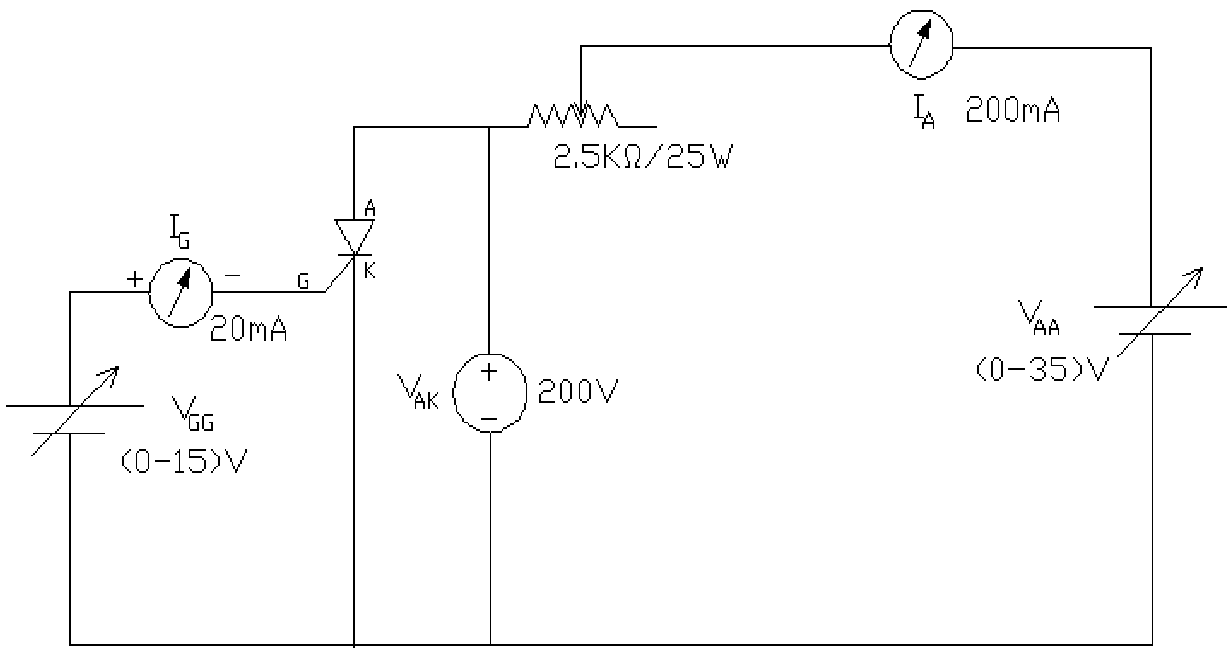
POWER ELECTRONICS LAB

LIST OF EXPERIMENTS

S.No	***Name of the experiment***	***Date***	***Signature***
1	Study of Characteristics of SCR, MOSFET & IGBT		
2	Single Phase Half Controlled Converter with R and RL load		
3	Single Phase Fully Controlled Bridge Converter with R and RL loads		
4	Single Phase AC Voltage Controller with R & RL Loads		
5	Single Phase Cycloconverter with R & RL Loads		
6	Single Phase Series Inverter with R & RL Loads		
7	Single Phase Parallel Inverter with R & RL Loads		
8	Gate Firing Circuits for SCR's		
9	Forced Commutation Circuits (Class A, B, C & D)		
10	Single Phase Dual Converter with RL Load		

CIRCUIT DIAGRAMS FOR SCR:



Circuit Diagram for Obtaining the Characteristics of SCR

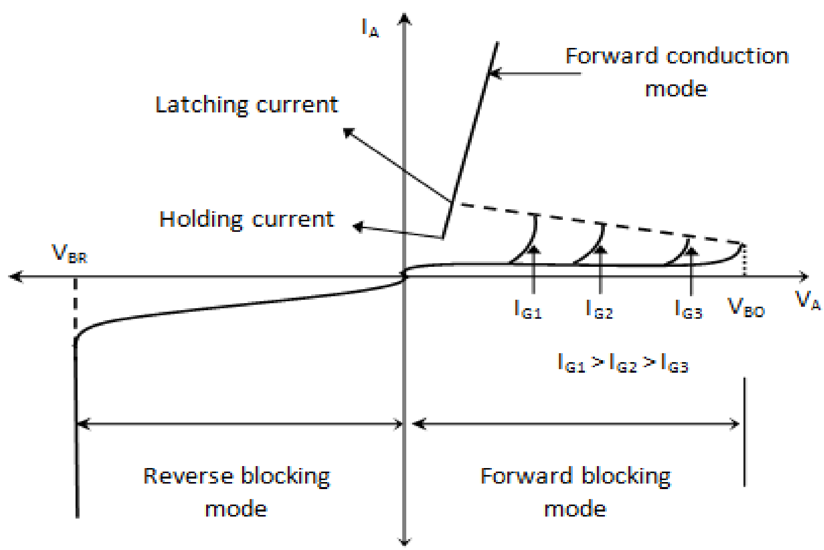


Fig. static V-I characteristics of SCR

STUDY OF CHARACTERISTICS OF SCR, MOSFET & IGBT

AIM: -

To plot the characteristics of SCR, MOSFET & IGBT

APPARATUS: -

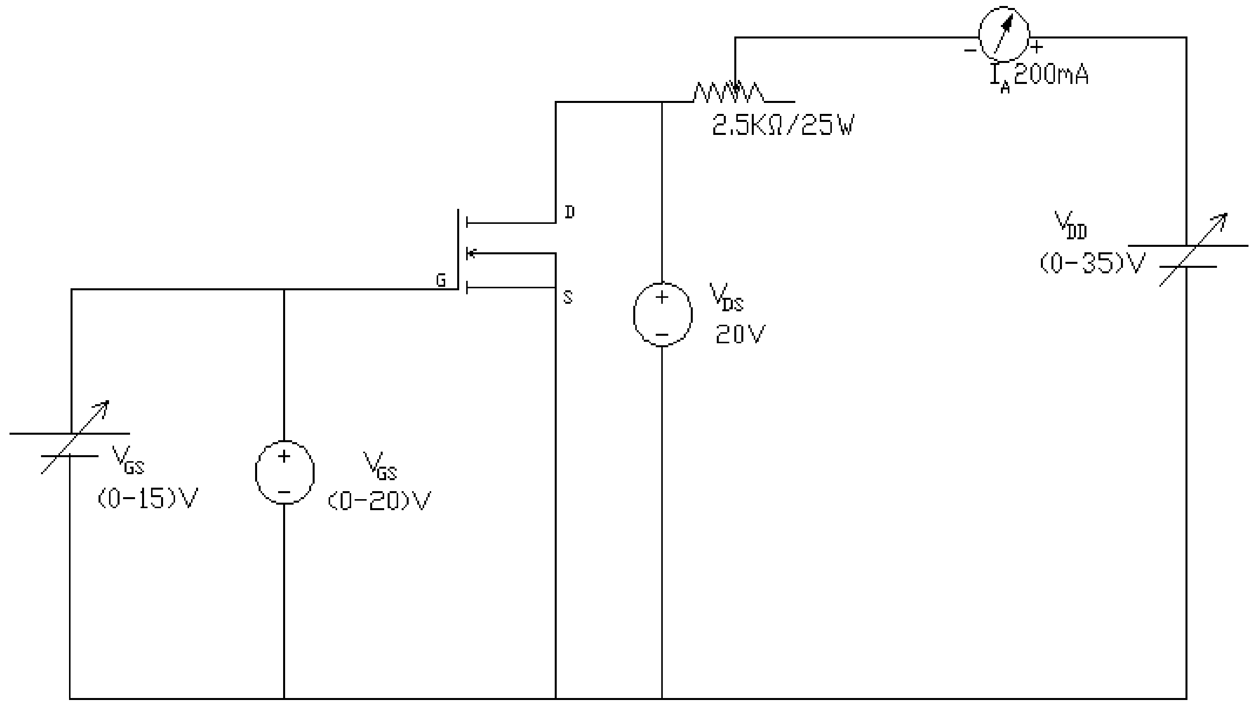
S.no	*Description*	*Quantity*
1	Characteristics Kit	1
2	Ammeter (0-200)mA	2
3	Voltmeter (0-20)V	2
4	RPS (0-30)V,2A	1

PROCEDURE:

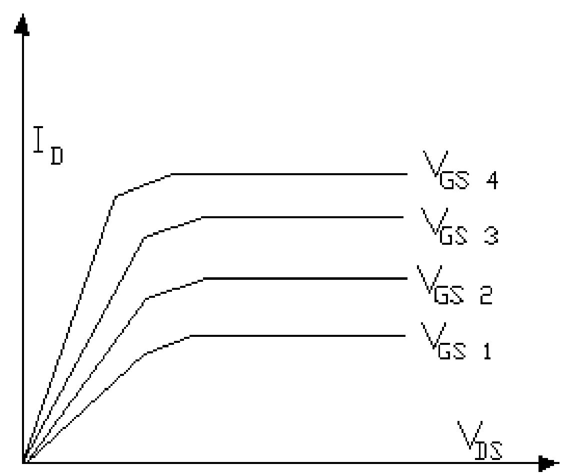
To obtain Characteristics of SCR:

1. The connections are made as per circuit diagram.
2. Switch on the regulated power supply. Apply 10V across anode & cathode of SCR.
3. Gradually increase the gate current till the SCR becomes ON. Note down V_{AK}, I_A.
4. Now increase supply voltage gradually and I_A are noted for three or four readings.
5. Steps 3 to 4 are repeated for another values of V_{AK} say 20V.
6. Tabulate the readings in the table.
7. Plot a graph of V_{AK} versus I_A.
8. To determine Holding current I_H :
   i) Keep proper V_{AK} to trigger SCR by gate current. Trigger SCR by applying gate current .Keep sufficient load current by varying load resistance in fully clock wise direction.
   ii) To open gate circuit, now reduce load current till SCR jump to blocking state.
   iii) The minimum current for which SCR suspend under ON condition is noted which is Holding current I_H.
9. Latching current is 1.5 to 2 times of holding current value

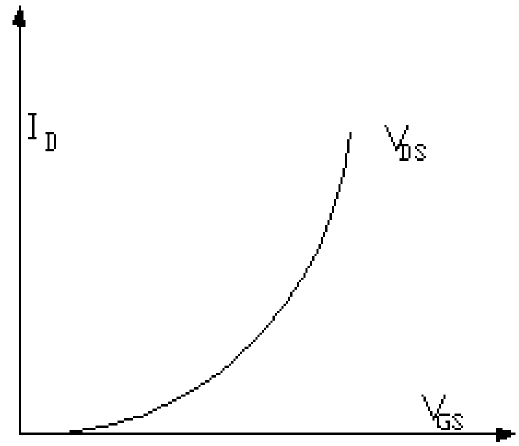
CIRCUIT DIAGRAMS FOR MOSFET:



Circuit Diagram for Obtaining the Characteristics of MOSFET



Output Characteristics for MOSFET



Transfer Characteristics for MOSFET

To obtain Characteristics of MOSFET:

Output Characteristics:

1. The connections are made as per circuit diagram
2. Switch on the equipment. Keep V_{DS} say 10V, vary V_{GS} note down the range of V_{GS} for which drain current is varying for constant V_{GS}.
3. Keep V_{GS} constant, (V_{GS} must be within the range determined by step 2).
4. Vary V_{DS} in steps, note down corresponding I_D.
5. Step 4 is repeated for different values of V_{GS}.
6. Tabulate the readings in the table.
7. Plot a graph of I_D against V_{DS} for different V_{GS}.

Transfer Characteristics:

1. The connections are made as per circuit diagram
2. Switch on the equipment. Keep V_{DS} say 10V, vary V_{GS} in steps ,note down the corresponding drain current I_D.
3. Tabulate the readings in the table.
4. Plot a graph of I_D against V_{GS}.

