MAHA BARATHI ENGINEERING COLLEGE,CHINNASALEM

DEPARTMENT OF EEE

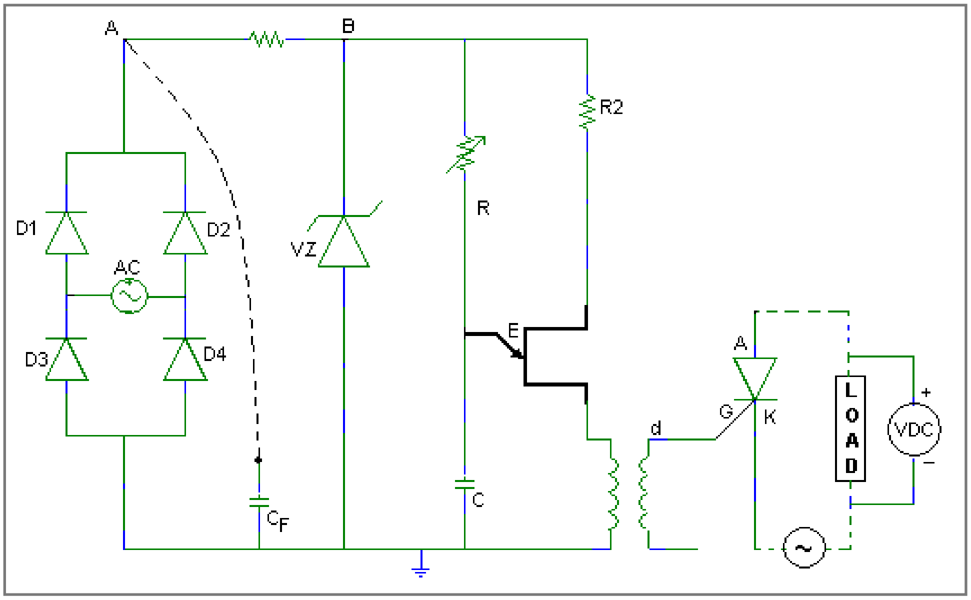
EE6611 POWER ELECTRONICS AND DRIVES LABORATORY

LIST OF EXPERIMENTS:

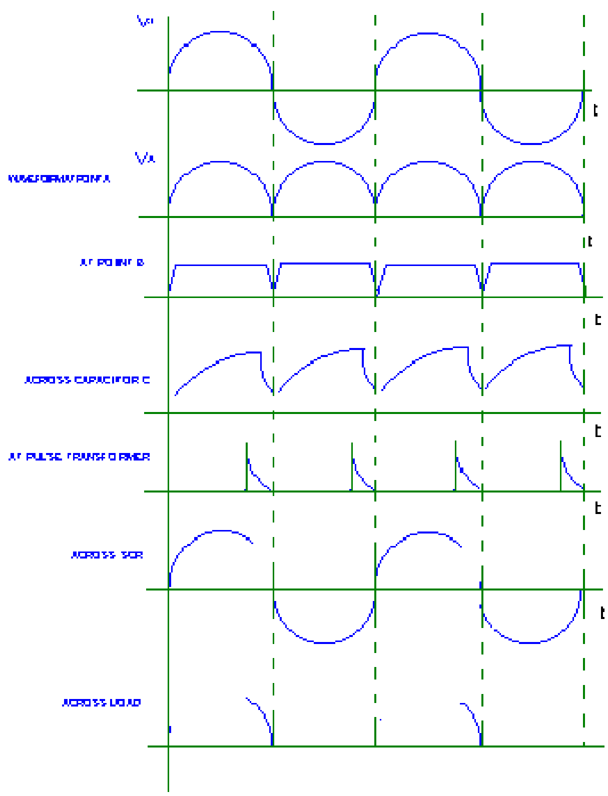
1. GATE PULSE GENERATION USING R,RC AND UJT.
2. CHARACTERISTICS OF SCR AND TRIAC
3. CHARACTERISTICS OF MOSFET AND IGBT
4. AC TO DC HALF CONTROLLED CONVERTER
5. AC TO DC FULLY CONTROLLED CONVERTER
6. STEP DOWN AND STEP UP MOSFET BASED CHOPPERS
7. IGBT BASED SINGLE PHASE PWM INVERTER
8. IGBT BASED THREE PHASE PWM INVERTER
9. AC VOLTAGE CONTROLLER
10. SWITCHED MODE POWER CONVERTER.
11. SINGLE PHASE FULL WAVE RECTIFIER WITH R & RL LOAD
12. THREE PHASE FULLY CONTROLLED RECTIFIER WITH R & RL LOAD
13. SINGLE PHASE AC VOLTAGE REGULATOR

TOTAL: 45 PERIODS

Circuit Diagram:



Waveforms:



1.GATE PULSE GENERATION USING R,RC AND UJT.

AIM:

To rig up and verify the operation of the SCR firing circuit using UJT.

APPARATUS REQUIRED:

CRO probes, Patch cords, UJT trainer kit, Digital Multi meters.

DESIGN:

VBB = DC supply voltage Assume C and find RC
Vp = Peak voltage of UJT
Vv = Valley voltage of UJT
Where Remix = (VBB – VP) / Imp
T = Time of triggering pulse
Rmin = (VBB – Vv) / Iv
RB = Internal resistance of UJT (5kΩ)
η = Intrinsic standoff ratio R1 = 0.7RBB / ηVBB
η = 0.65

PROCEDURE:

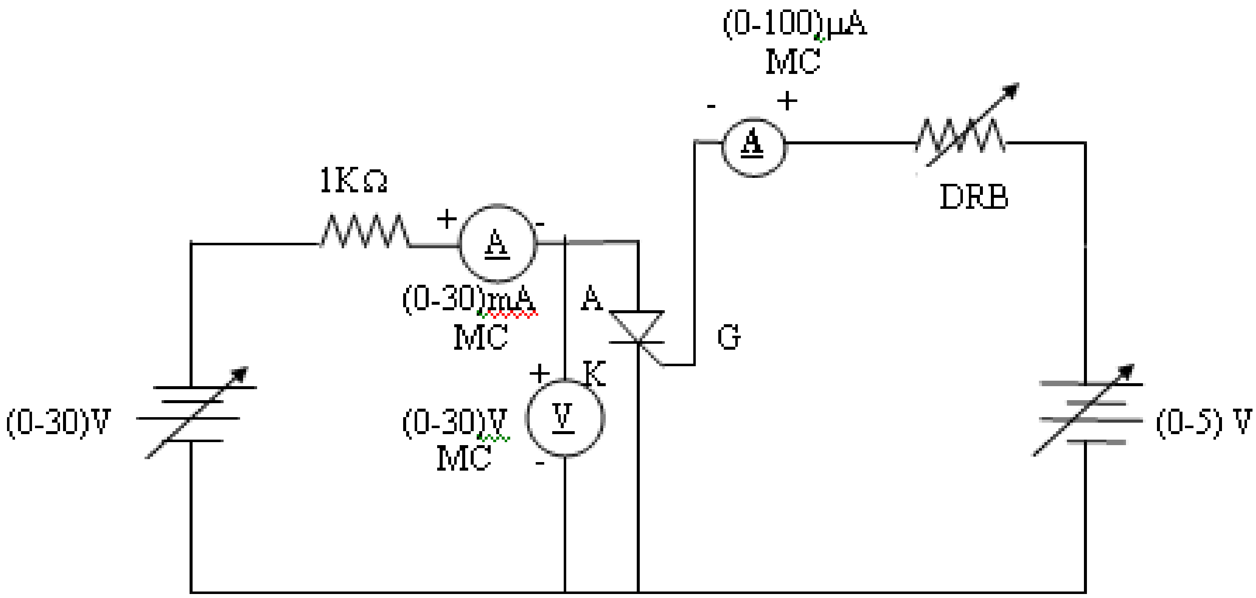
1. The trainer kit is switched on with an AC supply voltage of 230V and 50Hz.
2. A probe is connected to the CRO and one point is connected to the ground of the pulse transformer primary.
3. The rectified o/p across the diode is measured at point ‘A’ and is displayed on the CRO.
4. The voltage across the sneer diode and the capacitor is found out at point B
5. Note down the waveforms across the capacitor at point ‘C’.
6. Note down the trigger waveform across the primary of pulse transformer.
7. Now the ground is removed and it is connected to the ground of the secondary and note down Vdc.
8. The waveform across the SCR and at point ‘D’ is found and plotted.
9. NOTE: Isolation of primary and secondary sides of pulse transformer is to be strictly maintained while measurements are carried out.

Tabular column:

TMS	θf	Vdc

RESULT:

CIRCUIT DIAGRAM:



TABULAR COLUMN:

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

2(a).CHARACTERISTICS OF SCR

AIM:

To determine VI characteristics of SCR and to study the operation of Single Phase Single Pulse Converter using SCR.

APPARATUS REQUIRED:

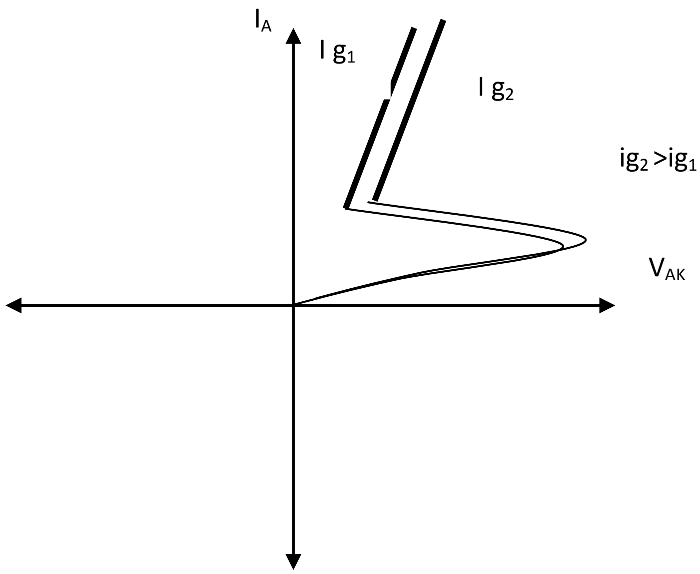
S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	SCR Module kit	220 V / 5 A		1
2	Thyristor Trainer Module Kit			1
3	Firing Circuit Module			1
4	Voltmeter	(0-30) V	MC	1
5	Ammeter	(0-30)mA	MC	1
6	Ammeter	(0-100)μA	MC	1
7	Patch Chords			10

PROCEDURE:

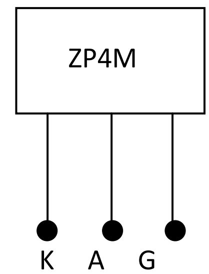
1. To determine the Characteristics of SCR

1) Make the connections as per the circuit diagram.
2) Switch on the supply
3) Set the gate current at a fixed value by varying RPS on the gate-cathode side.
4) Increase the voltage applied to anode-cathode side from zero until breakdown occurs.
5) Note down the breakdown voltage.
6) Draw the graph between anode to cathode voltage (v_{ak}) and anode current (i_a)

MODEL GRAPH:

