DRONACHARYA
Group of Institutions

POWER ELECTRONICS LAB

LABORATORY MANUAL

B.TECH.(EEE)   SEMESTER -VI

SUBJECT CODE: KEE-653

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DRONACHARYA GROUP OF INSTITUTIONS

DEPARTMENT OF EEE

#27 KNOWLEDGE PARK 3

GREATER NOIDA

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List of Experiments mapped with COs

S. No	Aim of the	COs
1.	To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor	CO1
2.	To study V-I characteristics of SCR and measure latching and holding currents.	CO4
3.	To study the output and transfer characteristics of MOSFET	CO1
4.	To Study Single Phase Half Controlled Bridge Converter	CO2
5.	To study three-phase fully controlled bridge rectifier with resistive and inductive loads.	CO3
6.	To study single-phase ac voltage regulator with resistive and inductive loads.	CO3
7.	To study single phase cyclo-converter	CO4
8.	To study MOSFET/IGBT based single-phase bridge inverter	CO5
9.	To obtain the simulation of single-phase half wave-controlled rectifier with R and RL load and plot load voltage and load current waveforms.	CO2
10.	To obtain simulation of single phase fully controlled bridge rectifier and plot load voltage and load current waveform for inductive load.	CO2

EXPERIMENT 1

OBJECTIVE: **To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor**

APPARATUS REQUIRED:

S. no.	Name of equipment's/components	Specification	Range/Rating	Qty.
1	IGBT, MOSFET & Power Transistor Trainer Kit	-	-	1
2	Patch chords	-	-	
3	DC Voltmeter	-	Digital	1
4	DC Ammeter	-	Digital	1

BRIEF THEORY:

The meaning of IGBT, MOSFET & Power Transistoris to switch on the concerning components. Switch on means in the case of IGBT collector to emitter should fully internally shorted i.e., voltage between emitter and collector should be almost zero or few milli volts and in the case of non-triggering conditions emitter to collector internally totally open circuit. In the field the requirement is to operate many or at least two IGBTs at a time. To make proper electrically isolation in between triggering pulses is required here we will be discussed the same. Such type of triggering circuit is use for MOSFET and for power transistor more current is required so driver amplifier is used to drive the power transistor.

Gate Frequency Generation: The Gate frequency generation circuit is given in Fig-'1'. To operate Gate wave circuit +5 V DC is developed through diode D1, D2, D3, D4, C3,C4 and IC 5. IC_1 is a stable multi vibrator VR1 to control its frequency. It will give the output from pin no. 3 and fed to IC2 that is JK flip-flop and its output will come through pin no. 14 & pin no. 15. The frequency at 14 and 15 will half a stable multivibrator frequency. The output from pin no. 15 will feed to opto coupler IC3 and output of opto coupler is fed to driver transistor T1. The output of T1 will be fed to the base of power transistor T2, the process will same as IC3 and T1. The difference between them pins no 15 of IC2 will at 0º and pin no 14 of IC 2 will at 180º.

For electric isolation every opto coupler is required separate isolated 12 V supply, so it also given in diagram.

Triggering of IGBT:

To triggering of IGBT, its required emitter to gate voltage approximates 10 V DC. To operate at a time many IGBTs, electrically isolation is required. So, it's necessary to use opto coupler for triggering of IGBTs at a time with perfect electrically isolation. IGBT is volt- age operated device so voltage with current is not required the gate current almost negligible. The output voltage from opto coupler is sufficient to trigger IGBT.

The gate of IGBT should never hang in air. Because due to available voltage in air the IGBT may partially ON and may heat & damage so its Gate to emitter a high ohmic resistance approximate 10K is

hard

coupled. The IGBTs is the combination of MOSFET &power transistor to use at high voltage switching.
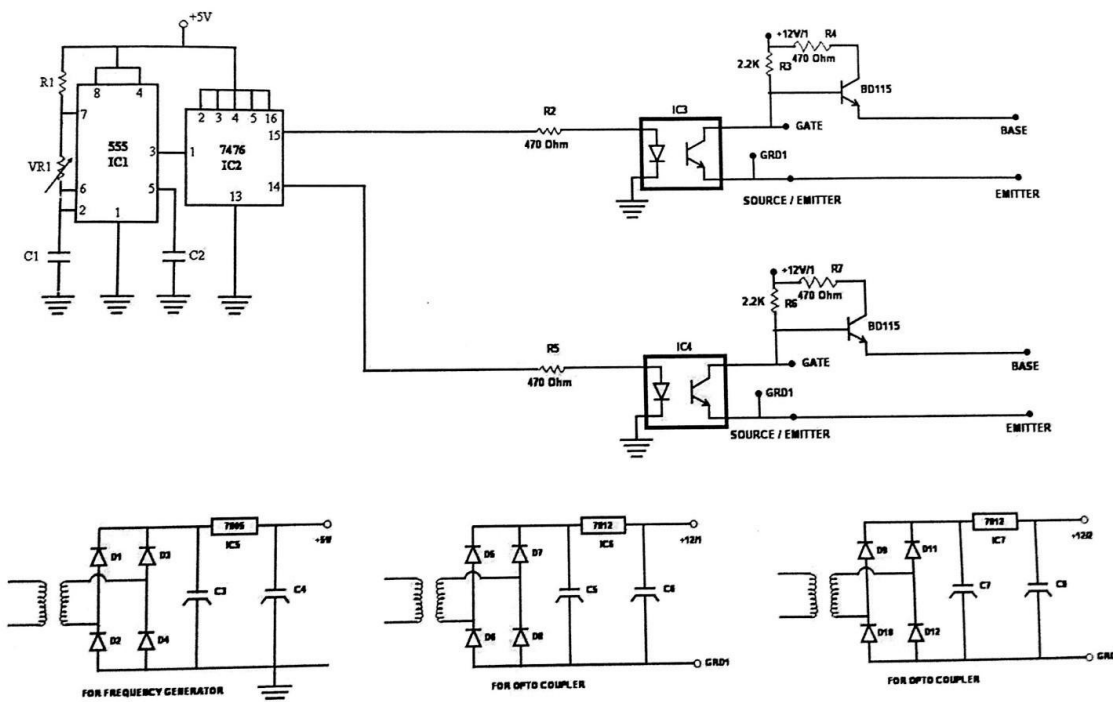
Triggering of MOSFET:

All features to trigger the MOSFET is same as IGBT, only difference is MOSFET is used for low voltage switching. Safety measures 10 K resistance is also required. Source to gate

voltage approximate 10 V DC is required. Same electrically isolation is required which is operate by opto coupler.

Triggering of Power Transistor:

Transistor is current operated device to switching it the requirement is low voltage but few milli amps current also. The output of opto coupler is fed to a driver transistor and transis- tor will provide sufficient power to a drive a power transistor. Power transistor mostly used for high voltage and high frequency switching.

Circuit diagram

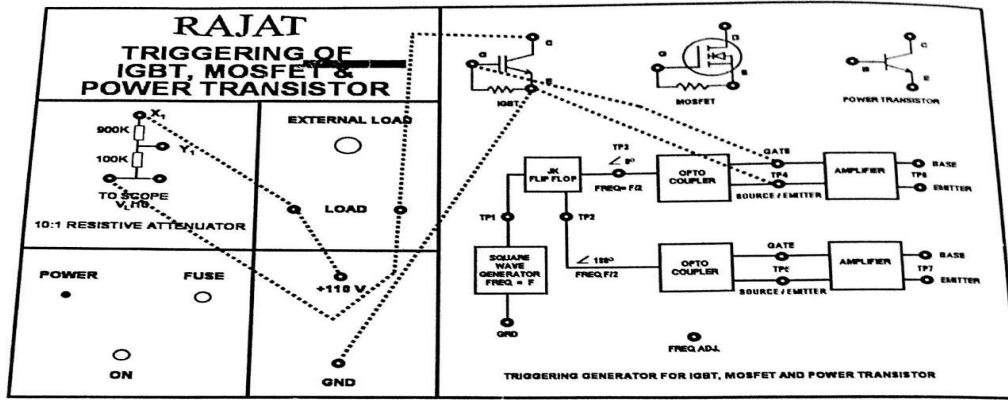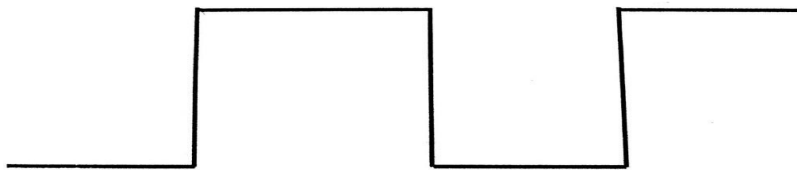FIG-'1' : TRIGGERING CIRCUIT DIAGRAM FOR IGBT, MOSFET & POWER TRANSISTOR
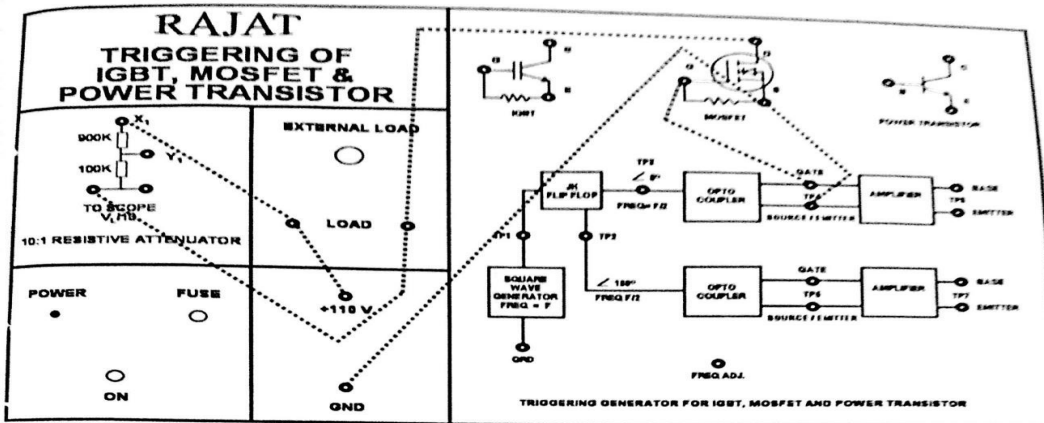
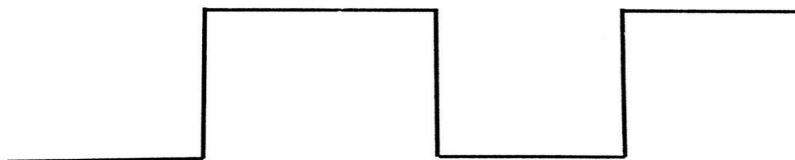**FIG – '3'**

