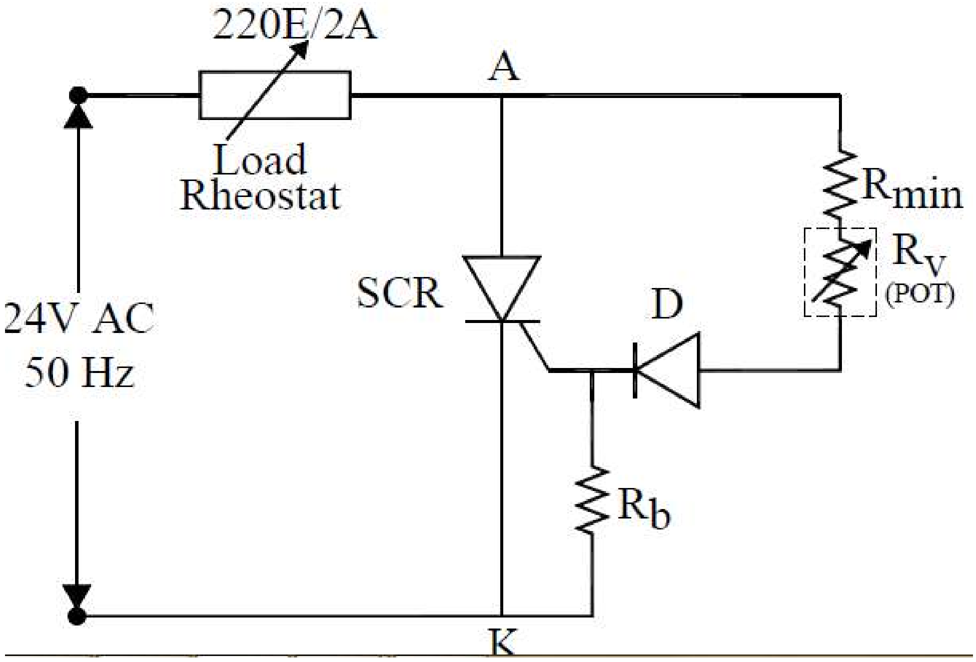
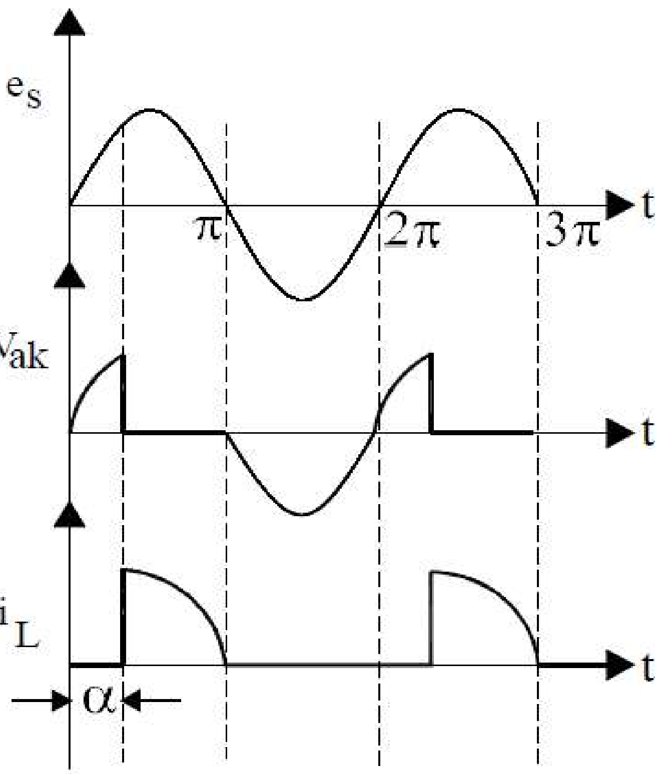
CIRCUIT DIAGRAM:

RESISTANCE FIRING CIRCUIT:



MODEL GRAPH



Ex. No. 1 **R, RC & UJT FIRING CIRCUIT FOR SCR**

Date:

AIM

To study operation of R, RC & UJT firing circuit for SCR

APPARATUS REQUIRED

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	SCR Module kit		PEC16MIA	1
2	Patch Chords			As required
3	Rheostat	220Ω/2A		1

THEORY

RESISTANCE FIRING CIRCUIT

Resistance trigger circuits are the simplest & most economical method. During the positive half cycle of the input voltage, SCR become forward biased but it will not conduct until its gate current exceeds gate threshold, V_{gt} . Diode D allows the flow of current during positive half cycle only. R_V is the variable resistance and is used to limit the current through the circuit (I_g) and to vary the gate voltage and thus the firing angle. During the positive half cycle current I_g flows. Ig increases and when V_g=V_{gt}= I_{gmin}R the SCR turns ON .The firing angle can be varied from 0 — 90° by varying the resistance R1.

RC FIRING CIRCUIT

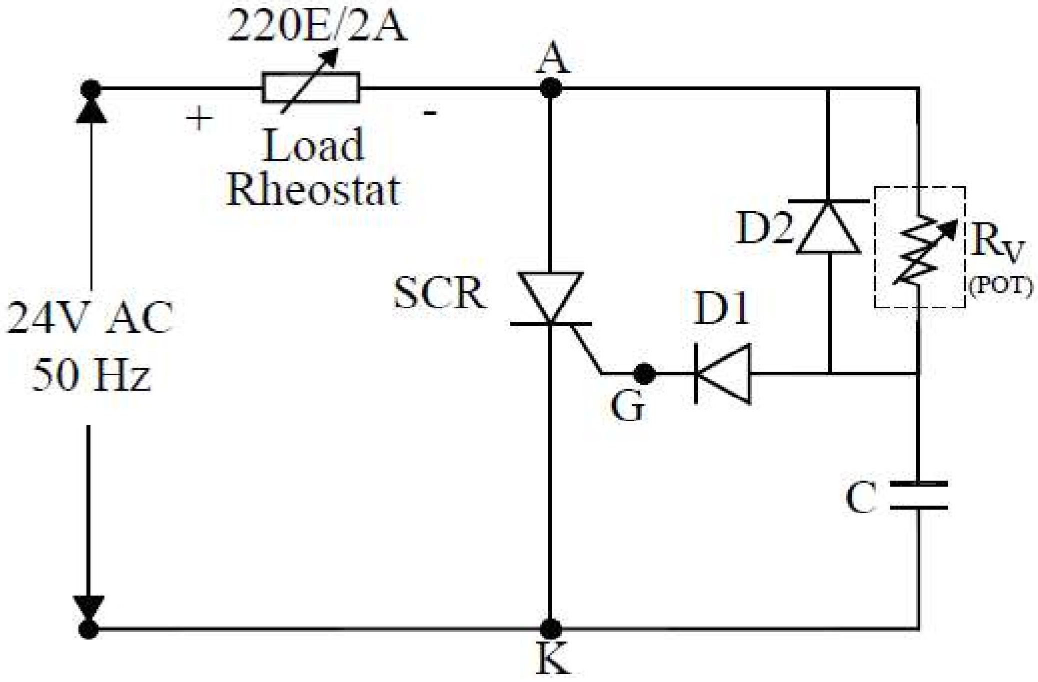
By varying the variable resistance R_V, the firing angle can be varied. Capacitor, C charges and discharges with a phase shift. When the capacitor voltage equal to the gate threshold voltage V_{gt}, SCR get triggered. Diode D prevents the negative voltage to gate.

