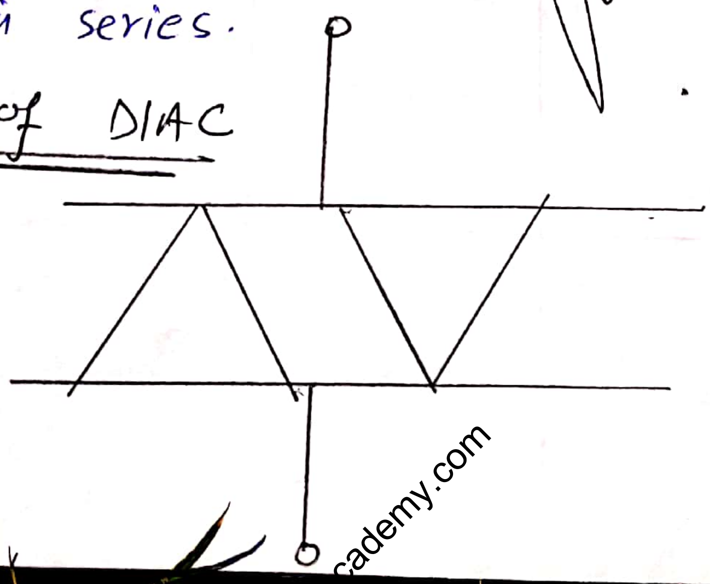
- Power electronics control unit PE 481.
- Basic triggering circuit PE 481 D.
- Oscillosope.
- Connecting wires.

98/100

Theory

A DIAC is a biderectional semiconductor 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 behavior is bidirectional and thus it function takes place in both halves of an AC cycle.
A DIAC has two ~~diodes~~ electrodes and is used in triggering of thyristors and it is just like two diodes connected in series.

Symbol of DIAC

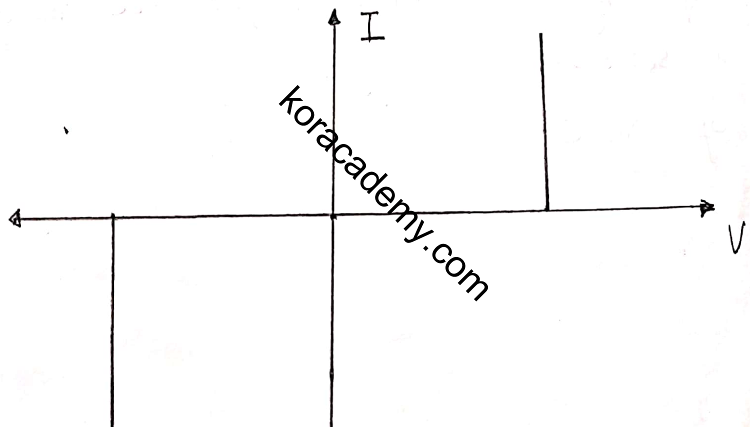


The breakover voltage of DIAC depends upon the specification for the particular component type. When the DIAC breakover voltage occurs, the resistance of the component decreases abruptly and this leads to a sh[arp] decrease in voltage drop across the DIAC, and a correspon[ding] increase in current. The DIAC will remain in its conducti[ng] state untill the current flow through it drops below a particular value known as the holding current. When current falls below the holding level, the DIAC swit[ches] back to its high resistance or non conducting state.

Applications of DIAC

- The DIAC is widely used to assist even triggering of a TRIAC when used in AC switches and as a result they are often found in light dimmers such as those used in domestic lightning.
- It is used in speed control of universal motor.

VI characteristics of DIAC.



Difference B/w: DIAC and Thyristor.

DIAC have no gate terminal, unlike some other thyristors that. They are commonly used to trigger such as TRIAC.

Difference B/w DIAC and Symbol diodes.

Unlike ~~sym~~ simple diodes, DIAC conduct in both forward and reverse directions if a voltage higher than the breakover voltage is applied whereas the simple diode starts conduction in only forward conduction.

Procedure

Connect the DIAC with oscilloscope to analyze the current and voltage across the DIAC.

- Increase the input voltage slowly from 0 level.
- When the voltage becomes greater than breakover voltage, current starts flowing through the device.

Conclusion

From this lab we conclude that DIAC is a special type of switch that is used to make the current flow in both forward and backward directions when the breakover voltage is reached.

17PWELE5087 03/12/19

Lab 10

To study the dynamic characteristics of TRIAC.

97/100

Apparatus

Power electronics control unit PE 481.
AC thyristor circuits PE 481 C
Oscilloscope
connecting cables.

Theory

TRIAC stands for 'Triode for alternating current'. A TRIAC is a semiconductor device with three terminals that conducts current in either direction when triggered.

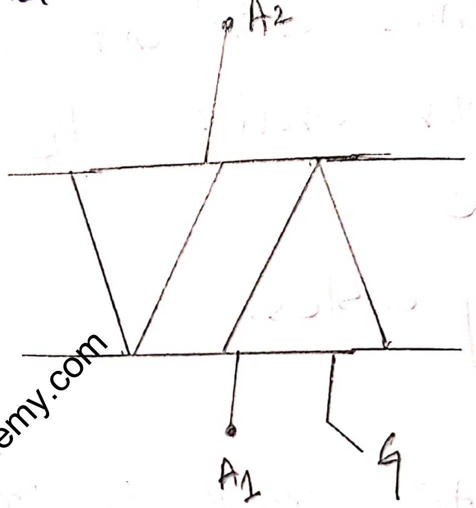
TRIAC differs from SCR such that current flows in both directions, whereas SCR conducts current only in a single direction.