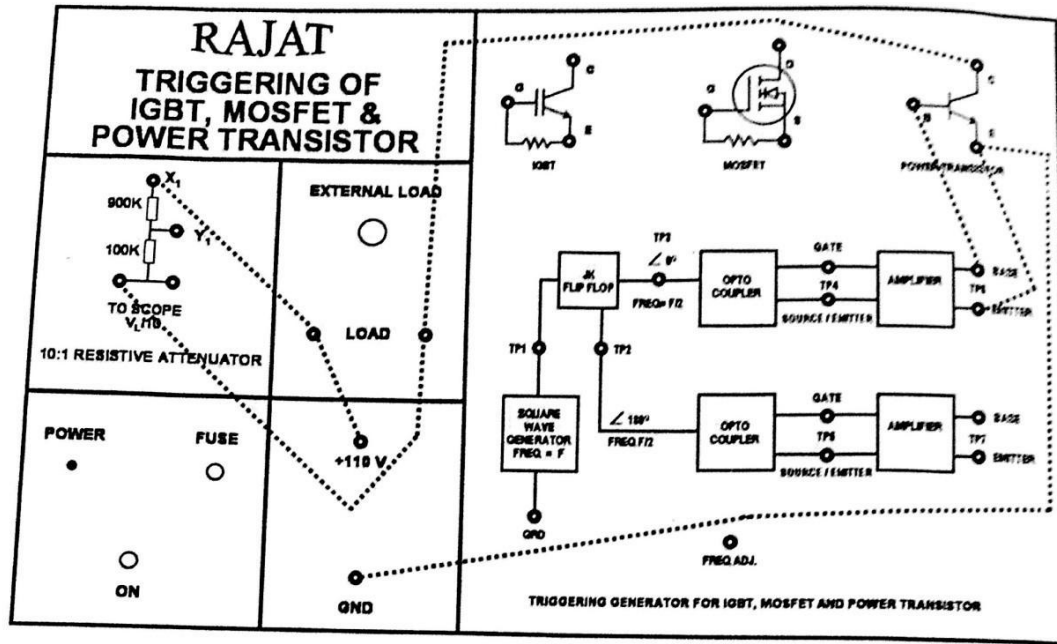**FIG – '4'**
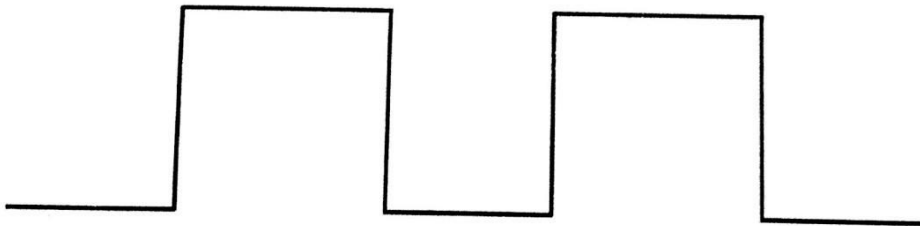

FIG – '5'

FIG – '6'

FIG – '7'

FIG – '8'

RESULT:

PROCEDURE:

1. Keep all positions at minimum.

2. Set Anode to Cathode voltage V_{AK} to some volts say 15V.

3. Now slowly vary the V_G voltage till the SCR triggers and note down the reading of gate current (I_G) and Gate Cathode voltage (V_{GK}) and rise of anode current I_A.

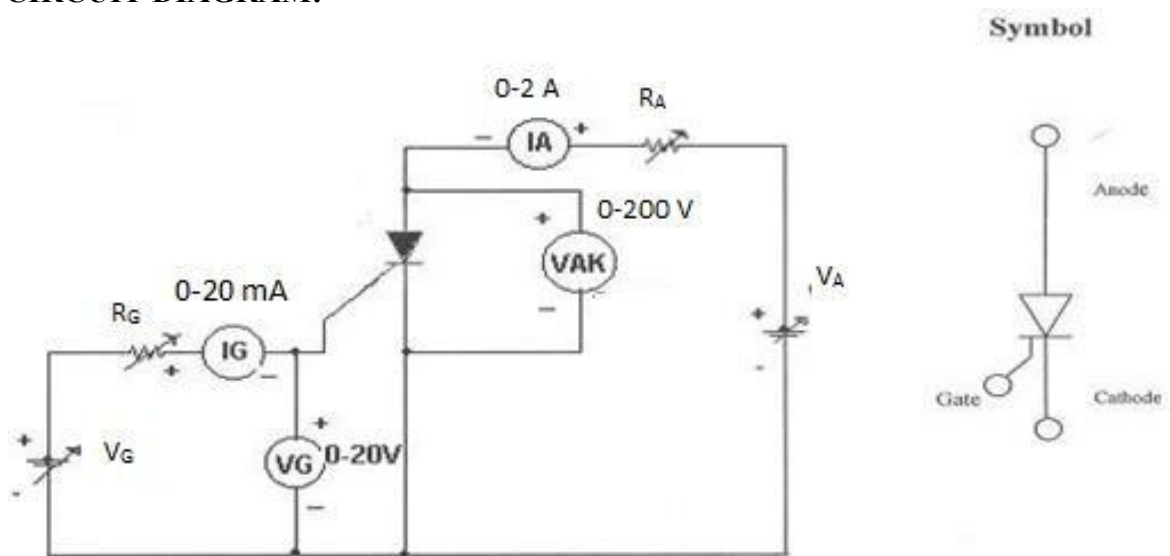4. Repeat the same for different Anode to Cathode voltage and find V_{AK} an

EXPERIMENT 2

OBJECTIVE: To plot the V - I Characteristics of SCR.

APPARATUS REQUIRED:

S. No	Equipment	Range	Type	Quantity
1	SCR characteristics Trainer	-	-	1
2	Patch chords	-	-	
3	DC Voltmeter	-	Digital	1
4	DC Ammeter	-	Digital	1

CIRCUIT DIAGRAM:

Study of Characteristics of SCR

PROCEDURE:
V - I CHARACTERISTICS:

1. Make all connections as per the circuit diagram.
2. Initially keep V_G & V_A at minimum position and R_1 & R_2 maximum position.
3. Adjust Gate current I_g to some constant by varying the V_G or R_G.
4. Now slowly vary V_A and observe Anode to Cathode voltage V_{AK} and Anode current I_A.
5. Tabulate the readings of Anode to Cathode voltage V_{AK} and Anode current I_A.
6. Repeat the above procedure for different Gate current I_g.

GATE TRIGGRING AND FINDING V_G AND I_G:-

1. Keep all positions at minimum.

2. Set Anode to Cathode voltage V_{AK} to some volts say 15V.

3. Now slowly vary the V_G voltage till the SCR triggers and note down the reading of gate current (I_G) and Gate Cathode voltage(V_{GK}) and rise of anode current I_A.

4. Repeat the same for different Anode to Cathode voltage and find V_{AK} and I_G values.

TO FIND LATCHING CURRENT:

1. Keep R_2 at middle position.

2. Apply 20V to the Anode to cathode by varying V_2.

3. Rise the Vg voltage by varying V_G till the device turns ON indicated by sudden rise in I_A. At what current SCR trigger it is the minimum gate current required to turn ON the SCR.

4. Now set R_A at maximum position, then SCR turns OFF, if it is not turned off reduce V_A

   up to turn off the device and put the gate voltage.

5. Now decrease the R_A slowly, to increase the Anode current gradually in steps.

6. At each and every step, put OFF and ON the gate voltage switches V_G. If the Anode current is greater than the latching current of the device, the device says ON even after switch OFF S1, otherwise device goes to blocking mode as soon as the gate switch is put OFF.

7. If $I_A > I_L$ then, the device remains in ON state and note that anode current as latching current.

8. Take small steps to get accurate latching current value.

TO FIND HOLDING CURRENT:

1. Now increase load current from latching current level by varying R_A & V_A.

2. Switch OFF the gate voltage switch S1 permanently (now the device is in ON state).

3. Now increase load resistance(R_2), so that anode current reducing, at some anode current the device goes to turn off .Note that anode current as holding current.