To obtain Characteristics of IGBT:

Output Characteristics:

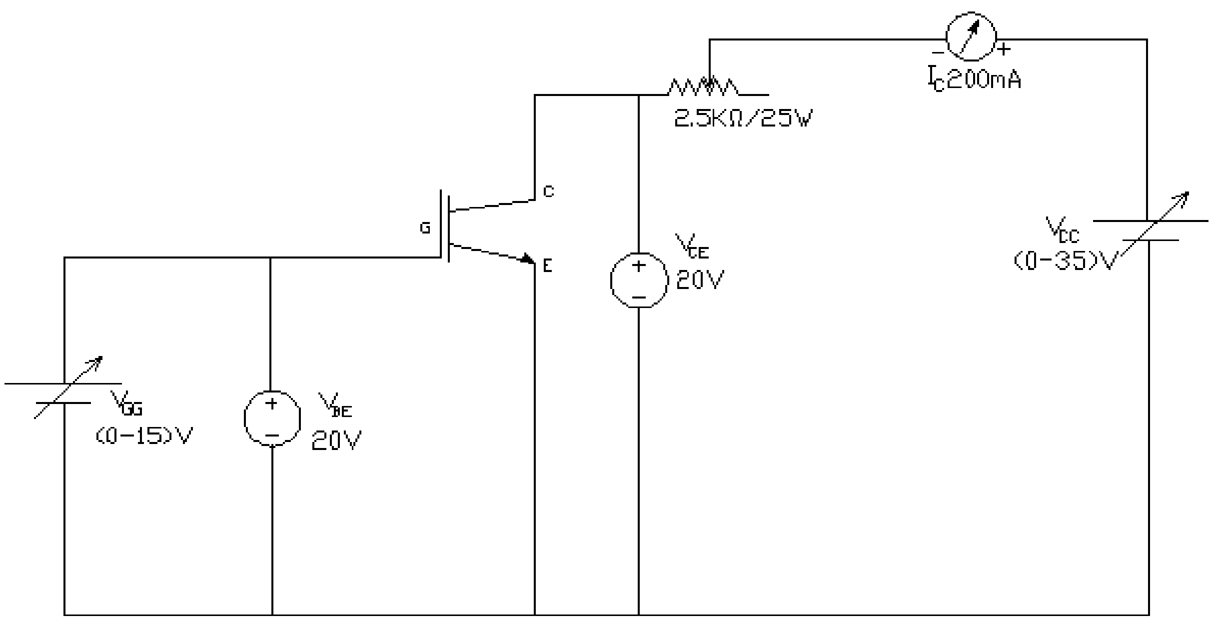
1. Connections are made as per circuit diagram.(Use 20V Voltmeter for V_{GE} , 200V Voltmeter for V_{CE} , 200 ma Ammeter for IC 15V Power supply for base & 35V Power supply for collection circuit).
2. Switch on the equipment .Keep V_{CE} 10V, vary V_{GE} note down the range of V_{GE} for which collector current is varying for constant V_{CE}.
3. Keep V_{GE} constant,(V_{GE} must be with in the range determined by step 2).
4. Vary V_{CE} in steps, note down the corresponding I_C.
5. Adjust V_{GE} to constant while doing step 4.
6. Step 4 is repeated for different V_{GE}.

7. Tabulate the readings in the table.
8. Plot a graph of I_C against V_{CE} for different V_{GE}.

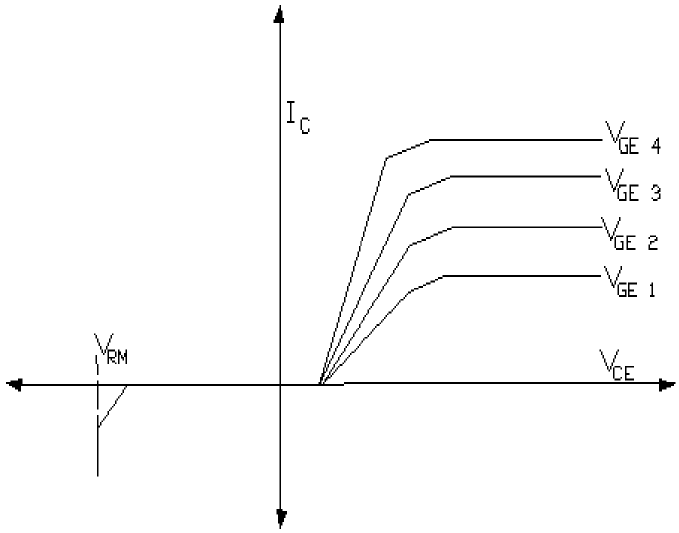
Transfer Characteristics:

1. Connections are made as per circuit diagram. (Use (0-20)V Voltmeter for V_{GE}, (0-200)V Voltmeter for V_{CE}, (0-200)mA Ammeter for IC 15V Power supply for base & 35V Power supply for collection circuit).
2. Switch on the equipment. Keep V_{CE} constant; vary V_{GE} in steps, Note down corresponding I_C.
3. Adjust V_{CE} to constant while doing step 2.
4. Tabulate the readings in the table.
5. Plot a graph of I_C against V_{GE} for different V_{CE}

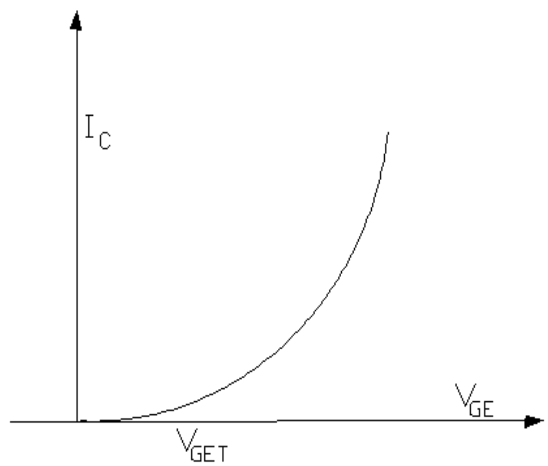
<u>CIRCUIT DIAGRAMS FOR IGBT:</u>



Circuit Diagram for obtaining the characteristics of IGBT



Output Characteristics for IGBT



Transfer Characteristics for IGBT

<u>PRECAUTIONS:</u>

1. All the connections should be tight.
2. Use unearthed CRO.

OBSERVATRIONS:

Static V-I Characteristics' of SCR

V_{G1} =

S.No	V_{AK}(V)	I_A(mA)

Static V-I Characteristics of SCR

V_{G2} =

S.No	V_{AK}(V)	I_A(mA)

Output Characteristics of MOSFET

V_{DS} =____________

Transfer Characteristics of MOSFET

V_{GS} =_____

S.No	V_{DS} (V)	I_D (mA)

S.No	V_{GS} (V)	I_D (mA)

Output Characteristics of IGBT
VGE =

Transfer characteristics of IGBT
VGE =

S.No	V_{CE} (V)	I_C (mA)

S.No	V_{GE} (V)	I_C (mA)

RESULT:

1-Φ HALF CONTROLLED BRIDGE CONVERTER WITH R &RL LOADS

AIM: To obtain the 1-Φ half controlled converter output wave forms with varying R and RL loads

APPARATUS:

1) 1-Φ Half controlled converter power circuit
2) Rheostat(50 Ω /2A)
3) (0-230V)/115V-115V isolation transformer
4) Inductance (0-150mH/5A)
5) CRO,probes & connecting wire

CIRCUIT DIAGRAM:

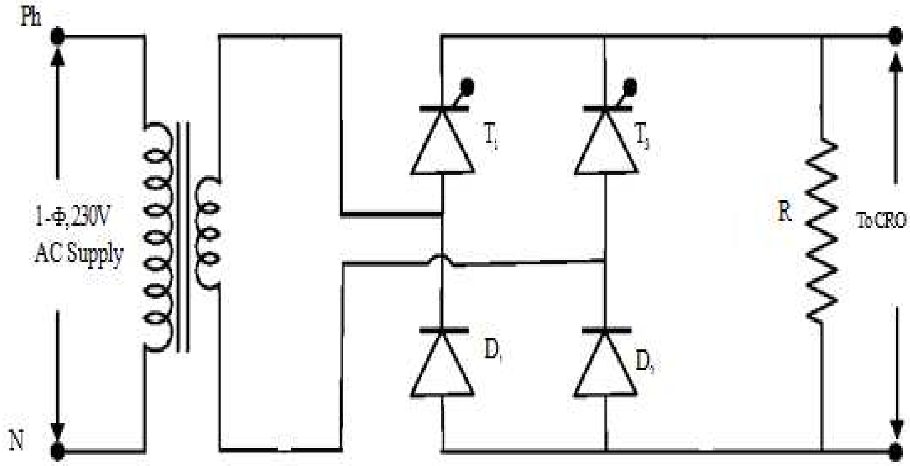


Fig-1 for R-load

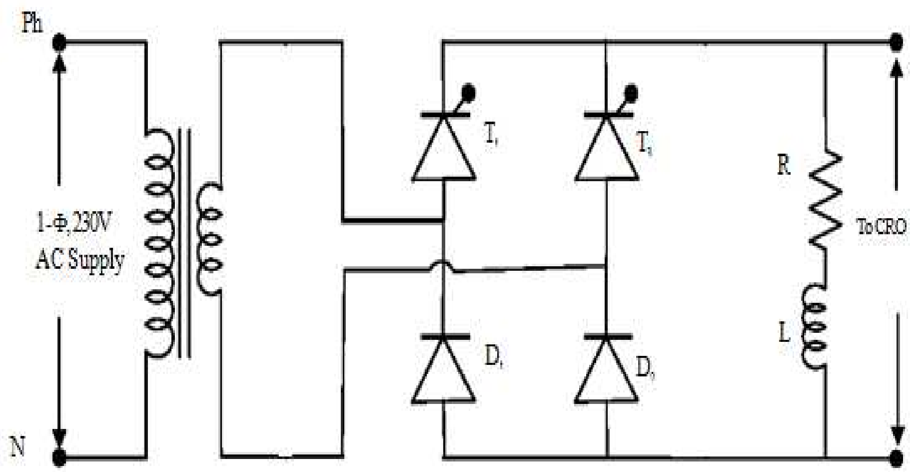
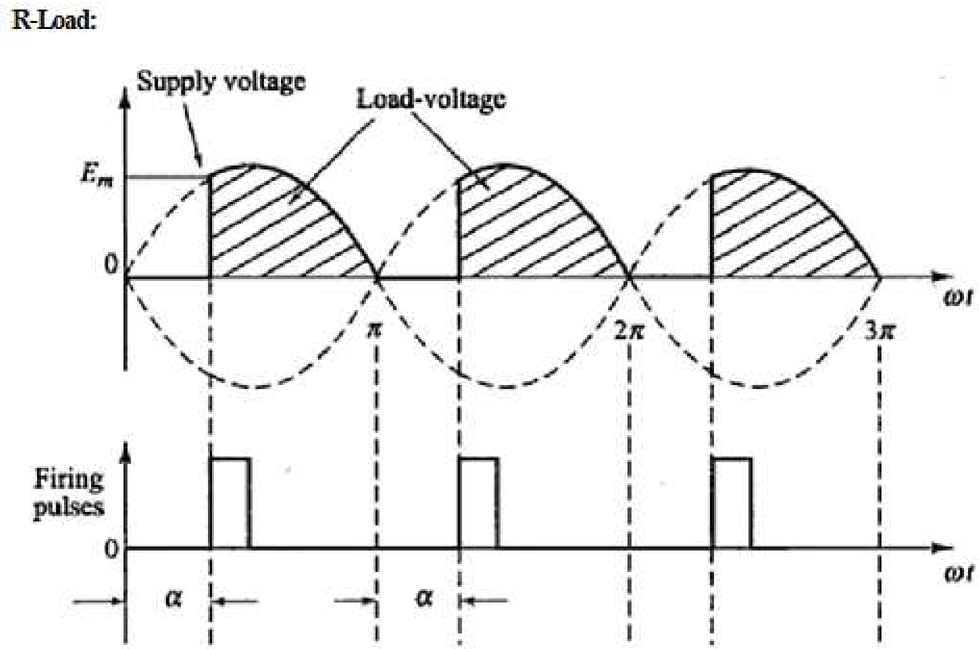
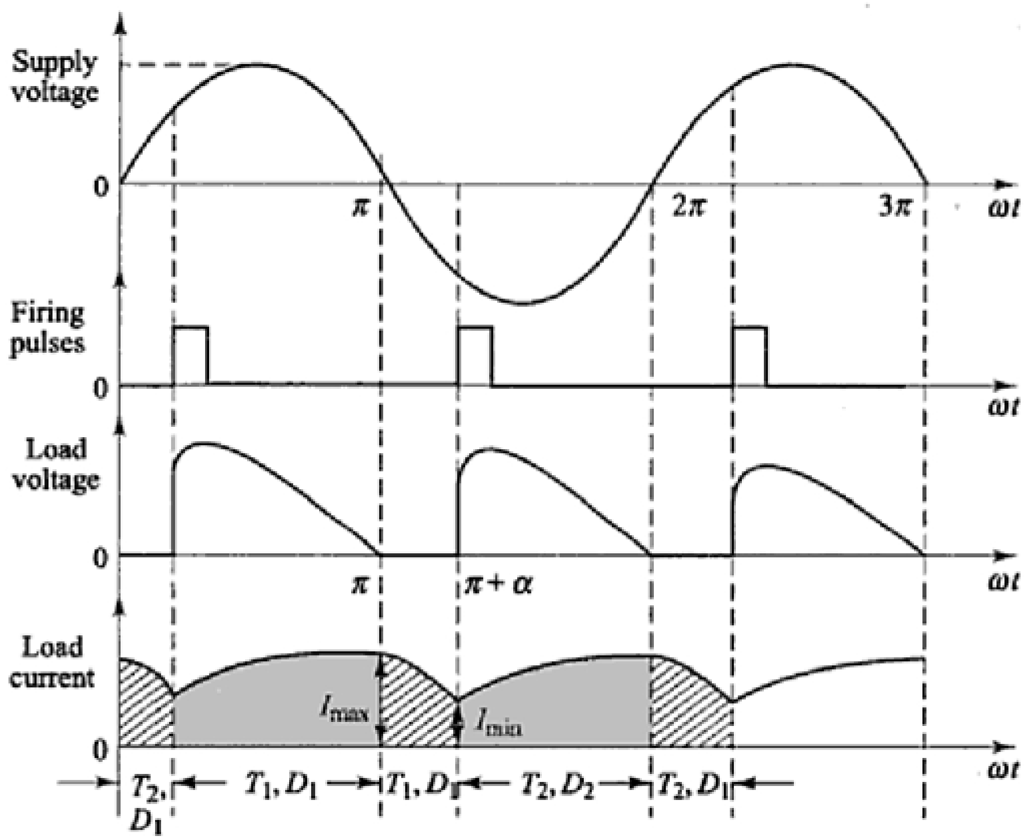