UJT FIRING CIRCUIT

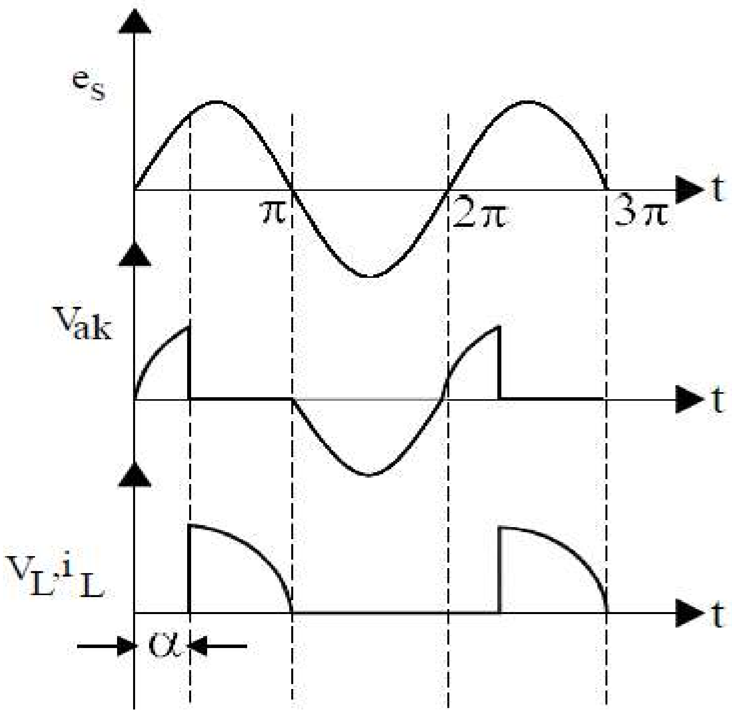
Diode Rectifier converts input ac to dc. Resistor R limits the circuit current to a suitable value for the zener diode and UJT.Zener diode 'Z' functions to clip the rectified voltage to a standard level. The zener voltage V_Z is applied to the RC charging circuit. Charging of capacitor C is at a rate determined by R1 and R3.When voltage across the capacitor, V3 reaches the unijunction threshold voltage ηV_2, the UJT junction breaks down and the capacitor C discharges through the primary of pulse transformer. As the current is in the form of pulse, windings of the pulse transformer have pulse voltages at their secondary terminals and can turn on the SCR.As the charging rate of capacitor varies by varying R3, firing angle can be controlled by varying R3.Firing angle can be controlled in a range of 0^0 to $180^{0.}$

CIRCUIT DIAGRAM:

RESISTANCE-CAPACITANCE FIRING CIRCUIT:



MODEL GRAPH



R - FIRING CIRCUIT

Connection Procedure:

1. Connect the input supply to the module.
2. Connect P & N terminals to T7 & T9.
3. Connect one end of load rheostat to Anode of SCR.
4. Connect the other end of the load rheostat to the P terminal of 24V AC Supply.
5. Connect the cathode of SCR to the N terminal of 24V AC supply.
6. Connect G & K terminals of firing circuit to G & K terminals of SCR.
7. Connect the CRO ground to anode of SCR. Connect channel 1 probe to T7 & channel 2 probe to cathode of SCR.

Experiment Procedure:

1. Verify the connection as per the connection diagram.
2. Switch ON the 24V AC supply.
3. Observe the waveform for input AC voltage & Load voltage.
4. Calculate the DC output voltage using the equation

$$V_{dc} = \frac{\sqrt{2}V}{2\pi}(1 + \cos\alpha)$$

α	-	Firing angle delay
V	-	RMS value of the ac input voltage.

RC - FIRING CIRCUIT

Connection Procedure:

1. Connect the input supply to the module.
2. Connect P & N terminals to T12 & T13.
3. Connect one end of load rheostat to Anode of SCR.
4. Connect the other end of the load rheostat to the P terminal of 24V AC Supply.
5. Connect the cathode of SCR to the N terminal of 24V AC supply.
6. Connect G & K terminals of firing circuit to G & K terminals of SCR.
7. Connect the CRO ground to anode of SCR. Connect channel 1 probe to T12 & channel 2 probe to cathode of SCR.

Experiment Procedure:

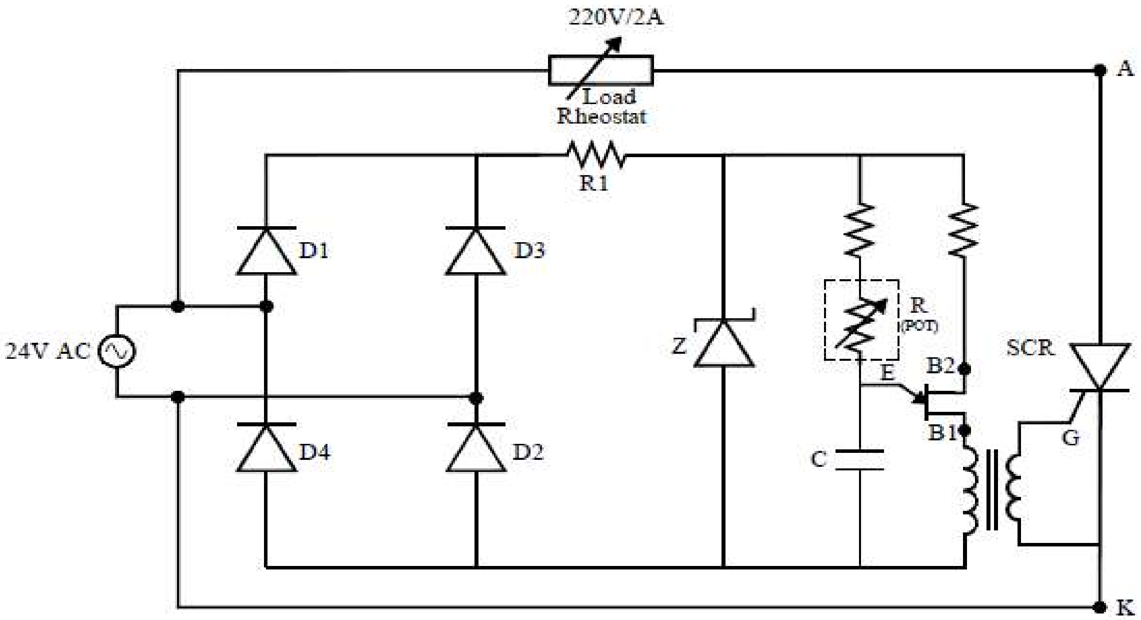
1. Verify the connection as per the connection diagram.
2. Switch ON the 24V AC supply.
3. Observe the waveform for input AC voltage & Load voltage.
4. Calculate the DC output voltage using the equation

$$V_{dc} = \frac{\sqrt{2}V}{2\pi}(1 + \cos\alpha)$$

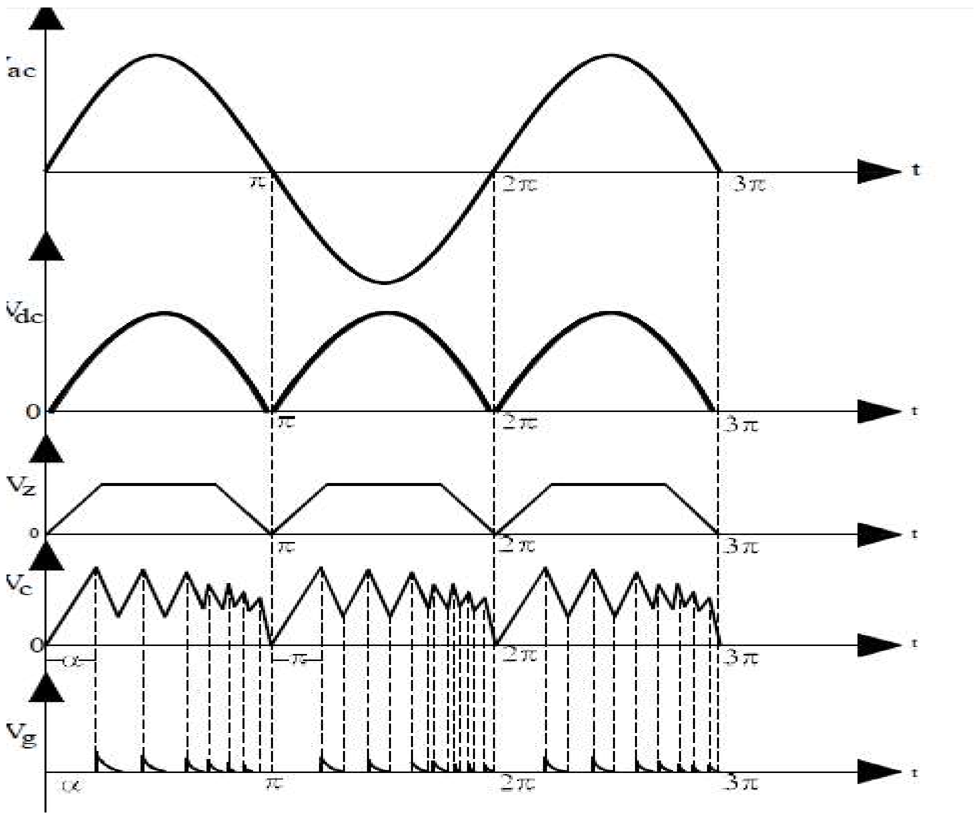
α	-	Firing angle delay
V	-	RMS value of the ac input voltage.