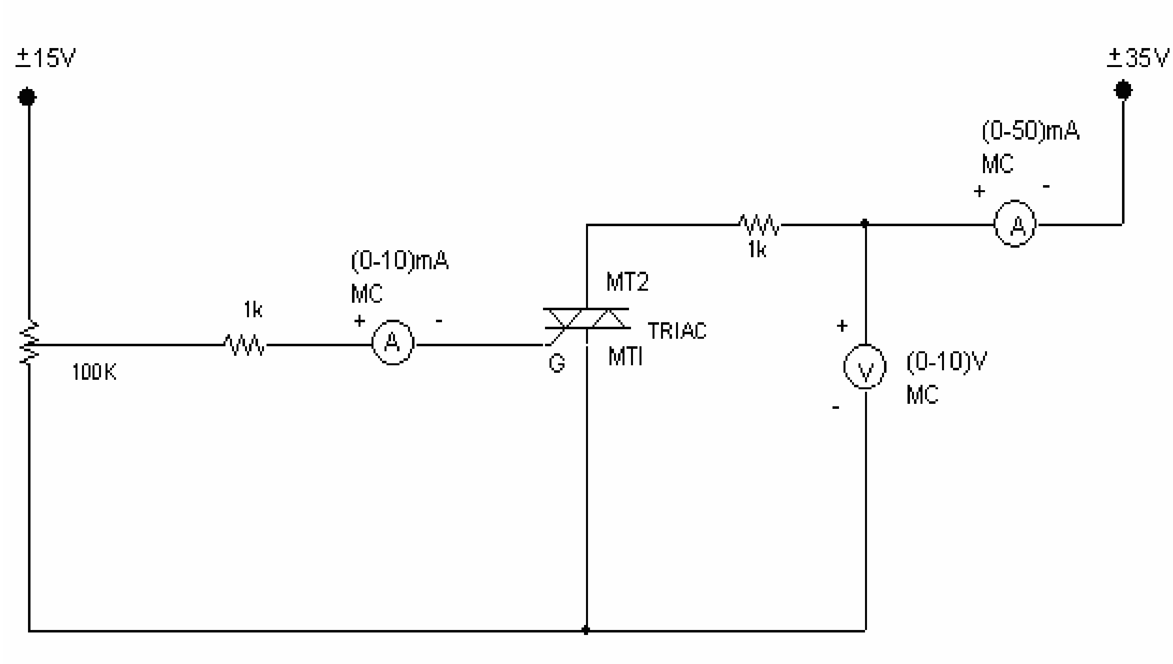


Pin configuration



RESULT:

CIRCUIT DIAGRAM:



TABULAR COLUMN:

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

2(b). CHARACTERISTICS OF TRIAC

AIM:

To determine the characteristics of TRIAC.

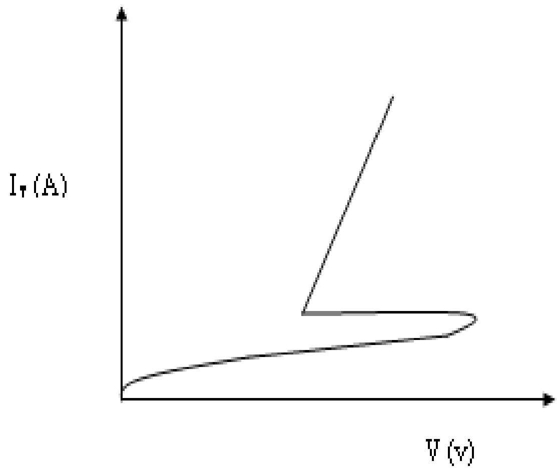
A**PPARATUS REQUIRED**:

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	TRIAC Module kit	220 V / 5 A		1
2	Regulated Power Supply	(0-5) V		1
3	Regulated Power Supply	(0-15) V		1
4	Voltmeter	(0-30) V	MC	1
5	Ammeter	(0-30)mA	MC	1
6	Ammeter	(0-50)mA	MC	1
7	Resistor	1 kΩ		1
8	Patch Chords			10

PROCEDURE:

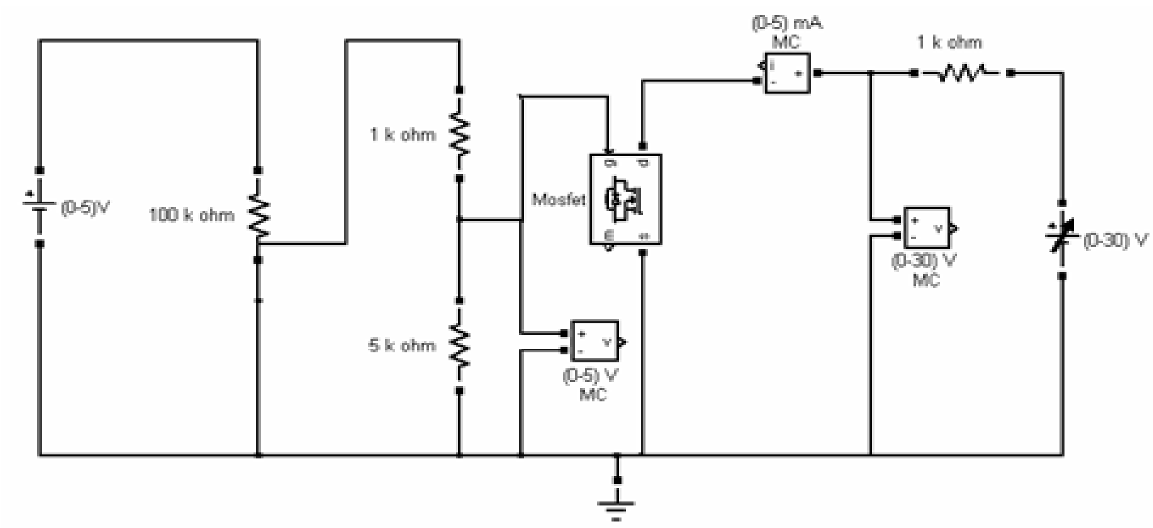
1. Make the connections as per the circuit diagram.
2. Switch on the supply.
3. Set the gate current at a fixed value by varying RPS on the
4. gate- cathode side.
5. Increase the voltage applied across anode and corresponding current is noted.
6. The above steps are repeated for different values of $I_{G.}$
7. Draw the graph between anode to cathode voltage (V_{AK}) and anode
8. current (I_A)

MODEL GRAPH:



RESULT :

CIRCUIT DIAGRAM (MOSFET) :



DRAIN (or) OUTPUT CHARACTERISTICS:

S.No	V_{GS} =….(V)	
	V_{DS} (mV)	I_D (mA)

3. CHARACTERISTICS OF MOSFET & IGBT

AIM :

To determine the characteristics of MOSFET & IGBT..

A**PPARATUS REQUIRED**:

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	MOSFET & IGBT Module kit	220 V / 5 A		1
2	Voltmeter	(0-5) V	MC	1
3	Voltmeter	(0-30) V	MC	1
4	Ammeter	(0-5)mA	MC	1
5	Patch Chords			Req

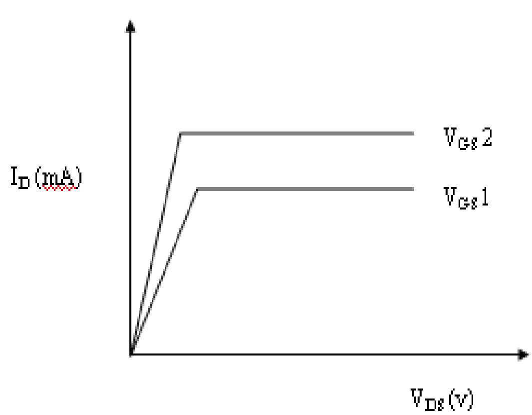
PROCEDURE:

1) Make the connections as per the circuit diagram.
2) Switch on the supply.
3) Set the gate current at a fixed value by varying RPS on the gate-cathode side.
4) Vary the voltage applied across Gate and corresponding V_{DS} (V_{CE}) and I_D (I_C) is noted .
5) The above steps are repeated for different values of I_G .
6) Vary the voltage across Collector and Emitter and noted down V_{GE} and I_C.
7) Draw the graph between V_{GS} (V_{CE}) and I_D (I_C) and V_{GS} (V_{GE}) and I_D (I_C).

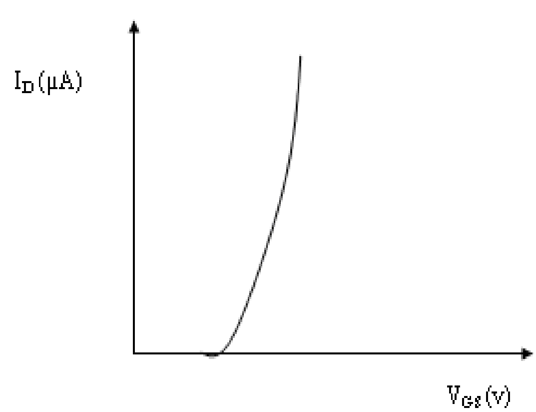
TRANSFER CHARACTERISTICS OR INPUT CHARACTERISTICS:

S.No	V_{DS} =….(V)	
	V_{GS} (mV)	I_D (mA)

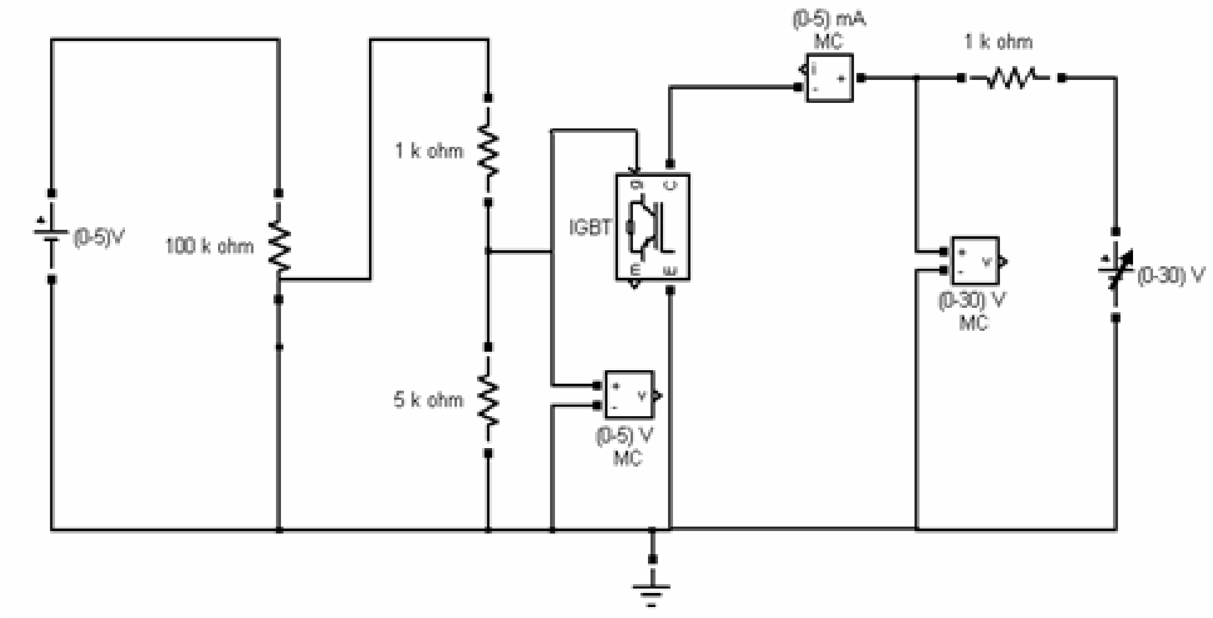
DRAIN or OUTPUT CHARACTERISTICS:



TRANSFER CHARACTERISTICS



CIRCUIT DIAGRAM (IGBT) :