Most TRIACs can be triggered by applying a positive or negative voltage at the gate terminal whereas an SCR requires a positive voltage.

Once triggered SCR continues to conduct, even if the gate current ceases until the main current drops below a certain level called holding current.

TRIAC's bidirectionality makes them convenient switches for alternating current. In addition, applying triggering pulse at a controlled phase angle of the in the main circuit allows control of the average current flowing into the load.

Symbol



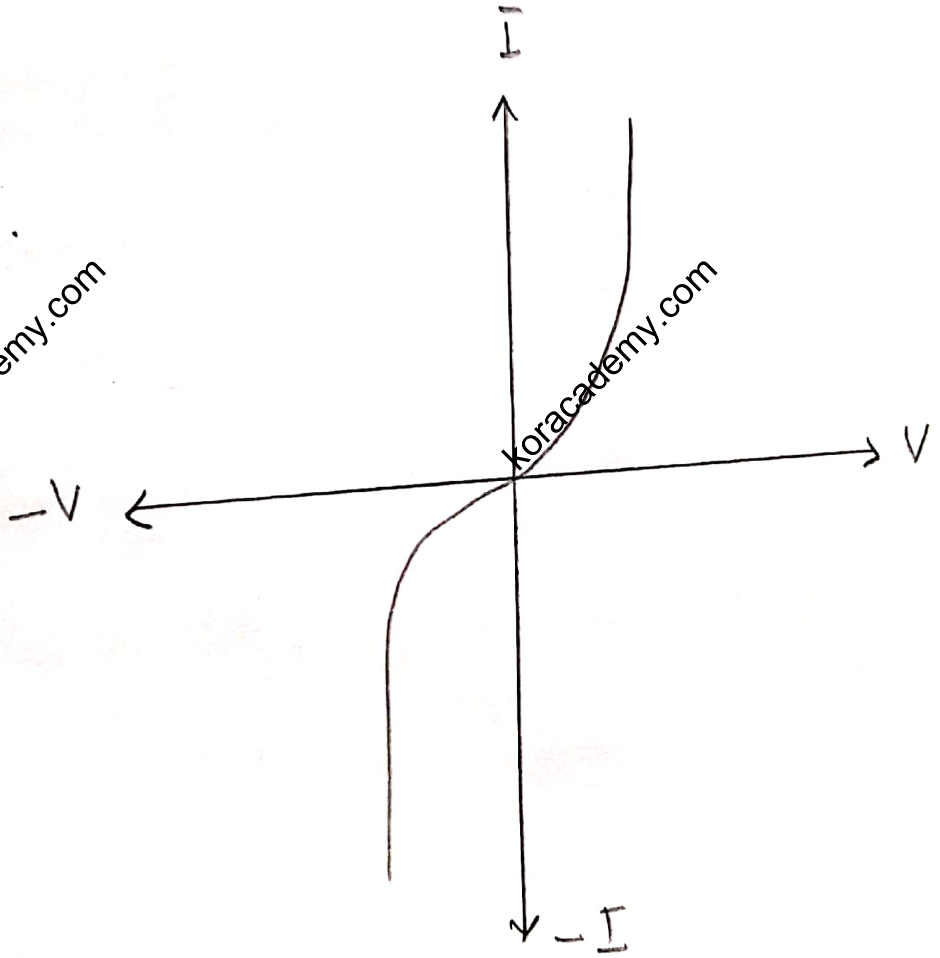
Applications

TRIAC's are used in many applications. The electronic components are often used in low to medium power AC switching requirements, where large levels of power need to be switched. TRIACs are used in

- Lighting control especially in domestic dimmers.
- control of fans and small motors.
- Electronic switches for general AC switching and control.
- TRIACs can be included in modules called solid state relays. Here an optical version of this semiconductor device is activated by an LED light source triggering

the solid state relay according to the input signal.

V.I Characteristics of TRIAC



17PWELE5087 03/12/19

Lab 11

To Study voltage regulation using TRIAC in phase control mode.

Apparatus

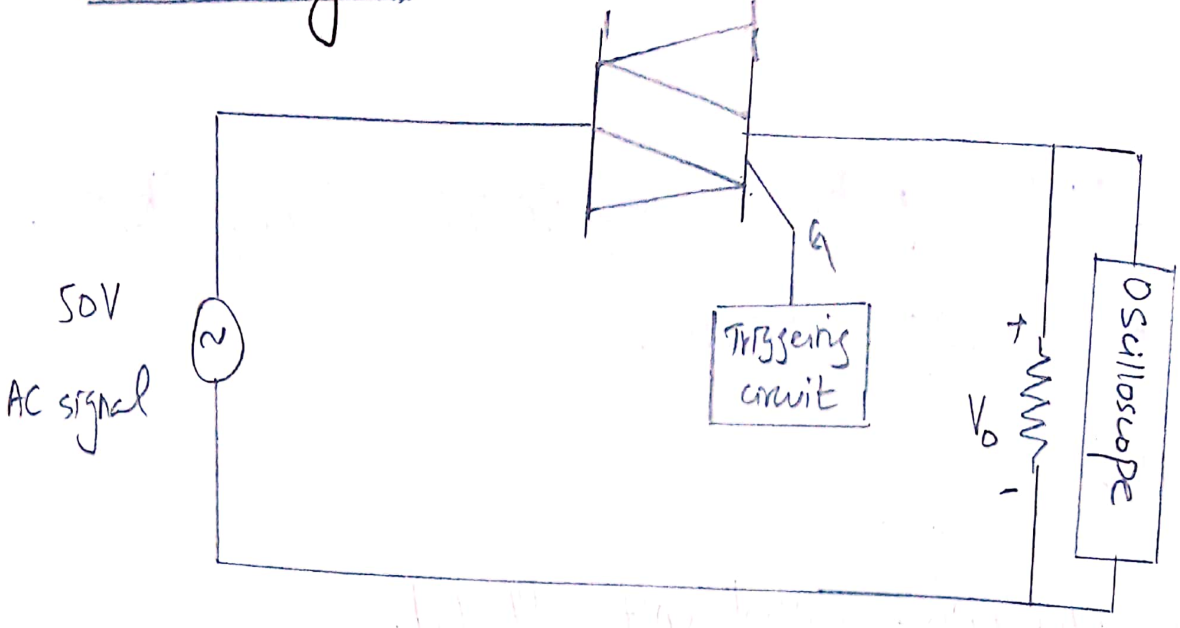
- Power electronics control unit PE 481.
- AC thyristor circuit PE 481C.
- Power electronics LCR load unit. PE 481
- Basic triggering circuit PE 481 D.
- oscilloscope
- connecting cables.