4. Take small steps to get accurate holding current value.

5. Observe that $I_H < I_L$.

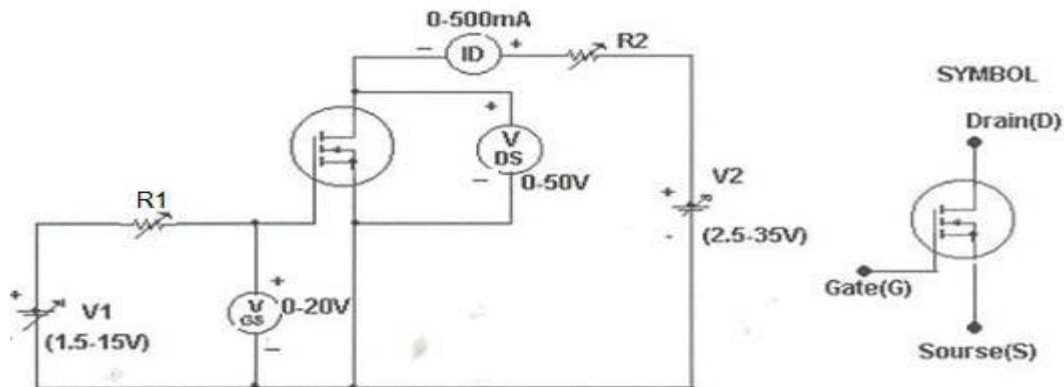**MODEL GRAPH:**
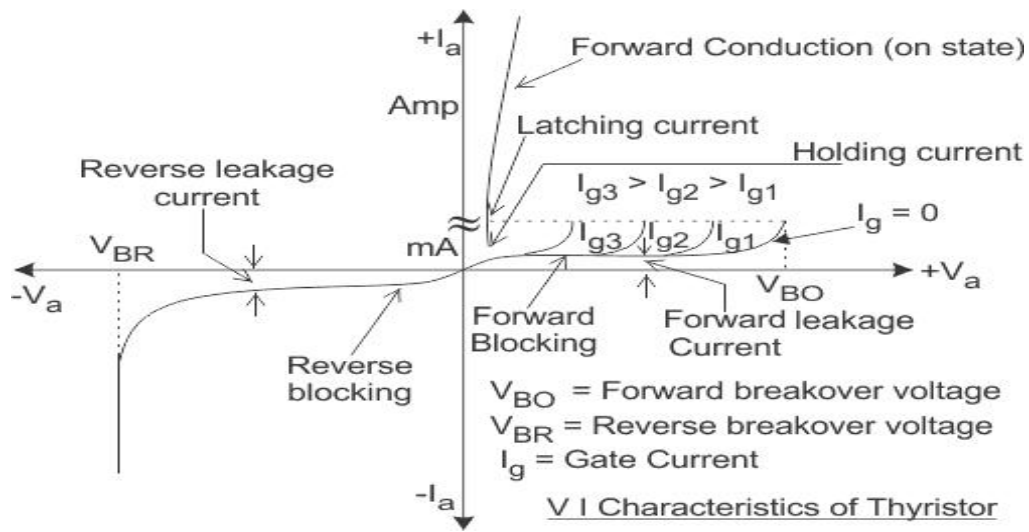
V- I Characteristics of SCR

RESULT:

EXPERIMENT 3

OBJECTIVE: To study the output and transfer characteristics of MOSFET

APPARATUS REQUIRED:

S. No	Equipment	Range	Type	Quantity
1	MOSFET characteristics Trainer	-	-	1
2	Patch chords	-	-	
3	DC Voltmeter	-	Digital	1
4	DC Ammeter	-	Digital	1

CIRCUIT DIAGRAM:

Study of Characteristics of MOSFET

**PROCEDURE:**
TRANSFER CHARACTERISTICS:

1. Make all connections as per the circuit diagram.

2. Initially keep V_1 & V_2 at minimum position and R_1 & R_2 middle position.

3. Set V_{DS} to some say 10V.

4. Slowly vary Gate source voltage V_{GS} by varying V1.

5. Note down I_D and V_{GS} readings for each step.

6. Repeat above procedure for 20V & 30V of V_{DS}. Draw Graph between I_D & V_{GS}.
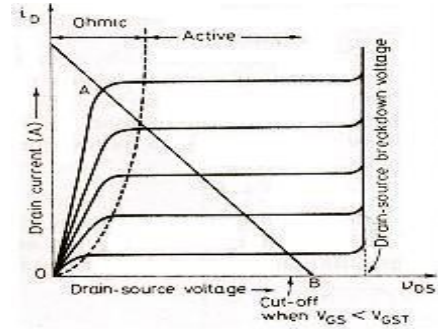
OUTPUT CHARACTERISTICS:

1. Initially set V_{GS} to some value say 3V by varying V1.

2. Slowly vary V2 and note down I_D and V_{DS}.

3. At particular value of V_{GS} there a pinch off voltage between drain and source.
   If $V_{DS} < V_P$ device works in the constant resistance region and I_O is directly proportional to
   V_{DS}. If $V_{DS} > V_P$ device works in the constant current region.

4. Repeat above procedure for different values of V_{GS} and draw graph between I_D vs V_{DS}

MODEL GRAPH:
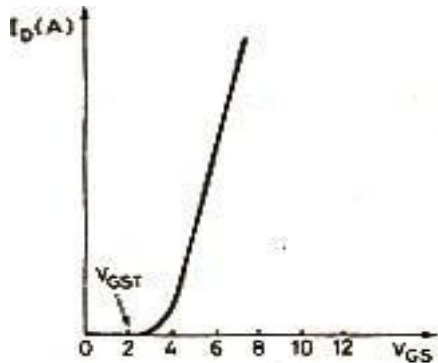
Transfer Characteristic of MOSFET

Output Characteristics of MOSFET

V- I Characteristics of SCR

TABULAR COLUMN:

S. No.	V_{GS} = VOLTS	
	V_{DS} (Volts)	I_D (Amps)
1		
2		
3		
4		
5		

S. No	V_{GS} = VOLTS	
	V_{DS} (Volts)	I_D (Amps)
1		
2		
3		
4		
5		

S. No	V_{DS}= (Volts)	
	V_{GS} (V)	I_D(A)
1		
2		
3		
4		

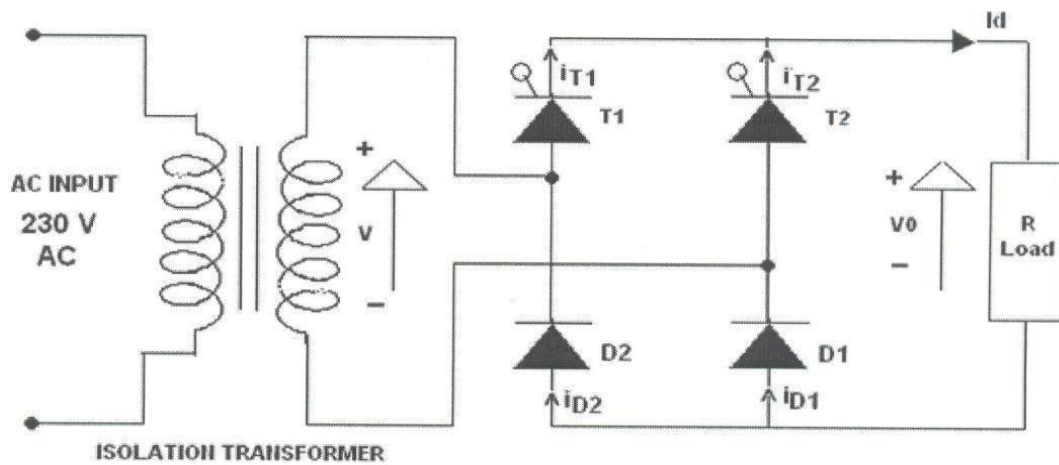| S. No	V_{DS} = (Volts)	
	V_{GS} (V)	I_D(A)
1		
2		
3		
4		

RESULT:

EXPERIMENT – 4

AIM: To study the single-phase half controlled bridge converter with R & RL Load.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Single phase half-controlled bridge converter powercircuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Isolation Transformer			
5	Variable Rheostat			
6	Inductor			
7	DC Voltmeter			
8	DC Ammeter			

CIRCUIT DIAGRAM:

Circuit Diagram of Single Phase Half Controlled Bridge Converter

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Connect first 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB

and IRSswitch and trigger output ON switch.

5. Connect CRO probes and observe waveforms in CRO, Ch-1 or Ch-2, across load anddevice in single phase half controlled bridge converter.

6. By varying firing angle gradually up to 180^0 and observe related waveforms.

7. Measure output voltage and current by connecting AC voltmeter & Ammeter.

8. Tabulate all readings for various firing angles.

9. For RL Load connect a large inductance load in series with Resistance and observe allwaveforms and readings as same as above.

10. Observe the various waveforms at different points in circuit by varying the Resistive Loadand Inductive Load.

11. Calculate the output voltage and current by theoretically and compare with it practicallyobtained values.

MODEL GRAPH:
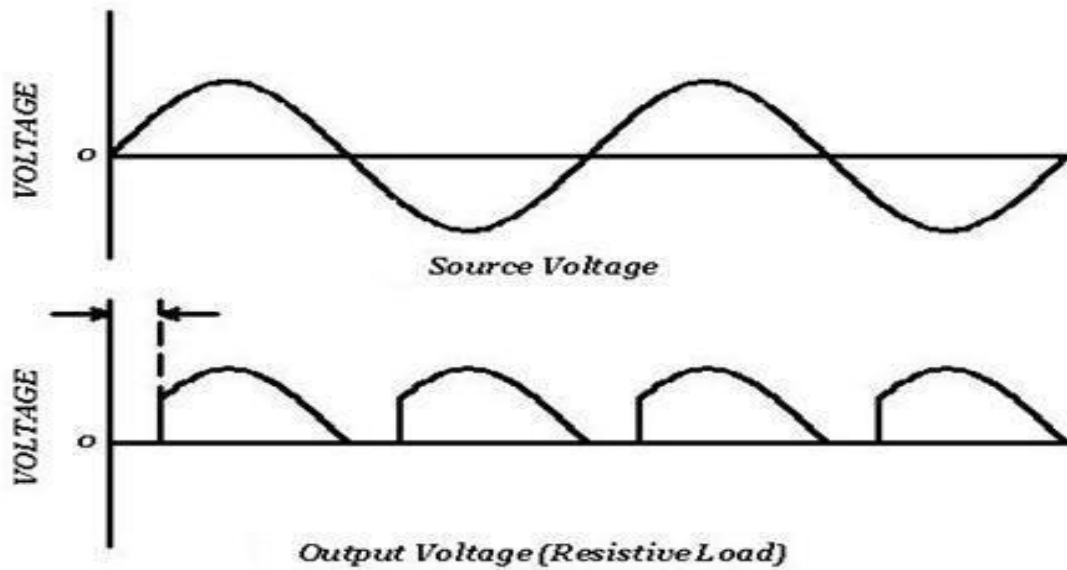
Output Wave Forms of Single Phase Half Controlled Bridge Converter