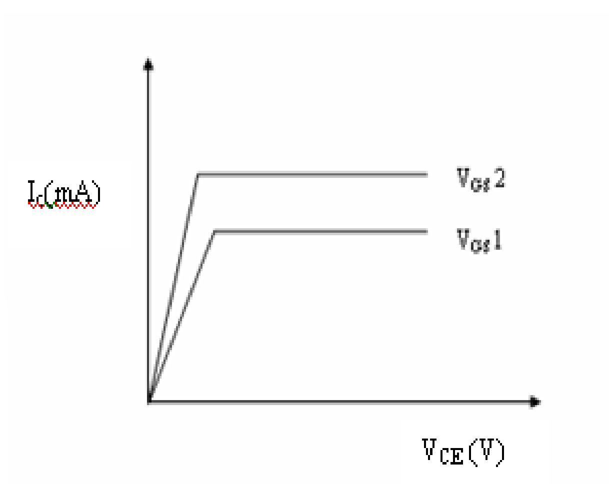
VI CHARACTERISTICS OR OUTPUT CHARACTERISTICS::

S.No	V_{GE} =….(V)	
	V_{CE} (mV)	I_C (mA)

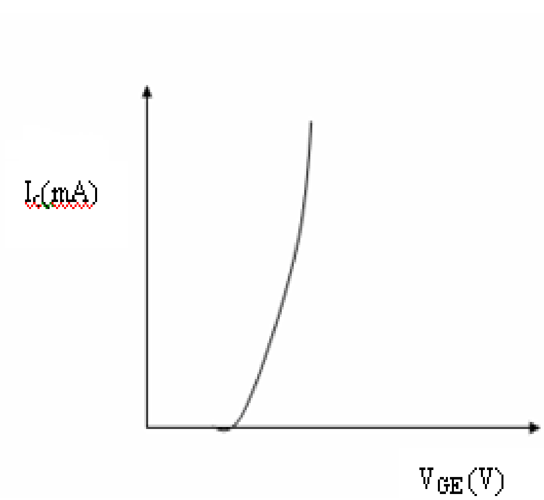
TRANSFER CHARACTERISTICS OR INPUT CHARACTERISTICS::

S.No	V_{CE} =….(V)	
	V_{GE} (mV)	I_C (mA)

DRAIN or OUTPUT CHARACTERISTICS

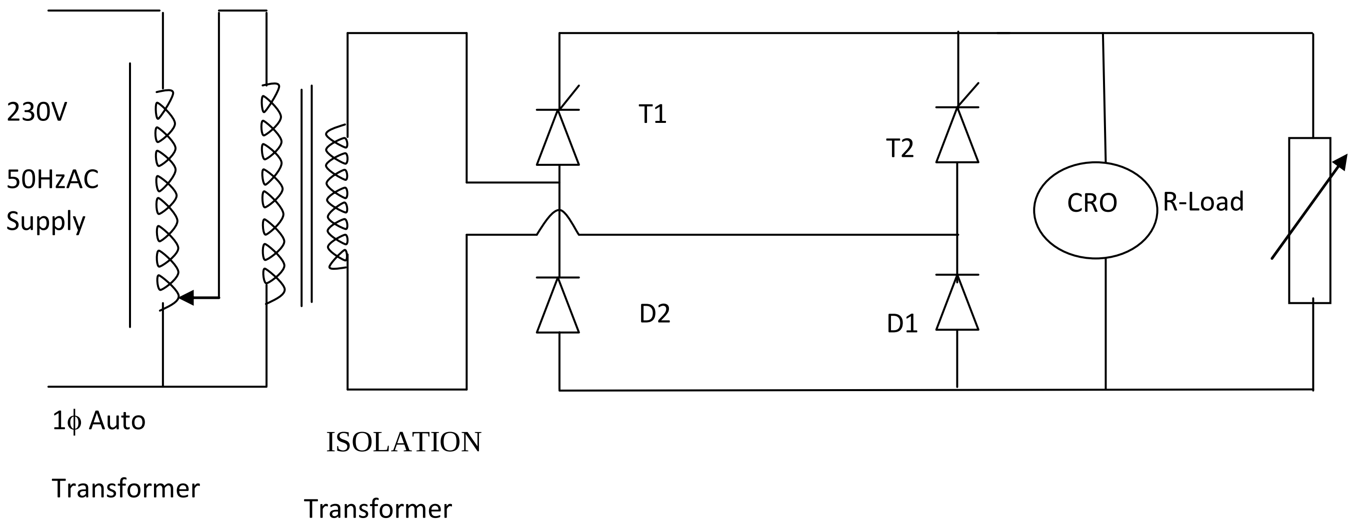


TRANSFER CHARACTERISTICS



RESULT:

CIRCUIT DIAGRAM :



TABULATOR COLUMN:

S.No.	Set Firing angle α in (degree)	Output voltage Vo (volts)	TIME in Sec		Observed angle α_o in (degree)
			t_{on}	T	

4. AC TO DC HALF CONTROLLED CONVERTER

AIM:

To construct a single phase half controlled Converter and plot its output response.

APPARATUS REQUIRED:

S.NO.	APPARATUS	RANGE	TYPE	QUANTITY
1	Half controlled Converter Power circuit kit	1ϕ, 230V,10A	-	1
3	SCR firing circuit kit	1Φ ,230V,5A	-	1
4	Isolation Transformer	230V/115-55-0-55-115	-	1
5	Auto-transformer	230V/0-270V, 4A	-	1
6	Patch chords	-	-	15

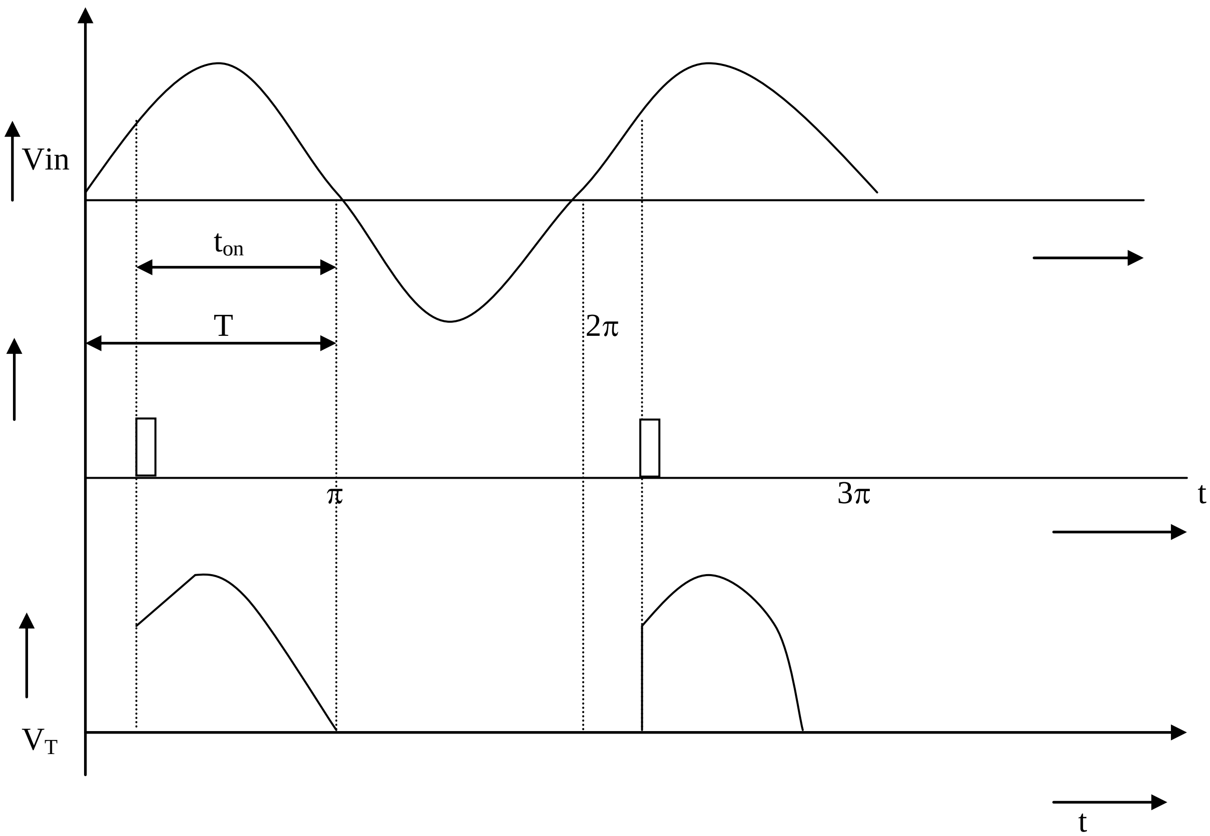
PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Keep the multiplication factor of the CRO's probe at the maximum position.
3. Switch on the thyristor kit and firing circuit kit.
4. Keep the firing circuit knob at the 180 °position.
5. Vary the firing angle in steps.
6. Note down the voltmeter reading and waveform from the CRO.
7. Switch off the power supply and disconnect.

FORMULA :

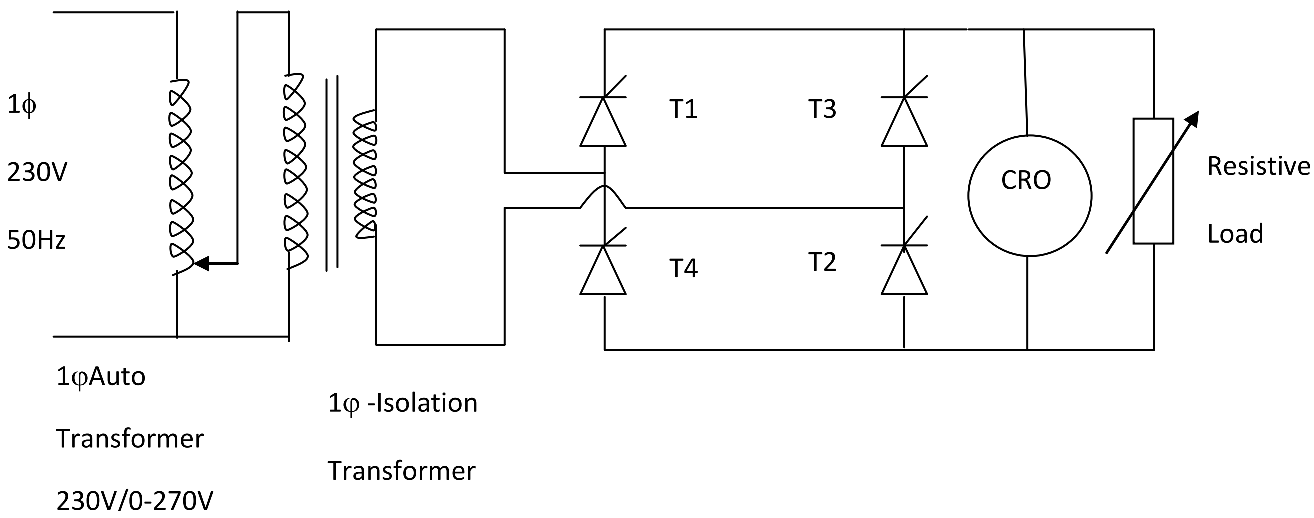
$$\text{Firing angle} \quad \alpha_o = \left(\frac{ton}{T}\right) 180$$

MODEL GRAPH:



RESULT :

CIRCUIT DIAGRAM :



S.No.	Set Firing angle α in (degree)	Output voltage Vo (volts)	TIME in Sec		Observed angle α_o in (degree)
			t_{on}	T	

5.AC TO DC FULLY CONTROLLED CONVERTER

AIM:

To construct a single phase fully controlled Converter and plot its response.