Theory

TRIAC is a bidirectional semiconductor 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 TRIAC to make it trigger.

In AC thyristor circuits PE 481 C module, we already have a TRIAC circuit, to which AC input 30V signal is applied and we use this TRIAC in an

Circuit diagram



Procedure

- The circuit is made according to the shown circuit diagram.

- Apply the firing angle from the basic triggering circuit.

- Connect the output of load with oscilloscope to analyze the output voltage across the load.

- For different values of firing angle (α), calculate the RMS voltage at output.

- Also measure the actual RMS voltage across the load and calculate the error.

Observations And Calculations.

$19 \text{ div} = 360^\circ$

$1 \text{ div} = \frac{360}{19} = 18.94^\circ$

$\alpha_1 = 3$ divisions

$\Rightarrow \alpha_1 = 3 \times 18.94 = 56.82^\circ$

$\alpha_2 = 6$ divisions

$\Rightarrow \alpha_2 = 6 \times 18.94 = 113.64^\circ$

$\alpha_3 = 5$ divisions.

$\Rightarrow \alpha_3 = 5 \times 18.94 = 94.7^\circ$

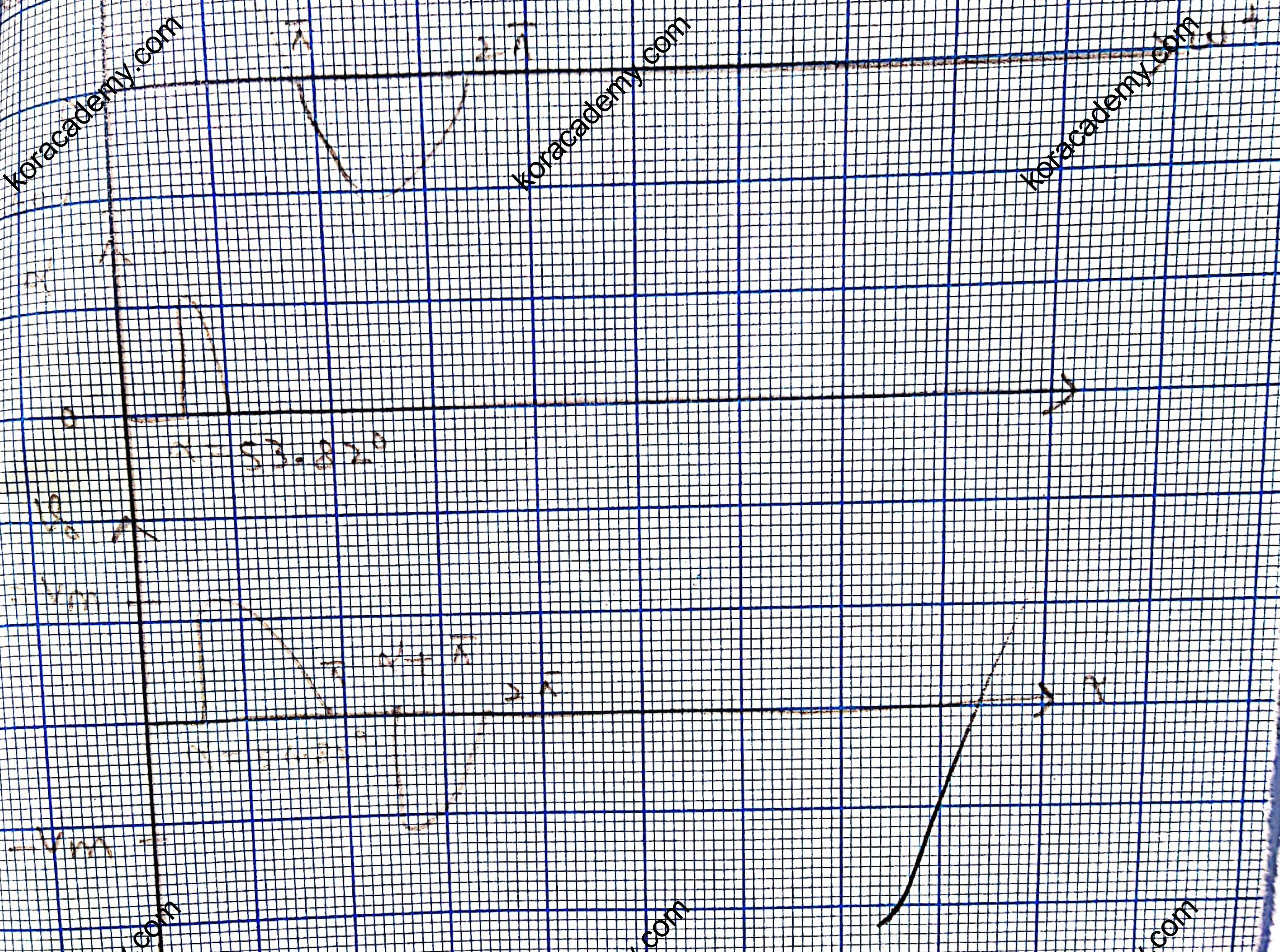
α	Vo rms actual	Vo rms calculated	Error %
56.82°	40.05 V	38.01 V	5.09%
113.64°	24.13 V	23.22 V	3.7%
94.7°	28.5 V	27.1 V	4.9%