Fig-2 for RL-load

WAVE FORMS:


R-Load:
Supply voltage
Load-voltage
E_m
0
π
2π
3π
ωt
Firing pulses
0
α
α
ωt

R-L load:


Supply voltage
0
π
2π
3π
ωt
Firing pulses
0
ωt
Load voltage
0
π
$\pi + \alpha$
ωt
Load current
I_{max}
I_{min}
0
ωt
T_2, D_1
T_1, D_1
T_1, D_1
T_2, D_2
T_2, D_1

Tabular forms:

R-LOAD

Serial No.	Firing Angle(α)	Output Voltage R-Load Practical		Output Voltage R-Load Theoretical		Output Current
		V_{DC} (V)	V_{RMS} (V)	V_{DC} (V)	V_{RMS} (V)	I_{dc}(A)

RL-LOAD

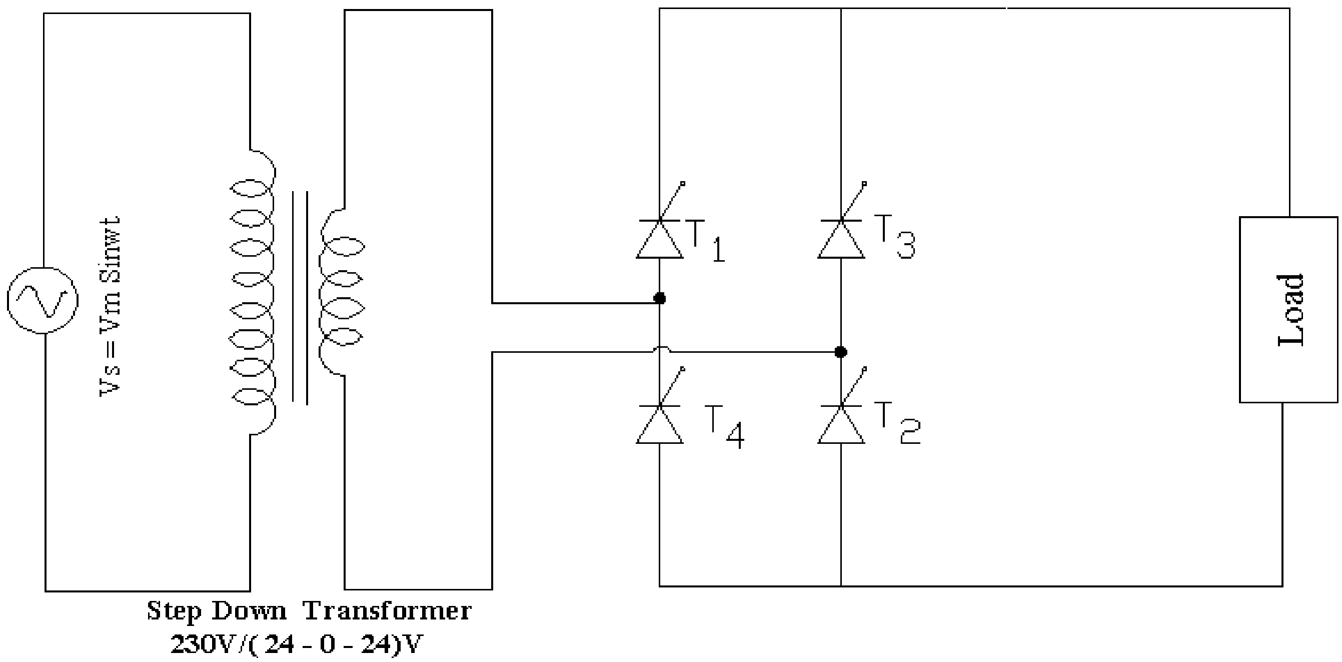
Serial No.	Firing Angle (α)	Output Voltage RL Load Practical		Output Voltage RL Load Theoretical		Output Current
		V_{DC} (V)	V_{RMS} (V)	V_{DC} (V)	V_{RMS} (V)	I_{dc}(A)

PROCEDURE:

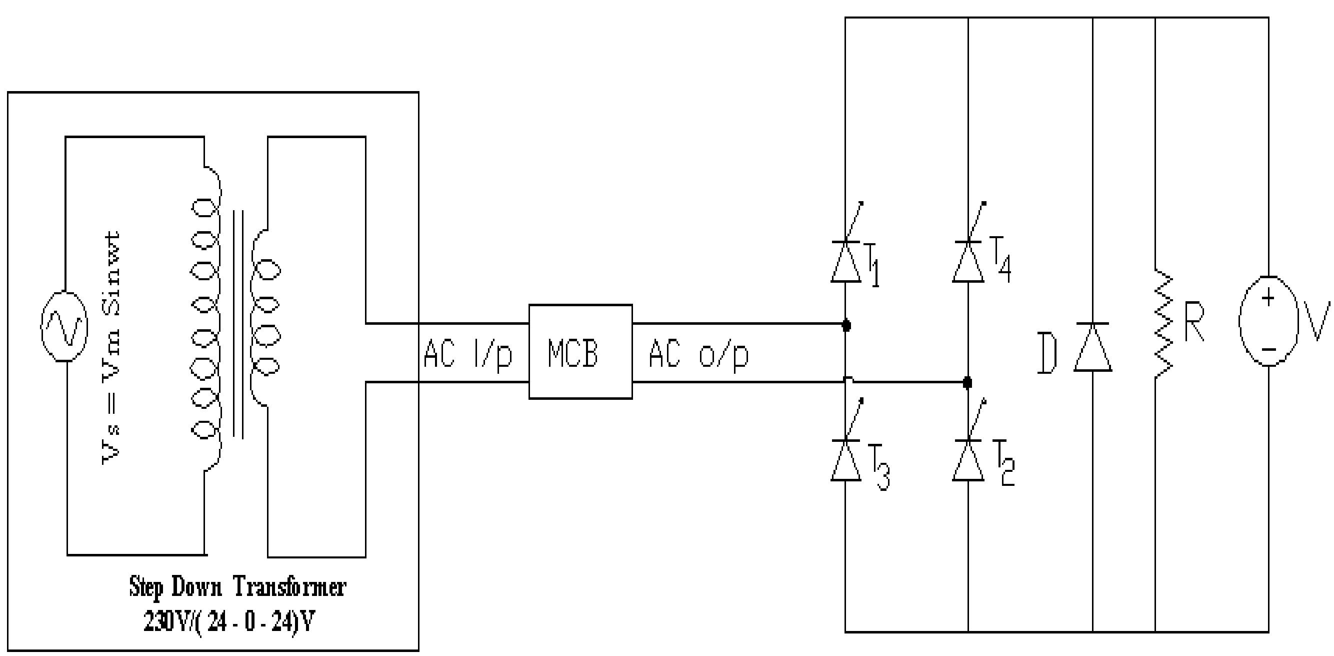
1. Connect the circuit as shown in fig.
2. First apply the trigger pulses to the circuit &observe the pulses.
3. Appy the AC supply and switch on the firing circuit
4. By placing rheostat in maximum resistance position
5. Verify the output wave forms at different firing angles
6. By connecting an inductive load in series with resistance observe the output wave forms.

RESULT:

CIRCUIT DIAGRAMS:



Circuit Diagram for Single Phase Fully Controlled Bridge Converter



Panel Diagram for Single Phase Fully Controlled Bridge Converter

SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER

WITH R & RL LOAD

AIM: -

To study the operation of a single-phase fully controlled bridge Converter and to observe the output waveforms with R and RL loads.

APPARATUS: -

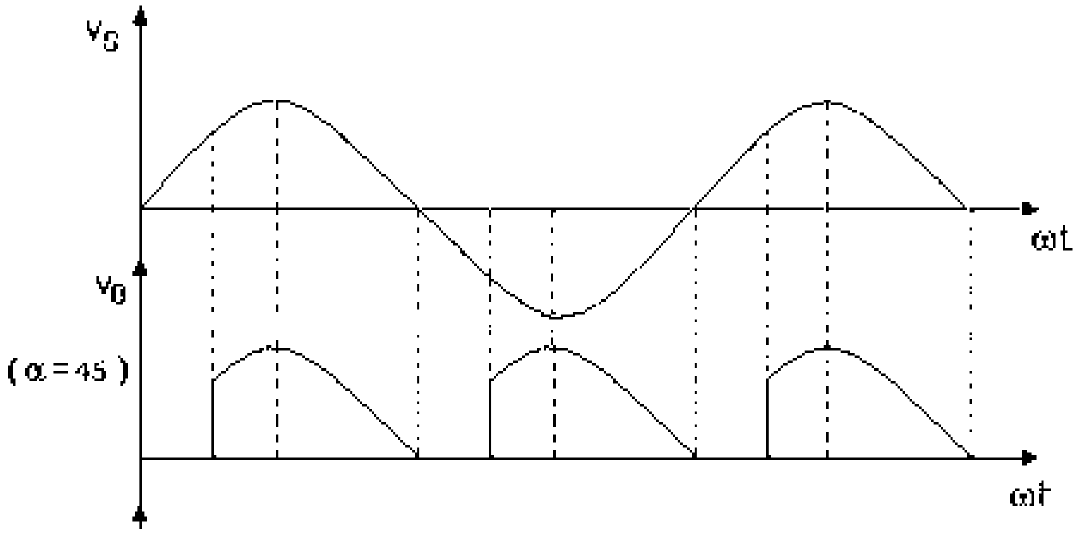
S.no	*Description*	*Quantity*
1	Single-phase fully controlled bridge Converter kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1
4	Decade Inductance Box	1
5	Decade Capacitance Box	1

PROCEDURE: -

1. Make the inter connections of the power circuit as shown in the circuit diagram.
2. Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.
3. Before switching ON the supply ensure that switching sequence is followed.
4. A 50Ω/2A rheostat is connected across the load terminals.
5. Apply 10V AC input voltage using isolation transformer.
6. Observe and plot the variations in the output voltage, current waveforms with the help of CRO.
7. Repeat step 6 by varying firing angles in sequence.
8. Repeat step 6 and step 7 for RL loads.