TABULAR COLUMN:

S. No	Input Voltage(V in)	Firing angle in Degrees	Output voltage (V0)		Output Current (I0)	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

V_0 = ($\sqrt{2}V$ / $\prod$) * (1+Cos α)

I_0 = ($\sqrt{2}V$ / $\prod R$) * (1+Cos

α)α = Firing Angle

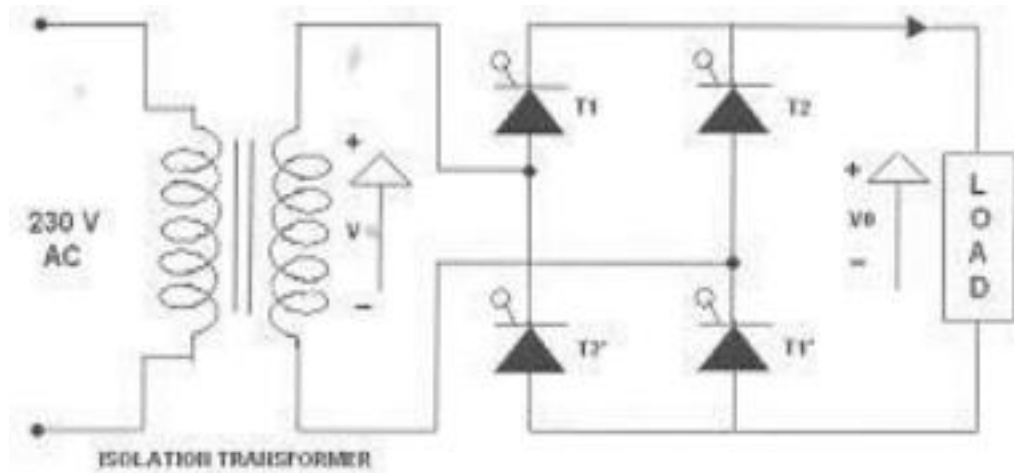V = RMS Value across transformer output

RESULT:

EXPERIMENT – 5

OBJECTIVE: To study the single phase fully controlled bridge converter with R & RL Load.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Single phase full controlled bridge converter powercircuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Isolation Transformer			
5	Variable Rheostat			
6	Inductor			
7	DC Voltmeter			
8	DC Ammeter			

CIRCUIT DIAGRAM:

Single Phase Fully Controlled Bridge Converter

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB

and IRSswitch and trigger output ON switch.

5. Connect CRO probes and observe waveforms in CRO across load and device in singlephase fully controlled bridge converter.

6. By varying firing angle gradually up to 180^0 and observe related waveforms.

7. Measure output voltage and current by connecting AC voltmeter & Ammeter.

8. Tabulate all readings for various firing angles.

9. For RL Load connect a large inductance load in series with Resistance and observe allwaveforms and readings as same as above.

10. Observe the various waveforms at different points in circuit by varying the Resistive Loadand Inductive Load.

11. Calculate the output voltage and current by theoretically and compare with it practicallyobtained values.
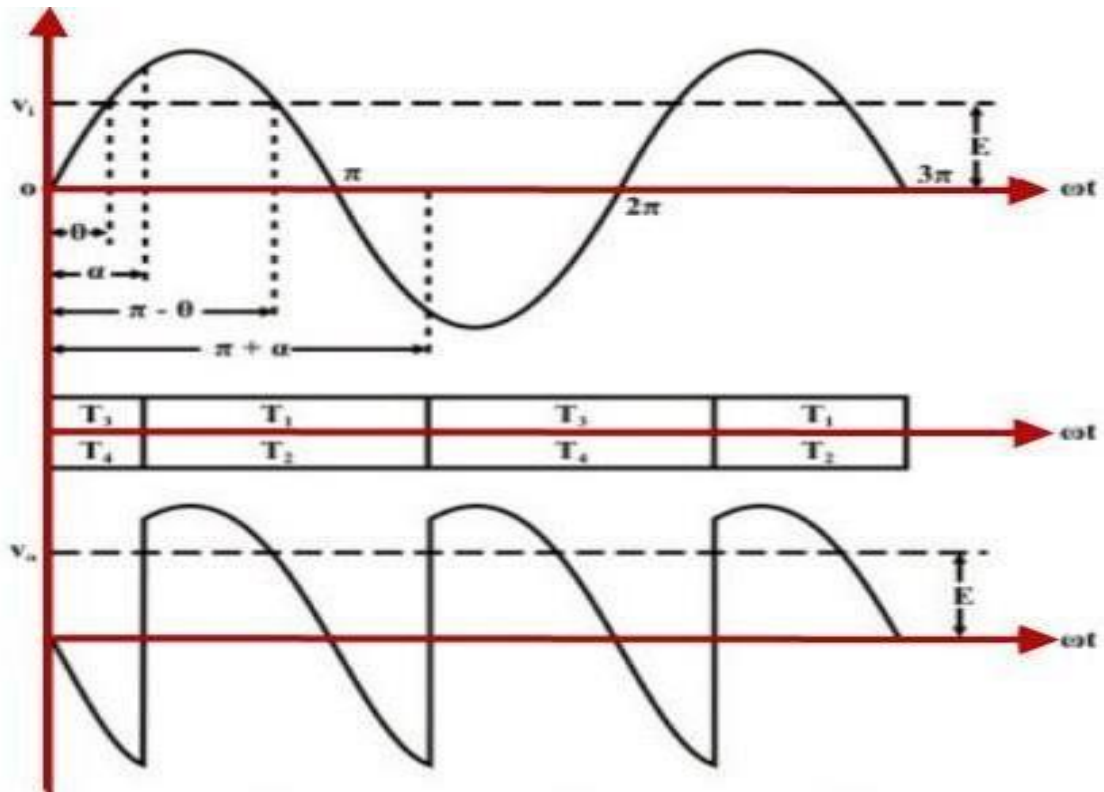
TABULAR COLUMN:

S. No	Input Voltage (Vin)	Firing anglein Degrees	Output voltage (V0)		Output Current (I0)	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

	For R-L Load:	**For R Load:**
V0	$= (2\sqrt{2}V/\prod) * \cos \alpha$	$V_0 = (\sqrt{2}V/\prod) * (1+\cos \alpha)$
I0	$= (2\sqrt{2}V/\prod R) * \cos \alpha$	$I_0 = (\sqrt{2}V /\prod R) * (1+\cos\alpha)$
α	= Firing Angle	
V	= RMS Value across transformer output	

MODEL GRAPH:

Single Phase Fully Controlled Bridge Converter
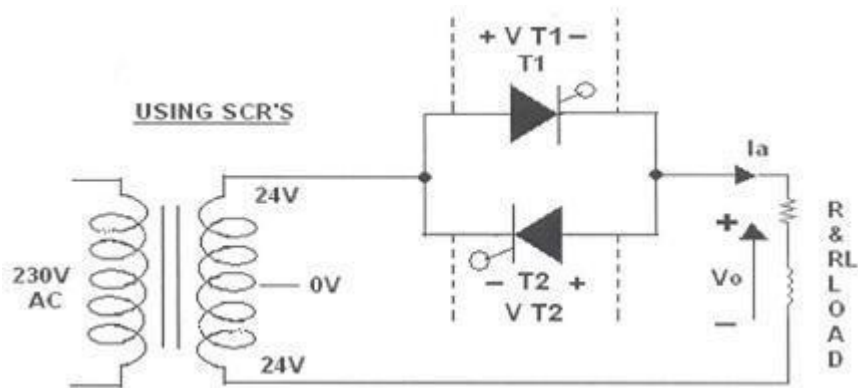
RESULT:

EXPERIMENT – 6

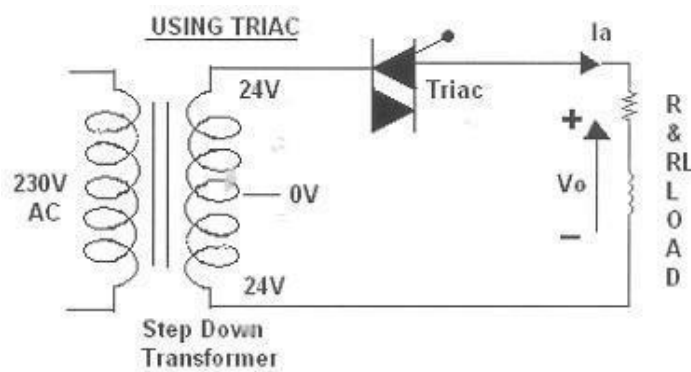**AIM:** To study the single phase AC voltage controller with R and RL Load

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Single phase AC voltage controller power circuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Isolation Transformer			
5	Variable Rheostat			
6	Inductor			
7	AC Voltmeter			
8	AC Ammeter			

CIRCUIT DIAGRAM:

Single Phase AC Voltage Controller with Thyristors

Single Phase AC Voltage Controller with Traic

PROCEDURE:

AC VOLTAGE CONTROLLER WITH TWO THYRISTORS:
1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB and IRSswitch and trigger output ON switch.
5. Observe waveforms in CRO, across load by varying firing angle gradually up to 180^0.
6. Measure output voltage and current by connecting AC voltmeter & Ammeter.
7. Tabulate all readings for various firing angles.
8. For RL Load connect a large inductance load in series with Resistance and observe allwaveforms and readings as same as above.
9. Observe the various waveforms at different points in circuit by varying the Resistive Loadand Inductive Load.
10. Calculate the output voltage and current by theoretically and compare with it practicallyobtained values.