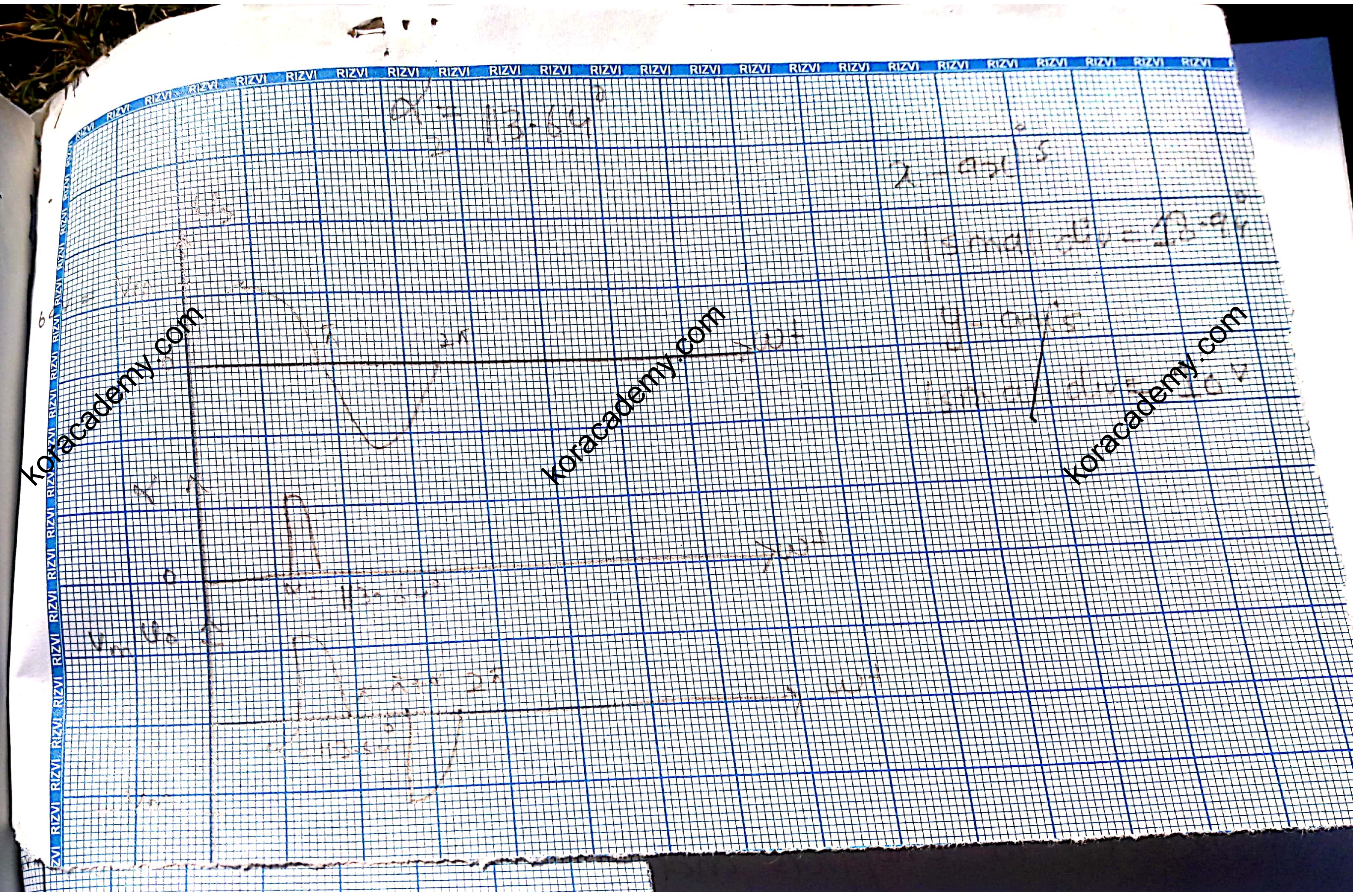
Conclusion.