CIRCUIT DIAGRAM:

UJT FIRING CIRCUIT:



MODEL GRAPH



R - FIRING CIRCUIT

Connection Procedure:

1. Connect the input supply to the module.
2. Connect one end of load rheostat to Anode of SCR.
3. Connect the other end of the load rheostat to the P terminal of 24V AC Supply.
4. Connect the cathode of SCR to the N terminal of 24V AC supply.
5. Connect G1 & K1 terminals of UJT firing circuit to G & K terminals of SCR.

Experiment Procedure:

1. Verify the connection as per the connection diagram.
2. Switch ON the 24V AC supply.
3. Connect the CRO ground to ground terminal of UJT firing circuit.
4. Observe the waveform for input AC voltage & Load voltage.
5. Calculate the DC output voltage using the equation

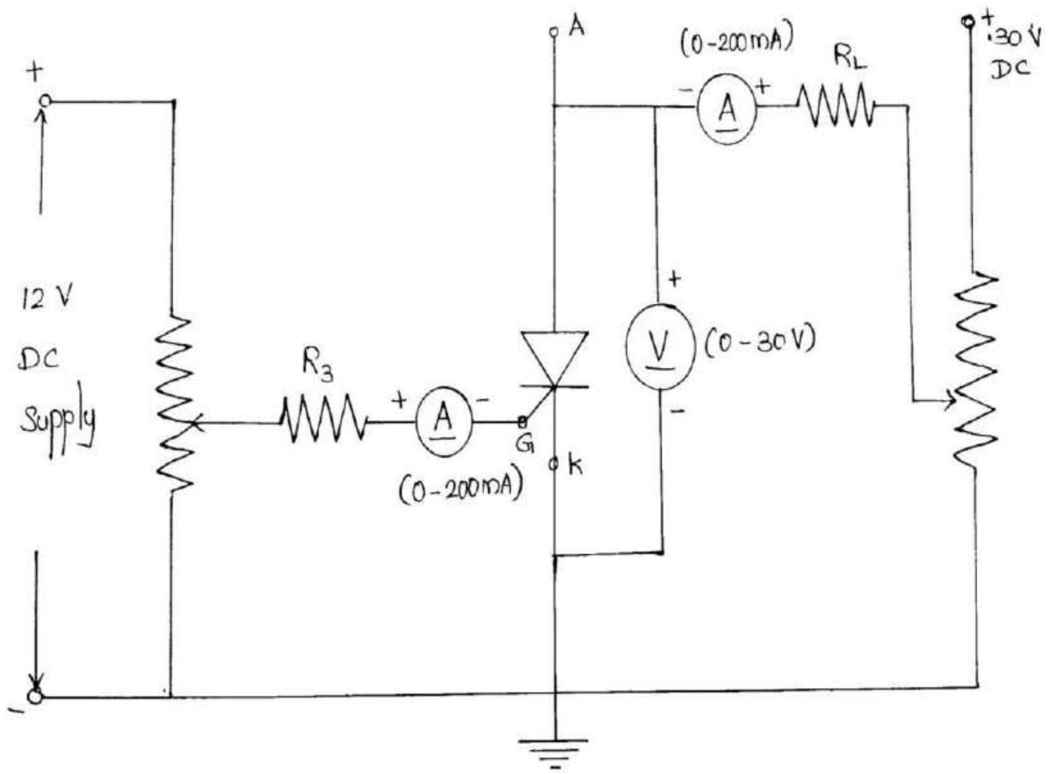
$$Vo = \frac{V_m}{\pi}(1 + \cos\alpha) \qquad Vm = \sqrt{2} * V$$

α	-	Firing angle delay
V	-	RMS value of the ac input voltage.

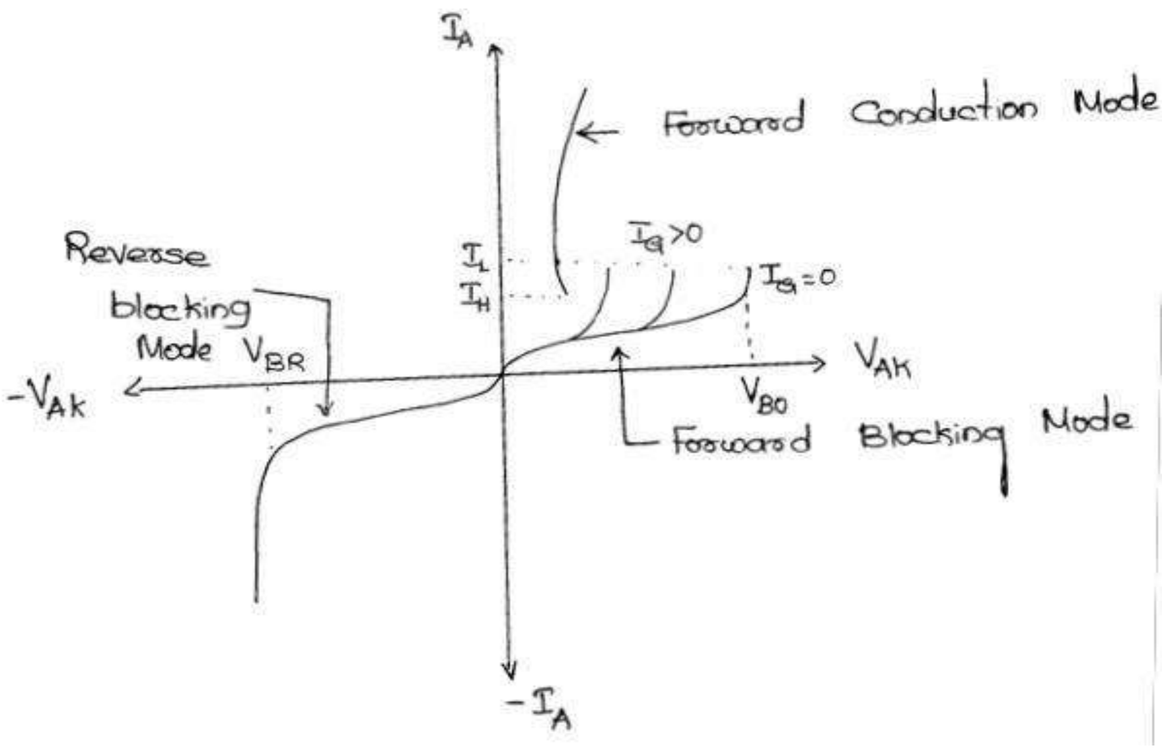
RESULT

Studied the operation of R, RC & UJT firing circuit for SCR .