A.C. VOLTAGE CONTROLLER WITH TRIAC:

1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulse from firing circuit to TRIAC as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB and IRSswitch and trigger output ON switch.
5. Observe waveforms in CRO, across load by varying firing angle gradually up to 180^0.
6. Measure output voltage and current by connecting AC voltmeter & Ammeter.
7. Tabulate all readings for various firing angles.
8. For RL Load connect a large inductance load in series with Resistance and observe allwaveforms and readings as same as above.
9. Observe the various waveforms at different points in circuit by varying the Resistive Loadand Inductive Load.
10. Calculate the output voltage and current by theoretically and compare with it practicallyobtained values.

TABULAR COLUMN:

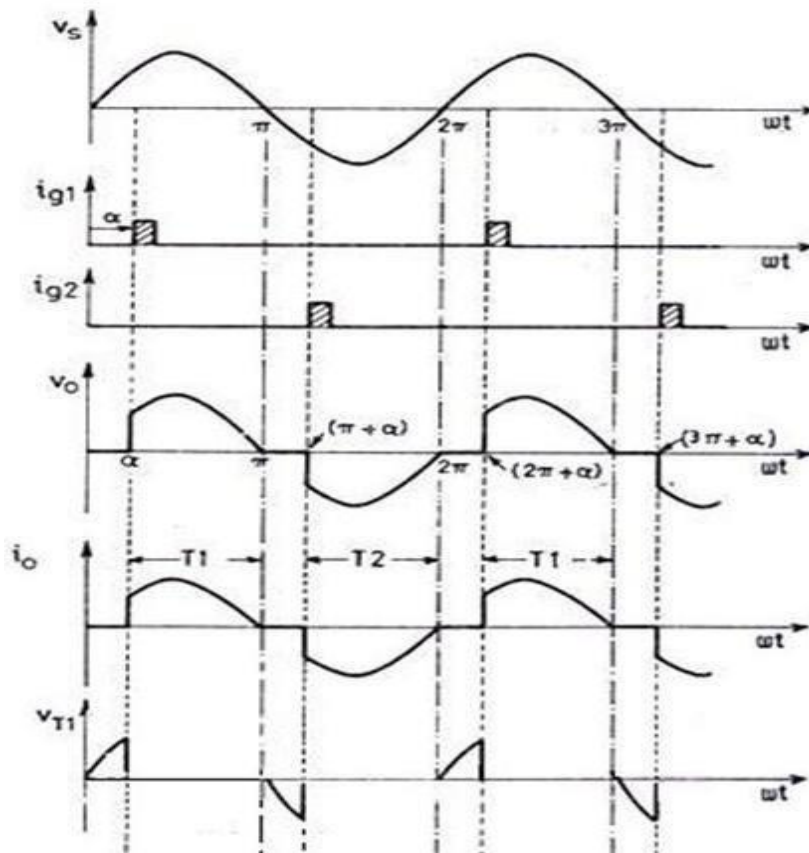| S. No.	Input Voltage (V in)	Firing angle in Degrees	Output voltage (V0r)		Output Current (I0r)	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

I_{0r} = V_{0r} / R

α = Firing Angle

V = RMS Value across transformer output

MODEL GRAPH:

Single Phase AC Voltage controller with R - Load
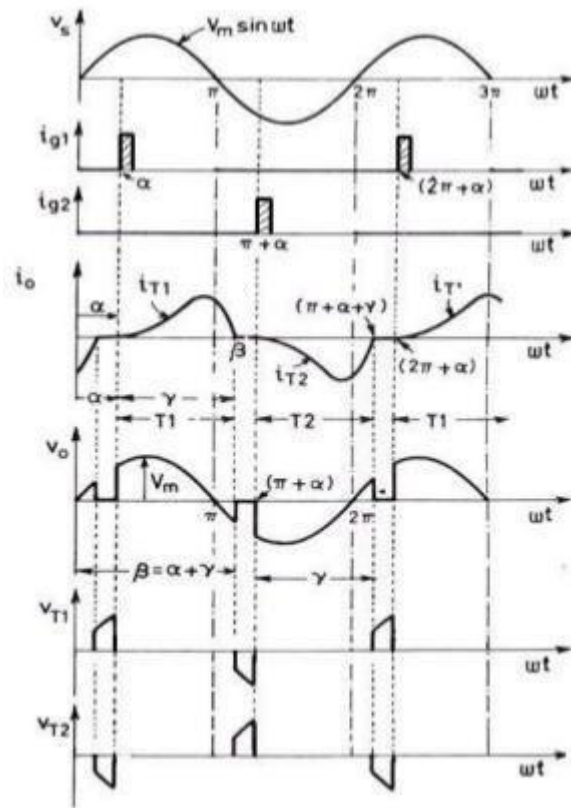
Single Phase AC voltage controller with RL Load

RESULT:

EXPERIMENT – 7

AIM: To study the single - phase Cyclo Converter with R & RL Load.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Single phase Cycloconverter power circuit andfiring circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Isolation Transformer (Centre - Tapped)			
5	Variable Rheostat			
6	Inductor			
7	AC Voltmeter			
8	AC Ammeter			
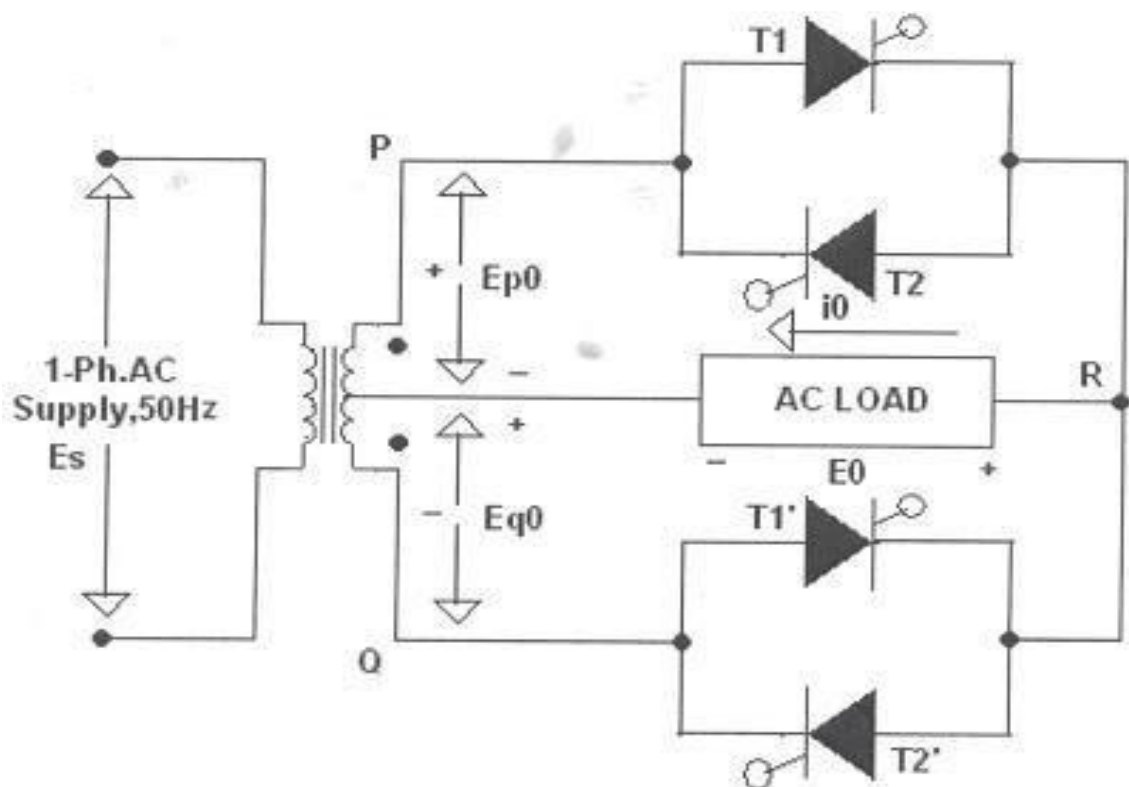
CIRCUIT DIAGRAM :

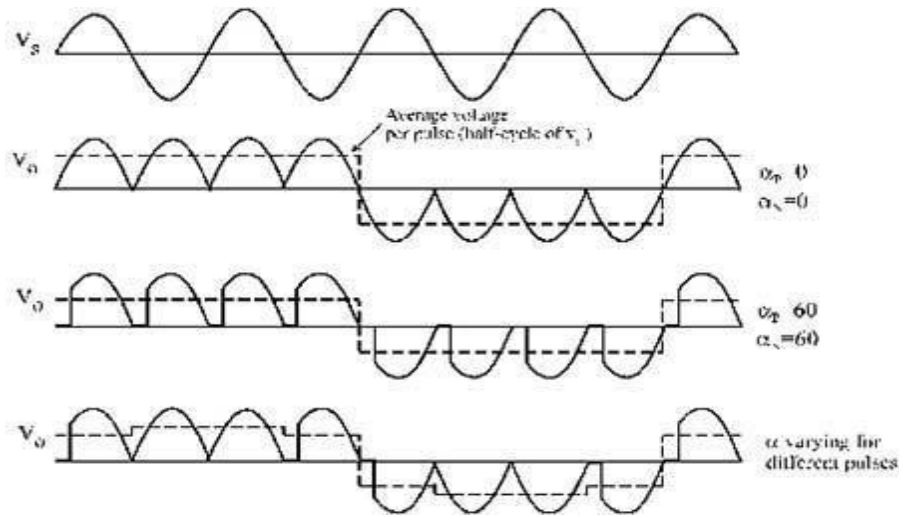**Circuit Diagram of Single Phase Cyclo – Converter**

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Connect firstly (30V-0-30V) AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals.
5. Set the frequency division switch to (2,3,4,…9) your required output frequency.
6. Switch ON the MCB and IRS switch and trigger output ON switch.
7. Observe waveforms in CRO, across load by varying firing angle gradually up to 180^0 andalso for various frequency divisions (2,3,4,…9).
8. Measure output voltage and current by connecting AC voltmeter & Ammeter.
9. Tabulate all readings for various firing angles.
10. For RL Load connect a large inductance load in series with Resistance and observe allwaveforms and readings as same as above.
11. Observe the various waveforms at different points in circuit by varying the Resistive Loadand Inductive Load.
12. Calculate the output voltage and current by theoretically and compare with it practicallyobtained values.