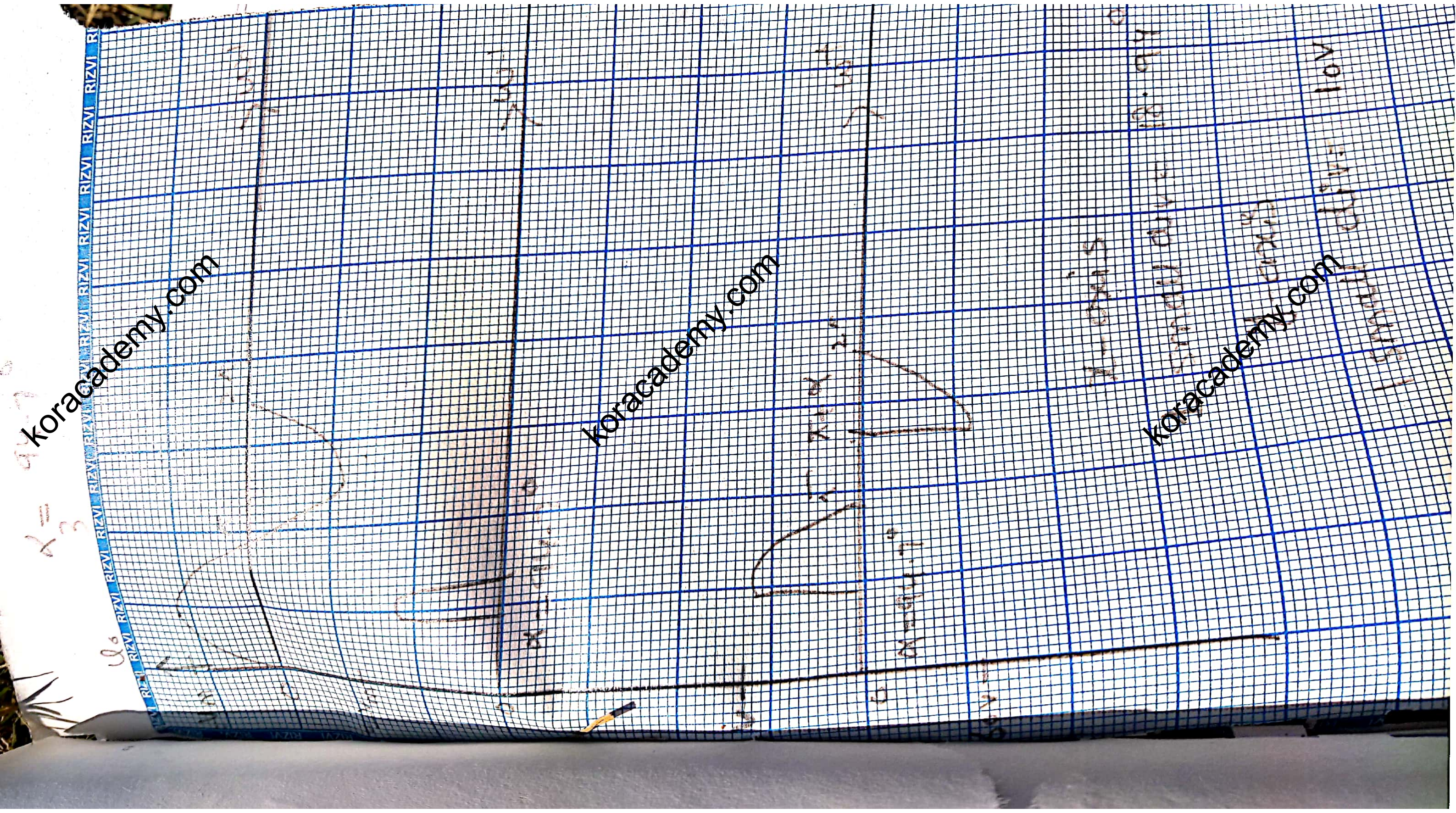
From this lab we conclude that when TRIAC is triggered, it conducts in both forward and backward directions and we can control the load voltage by changing the firing angle.

1 Small div = 18.94°

1 Small div = 10V







17PWELE5087 10-12-19

Lab12

To study the dynamic characteristics of SCR.

Apparatus

- Power electronics control unit PE 481.
- AC thyristor circuit PE 481 C.
- Basic triggering circuit PE 481 D.
- Oscilloscope.
- Connecting cables.

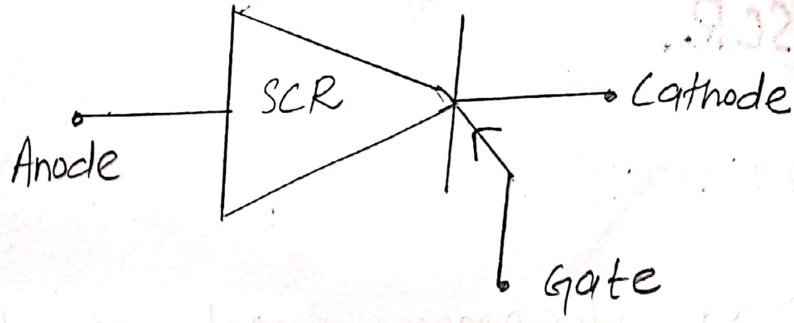
92/100

Theory

Silicon controlled rectifier (SCR) is a type of thyristor in which turn ON of the device is in our control whereas the turn OFF is not.
In order to turn ON the SCR, a gate pulse is required to be given at the gate terminal and also the anode must be positive with respect to cathode. When these two conditions are met, the SCR starts conduction.
The minimum current that must be provided to the SCR to make current flow through it is called Latching

current : The minimum current that must be through the device is called holding current.