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 2(a) CHARACTERISTICS OF SCR

Date:

AIM

To determine the VI characteristics of SCR using PEC16MIA

APPARATUS REQUIRED

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	SCR Module kit		PEC16MIA	1
2	Voltmeter	(0-30) V	MC	1
3	Ammeter	(0-200)mA	MC	2
4	Patch Chords			As required

THEORY

An SCR is a unidirectional device as it can conduct from anode to cathode only. SCR is a four layer, three junction, p-n-p-n semiconductor switching device. It has three terminals anode, cathode & gate. The terminal connected to outer p region is called anode(A), the terminal connected to outer n region is called cathode(K) & that connected to inner p region is called gate (G). Static VI characteristics of a thyristor have three basic modes of operation; namely, reverse blocking mode, forward blocking mode & forward conduction mode.

PROCEDURE

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 POT on the gate-cathode side.
4) Now slowly increase the voltage (V_{AK}) by varying the POT on the anode-cathode side from zero until breakdown occurs.
5) Note down the breakdown voltage.
6) Further increase the anode to cathode voltage(V_{AK}) & note down anode current (I_A).
7) Draw the characteristics between anode to cathode voltage (V_{AK}) and anode current (I_A).

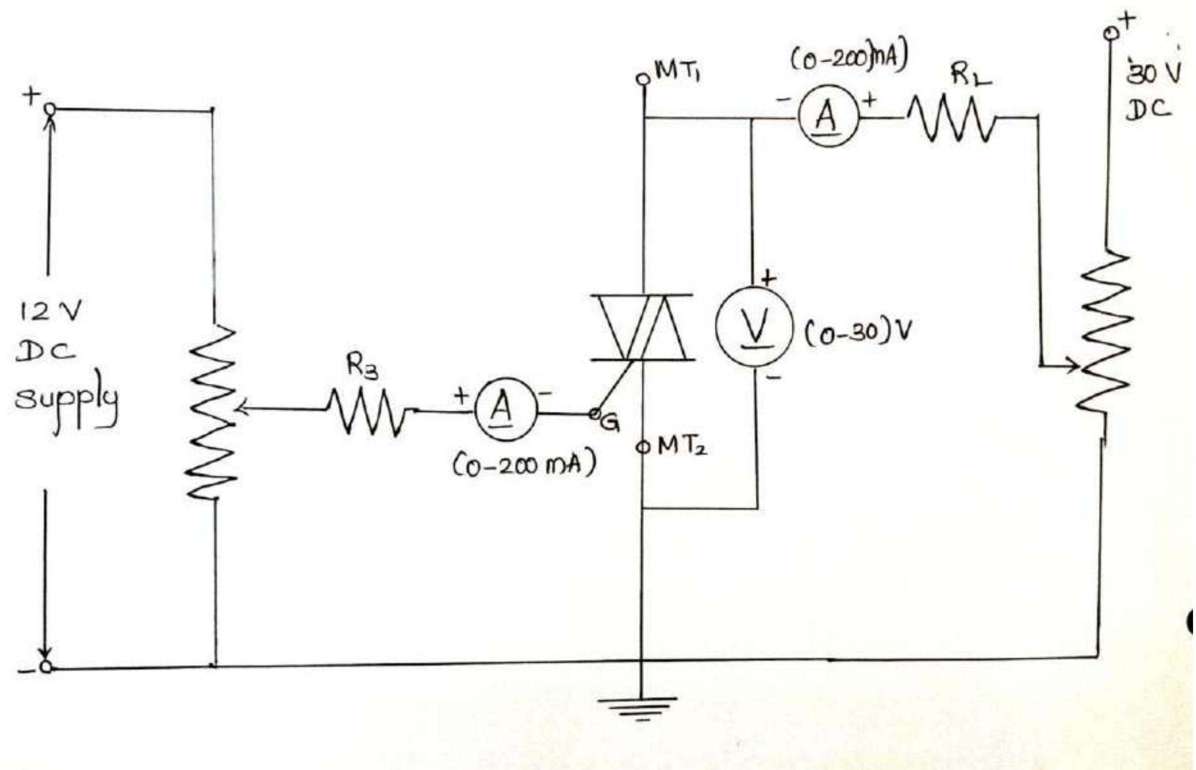
TABULAR COLUMN

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

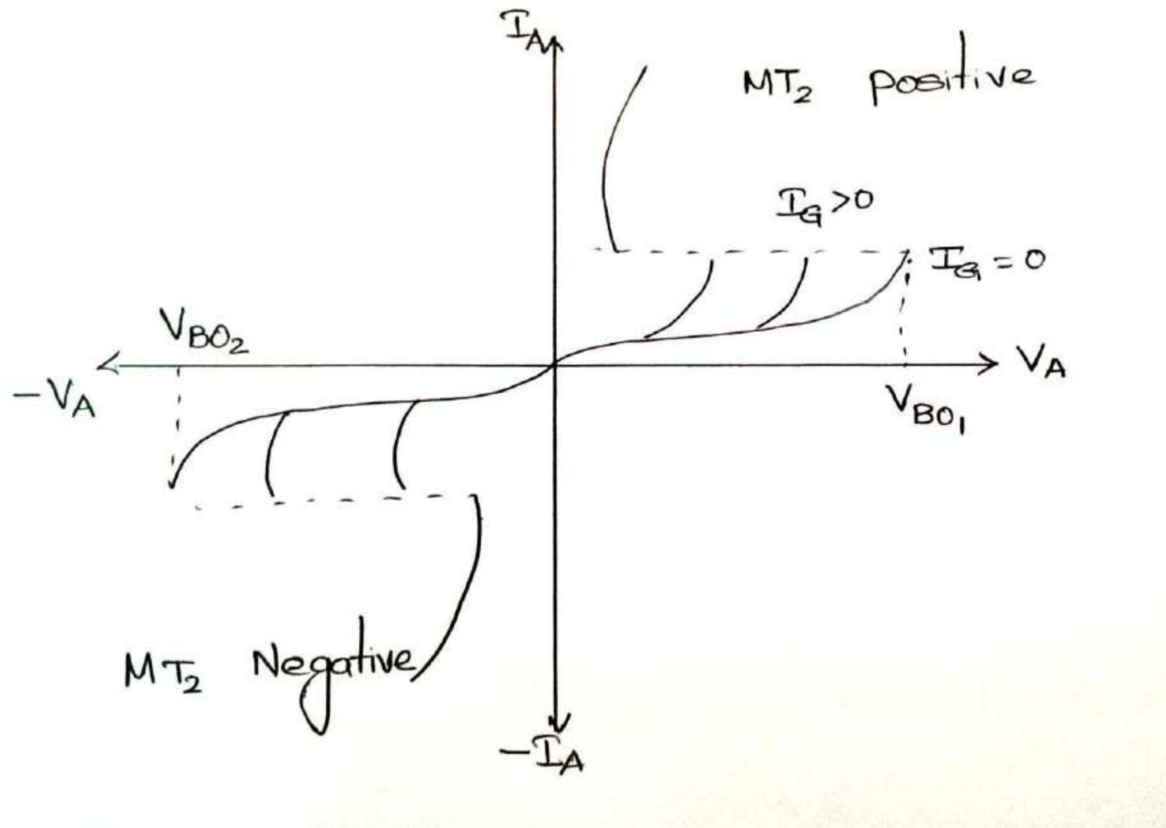
RESULT

Thus the VI Characteristics of SCR using PEC16MIA was determined.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 2(b) CHARACTERISTICS OF TRIAC

Date:

AIM

To determine the VI characteristics of TRIAC using PEC16MIA

APPARATUS REQUIRED

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	TRIAC Module kit		PEC16MIA	1
2	Voltmeter	(0-30) V	MC	1
3	Ammeter	(0-200)mA	MC	2
4	Patch Chords			As required

THEORY

A TRIAC is a bidirectional device. It can conduct from anode to cathode & cathode to anode. A TRIAC is equivalent to two SCRs connected in anti-parallel. It has three terminals namely; main terminal1 (MT1), main terminal2 (MT2) & gate G. The terminal MT1 is the reference point for measurement of voltages & currents at the gate terminal & at the terminal MT2. The gate G is near to terminal MT1.