TABULAR COLUMN:

S. No	Input Voltage (V in)	Firing angle in Degrees	Frequency Division	V_0 (V)	I_0 (A)	Input frequency fs	Output frequency fo	fo/fs

MODEL GRAPH:

Output Wave Forms of Single Phase Cyclo – Converter
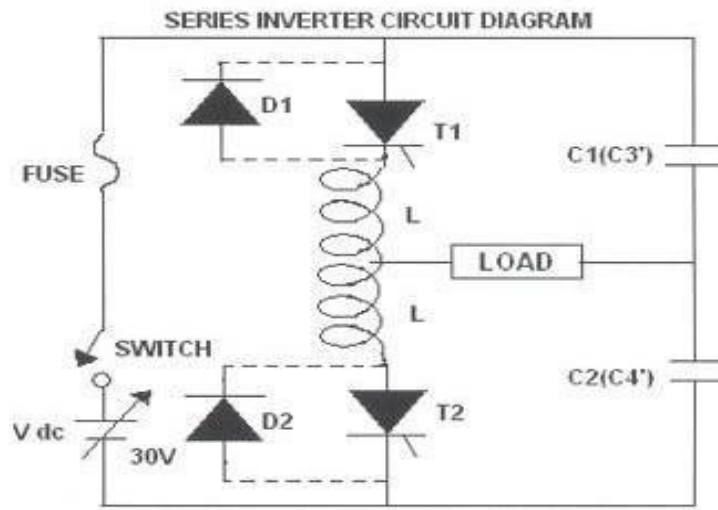
RESULT:

EXPERIMENT – 8

AIM: To obtain the performance characteristics of a single phase series inverter

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Series inverter power circuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Regulated dc power supply			
5	Variable Rheostat			
6	Inductor			

CIRCUIT DIAGRAM:

Circuit Diagram Single Phase Series Inverter

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Give the DC power supply 30V to the terminal pins located in the power circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB and IRSswitch and trigger output ON switch.
5. By varying the frequency pot, observe related waveforms.

6. If the inverter frequency is increases above the resonant frequency of the power circuit commutation fails. Then switch OFF the DC supply, reduce the inverter frequency and tryagain.

7. Repeat the above same procedure for different value of L,C load and also above the wave forms with and without fly wheel diodes.

8. Total output wave forms entirely depends on the load, and after getting the perfect wave forms increase the input supply voltage up to 30V and follow the above procedure.

9. Switch OFF the DC supply first and then Switch OFF the inverter.(Switch OFF the trigger pulses will lead to short circuit)

MODEL WAVEFORMS:
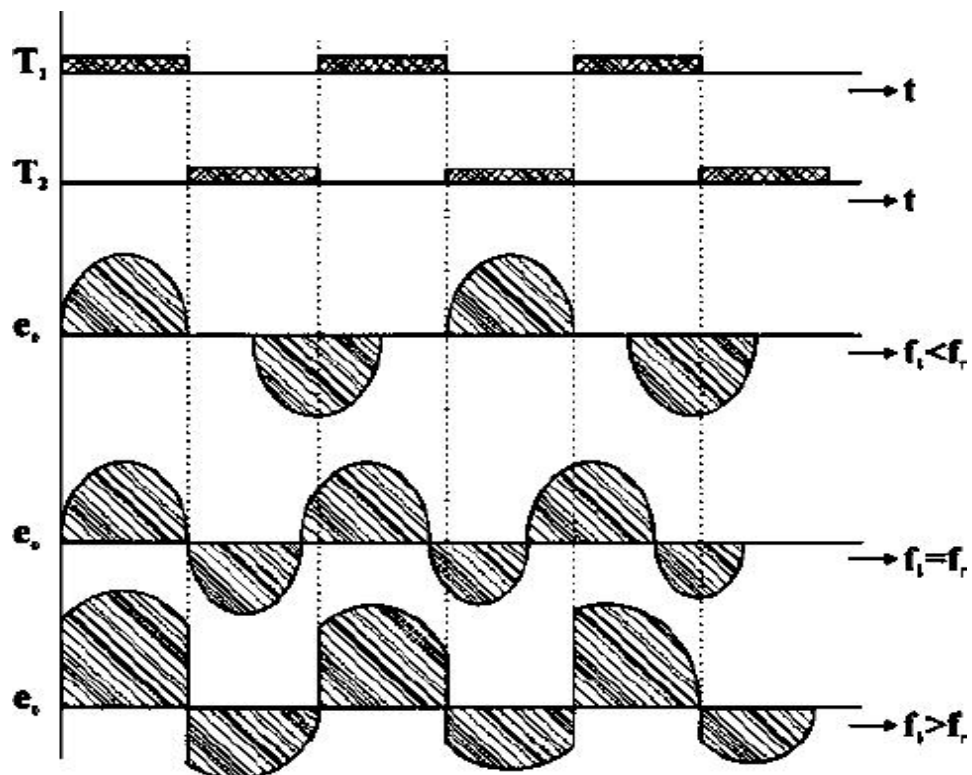
Output Wave Forms of Single Phase Series Inverter

RESULT:

Experiment No. 9

Objective:-Simulation of single phase half wave and full wave diode rectifier with R and R-L load onMATLAB

Software used:- MATLAB/Simulink

Theory:-

Single phase half wave rectifier:-

The circuit diagram of a single phase half wave rectifier is shown in figure (a). During the positive half cycle, diode is forward biased, it therefore conduct from $\omega t = 0$ to Π. During the positive half cycle, output voltage v_o = source voltage v_s and load current $i_o = {v_o}/{R}$.At $\omega t = M$, $v_o = 0$ and for R load,i_0 is also zero. As soon as v_s tends to become negative after $wt = \Pi$, diode D is reverse biased, it is therefore turned off and goes into blocking state .Output voltage as well as output current, are zero from $\omega t = M \ to \ 2M$. After $\omega t = M \ to \ 2M$. After $\omega t = 2\Pi$, diode is again forward biased and conduction begins.

For a Resistive load, output current i_o has the same waveform as that of the output voltage v_0.Diode voltage $v_D$is zero when diode conducts. Diode is reverse biased from $\omega t = M$ to 2Π as shown. The waveform of $v_s, v_0 \ and$ i_o .Here source voltage is sinusoidal i.e. $v_s = v_m \sin \omega t$.

Rms value of output voltage,

$$= [\frac{1}{2} \int_0 V^2 sin^2 \omega t. \ d(\omega t)]$$

$$= \frac{--}{2}$$

Average Value of load current,

$$I_o = {V_o}/{R} = {V_m}/{MR}$$

Rms value of load current,

$$I_{or} = {V_{or}}/{R} = {V_m}/{2}$$

 Single phase full wave rectifier:-

Primary function of full wave diode rectifier simulation is to establish a dc level from a sinusoidal

input voltage that has zero voltage. Single phase supply, is a fully controlled bridge- circuit .In the bridge circuit, diagonally opposite pairs of diodes are made to conduct, and are commutated, simultaneously.

During the first positive half-cycle, diodes D1 and D2 are forward biased and if they are triggered simultaneously, then current flows through the path L-D1-R-D2-N. Hence, in the positive cycle,

diodes D1 and D2 are conducting.

During the negative half cycle of the a.c. input, diodes D3 and D4 are forward biased and if they are triggered simultaneously, current flows through the path N-D3-R-D4-L. Diodes D1, D2 and D3, D4 are triggered at the same firing angle α in each positive and negative half-cycles of the supply voltage, respectively.

When the supply voltage falls to zero, the current also goes to zero. Hence, diodes D1 and D2 in positive half cycle and D3, D4 in negative half cycle turn off by natural commutation.

The related voltage and current waveforms for the circuit are shown in the figure given below the circuit diagram;

Procedure:-

1) Start the Matlab software.
2) Open a new simulation window by clicking on simulink button.
3) Window that appears in simulink library browser the window contains component that can be plotted into simulink or design window.
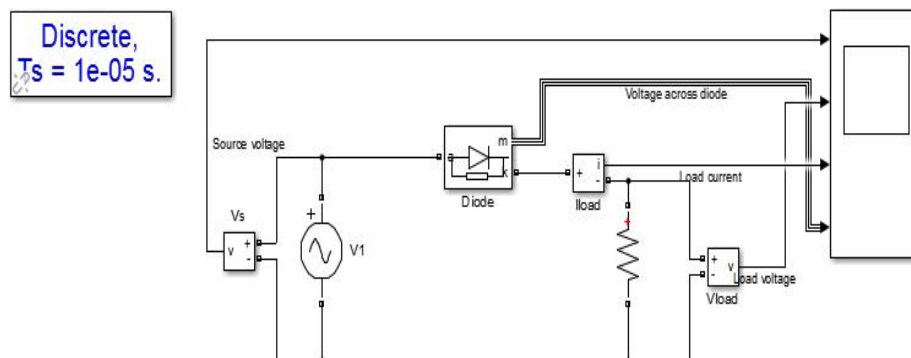4) Drag & drop the components from library.
5) Run the simulation.