9. Also observe waveforms by connecting firing wheeling diode & by using half controlled converter.

MODEL GRAPHS: -

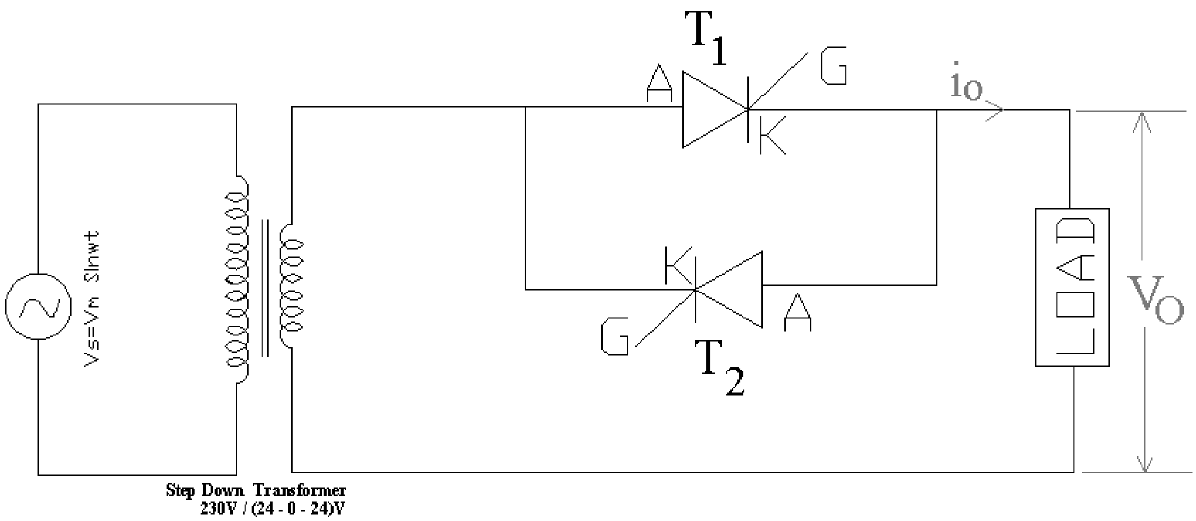


PRECAUTIONS: -

1. Identify the terminals of the SCR carefully before connecting the circuit.
2. Avoid loose contacts
3. Use an unearthed Oscilloscope.
4. Potentiometer is kept at minimum position before switching on the supply

RESULT:

CIRCUIT DIAGRAM: -



Circuit Diagram for Single Phase AC Voltage Controller

MODEL GRAPHS:

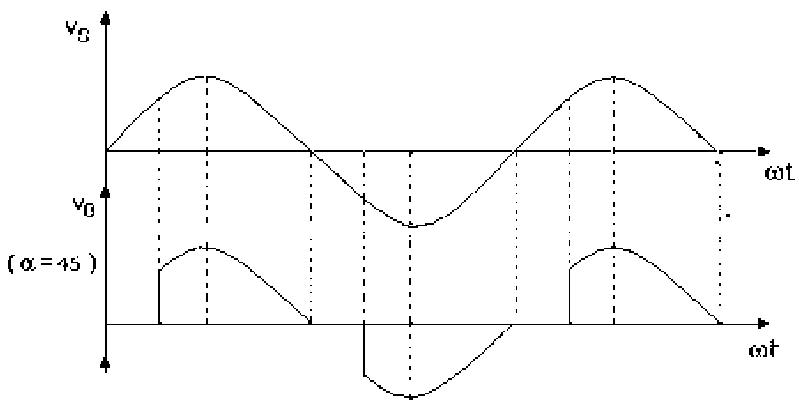
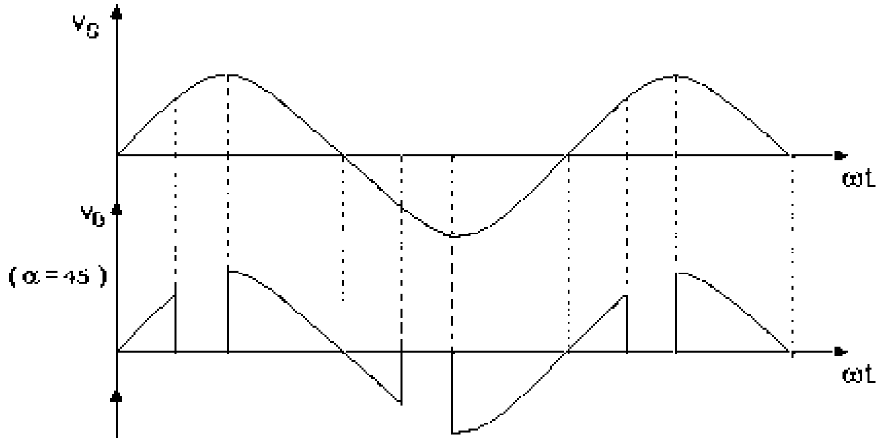


Fig (a) Output Voltage Waveforms with R Load



Fig(b) Output Voltage Waveforms with RL Load

SINGLE PHASE AC VOLTAGE CONTEROLLER WITH R & RL LOADS

AIM: -

To study the operation of a single-phase ac voltage controller and to observe the output waveforms.

APPARATUS: -

S.no	*Description*	*Quantity*
1	AC Voltage controller Kit	1
2	Unearthed C.R.O	1
3	Auto transformer	1
4	Connecting probes	1

PROCEDURE: -

(1) Make the connections of the power circuit as shown in the figure.
(2) Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K to the firing circuit module.
(3) Before switching ON the supply ensure that switching sequence is followed.
(4) The toggle switch on the power circuit module should be kept in the SCR module.
(5) A 50Ω/2A rheostat is connected across the load terminals.

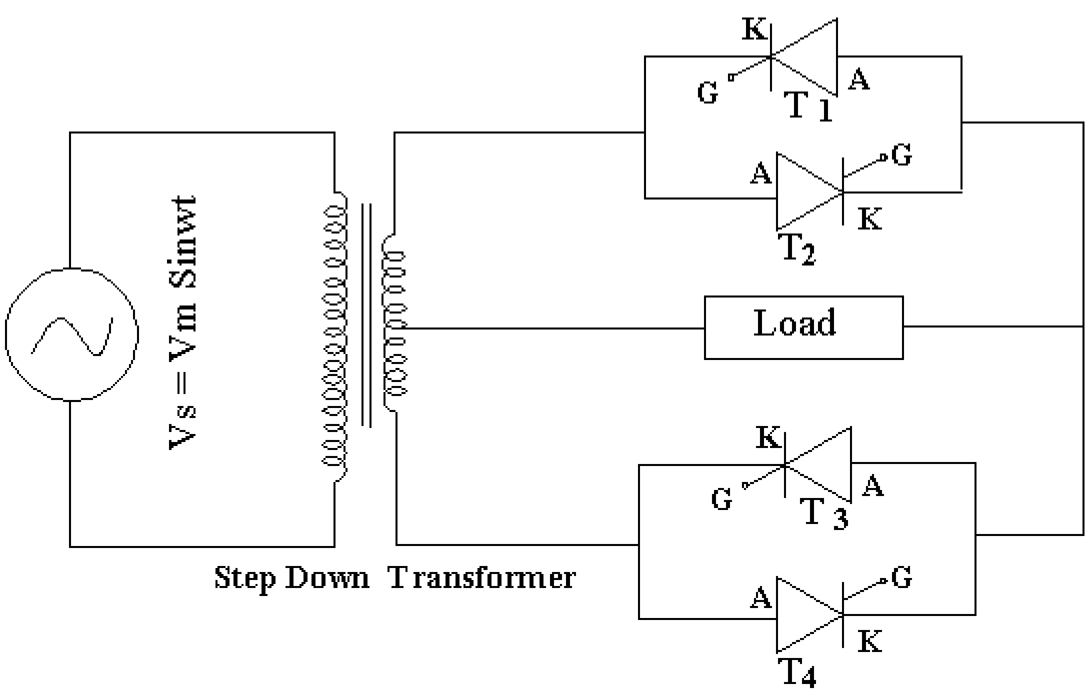
(6) Switch ON the step down transformer supply.
(7) Trigger SCR's, observe firing pulses & plot output voltage across load, currents waveforms with the help of CRO .
(8) Now repeat step 6 for R L loads.

PRECAUTIONS:

1. Identify the terminals of the SCR carefully before connecting the circuit
2. Use unearthed CRO
3. Disconnect all the circuit before going for next experiment.
4. Before switching on the supply see that the firing angle knob & the auto transformer are in minimum position.

RESULT:

CIRCUIT DIAGRAM: -



Circuit Diagram for Cyclo Converter

SINGLE PHASE CYCLOCONVERTER WITH R & RL LOADS

AIM:

To study the operation of single phase cyclo converter and to observe output waveforms.

APPARATUS: -

S.no	*Description*	*Quantity*
1	Single-phase Cycloconverters kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1

PROCEDURE: -

1. Keep SW_1 in off position.
2. Connect C.R.O across the load terminal see that load negative terminal and main ground are isolated through optoisolators. Keep vertical amplifier sensitivity in 10 volts/div.position.
3. Switch ON main supply. Take SW_1 to divide by 2,3 and 4 positions and observe the output waveform by properly adjusting the time division switch on the time sweep controls of C.R.O.

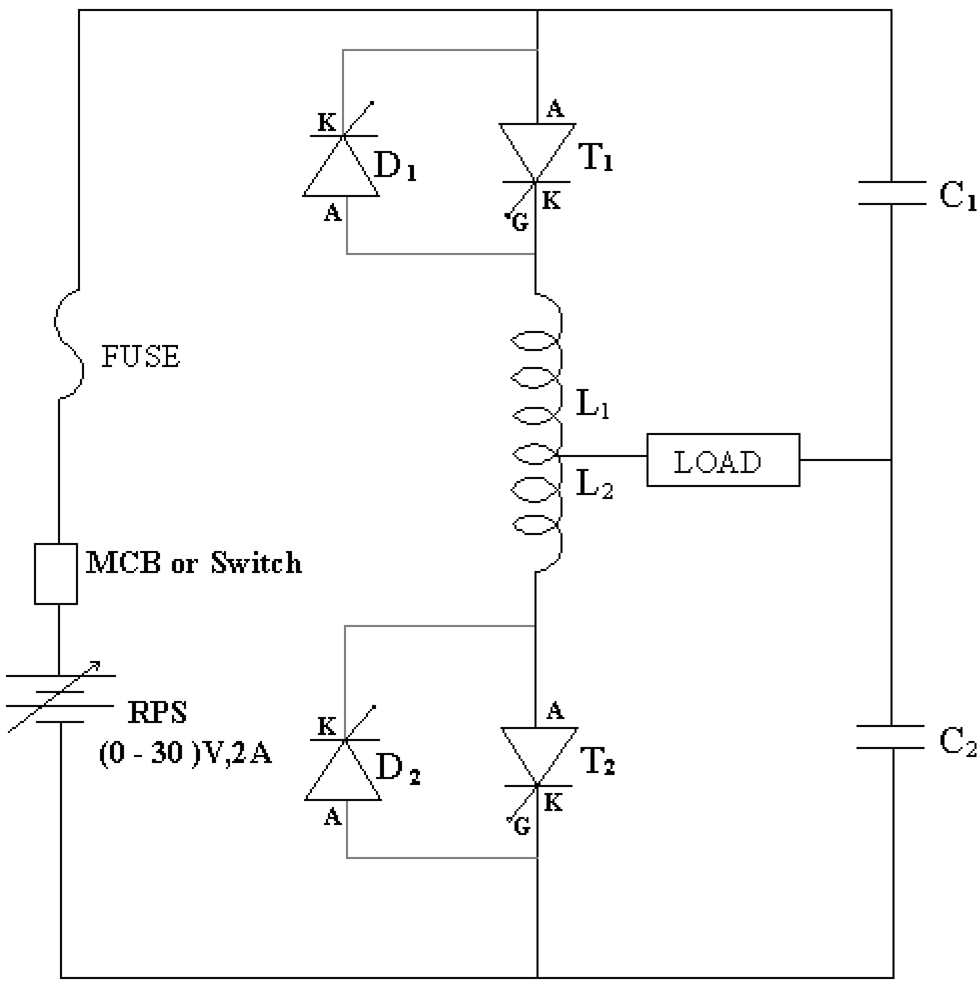
4. Now Keep SW_1 to position of divide by 2. Take the C.R.O terminals to the logic gate site. Connect the C.R.O negative terminal to the main ground and live input terminal to the binding posts marked in 1,2,3,4 etc for observation of the waveforms. Note down these waveforms.
5. Repeat the steps (4) for divide by 3 and divide by 4 positions of SW_1.