PROCEDURE

To determine the Characteristics of TRIAC

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 POT on the gate-MT1 side.
4) Now slowly increase the voltage (V_{MT1MT2}) by varying the POT on the MT1-MT2 side from zero until breakdown occurs.
5) Note down the breakdown voltage.
6) Further increase the MT1-MT2 voltage(V_{MT1MT2}) & note down MT1 current ($I_{MT!}$).
7) Draw the characteristics between MT1-MT2 voltage (V_{MT1MT2}) and MT1 current ($I_{MT!}$).

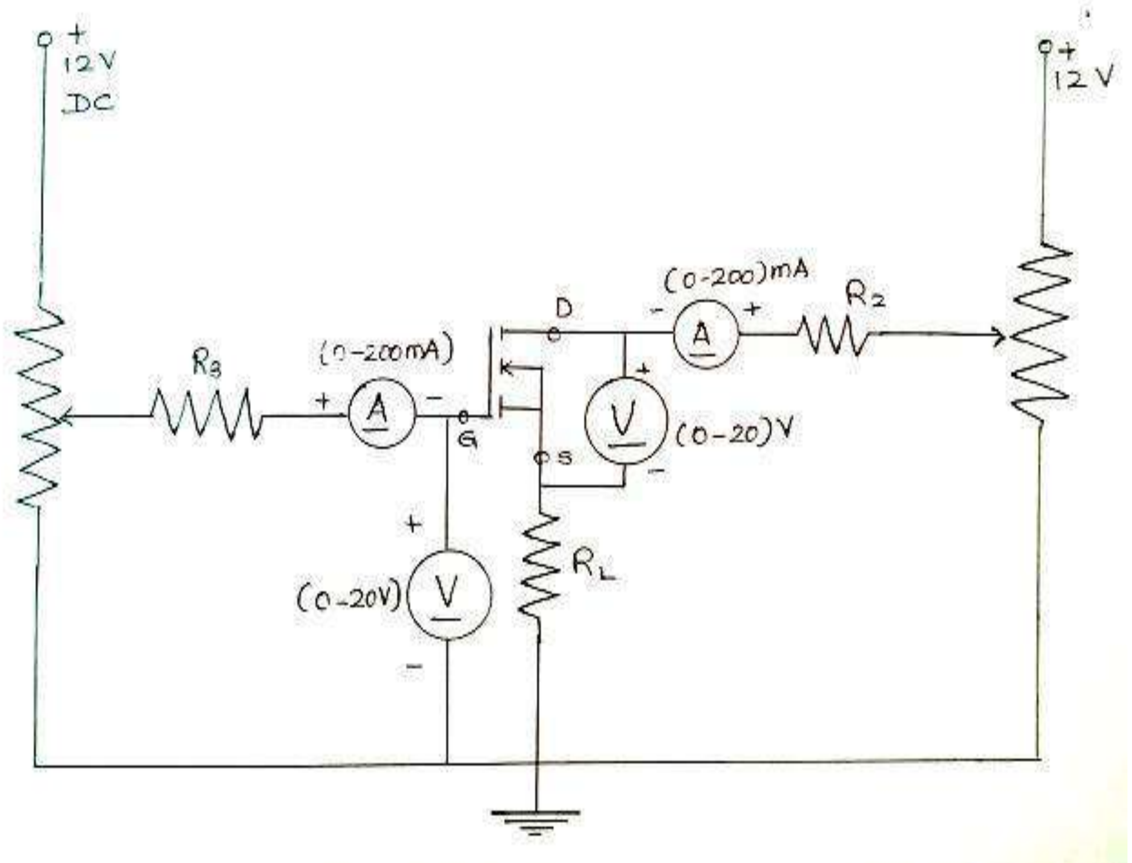
TABULAR COLUMN

S.No.	I_G = (mA)	
	$V_{MT1-MT2}$ (V)	I_{MT1} (mA)

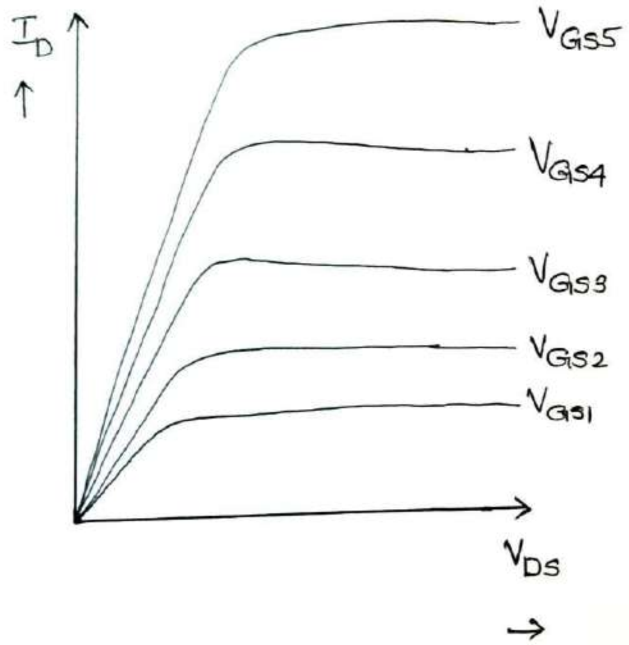
RESULT

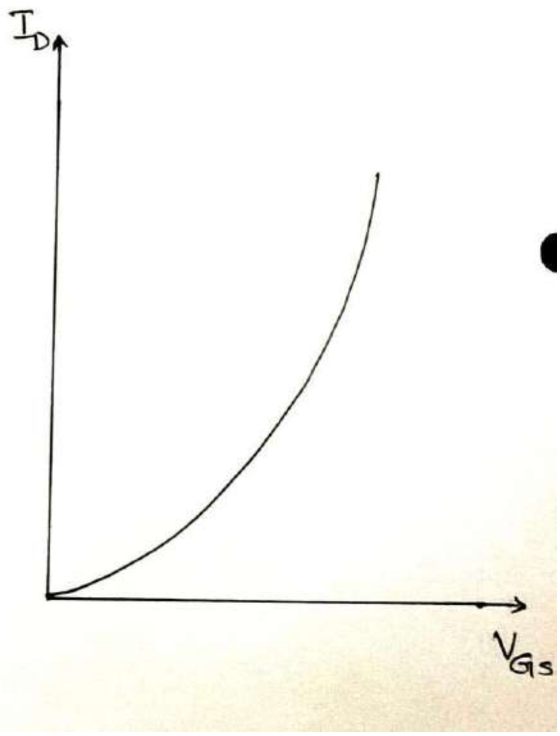
Thus the VI Characteristics of TRIAC using PEC16MIA was determined.

CIRCUIT DIAGRAM



MODEL GRAPH





Ex. No. 3(A) CHARACTERISTICS OF MOSFET

Date:

AIM

To determine the output & transfer characteristics of MOSFET using PEC16MIA

APPARATUS REQUIRED

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	MOSFET Module kit		PEC16MIA	1
2	Voltmeter	(0-30) V	MC	2
3	Ammeter	(0-200)mA	MC	2
4	Patch Chords			As required

THEORY

A metal oxide semiconductor field effect transistor(MOSFET) is a voltage controlled device. As its operation depends upon the flow of majority carriers only, MOSFET is a unipolar device. A power MOSFET has three terminals called drain(D),source(S) & Gate(G). In symbol of MOSFET arrow indicates the direction of electrons flow. The static characteristics of MOSFET are output & transfer characteristics. MOSFETs are widely used for high frequency applications.