Figure:-

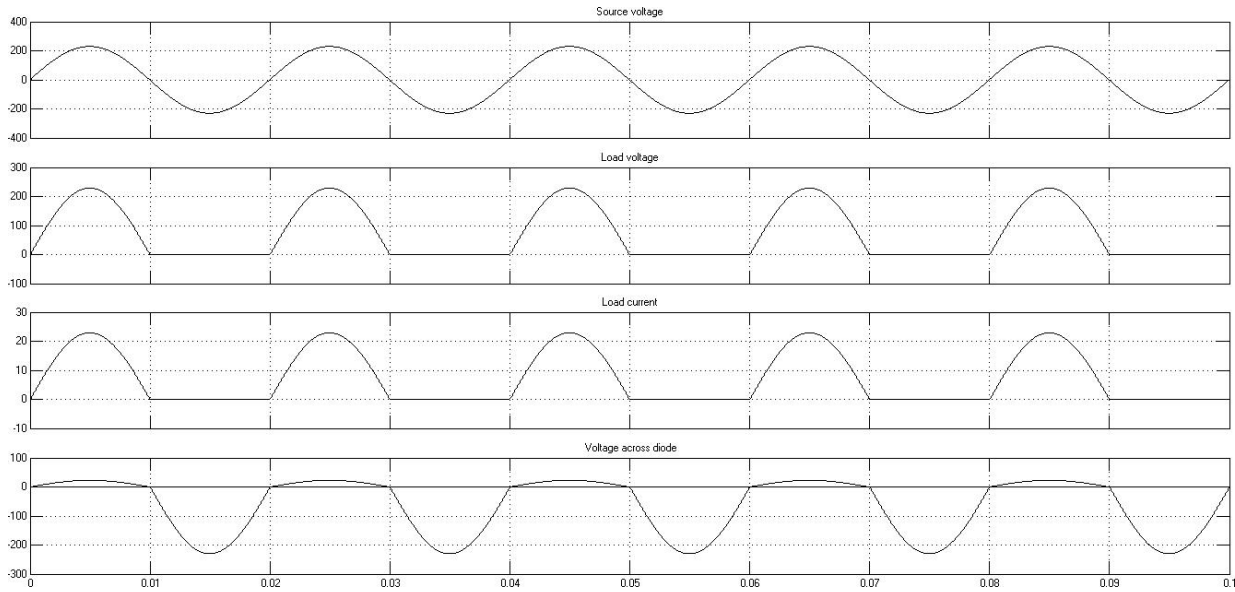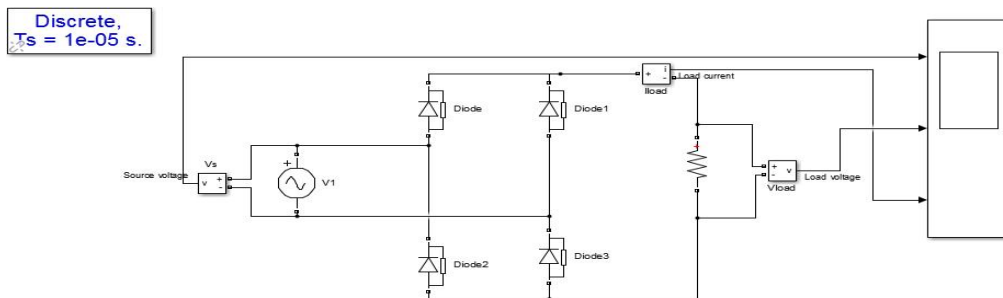Figure 1 simulink model of half wave rectifier

Figure 2 wave forms of half wave rectifier in terms of input voltage ,load voltage ,load current and voltage across diode

Figure 2 wave forms of half wave rectifier in terms of input voltage ,load voltage ,load current and voltage across diode
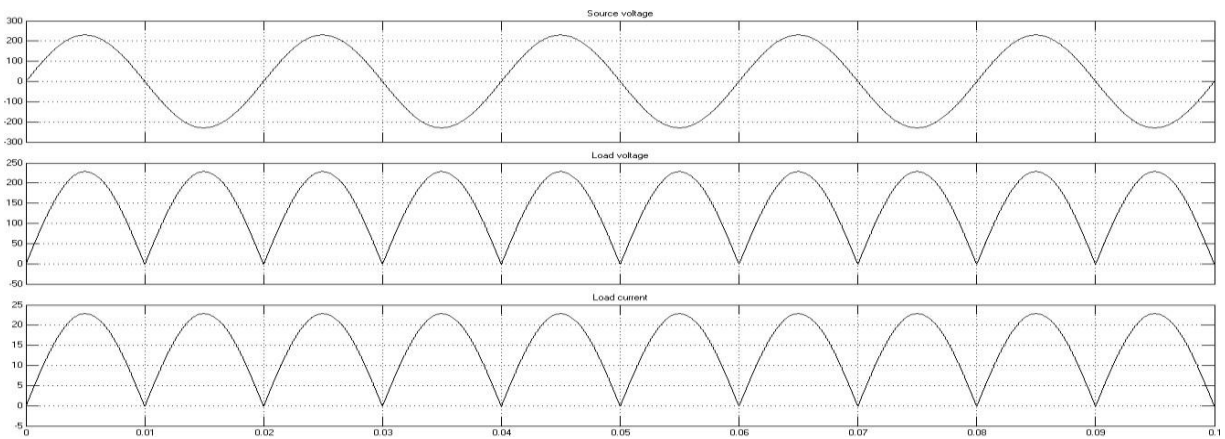

Figure 2 wave forms of half wave rectifier in terms of input voltage ,load voltage ,load current and voltage across diode

RESULT:-

Single phase Half wave and full wave diode rectifier has been studied.

Precautions:-

1) Connections must be properly alone.
2) Don't forget to drag powergui beside circuit diagram.

Experiment No. 10

Objective: Simulation of single-phase half wave phase-controlled converter with R and R-L loadon MATLAB.

Apparatus Required: MATLAB/SIMULINK installed on PC.

Theory:

The phase-controlled rectifiers using SCRs are used to obtain controlled dc output voltages from the fixed ac mains input voltage. A single-phase half wave-controlled converter only has one SCR is employed in the circuit. The performance of the controlled rectifier very much depends upon the type and parameters of the output (load) circuit.

For R load:

The output voltage is varied by controlling the firing angle of SCR. The simulation circuit of the half wave converter is shown in fig (1). During the positive half-cycle of input voltage, the thyristor anode voltage is positive with respect to cathode and the thyristor is said to be forward biased. When thyristor T_1 is fired at wt=α, thyristor T_1 **is** conducts and input voltage appears the load. When the input voltage starts to be negative at wt=∏, the thyristor anode is negative with respect to cathode and thyristor is said to be reverse biased; and it is turned off. The time after the input voltage starts to go positive until the thyristor is fired is called the delay or firing angle α. If the load is resistive, the load voltage and load current are similar. Average output voltage is half Controlled converter with R load is given by.

$$V_{dc\ (av)} = \frac{Vm}{2}[1+\cos α] \text{ (volts)}$$

where

Vm is the maximum input voltage α is the firing angle of the SCR

The simulation waveforms for half wave phase controlled converter with R load for firing angle(30^0&60^0) in terms firing pulse, input voltage, output voltage and load current are shown in figure 2&figure3 respectively . This converter is not used in industrial applications because its output has high ripple content and low ripple frequency

For RL load:

When the load is resistive, SCR1 conduct from α to π. The nature of the load current depends on the values of R and L in the inductive load. The simulation circuit of the half wave converter with RL load is shown in fig (4). Because of the inductance, the load current keeps on increasing and becomes maximum at π. At π, the supply voltage reverses but SCRs 1 does not turn off. This is because the load inductance does not allow the current to go to zero instantly. Thus the energy stored in the inductance flows against the supply mains. The output voltage is negative from π to π + α since supply voltage is negative.

Where

Vm is the maximum input voltageα is the firing angle of the SCR

$V_{dc\ (av)} = Vm\ [\cos\beta - \cos\alpha]$ (volts)

The simulation waveforms for half wave phase-controlled converter with RL load for firing angle $(30^0 \& 60^0)$ in terms firing pulse, input voltage, output voltage and load current are shown in figure 5&figure6 respectively. This converter is not used in industrial applications because its output has high ripple content and low ripple frequency

Procedure:

1. Make the connections as per circuit diagram with elements taken from the MATLAB library for both R & RL load.
2. Simulate them.
3. Observe the waveform carefully on scope.

Result:

Simulation of half wave-controlled rectifier with R & RL load have been simulated.