Symbol



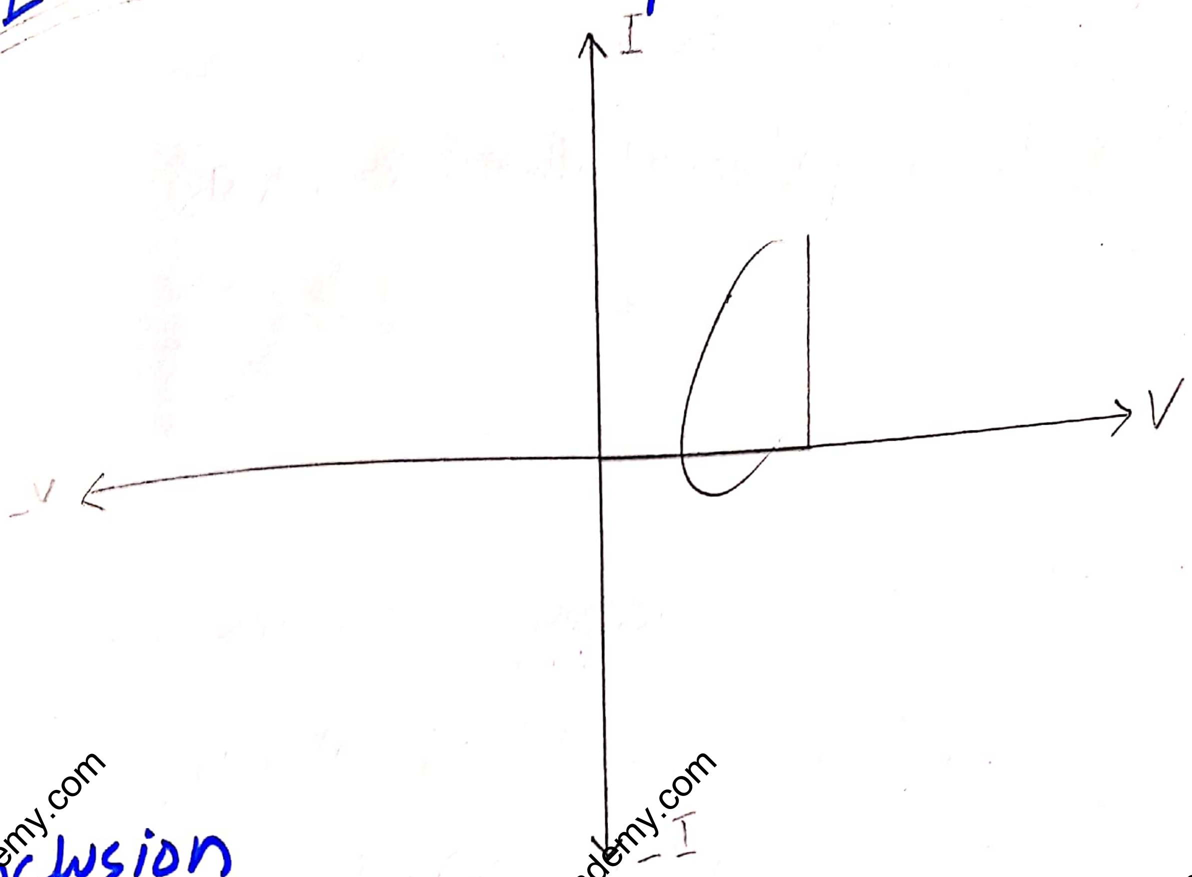
Applications

- It is used as a switch.
- It is used in AC voltage stabilizers.
- It is used in choppers and inverters.
- It is used as a DC circuit breaker.
- It is used for power control.

Procedure

- Change the oscilloscope mode to xy mode so we can analyze both voltage and current through S simultaneously on oscilloscope.
- x axis is for voltage across SCR.
- y axis is for current through the device.
- Connect SCR with oscillosope.
- Analyze the output VI characteristics and plot

V-I Characteristics of SCR



Conclusion

In this lab we observed the dynamic characteristics of an SCR. Also we observed the VI characteristics on the oscillosope. Note that we can change the output by changing the firing angle (α).

17PWELE5087 10-12-19

Lab 13

To study voltage regulation using inverse parallel thyristor.

98/100

Apparatus

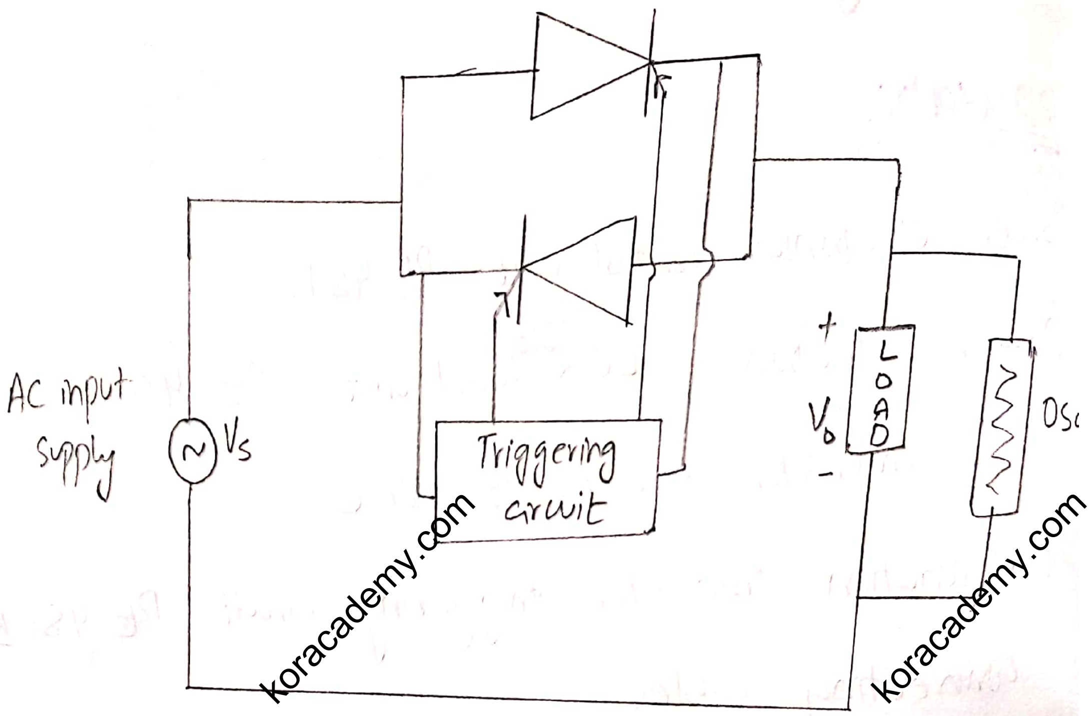
- Power electronics control unit PE 481.
- Power electronics LCR load unit PE 481.
- AC thyristor circuit PE 481 C.
- Uni junction transistor triggering circuit PE 481 E.
- connecting cables.
- Oscilloscope.