PROCEDURE

To determine the Output Characteristics of MOSFET

1) Make the connections as per the circuit diagram.
2) Switch on the supply
3) Set the gate-source voltage (V_{GS}) at a fixed value by varying POT on the gate side.
4) Now slowly increase the drain-source voltage (V_{DS}) by varying the POT on drain-source side from zero till the MOSFET gets turn ON.
5) Note down the V_{DS}& I_D.
6) Further increase the drain-source voltage (V_{DS}) & note down I_D.
7) Draw the characteristics between drain-source voltage (V_{DS})and drain current I_D.

OUTPUT CHARACTERISTICS

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

TRANSFER CHARACTERISTICS

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

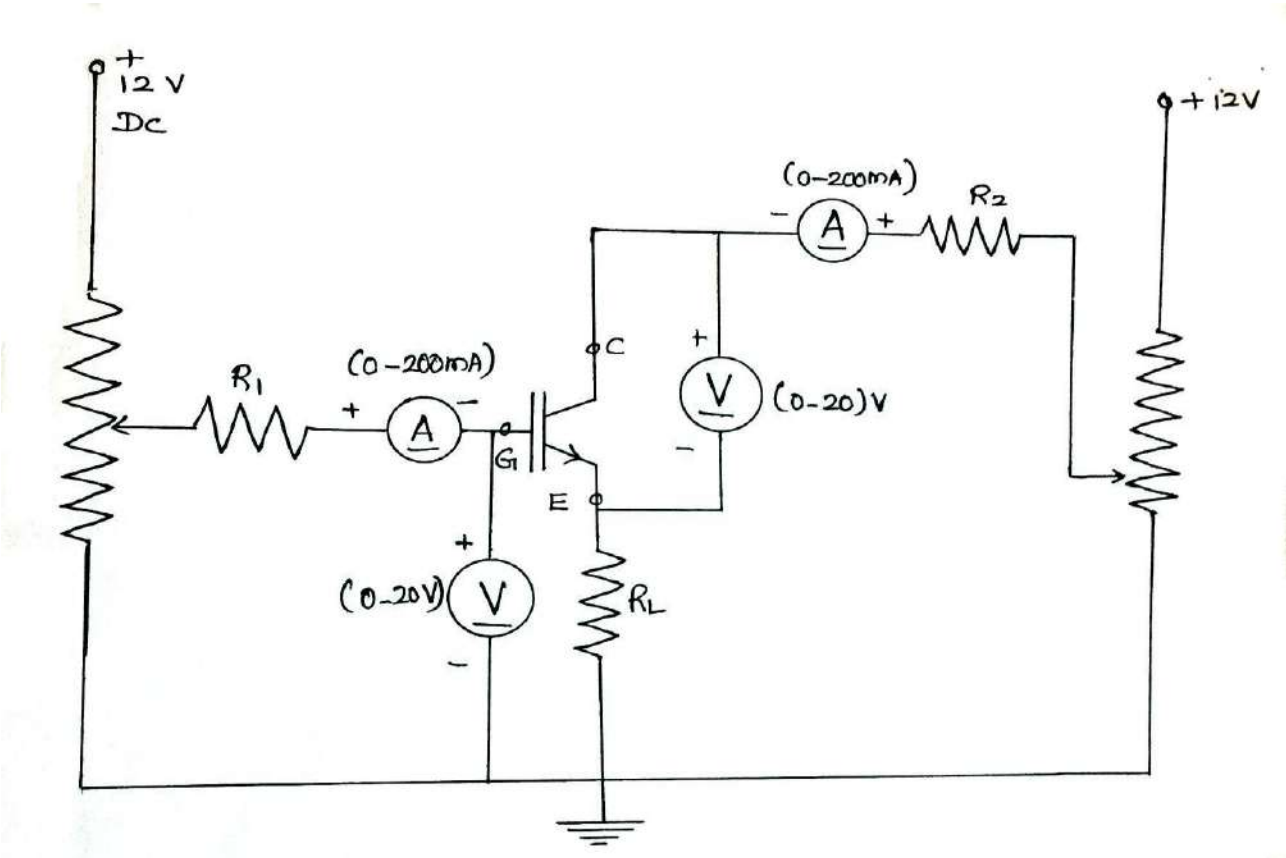
To determine the transfer Characteristics of MOSFET

1) Make the connections as per the circuit diagram.
2) Switch on the supply
3) Set the drain-source voltage (V_{DS}) at a fixed value by varying POT on the drain-source side.
4) Now slowly increase the gate-source voltage (V_{GS}) by varying the POT on gate side from zero till the MOSFET gets turn ON.
5) Note down the V_{GS}& I_D.
6) Further increase the gate-source voltage (V_{GS}) & note down I_D.
7) Draw the characteristics between gate-source voltage (V_{GS})and drain current I_D.

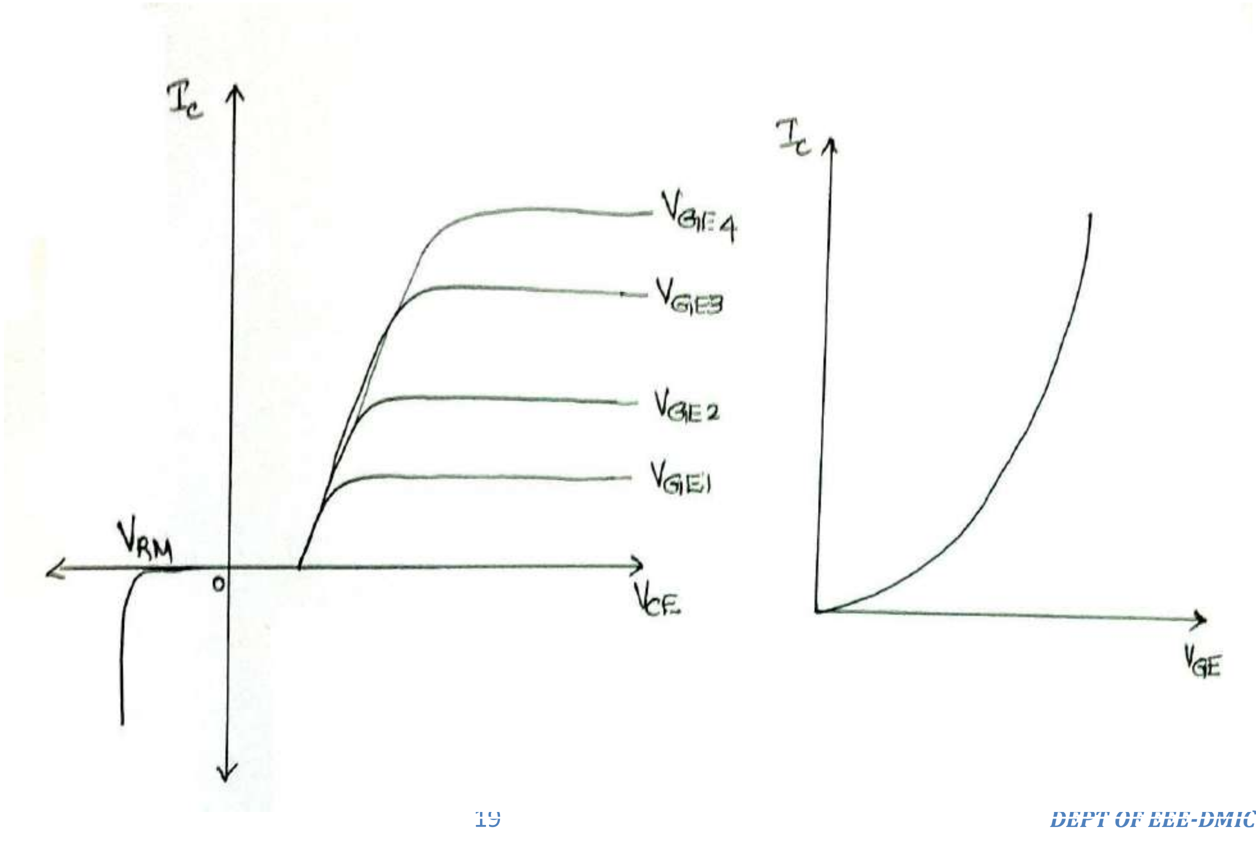
RESULT

Thus the output & transfer characteristics of MOSFET using PEC16MIA were determined.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 3(B) CHARACTERISTICS OF IGBT

Date:

AIM

To determine the output & transfer characteristics of IGBT using PEC16MIA

APPARATUS REQUIRED

S.No.	APPARATUS	RANGE	TYPE	QUANTITY
1	IGBT Module kit		PEC16MIA	1
2	Voltmeter	(0-30) V	MC	2
3	Ammeter	(0-200)mA	MC	2
4	Patch Chords			As required

THEORY

Insulated Gate Bipolar Transistor (IGBT), combines the advantages of both BJT & MOSFET. So an IGBT has high input impedance like MOSFET & low on state power loss as in a BJT. IGBT is free from second breakdown problem. A IGBT has three terminals called collector(C), emitter (E) & Gate(G). The static characteristics of IGBT are output & transfer characteristics. IGBTs are used in medium power applications such as dc & ac drives.