APPARATUS REQUIRED:

S.NO	ITEM	RANGE	TYPE	QUANTITY
1	Fully controlled Converter Power circuit kit	1ϕ, 230V,10A	-	1
3	SCR firing circuit kit	1Φ ,230V,5A	-	1
4	Isolation Transformer	230V/115-55-0-55-115	-	1
5	Auto-transformer	230V/0-270V, 4A	-	1
6	Loading Rheostat	100Ω / 2A	-	1
7	CRO	20MHz	-	1
8	Patch chords	-	-	15

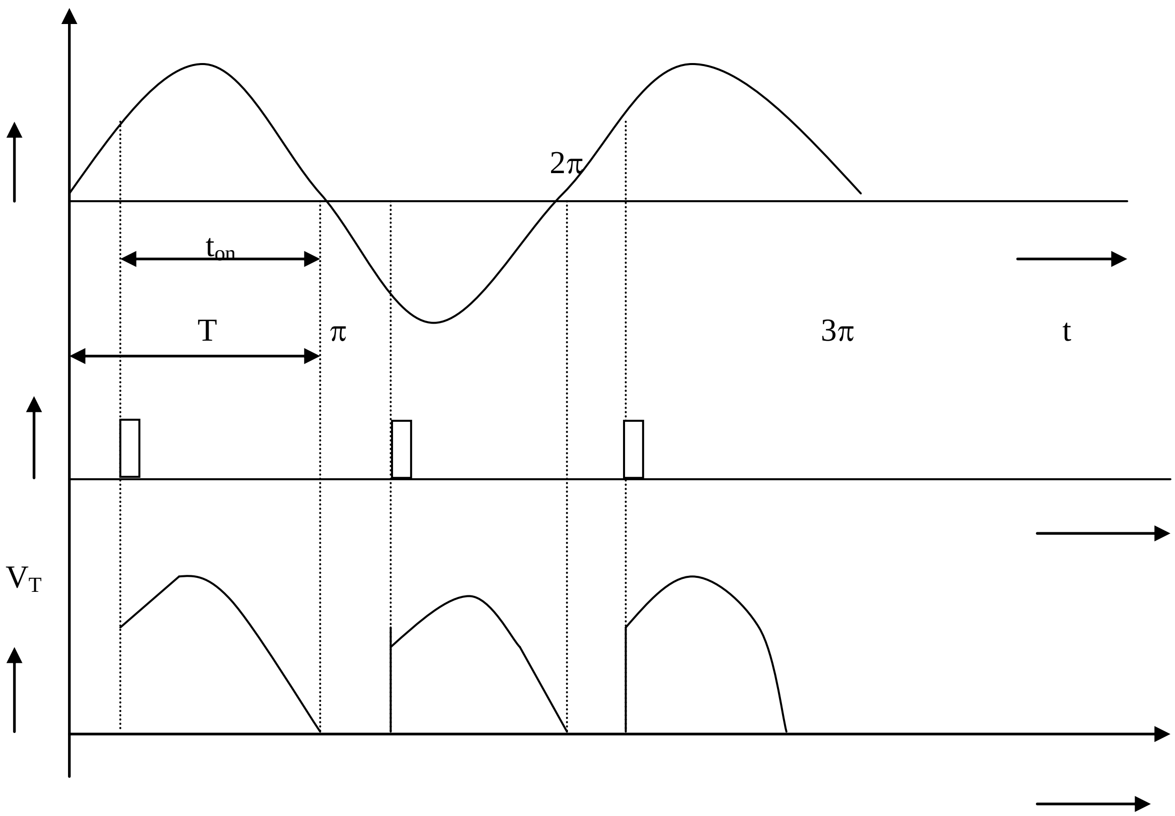
FORMULA :

$$\text{Firing angle} \quad \alpha_o = \left(\frac{ton}{T}\right) 180$$

PROCEDURE:

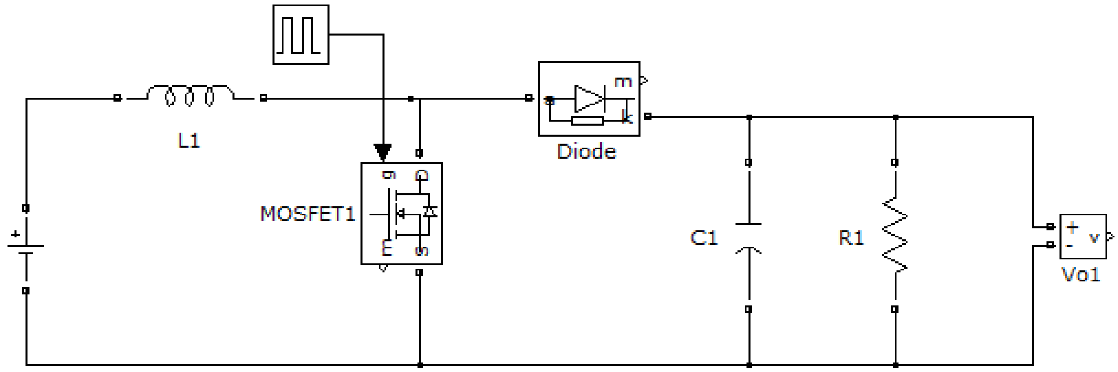
1. Make the connections as per the circuit diagram..
2. Keep the multiplication factor of the CRO's probe at the maximum position.
3. Vary the firing angle in steps.
4. Note down the voltmeter reading and waveform from the CRO.
5. Switch off the power supply and disconnect.

MODEL GRAPH:



RESULT:

CIRCUIT DIAGRAM (STEP UP CHOPPER) :



TABULAR COLUMN (STEP UP CHOPPER):

Vs = ____________ V

S.NO	T_{ON} (sec)	T_{OFF} (sec)	T (sec)	Duty Ratio $k=T_{ON} / T$	Vo=Vs/(1-K)

6. STEP UP AND STEP DOWN MOSFET BASED CHOPPERS

AIM:

To construct Step down & Step up MOSFET based choppers and to draw its output response.

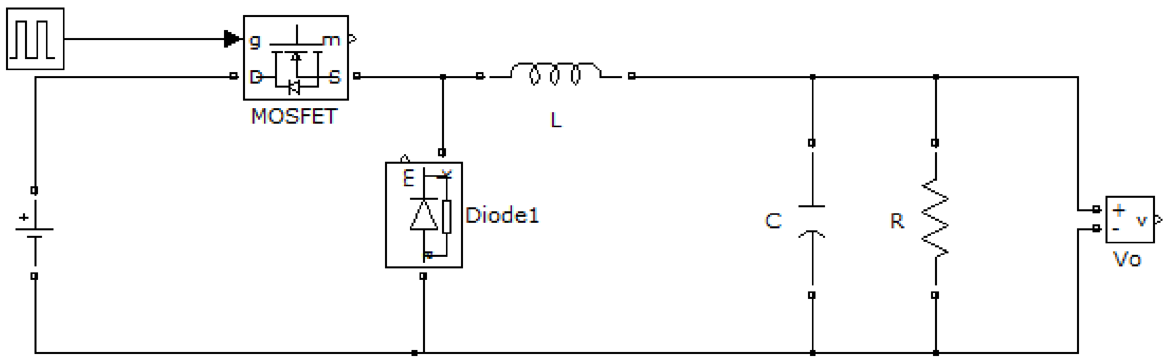
APPARATUS REQUIRED:

S.NO	ITEM	RANGE	QUANTITY
1	Step up & Step down MOSFET based chopper kit		1
2	CRO	20 MHZ	1
3	Patch chords		15

PROCEDURE (STEP UP CHOPPER & STEP DOWN CHOPPER) :

1. Initially keep all the switches in the OFF position
2. Initially keep duty cycle POT in minimum position
3. Connect banana connector 24V DC source to 24V DC imput.
4. Connect the driver pulse [output to MOSFET input
5. Switch on the main supply
6. Check the test point waveforms with respect to ground.
7. Vary the duty cyle POT and tabulate the Ton, Toff & output voltage
8. Trace the waveforms of Vo Vs & Io
9. Draw the graph for Vo Vs Duty cycle, K

CIRCUIT DIAGRAM (STEP DOWN CHOPPER):

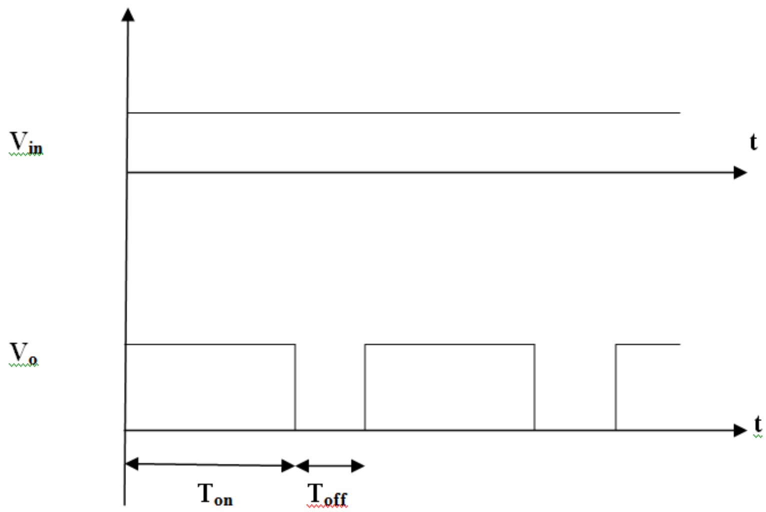


TABULAR COLUMN (STEP DOWN CHOPPER):

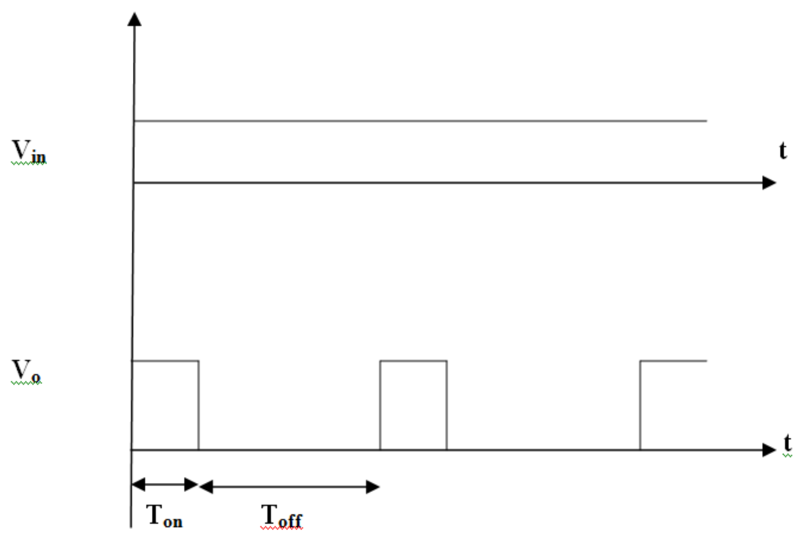
Vs = ____________ V

S.NO	T_{ON} (sec)	T_{OFF} (sec)	T (sec)	Duty Ratio $k=T_{ON} / T$	Vo=kVs

MODEL GRAPH (STEP UP CHOPPER) :