PRECAUTIONS:

1. The frequency variable knob is kept at zero before switching ON the supply.
2. Use an unearthed CRO.

RESULT: -

CIRCUIT DIAGRAM:



Circuit Diagram for Series Inverter

SINGLE PHASE SERIES INVERTER WITH R & RL LOADS

AIM: -

To study the operation of a series inverter for various types of load and observe the output waveforms.

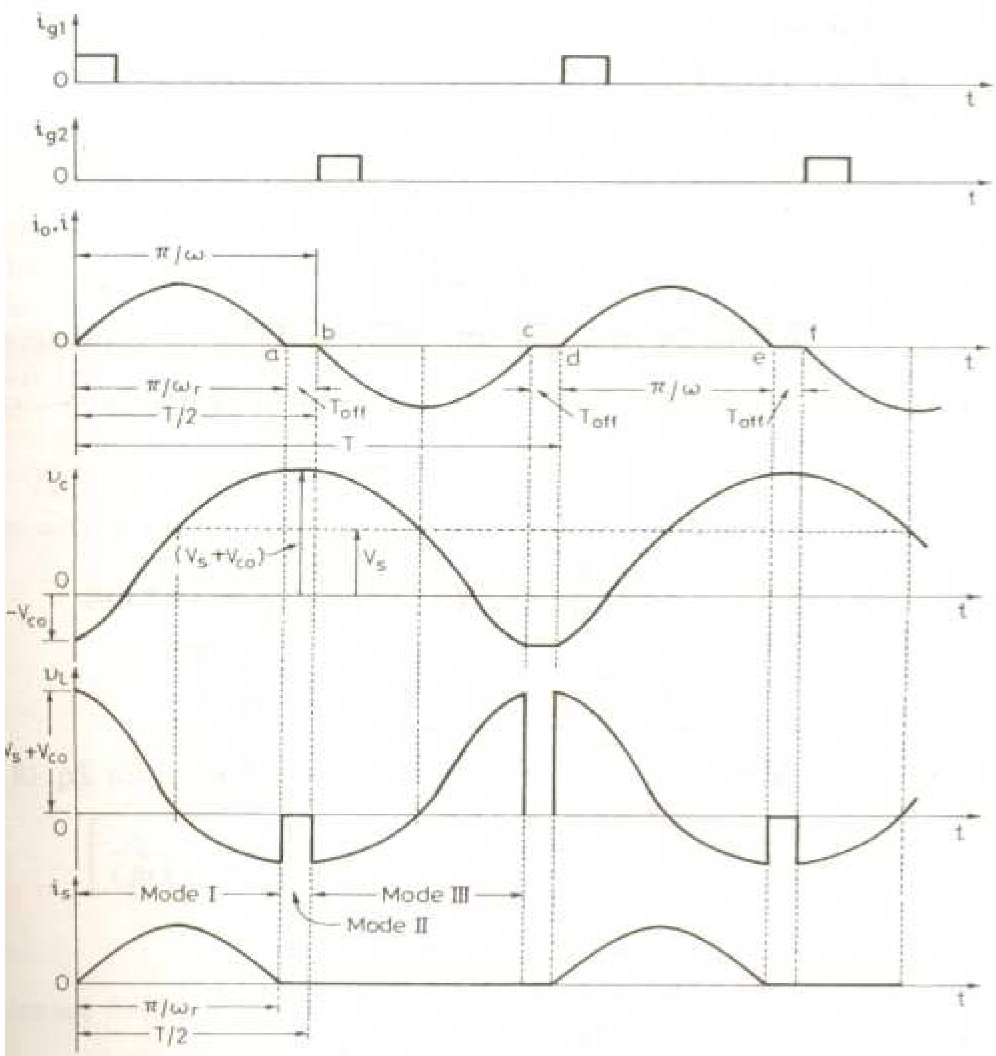
APPARATUS: -

S.no	*Description*	*Quantity*
1	Series inverter Kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1

PROCEDURE:

1. Make the inter connections of the power circuit as shown in the circuit diagram.
2. Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.
3. Before switching ON the supply ensure that switching sequence is followed.
4. Connect CRO across the load.
5. Apply 10V DC input voltage by using (0-30) V, 2A RPS.
6. Thyristor are triggered by switching on the toggle switch provided in the firing circuit module.
7. Observe and plot the voltage waveforms across the load T_1 & T_2 with the help of CRO.
8. Repeat step 7 by varying the firing angle in sequence of 30^o.
9. Repeat step 7 and step 8 for RL loads (L = 25mH).

MODEL GRAPHS:



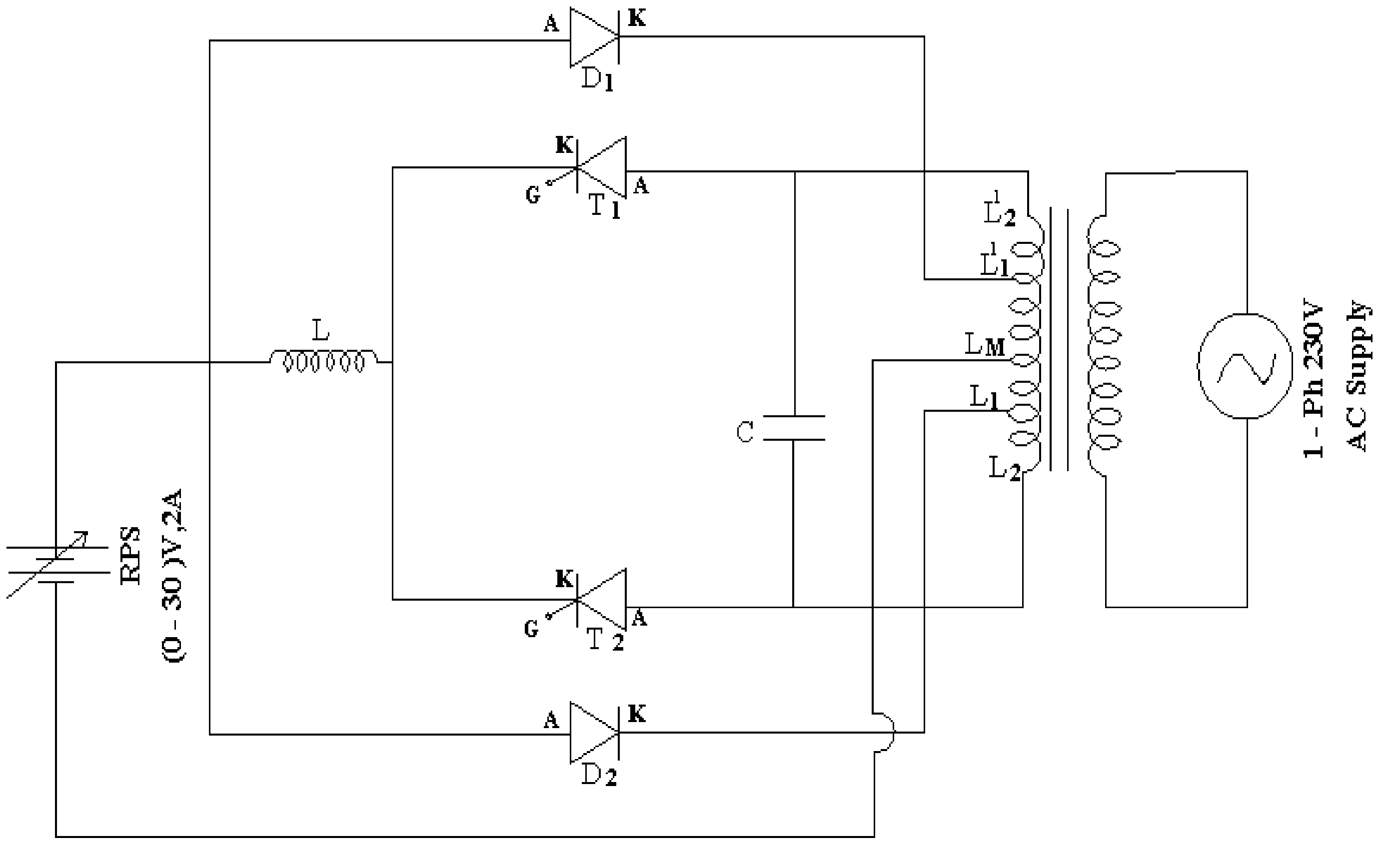
Voltage and Current Waveforms for Series Inverter.

PRECAUTIONS: -

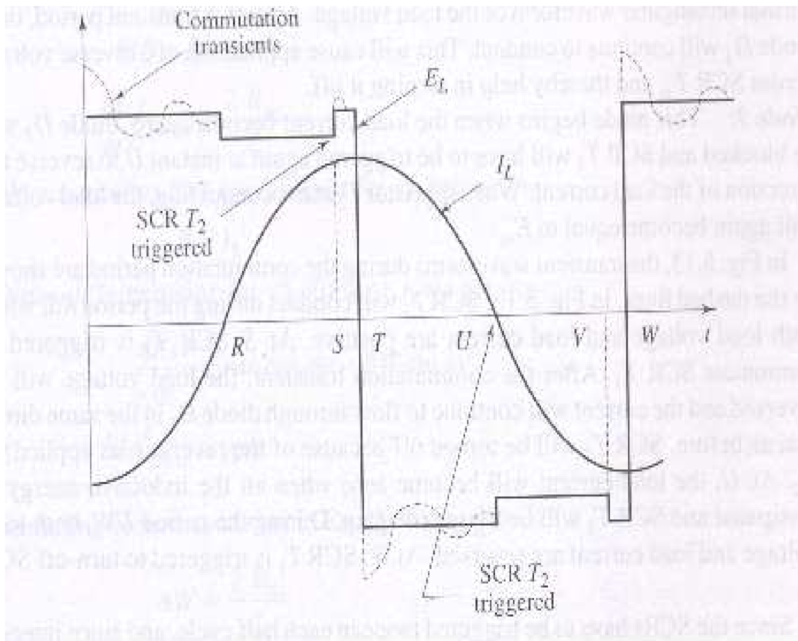
1. Identify the terminals of the SCR carefully before connecting the circuit
2. Use and unearthed CRO
3. Disconnect all the circuit before going for next experiment.
4. Before switching on the supply see that the firing angle knob & the auto transformer are in minimum position.

RESULT: -

CIRCUIT DIAGRAM:



MODEL GRAPHS:



Load Voltage and Current Wave forms

SINGLE PHASE PARALLEL INVERTER WITH R & RL LOADS

AIM:

To study the operation of a single-phase Parallel inverter and to observe the output waveforms.