Circuit Diagram:
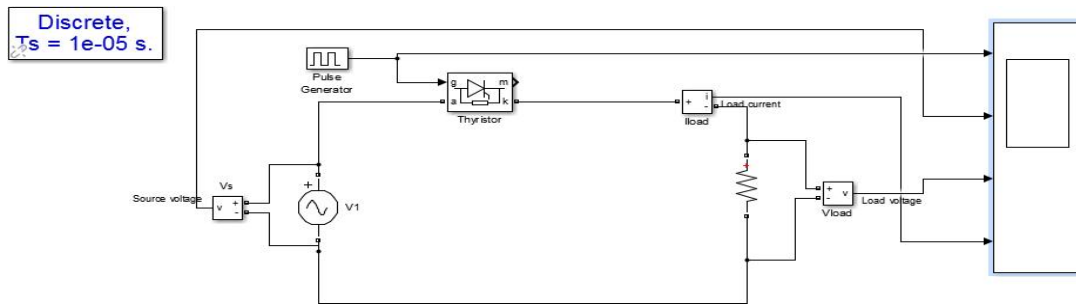
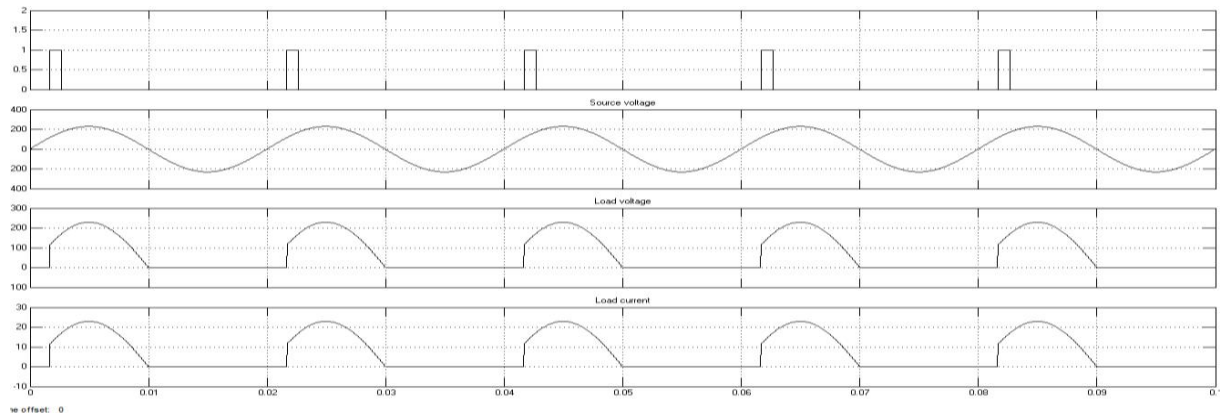Figure1Simulink model of single phase half wave with R load

Figure2 Wave forms of gate pulse, input voltage, output voltage and load current of single phase half wave with R load with firing angle 30^0
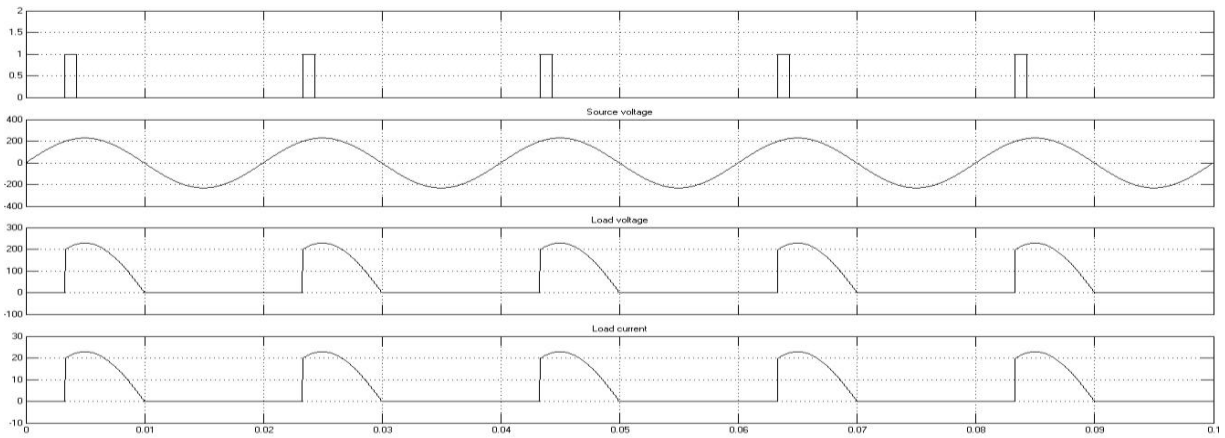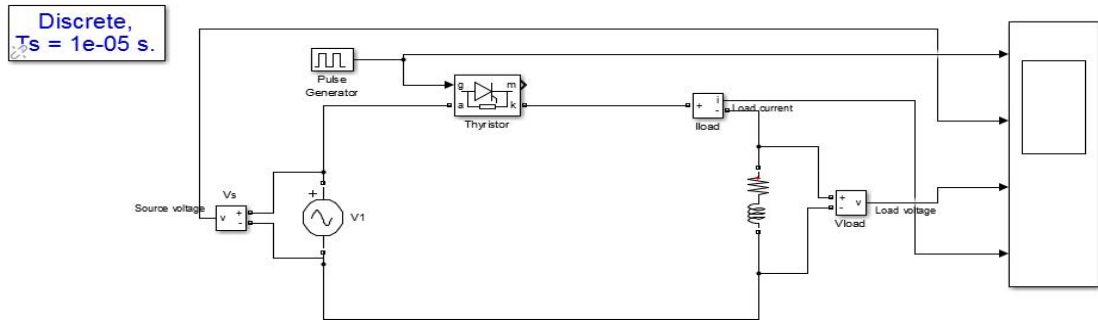
Figure3Wave forms of gate pulse, input voltage, output voltage and load current of single phase half wave with R load with firing angle 60^0

Figure 4Simulink model of single phase half wave with RL load

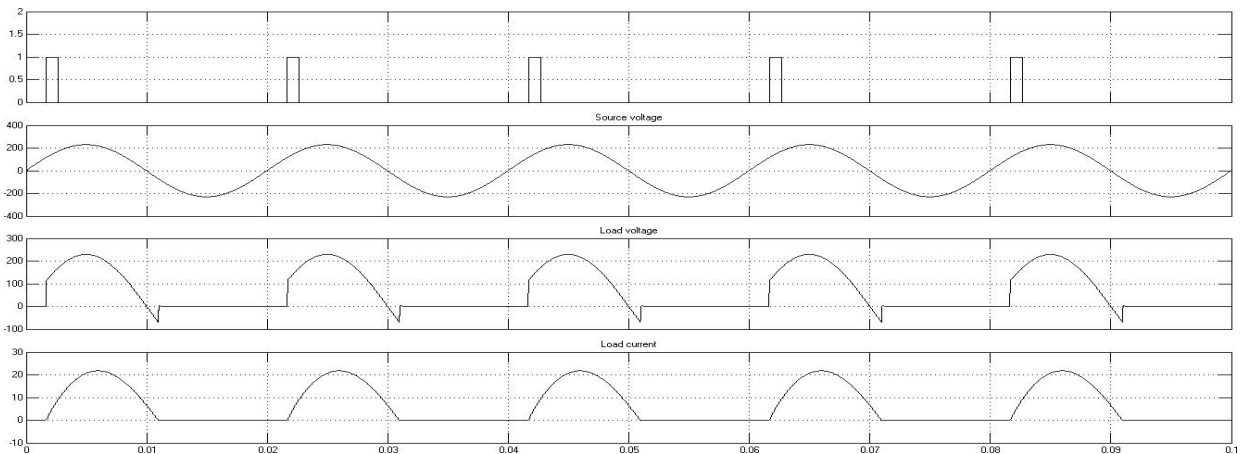

Figure5Wave forms of gate pulse, input voltage, output voltage and load current of single phase half wave with RL load with firing angle 30^0
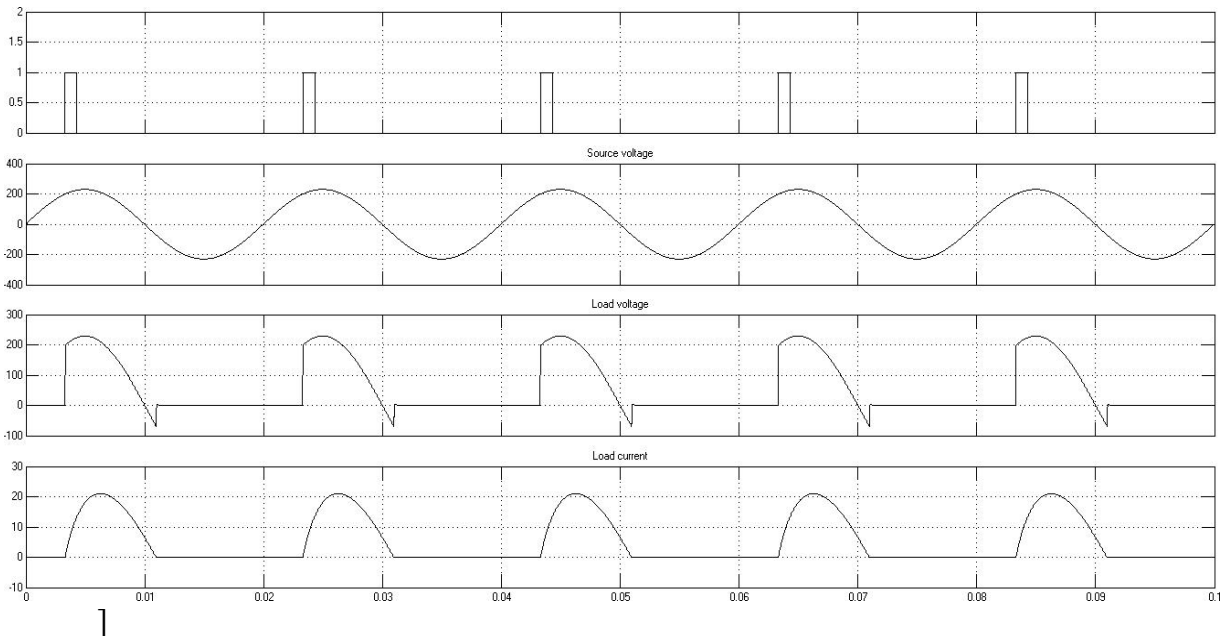
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Figure6Wave forms of gate pulse, input voltage, output voltage and load current of single-phase half wave with RL load with firing angle 60^0

Gating Sequence. The gating sequence for the thyristor is as follows:

1. Generate a pulse-signal at positive zero crossing of the supply voltage Vs.
2. Delay the pulse by desired angle α and apply it between the gate and cathode terminal terminals of T1 through a gate-isolating circuit.

This lab manual has been updated by

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Crosschecked
By HOD EEE

Please spare some time to provide your valuable feedback.