Theory

A thyristor is a solid state semiconductor device with four layers of P and N type materials. It acts exclusively as a bistable switch, conducting when the gate recieves a current trigger. An SCR is a type of thyristor in which turn ON is controlled whereas turn OFF is not. SCR starts conduction when its anode is positive with respect to cathode and gate pulse is applied at the gate terminal.

When two SCR's are connected in anti parallel it is called inverse parallel thyristor.

Circuit Diagram



Procedure

- Make the circuit according to the shown circuit diagram using the mentioned apparatus.
- Input signal is applied and the firing pulse is provided to trigger the SCRs.
- For positive half cycle, one SCR is forward biased and starts conduction after recieving gate signal.
- For negative half cycle, 2nd SCR becomes forward biased and conducts, whereas for this time SCR 1 is reverse biased.

- Analyze the output voltage across the load using oscilloscope.
- For different values of firing angle, analyze the circuit and plot the graphs.

Observations And Calculations

Horizontally

20 divisions = 360°

$\Rightarrow$ 1 division = $\frac{360°}{120}$ = 18°

α_1 = 2 divisions = 2 × 18° = 36°

α_2 = 3 divisions = 3 × 18° = 54°

α_3 = 6 divisions = 6 × 18° = 108°

Vertically

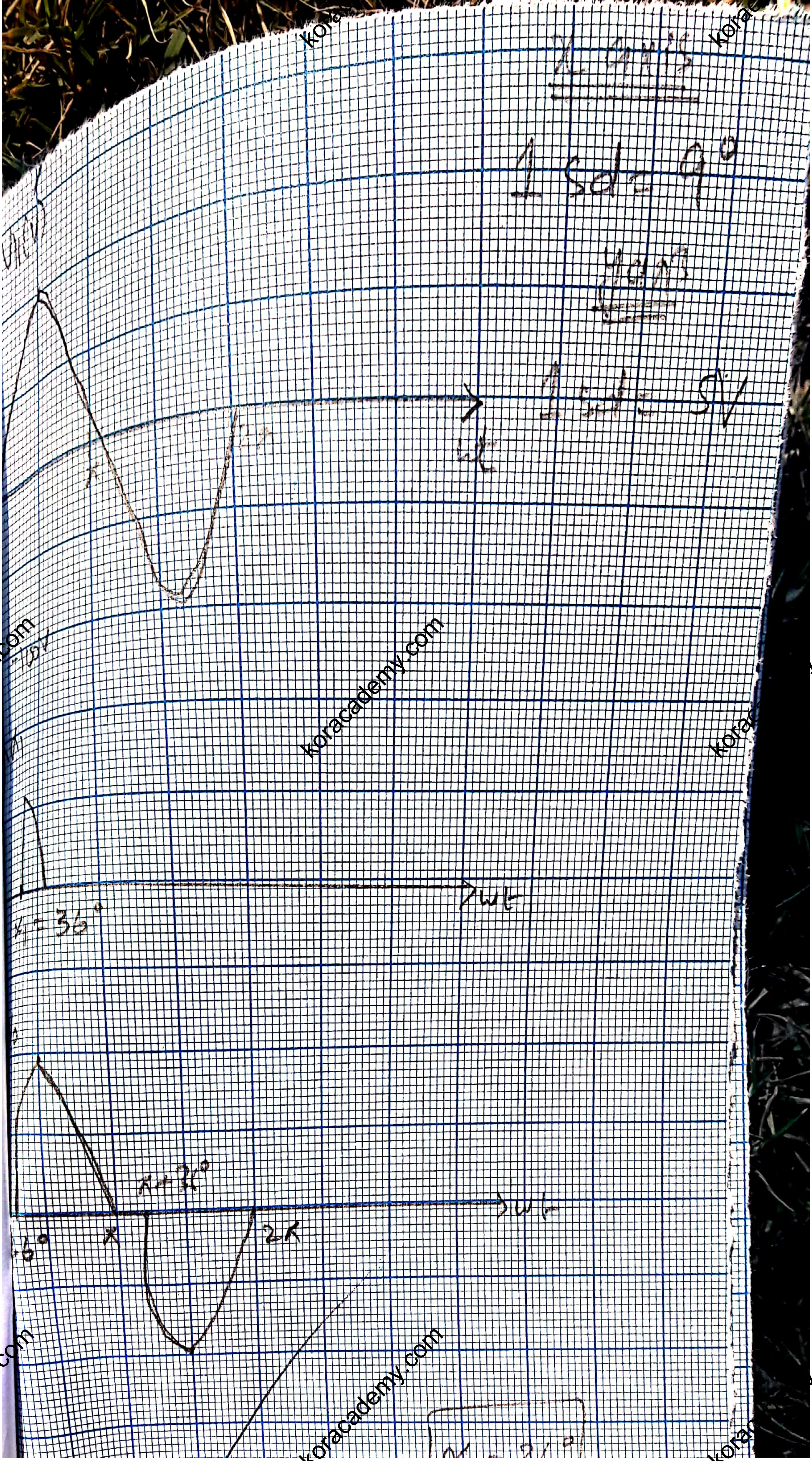
V_m = 10 divisions.