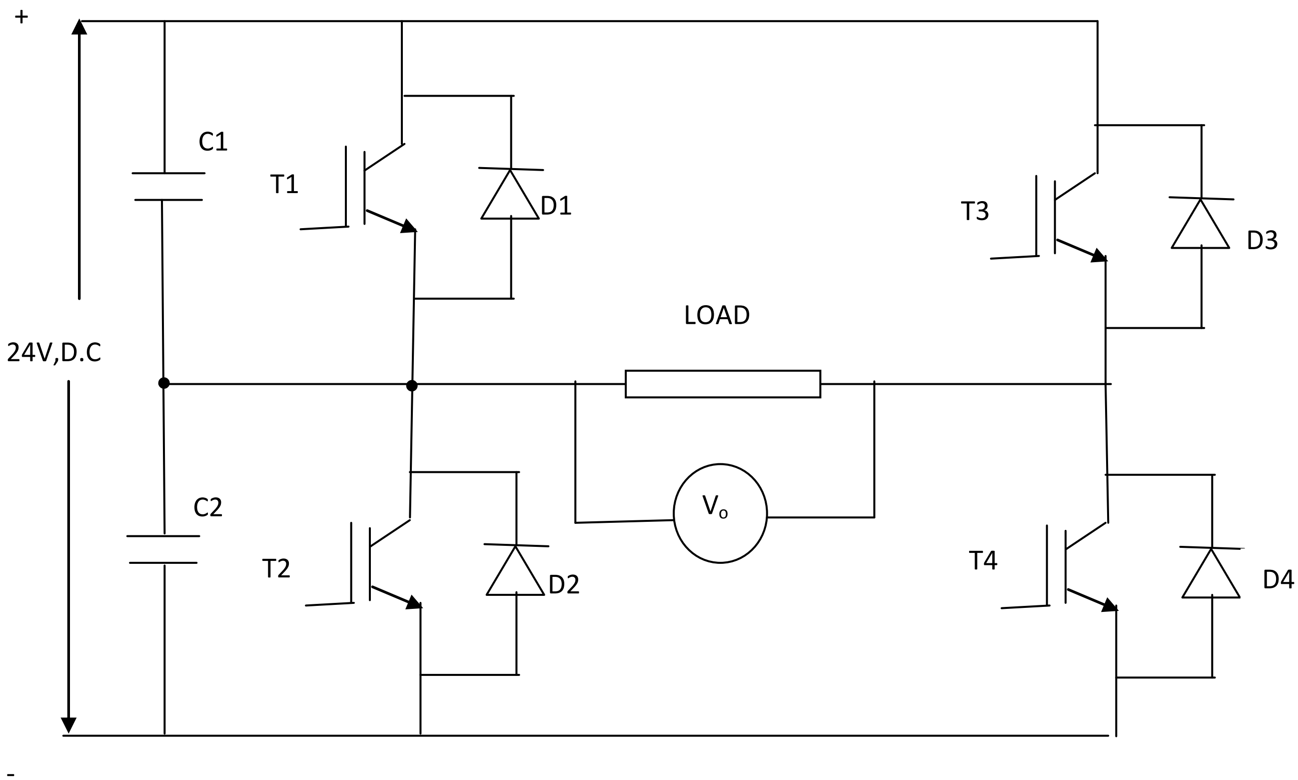


MODEL GRAPH (STEP DOWN CHOPPER) :



RESULT:

CIRCUIT DIAGRAM:



TABULAR COLUMN:

S.no	Output voltage (v)	Output frequency

7.IGBT BASED SINGLE PHASE PWM INVERTER

AIM :

To obtain Single phase output wave forms for IGBT based PWM inverter

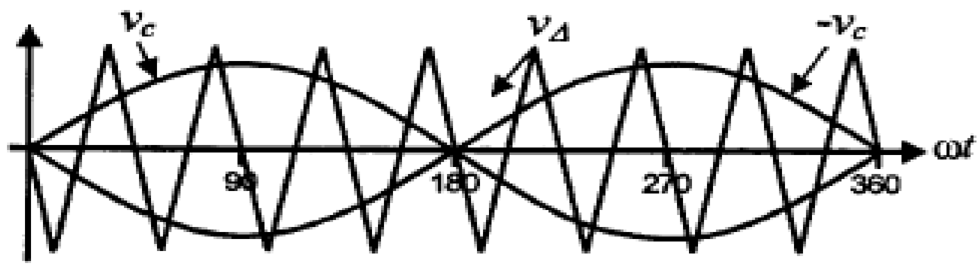
APPARATUS REQUIRED:

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	IGBT Based PWM inverter Kit	220/10A		1
2	CRO	20MHZ		1
3	Patch Chord	-		req
4	Load	-		1

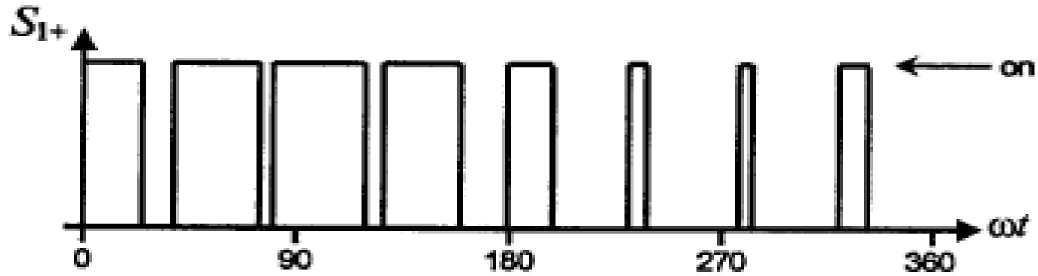
PROCEDURE :

1. Make the connection as per the circuit diagram.
2. Connect the gating signal from the inverter module.
3. Switch ON D.C 24 V.
4. Keep the frequency knob to particulars frequency.
5. Observe the rectangular and triangular carrier waveforms on the CRO.
6. Obtain the output waveform across the load Rheostat.

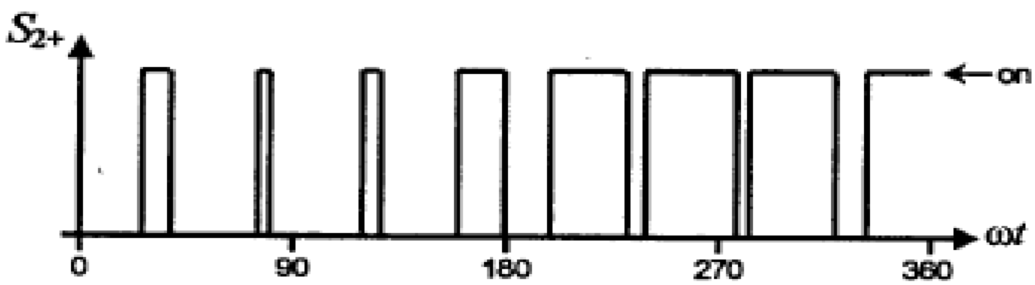
MODEL GRAPH:



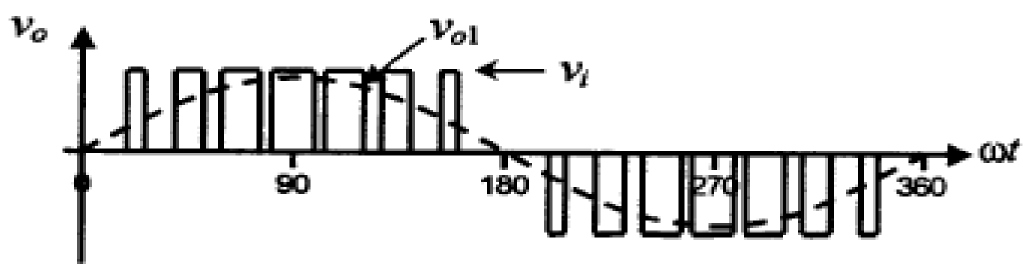
a)



b)



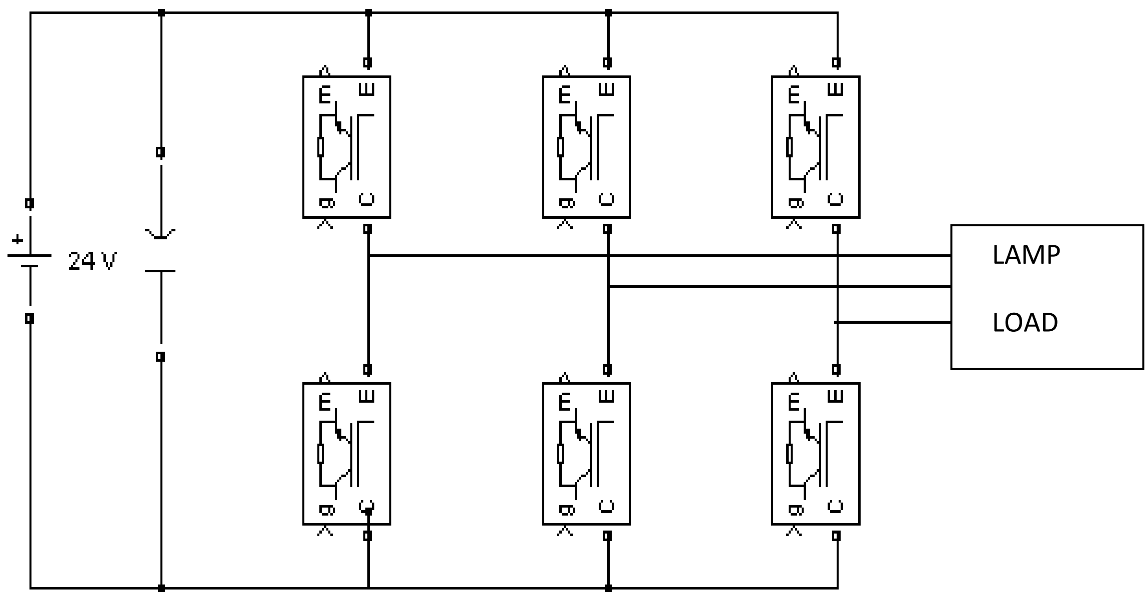
c)



d)

RESULT :

CIRCUIT DIAGRAM:



TABULAR COLUMN:

S.no	Output voltage (v)	Output frequency

8.IGBT BASED THREE PHASE PWM INVERTER

AIM:

To obtain Three phase output wave forms for IGBT based PWM inverter

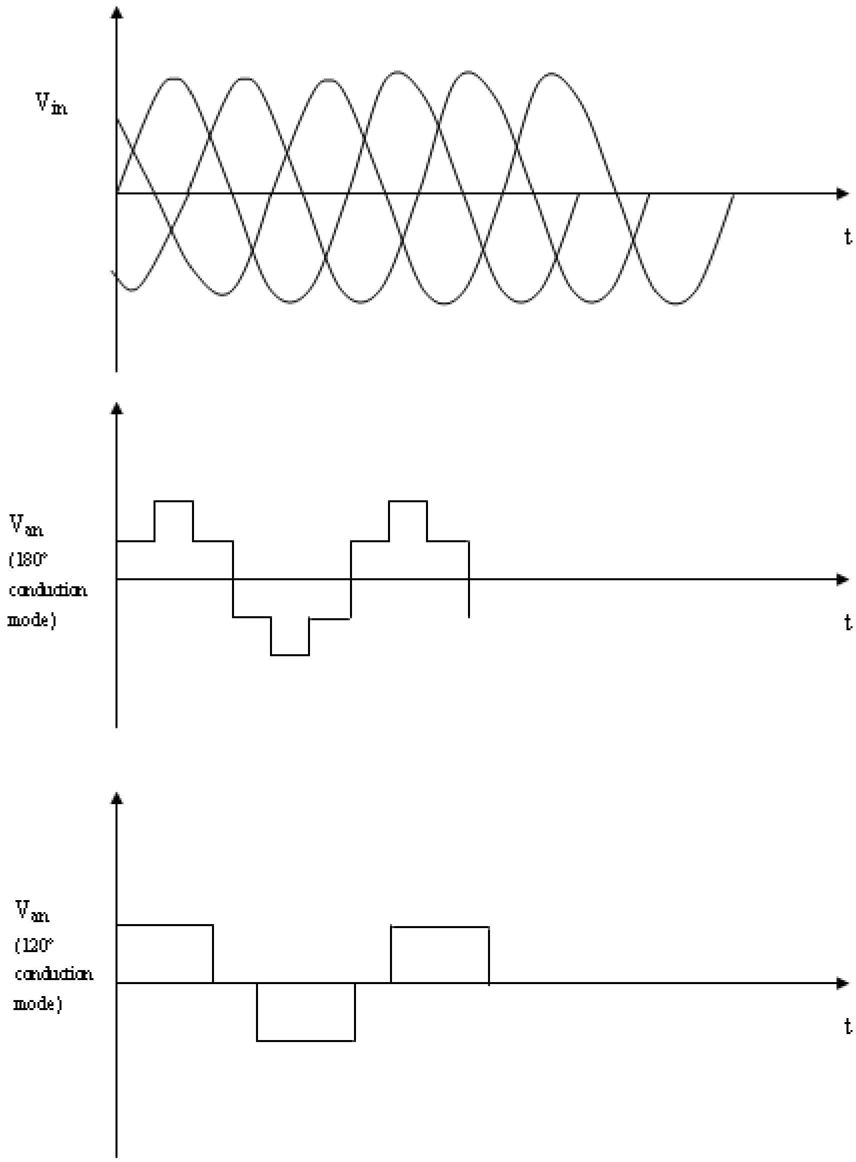
APPARATUS REQUIRED:

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	IGBT Based PWM inverter Kit	220/10A		1
2	CRO	20MHZ		1
3	Patch Chord			10
4	Load rheostat	50Ω/5A		1

PROCEDURE:

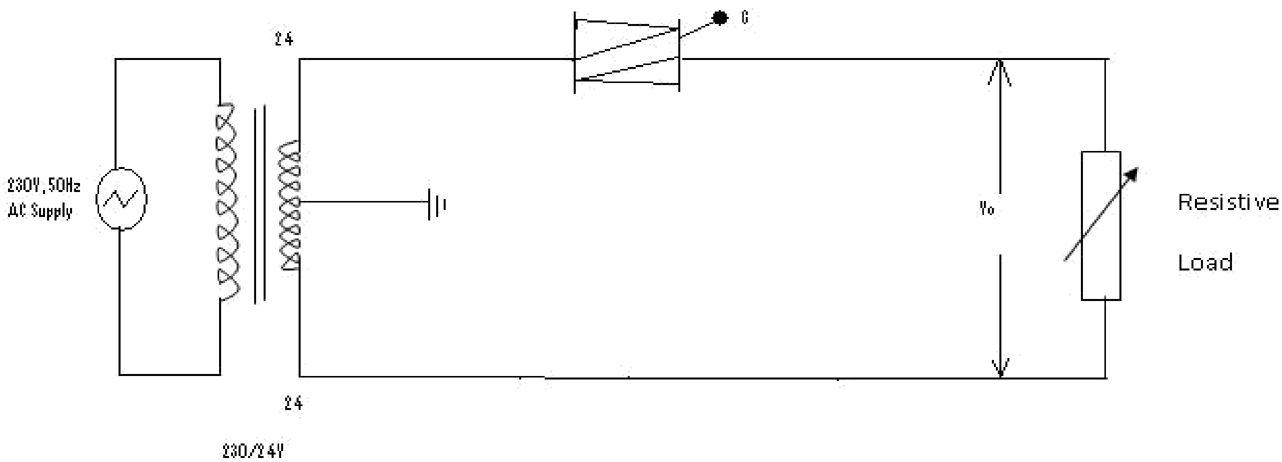
1. Make the connection as per the circuit diagram.
2. Connect the gating signal from the inverter module.
3. Switch ON D.C 24 V.
4. Keep the frequency knob to particulars frequency.
5. Observe the input and output waveforms for 180° conduction mode and 120° conduction mode in the CRO.
6. Obtain the output waveform across the load Rheostat.

MODEL GRAPH :



RESULT :

CIRCUIT DIAGRAM



Tabular column

S.No.	Firing Angle(α)	Output Voltage(Volts)	Time period(ms)
1			
2			
3			

9- AC VOLTAGE CONTROL USING TRIAC

Aim:

To study the 1-phase AC voltage control using TRIAC.

Apparatus Required:

i) Lamp – 60W

ii) Resistor - 100□ / 1W

iii) Potentio meter – 100K□

iv) Capacitor – 0.1□ F / 400V

v) Resistor – 1K□

vi) DIAC – DB3

vii) TRIAC BT 136

viii) Unearthed oscilloscope

Circuit Operation:

1. When potentiometer is in minimum position drop across potentiometer is zero and hence maximum voltage is available across capacitor. This V_c shorts the diac ($V_c > V_{bo}$) and triggers
2. When the potentiometer is in maximum position voltage drop across potentiometer is maximum. Hence minimum voltage is available across capacitor (V_c M V_{bo}) hence triac
3. When potentiometer is in medium position a small voltage is available across capacitor hence lamp glows with minimum intensity.

Procedure:

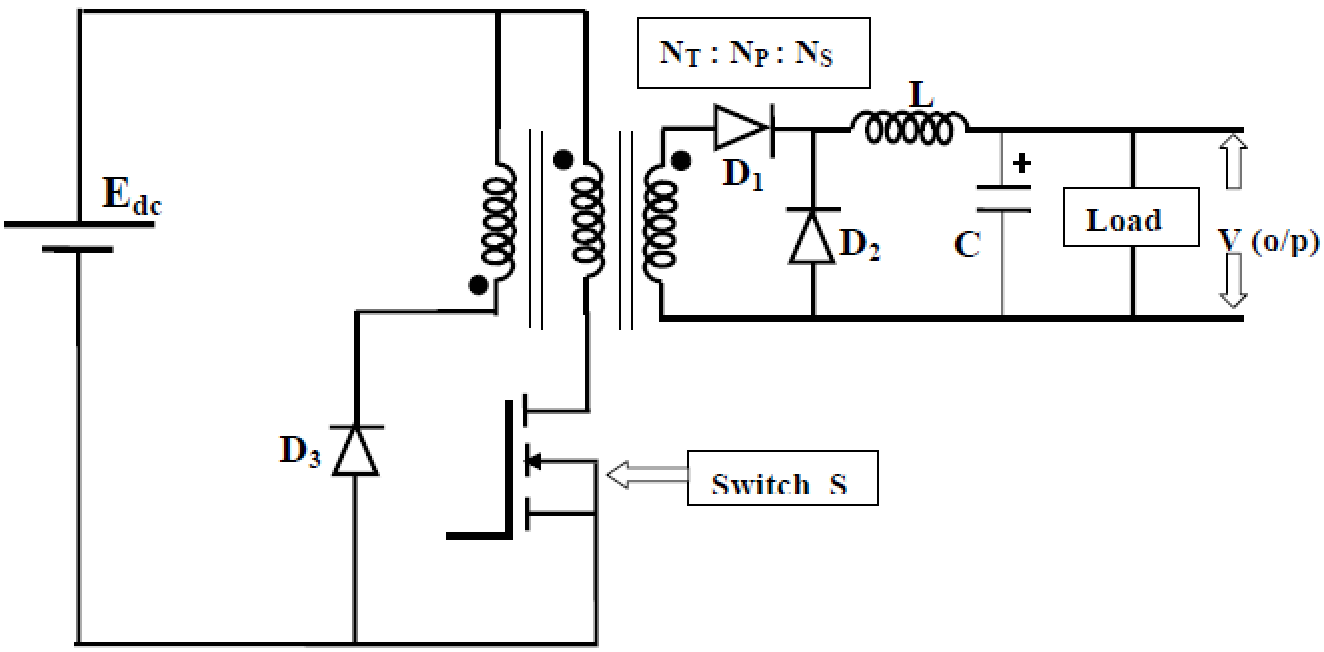
1. Connections are given as per the circuit diagram
2. Initially potentiometer kept at minimum position so lap does not glow at this instant.
3. Note the voltage across the diac and triac.
4. Capacitor and potentiometer using multimeter and CRO.
5. Potentiometer is now placed at medium and then to minimum position and their voltages were noted.

Theory:

Triac is a bidirectional thyristor with three terminals. Triac is the word derived by combining the capital letters from the words TRIode and AC. In operation triac is equivalent to two SCRs connected in anti-parallel. It is used extensively for the control of power in ac circuit as it can conduct in both the direction. Its three terminals are MT1 (main terminal 1), MT2 (main terminal 2) and G (gate).

Result:

CIRCUIT DIAGRAM



TABULAR COLUMN

Vs = ____________ V

S.NO	T ON (sec)	TOFF (sec)	T (sec)	Duty Ratio $k=T_{ON} / T$	Vo=Vs/(1-K)

10. SWITCHED MODE POWER CONVERTER

AIM:

To construct switched mode power converter and to draw its output response.

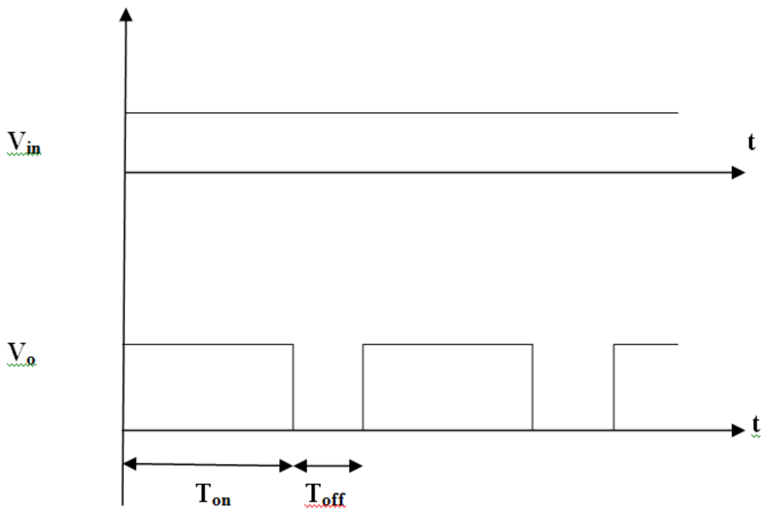
APPARATUS REQUIRED:

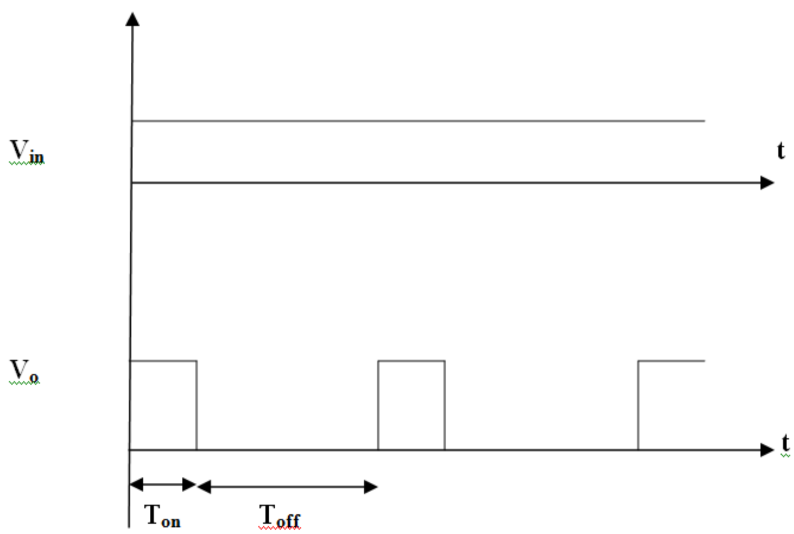
S.NO	ITEM	RANGE	QUANTITY
1	Step up & Step down MOSFET based chopper kit		1
2	CRO	20 MHZ	1
3	Patch chords		15

PROCEDURE (STEP UP CHOPPER & STEP DOWN CHOPPER) :

1. Initially keep all the switches in the OFF position
2. Initially keep duty cycle POT in minimum position
3. Connect banana connector 24V DC source to 24V DC imput.
4. Connect the driver pulse [output to MOSFET input
5. Switch on the main supply
6. Check the test point waveforms with respect to ground.
7. Vary the duty cyle POT and tabulate the Ton, Toff & output voltage
8. Trace the waveforms of Vo Vs & Io
9. Draw the graph for Vo Vs Duty cycle, K

MODEL GRAPH





RESULT:

11.SINGLE PHASE FULL WAVE RECTIFIER WITH R & RL LOAD

Aim:

To simulate the 1Ø fully Controlled rectifier circuit with R & RL load and obtain the corresponding waveforms using MATLAB/SIMULINK.