APPARATUS: -

S.no	Description	Quantity
1	Parallel inverter Kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1

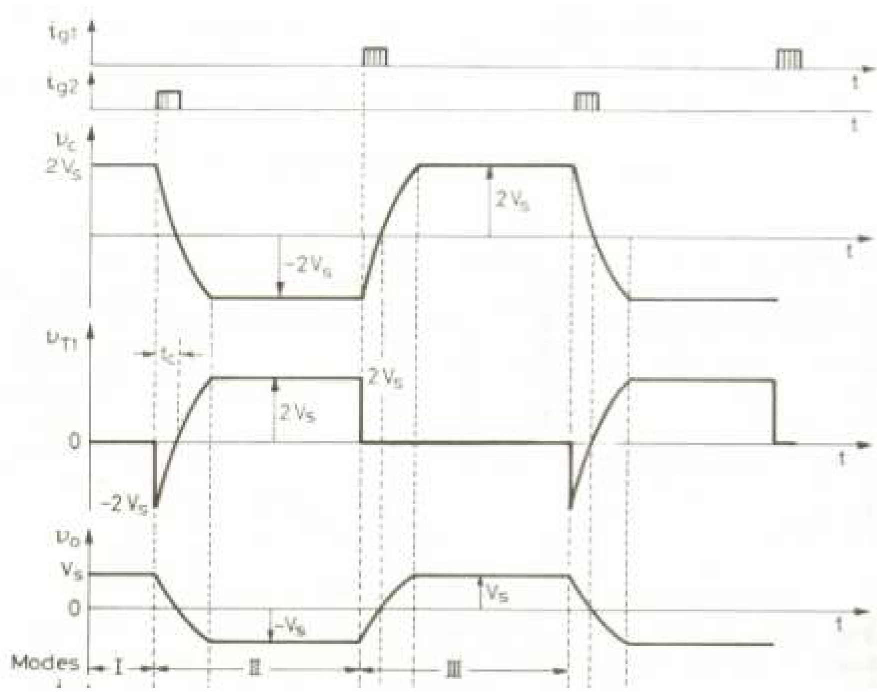
PROCEDURE:

1. Make the inter connections of the power circuit as shown in the circuit diagram.
2. Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.

3. Before switching ON the supply ensure that switching sequence is followed.
4. Connect CRO across the load.

1. Apply 10V DC input voltage by using 30V/2A RPS.
2. Switching on the toggle switch provided in the firing circuit module triggers Thyristors.
3. Observe and plot the voltage across load, current waveforms with the help of CRO.
4. Repeat step 7 by varying the firing angle in sequence of 30^o.
5. Repeat step 7 and step 8 for RL loads.

MODEL GRAPHS:



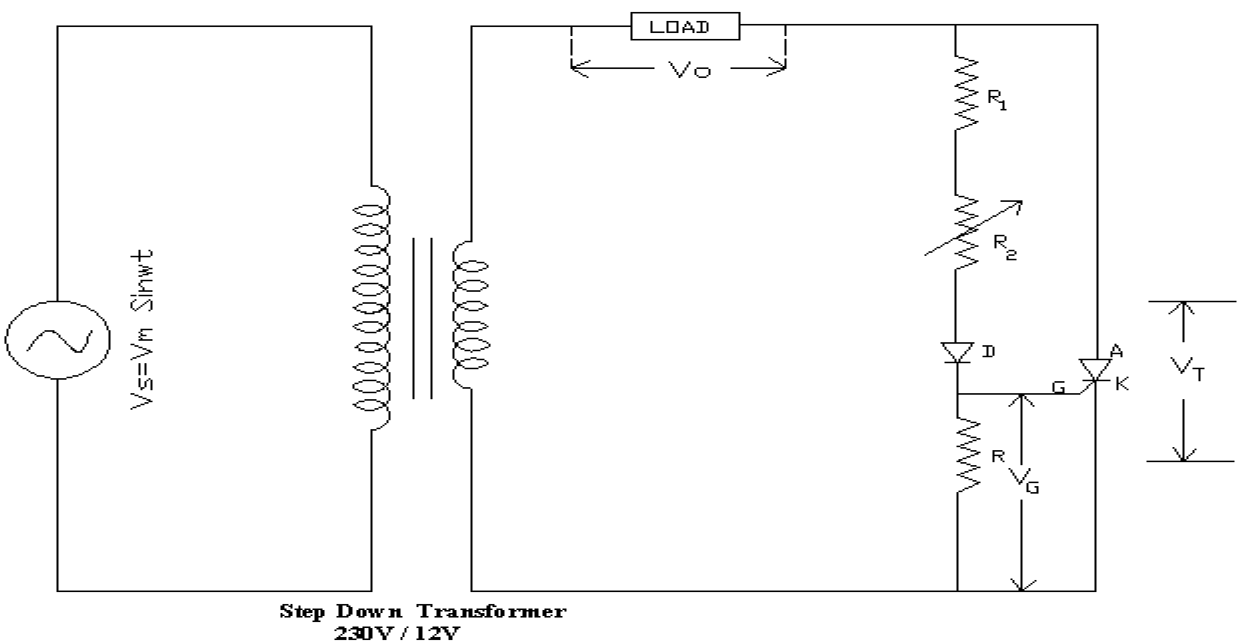
Load Voltage & Load Current Waveforms

Precautions: -

1. Identify the terminals of SCR carefully before connecting the circuit.
2. Use an unearthed CRO.
3. Before switching ON the supply see that the firing angle knob and the auto transformer are in minimum position.
4. When the inverter frequency increases above the resonant frequency commutation failure occurs. Switch OFF the DC supply and reduce the inverter frequency to continue the experiment.

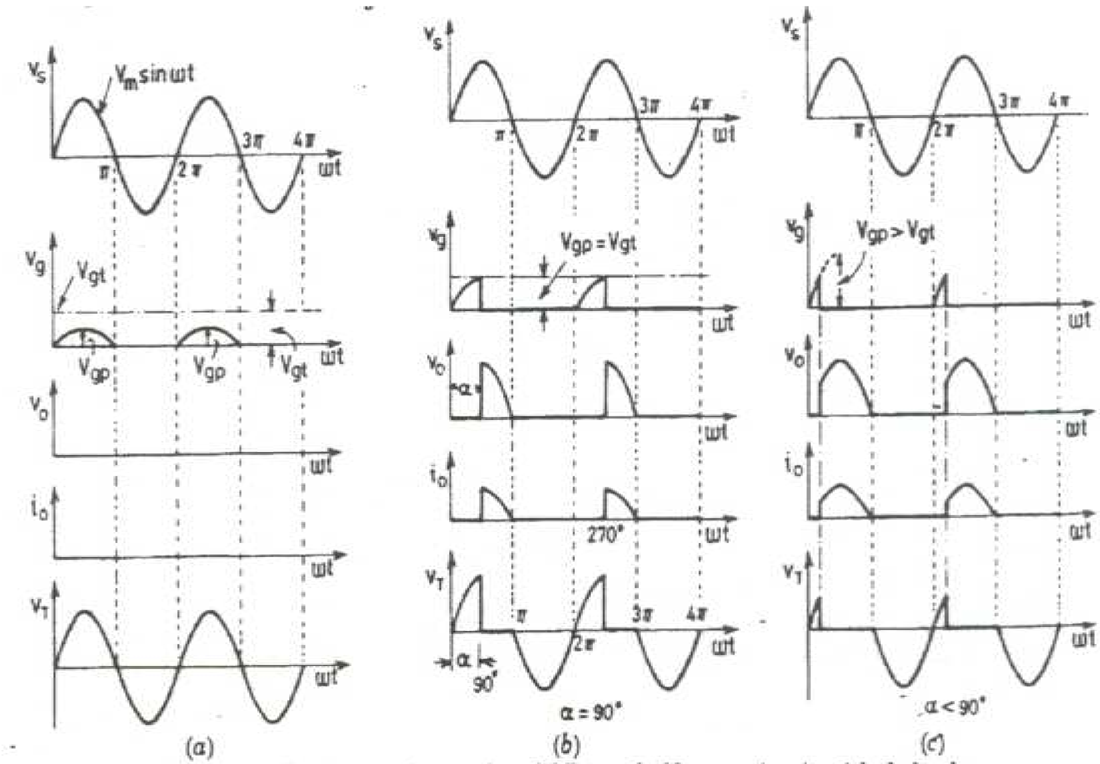
RESULT: -

CIRCUIT DIAGRAM:



Circuit Diagram to Obtain Resistance Triggering

MODEL GRAPHS:



GATE FIRING CIRCUITS FOR SCR (R, RC, UJT)

AIM: -

To trigger an SCR by using R, RC & UJT triggering circuits and observe the output waveforms for different firing angles.

APPARATUS: -

S.no	*Description*	*Quantity*
1	Triggering circuit Kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1

PROCEDURE:

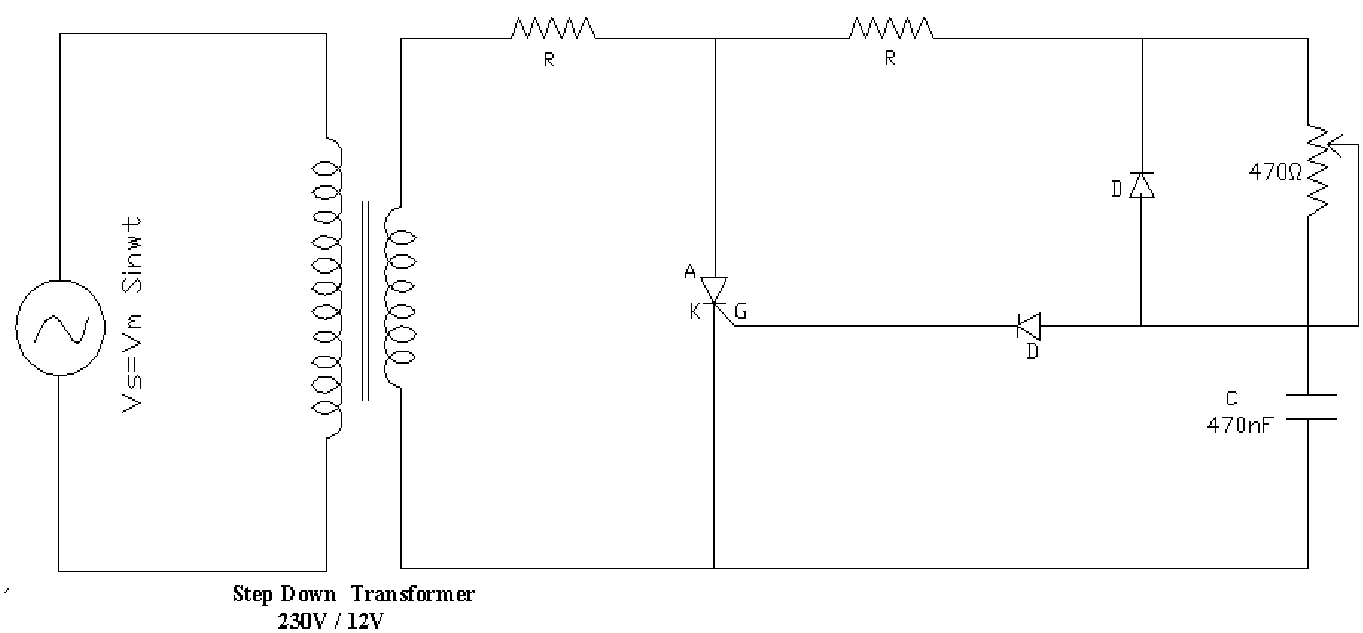
Resistance Firing Circuit:

(1) Apply 12V of AC input to the anode and cathode of SCR terminals from a step down transformer.
(2) Connect the anode, cathode & gate terminals of SCR to the corresponding A, K, G terminals in the R – Triggering circuit.
(3) Connect the load of 50Ω/2A between the load terminals.
(4) Observe the variations in the voltage across the load for different firing angles (by varying potentiometer) with the help of CRO, plot waveforms of firing signals & output voltage for firing angle 45^0, 90^0.