PROCEDURE

To determine the Output Characteristics of IGBT

1) Make the connections as per the circuit diagram.
2) Switch on the supply
3) Set the gate-emitter voltage (V_{GE}) at a fixed value by varying POT on the gate side.
4) Now slowly increase the collector-emitter voltage (V_{CE}) by varying the POT on collector-emitter side from zero till the IGBT gets turn ON.
5) Note down the V_{CE}& I_C.
6) Further increase the collector-emitter voltage (V_{CE}) & note down I_C.
7) Draw the characteristics between collector-emitter voltage (V_{CE}) and collector current I_C.

OUTPUT CHARACTERISTICS

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

TRANSFER CHARACTERISTICS

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

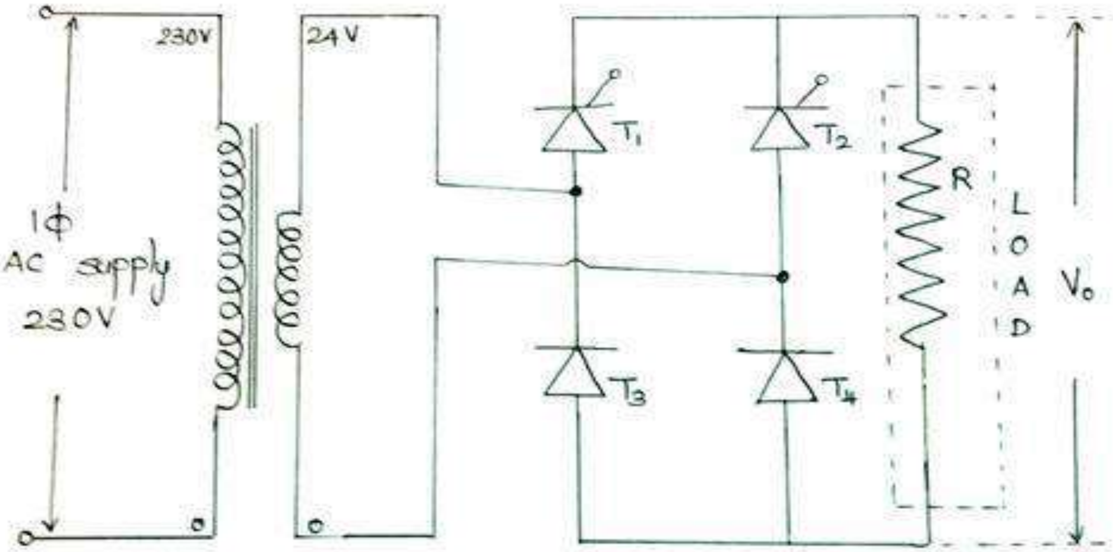
To determine the transfer Characteristics of IGBT

1) Make the connections as per the circuit diagram.
2) Switch on the supply
3) Set the collector-emitter voltage (V_{CE}) at a fixed value by varying POT on the collector-emitter side.
4) Now slowly increase the gate-emitter voltage (V_{GE}) by varying the POT on gate side from zero till the IGBT gets turn ON.
5) Note down the V_{GE}& I_C.
6) Further increase the gate-emitter voltage (V_{GE}) & note down I_C.
7) Draw the characteristics between gate-emitter voltage (V_{GE}) and collector current I_C.

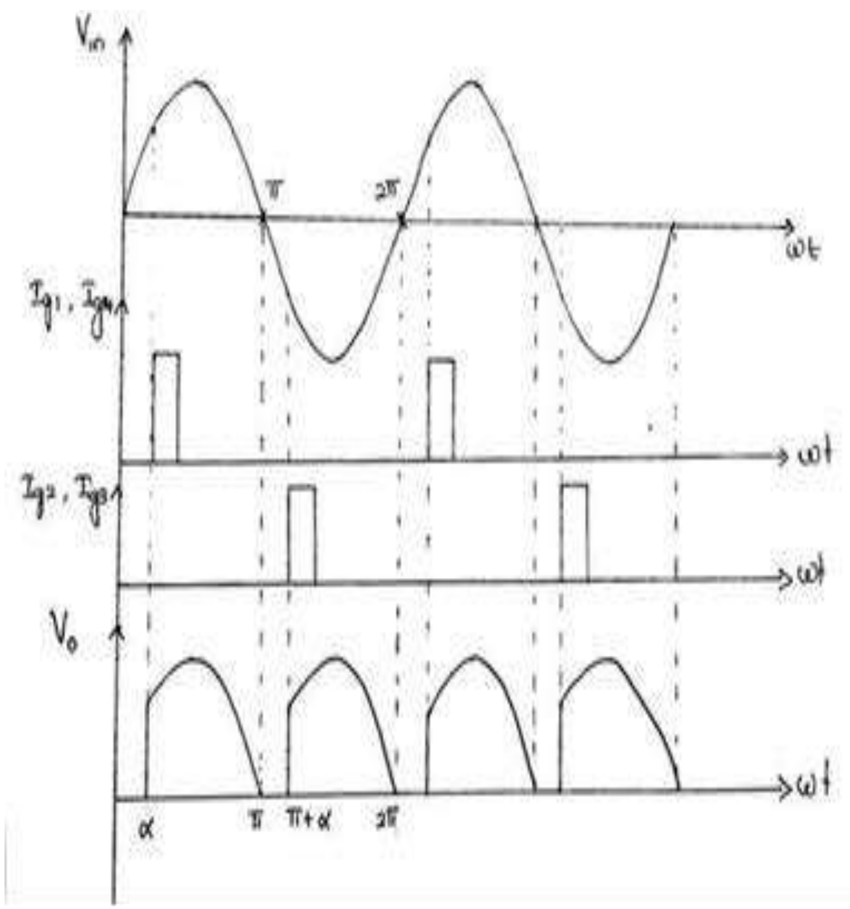
RESULT

Thus the output & transfer characteristics of IGBT using PEC16MIA were determined.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 4 AC TO DC HALF CONTROLLED CONVERTER

Date:

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
2	SCR firing circuit kit	1Φ ,230V,5A	-	1
3	CRO	20MHz	-	1
4	Patch chords	-	-	As Required

THEORY

A rectifier is a device which converts input ac signal into output dc signal. A thyristor is turned off as ac supply voltage reverse biases it, provided anode current has fallen to a level below the holding current. A single phase semi converter topology employs two SCRs & two diodes. It employs one SCR & one diode in each leg. It offers one-quadrant operation. Freewheeling action in semi-converter circuits render better power factor.