Formulae used:

Average dc voltage, $V_{dc}=\underline{V_m(}1+\cos\ )$ (volts)

Rms output voltage, $V_{rms}=\frac{V_m}{2}\ ((\ -\ )+\sin 2\ /2)^{1/2}$ (volts)

Average output current, $I_{dc}=V_{dc}/R$ (Amps)

RMS output current, $I_{rms}=V_{rms}/R$ (Amps)

Where,

V_m is the maximum input voltage

is the firing angle of the SCR.

Operation:

The phase controlled rectifiers using SCRs are used to obtain controlled dc output voltages from the fixed ac mains input voltage. The circuit diagram of a fully controlled converter is shown in Figure 2. The output voltage is varied by controlling the firing angle of SCRs. The single phase fully controlled converter consists of four SCRs. During positive half cycle, SCR1 and SCR 2 are forward biased. Current flows through the load when SCR1 and SCR2 is triggered into conduction. During negative half cycle, SCR3 and SCR4 are forward biased. If the load is resistive, the load voltage and load current are similar.

When the load is inductive, SCR1 and SCR2 conduct from to . The nature of the load current depends on the values of R and L in the inductive load. Because of the inductance, the load current keeps on increasing and becomes maximum at . At , the supply voltage reverses but SCRs 1 and 2 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 to + since supply voltage is negative.

Circuit diagram:

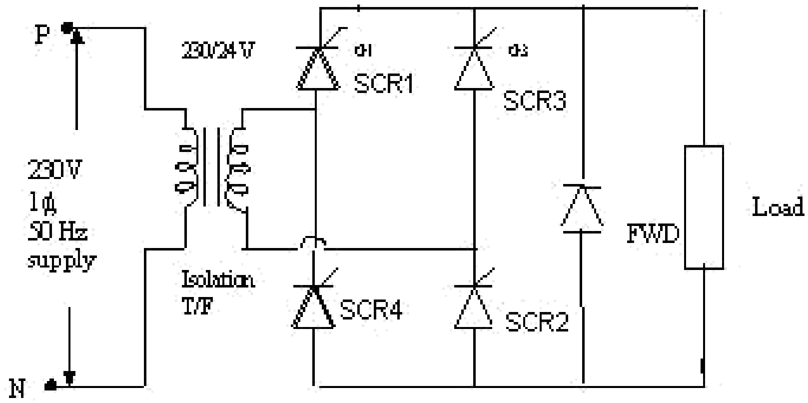
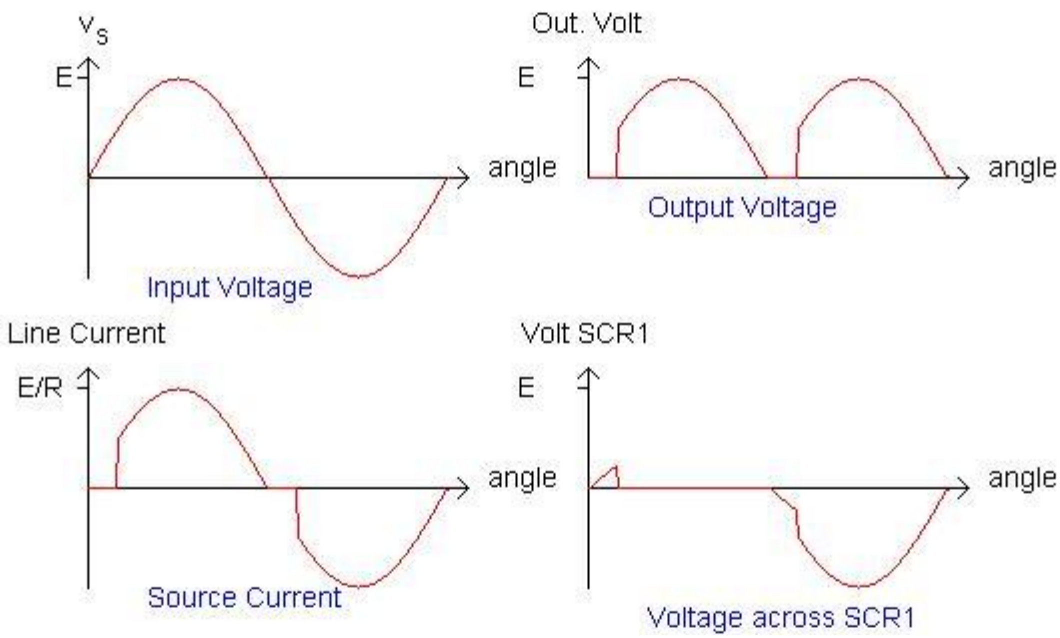
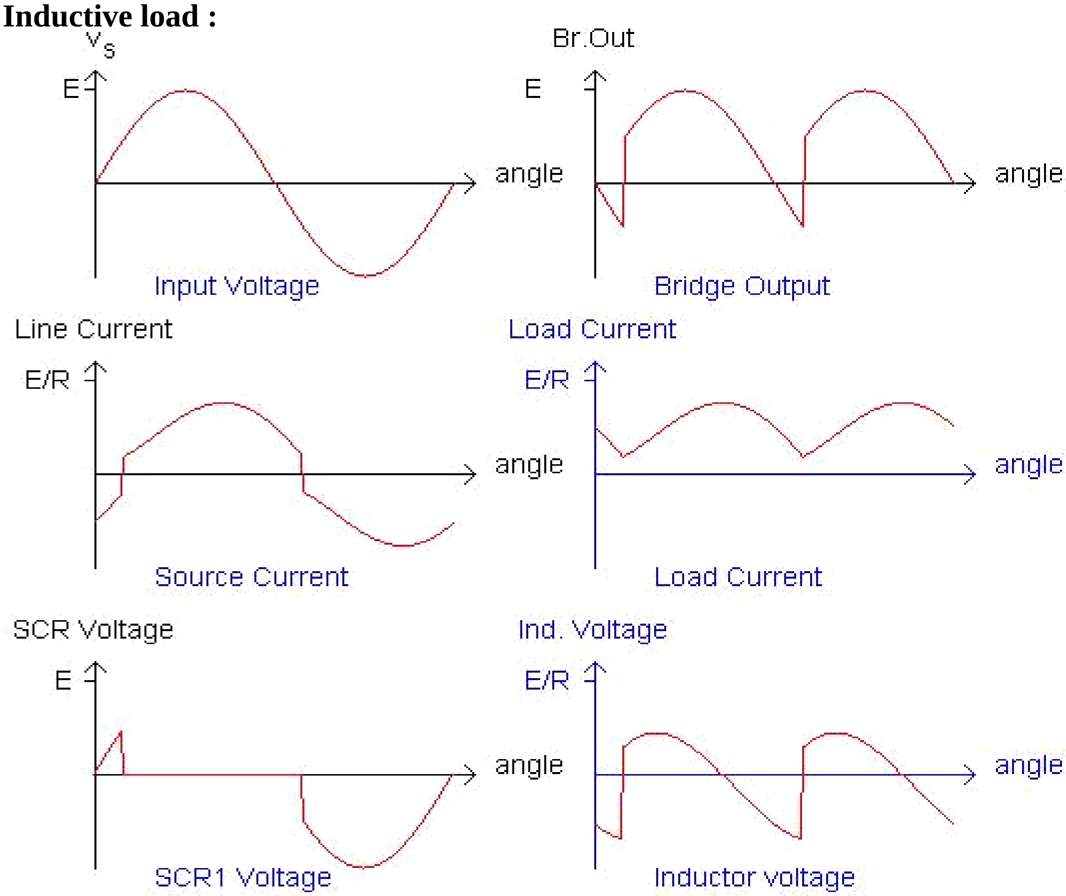


Figure 1. Single phase fully controlled converter

Model Graph:
Resistive load



Inductive load :



Result:

12.THREE PHASE FULLY CONTROLLED RECTIFIER WITH R & RL LOAD

Aim:

To simulate the 3Ø fully Controlled rectifier circuit with R & RL load and obtain the corresponding waveforms using MATLAB/SIMULINK

Theory:

The three phase full bridge converter works as three phase AC-DC converter for firing angle delay $0^0 < \alpha \leq 90^0$ and as three phase line commutated inverter for $90^0 < \alpha < 180^0$. The numbering of SCRs 1, 3, 5 for the positive group and 2, 4, 6 for negative group. This numbering scheme is adopted here as it agrees with the sequence of gating of six thyristors in a 3-phase full converter.