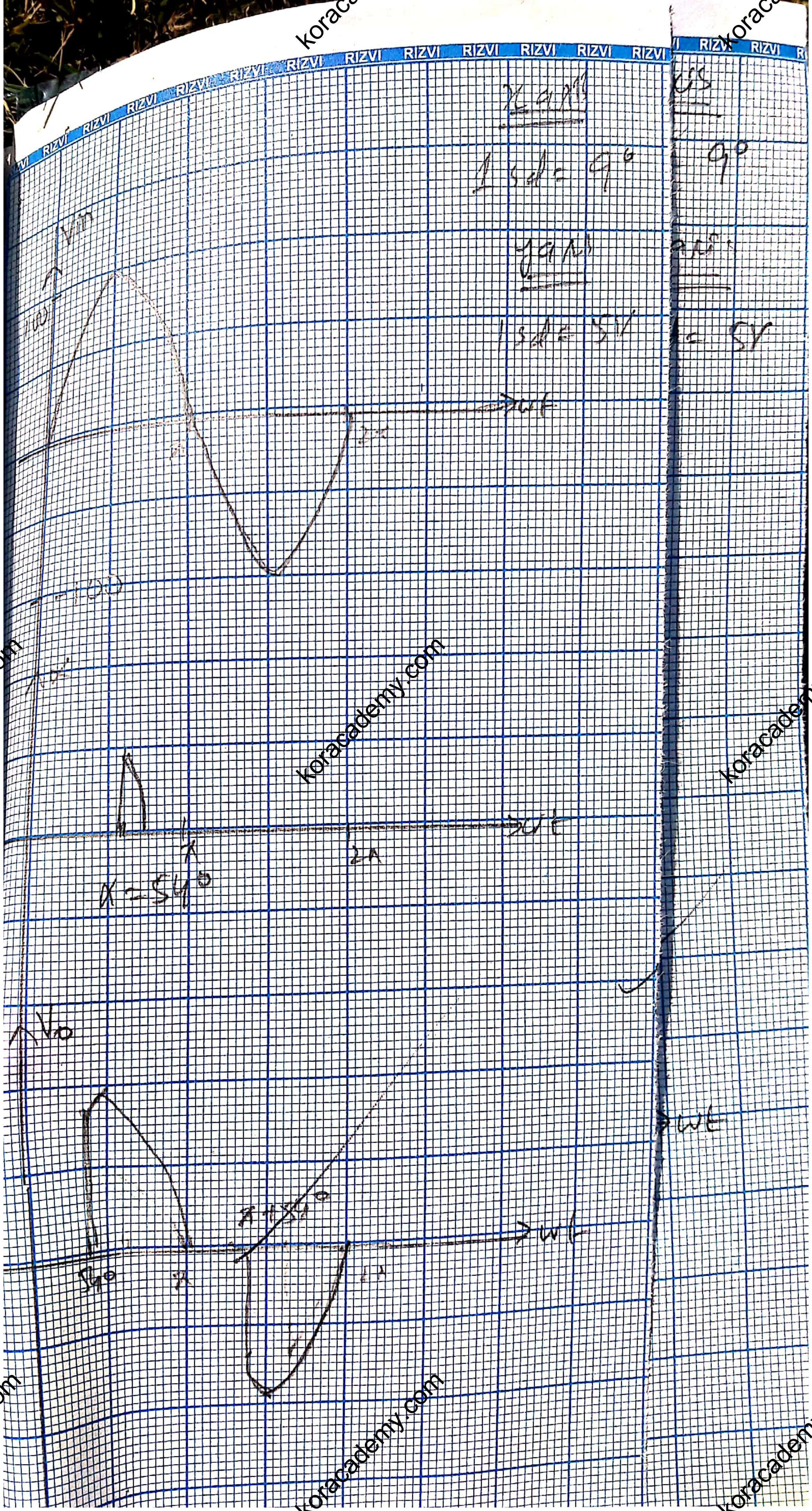
$\Rightarrow V_m$ = 10 × 10 × 1 = 100V

α^0	V_{orms} actual	V_{rms} calculated	% Error
36°	43.19V	41.21V	4.8 %
54°	40.61 V	40.09V	1.39 %
108°	28.28V	26.18V	8.02 %

Conclusion

From this lab we conclude that by using inverse parallel thyristors circuit, we have output voltage for both positive and negative cycles of input voltage and can be controlled with the firing angle (α).


X axis
1 sd = 9°
Y axis
1 sd = 5V
wt
wt
wt
2π


1 sd = 9°
1 sd = 5V
Vin
100
-100
ωt
2π
α = 54°
Vo
54°
π
π+54°

x axis

1sd = 9°

y axis

1sd = 5V