RC Firing Circuits:

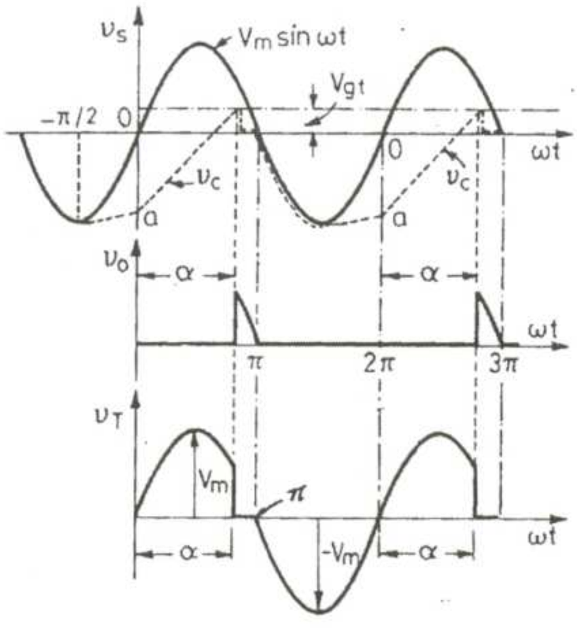
1. Apply 12V of AC input to the anode and cathode of SCR terminals from a step down transformer.
2. Connect the anode, cathode & gate terminals of SCR to the corresponding A, K, G terminals in the R – Triggering circuit.
3. Connect the load of 50Ω/2A between the load terminals.
4. Observe the variations in the voltage across the load for different firing angles (by varying potentiometer) with the help of CRO, plot waveforms of firing signals & output voltage for firing angle 45^0, 180^0.

<u>CIRCUIT DIAGRAM:</u>

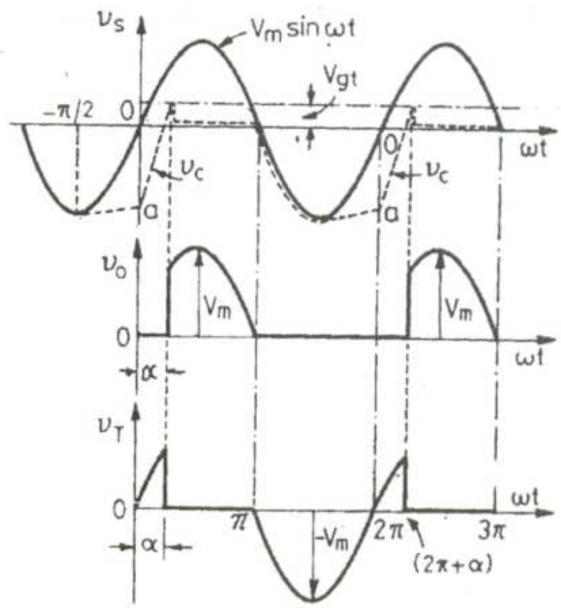


Circuit Diagram to Obtain RC Triggering

MODEL GRAPHS:

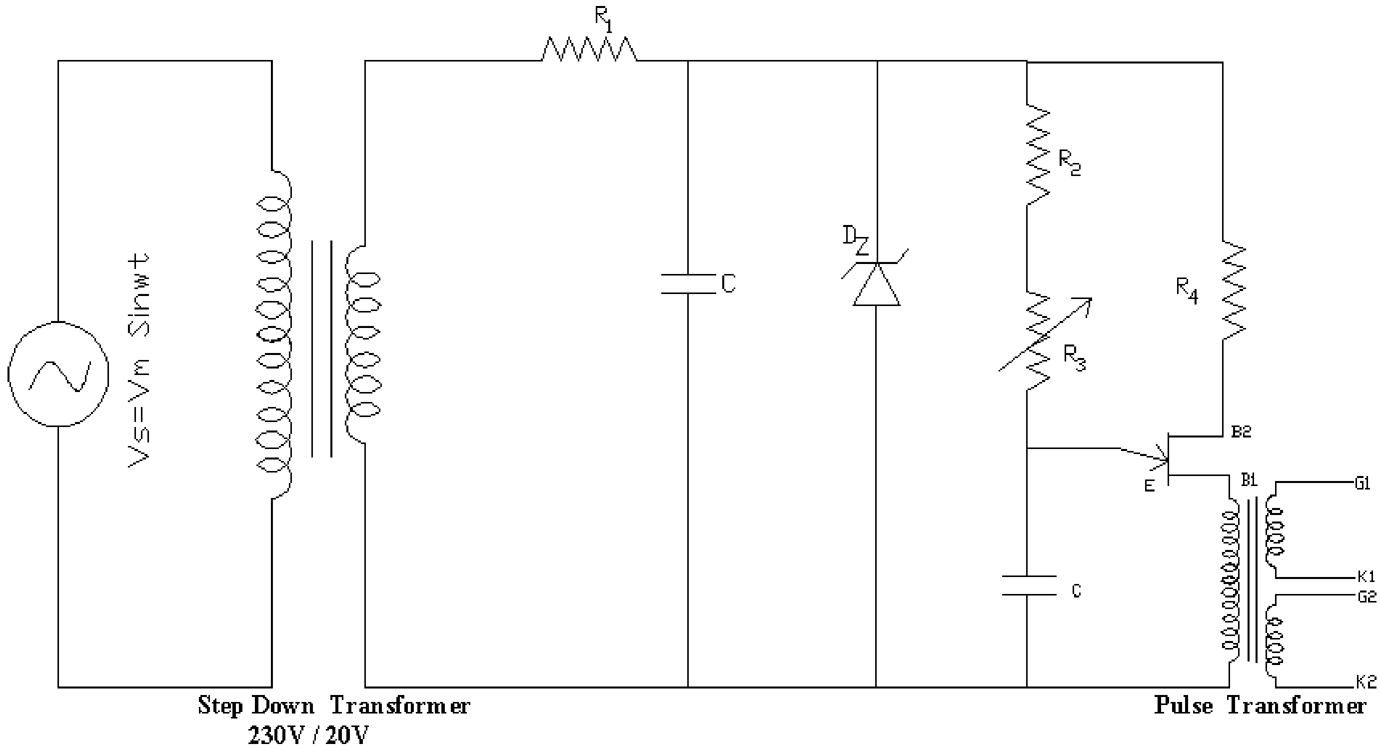


(a)



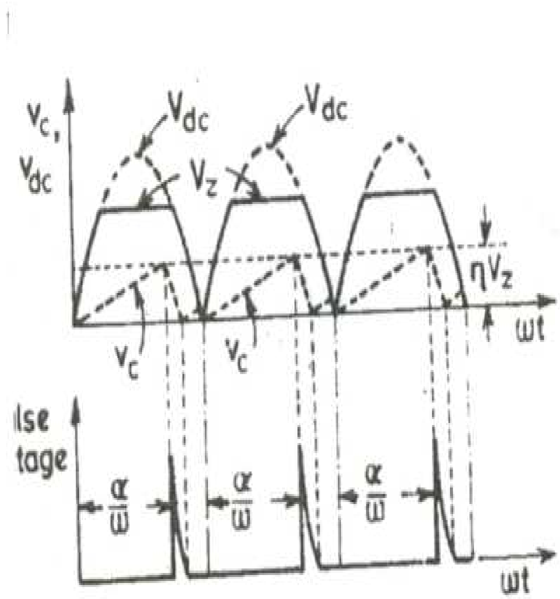
(b)

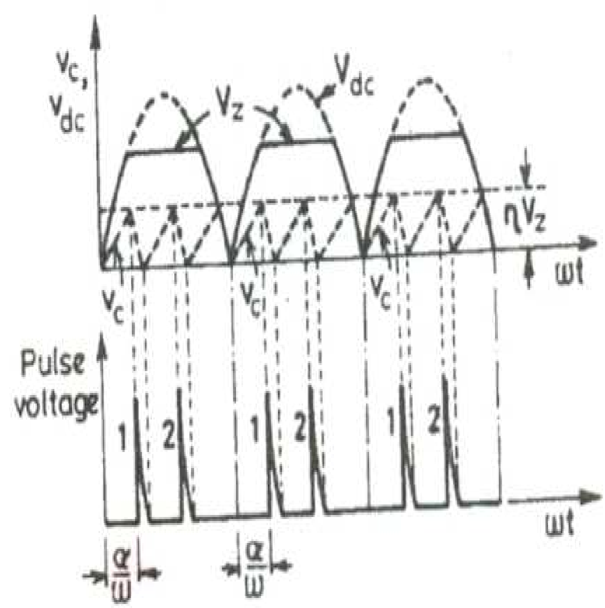
CIRCUIT DIAGRAM:



Circuit Diagram to Obtain UJT Triggering

MODEL GRAPHS:





UJT Firing Circuit:

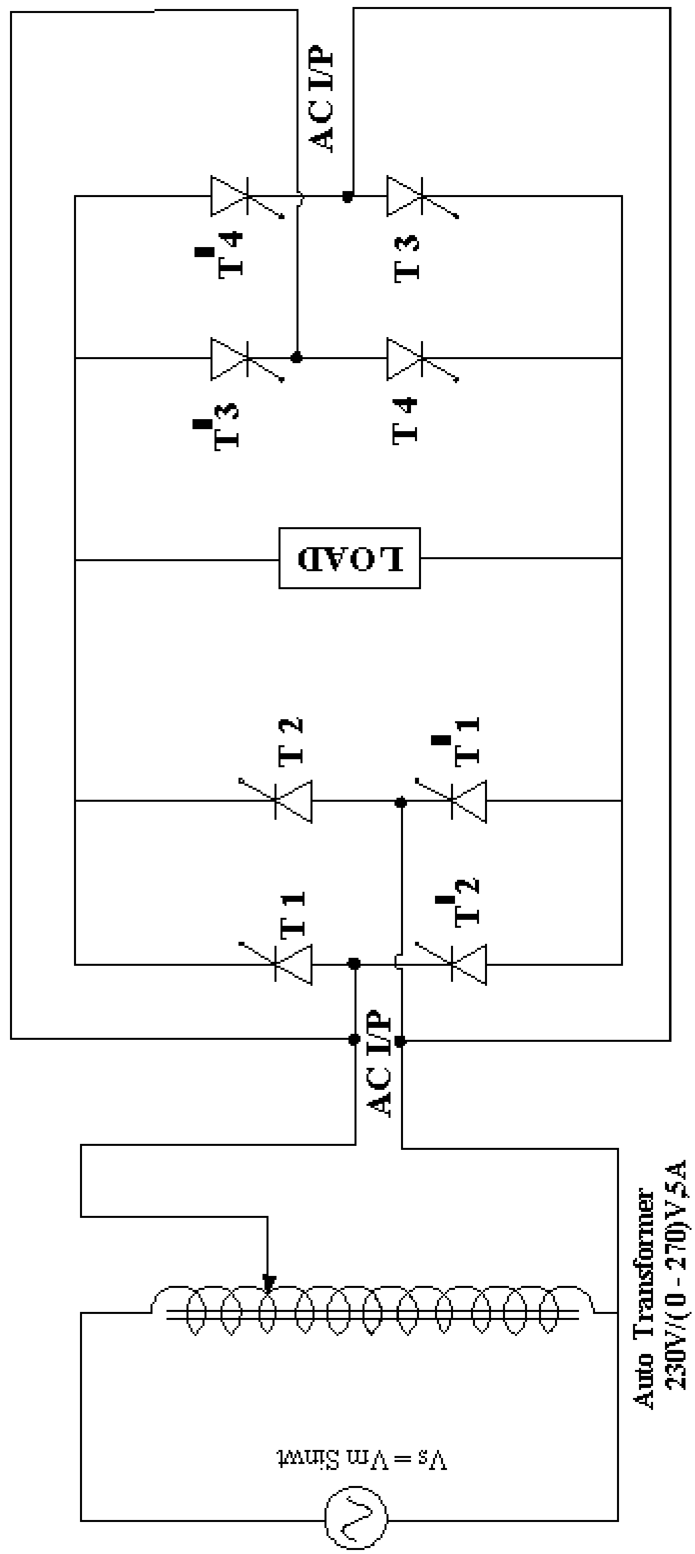
1. Apply 12V of AC input to the anode and cathode of SCR terminals from a step down transformer.
2. The rectified output is applied to the UJT terminals through the résistance as shown in the circuit diagram.
3. Connect the cathode & gate terminals of SCR to the corresponding K, G terminals in the UJT – Triggering circuit.
4. Connect the load of 50Ω/2A between the load terminals.
5. Switch ON the supply for UJT Triggering circuit.
6. Observe the variations in the voltage across the load for different firing angles (by varying potentiometer) with the help of CRO, plot waveforms of firing signals & output voltage for firing angle 45^0, 180^0.