Here each SCR is conduct for 120^0. At any time two SCRs, one from positive group and other from negative group must conduct together and this combination must conduct for 60^0.this means commutation occurs for every 60^0. For ABC phase sequence of three phase supply

Formulae used:

Average output voltage $V_0 = \frac{3V_{ml}}{\pi} \cos\alpha$

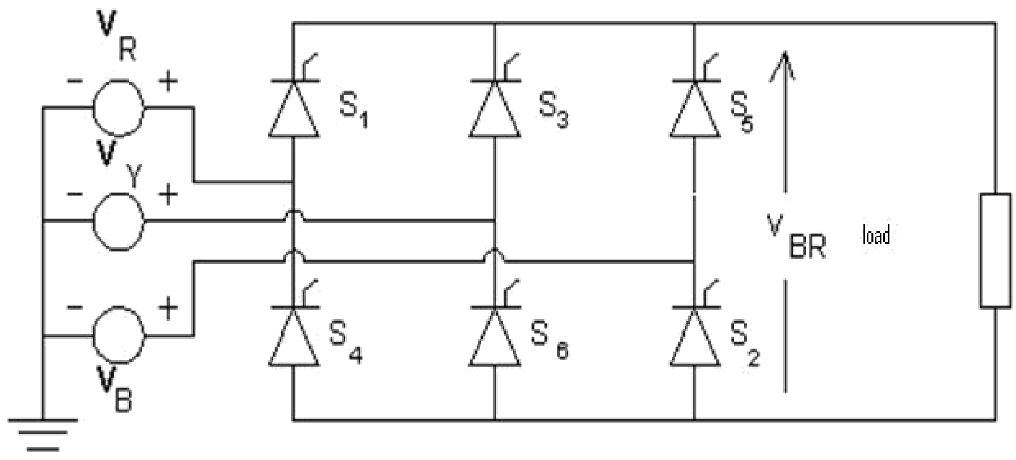
RMS value of output voltage $V_{0r} = V_{ml}\sqrt{\frac{3}{2\pi}}\,[\frac{\pi}{3} + \frac{\sqrt{3}}{2}\cos 2\alpha]^{1/2}$

RMS of the source current is $I_s = I_0\sqrt{\frac{2}{3}}$

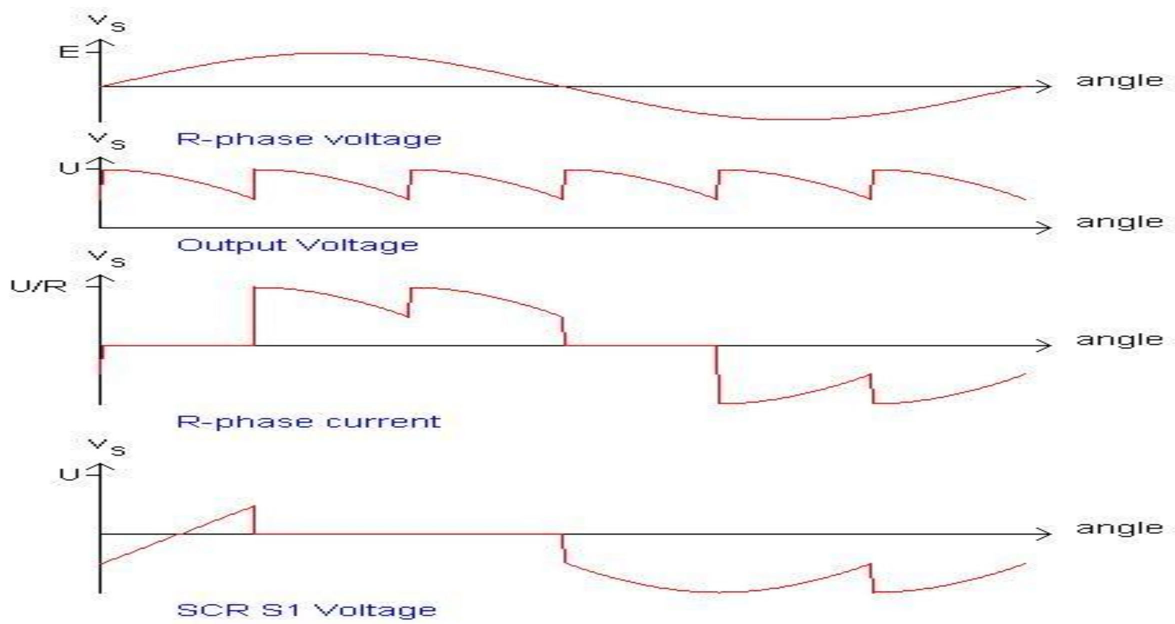
Each SCR conducts for 120^0 for every 360^0. Therefore the RMS value of SCR current is

$$I_{Th} = I_0\sqrt{\frac{1}{3}}$$

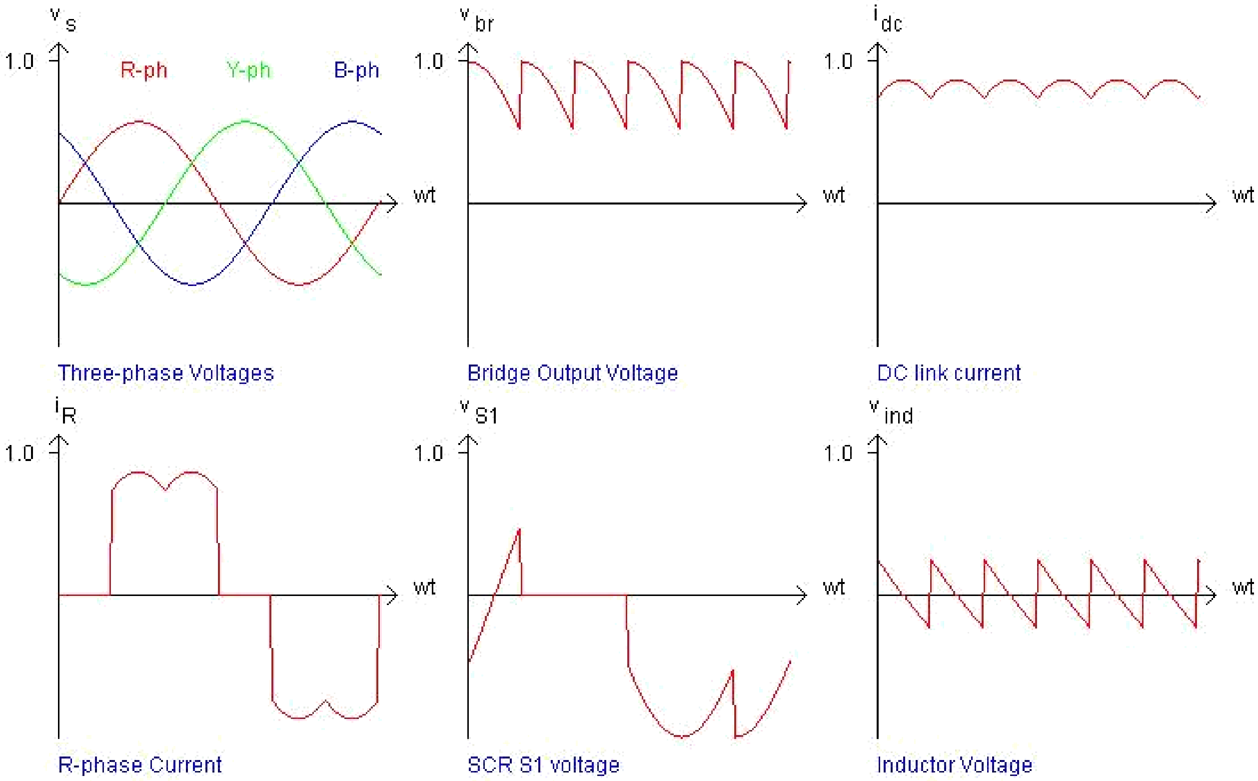
Circuit Diagram:



Model Graph:
Resistive load:



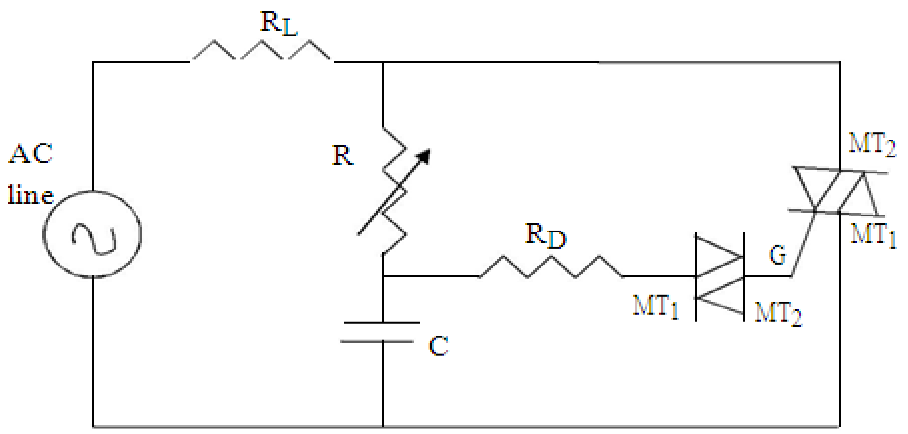
Inductive load:



Result:

Thus the three phase fully controlled Rectifier with R & RL Load circuit is simulated using MATLAB/SIMULINK and the corresponding waveforms are obtained.

CIRCUIT DIAGRAM



13.SINGLE PHASE AC VOLTAGE REGULATOR

Aim:

To simulate the 1Ø AC voltage regulator circuit and obtain the suitable waveforms using MATLAB/SIMULINK

Theory:
AC regulators are used to get variable AC voltage from the fixed mains voltage. Some of the important applications of AC regulators are: domestic and industrial heating, induction heating in metallurgical industries, induction motor speed control for fan and pump drives, transformer tap changers in utility systems, static reactive power compensators, lighting control etc., Earlier, auto transformers, transformers with taps and magnetic amplifiers were employed in these applications because of high efficiency, compact size, flexibility in control etc. Two thyristors in anti parallel are employed for full wave control. In this case, isolation between control and power circuit is most essential because of the fact that the cathodes of the two thyristors are connected to the common point. For low power applications, a triac may be used. In this case isolation between control and power circuitry is not necessary.

Formulae Used:
The triggering pulse is generated at the point at which the associated cosine wave becomes instantaneously equal to the control voltage.
In other words,

2V sin (- t) = V_R

At this instant t= and hence

2V sin (-) = V_R

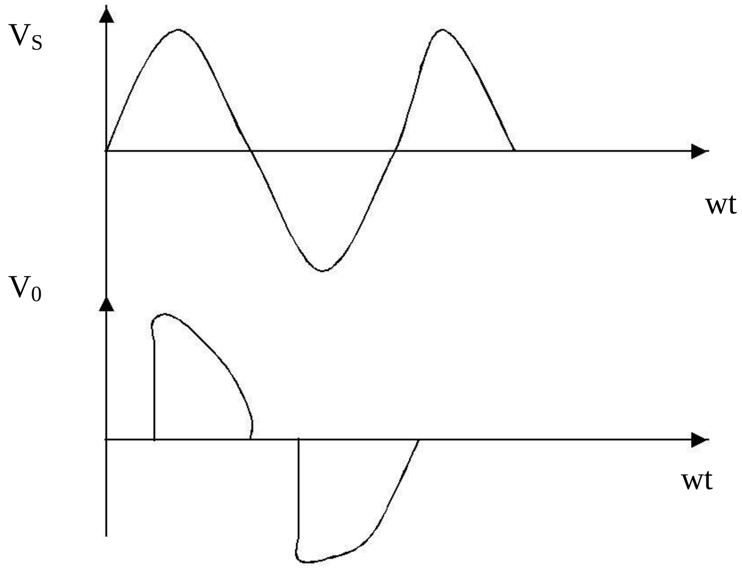
= - sin$^-$ (V_R/ 2V)

R_{max}=2 2V/ CV_R

Where, V_R- breakdown voltage of the Diac - firing angle delay

V- Supply voltage

Model Graph:



A triac control circuit for lamp dimmers is shown in Fig.1. A diac is a gateless triac designed to breakdown at a low voltage. During the positive half cycle, the triac requires a positive gate pulse for turning it on. This is provided by the capacitor C. When its voltage is above the breakdown voltage of the diac, the capacitor C discharges through the triac gate. When the triac turns on, the capacitor Voltage will be reset to zero. A similar operation takes place in the negative half cycles, and a negative gate pulse will be applied when the diac breaks down in the reverse direction. Adjustment of series resistance, R determines the charging rate of capacitor C and hence the value of the phase angle delay. The output power and thus light intensity are varied by controlling the phase of conduction of the triac.

Result:

Thus the 1 Ø AC Voltage regulator with R load circuit is executed with the help of MATLAB software and the graph is plotted.