PRECAUTIONS:

(1) Initially the potentiometer should be in minimum resistance position.
(2) Vary the Potentiometer gradually.
(3) Observe the output waveforms carefully on the CRO

RESULT:

CIRCUIT DIAGRAM:



Circuit Diagram for Dual Converter with Non Circulating Current Mode

SINGLE PHASE DUAL CONVERTER WITH RL LOAD

AIM:

To study the operation of a single phase dual converter in circulating and non – circulating current modes for various types of loads.

APPARATUS:

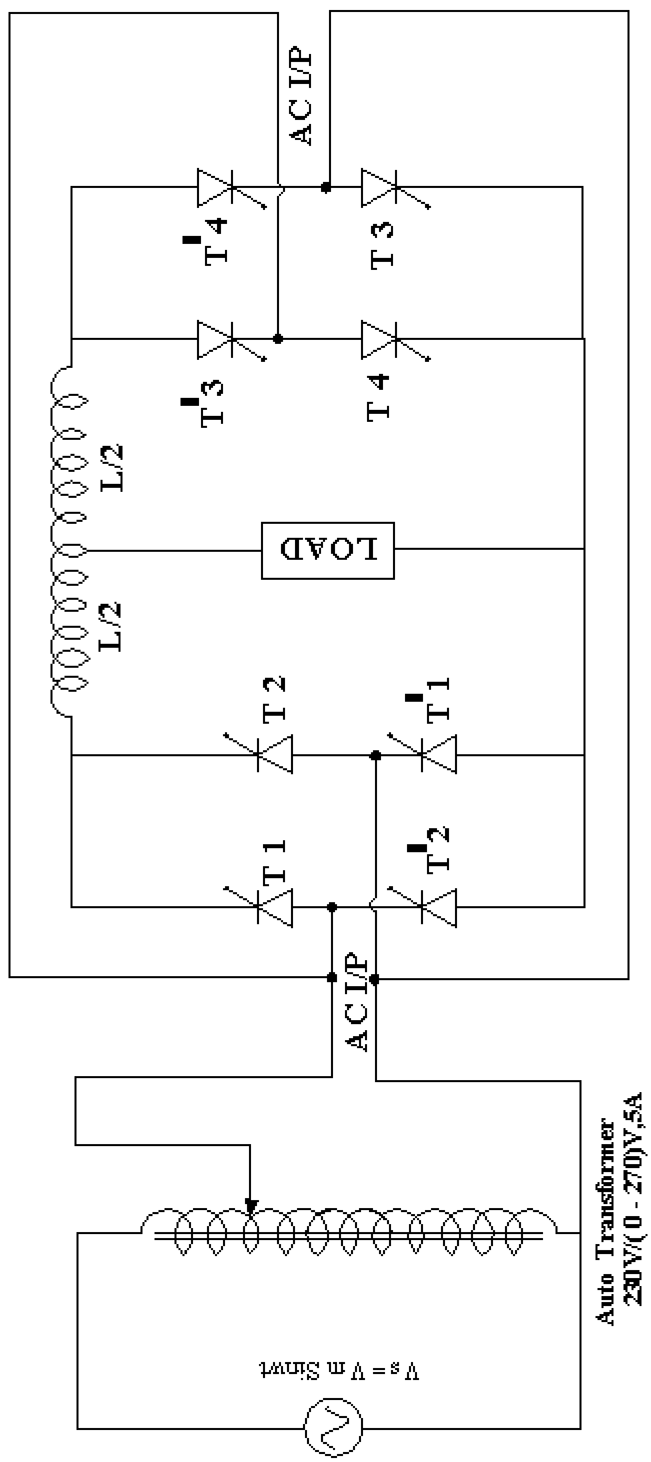
S.no	Description	Quantity
1	Dual Converter Kit	1
2	Unearthed C.R.O	1
3	Connecting probes	1
4	Loading resistor 50Ω/8A	1
5	Inductor with mid point 100 – 0 - mH	1
6	Inductor 25mH	1

PROCEDURE

DUAL CONVERTER WITH NON - CIRCULATING CURRENT MODE

(I) P – Converter is ON & N converter is OFF:

1) Make the connections as per the power circuit shown in the circuit diagram.
2) Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.
3) Before switching on the supply ensure that switching sequence is followed.
4) Connect CRO across the load.
5) Apply 10V AC input voltage using isolation transformer.
6) Make P – Converter ON & OFF the N Converter in the firing angle circuit module.
7) Observe and plot the variation in the output voltage waveform across the load terminals with the help of CRO.
8) Repeat step 7 by varying firing angle pulses in sequence.



Circuit Diagram for Dual Converter with Circulating Current Mode

(II) N – Converter is ON & P converter is OFF:

1) Make the connections as per the power circuit shown in the circuit diagram.
2) Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.
3) Before switching on the supply ensure that switching sequence is followed.
4) Connect CRO across the load.
5) Apply 10V AC input voltage using isolation transformer.
6) Make N – Converter ON & OFF the P Converter in the firing angle circuit module.
7) Observe and plot the variation in the output voltage waveform across the load terminals with the help of CRO.
8) Repeat step 7 by varying firing angle pulses in sequence.

DUAL CONVERTER WITH CIRCULATING CURRENT MODE

1) Make the connections as per the power circuit shown in the circuit diagram
2) Connect the trigger pulses to the gate and cathode terminals of SCR's from G & K terminals of the firing circuit module.
3) Before switching on the supply ensure that switching sequence is followed.
4) Connect CRO across the load.
5) Apply 10V AC input voltage using isolation transformer.
6) Make N – Converter ON & OFF the P Converter in the firing angle circuit module.
7) Observe and plot the variation in the output voltage waveform across the load terminals with the help of CRO.
8) Repeat step 7 by varying firing angle pulses in sequence.

PRECAUTUIONS:

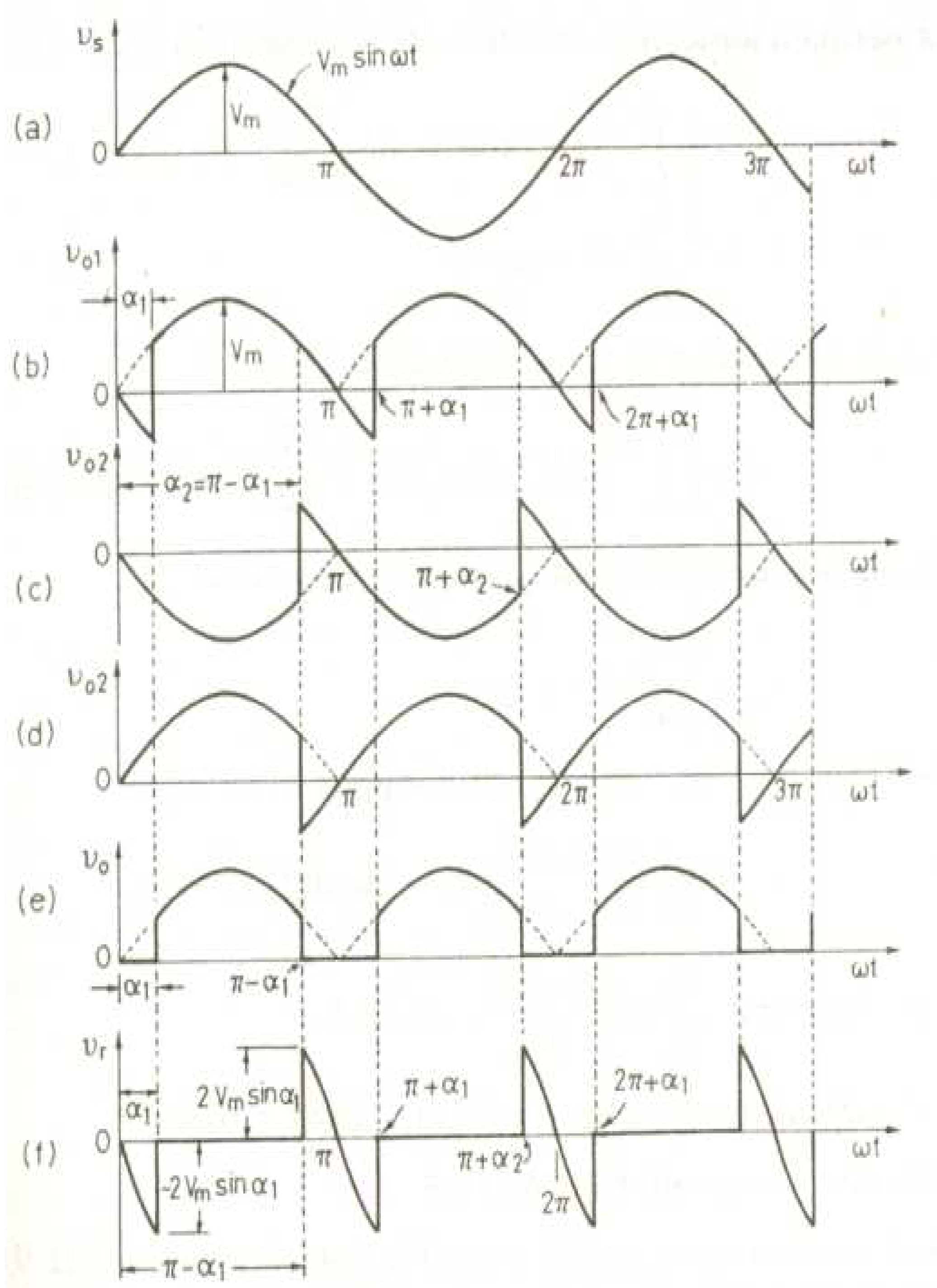
1. Identify the terminals of the SCR carefully before connecting the circuit.
2. Use an unearthed CRO.
3. Before switching ON the supply see that the firing angle knob and auto transformer are in minimum position.
4. Without centre tapped inductor between the two converters don't operate in circulating current mode.

OBSERVATIONS:

Dual Converter with Non - Circulating Current Mode of Operation:

S.No.	Firing Angle in Degrees	P – ON & N - OFF		N – ON & P - OFF	
		Vo (Theoretical) in Volts	Vo (Practical) in Volts	Vo (Theoretical) in Volts	Vo (Practical) in Volts

MODEL GRAPHS:

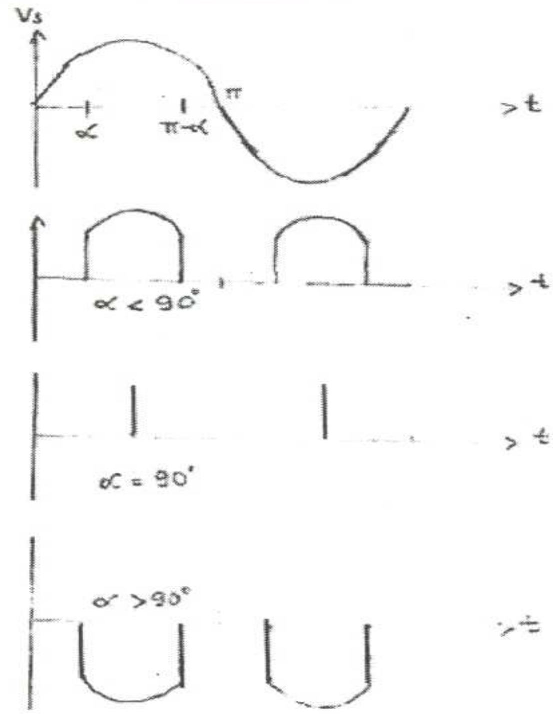


Voltage and Current Waveforms for Dual Converter

Dual Converter with Circulating Current Mode of Operation:

S.No	Firing Angle α 1	Firing Angle α 2	Vo (Theoretical)	Vo (Practical)

MODEL WAVEFORMS:



RESULT: -