FORMULA

$$V_o = V_m(1+\cos\alpha)/\Pi$$

Where, V_o – Output voltage

V_m – Input Voltage

α - Duty Cycle

PROCEDURE

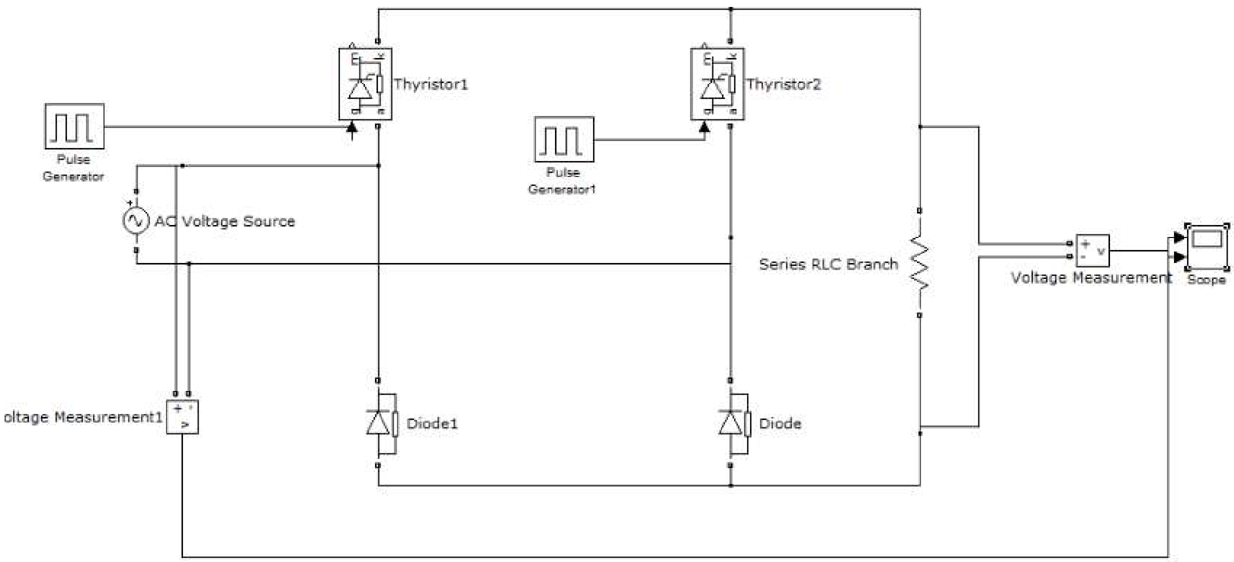
1. Make the connections as per the circuit diagram.
2. Switch on the thyristor kit and firing circuit kit.
3. Vary the firing angle in steps.
4. Observe the waveform from the CRO & Note down the Input & Output, Amplitude & time readings.
5. Draw the Output Response.

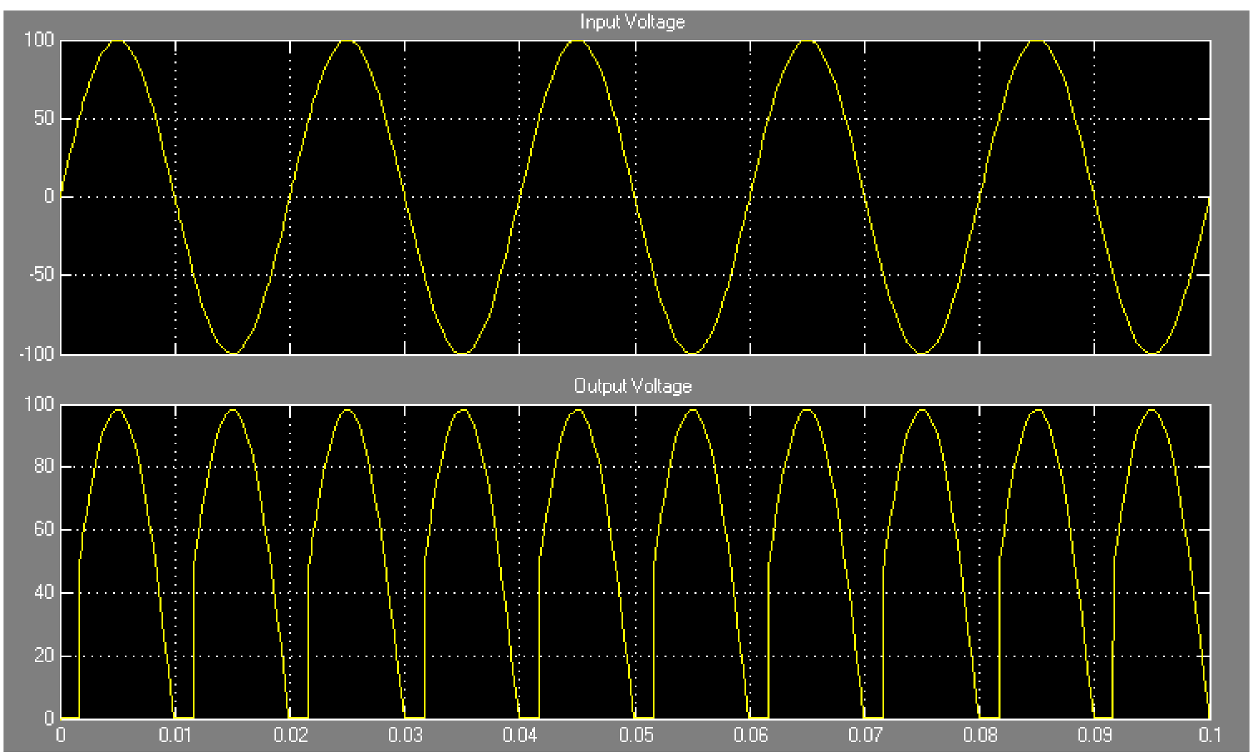
TABULATOR COLUMN

S.No.	Amplitude(V)	Time Period (mS)	Firing Angle α (Degree)	Output Voltage Vo (Volts)

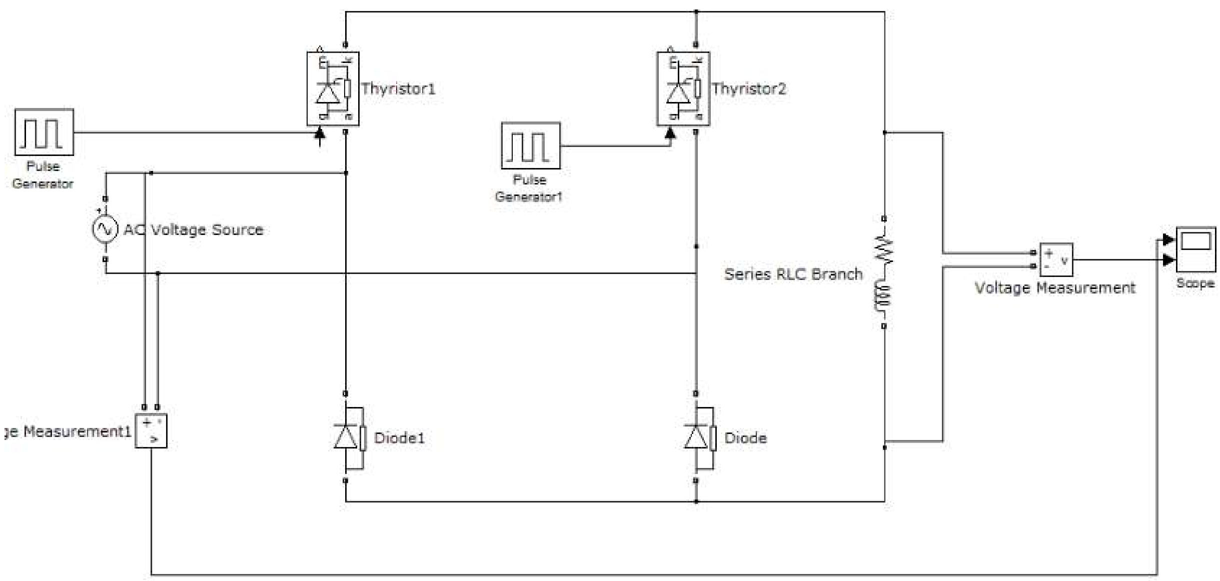
SIMULATION

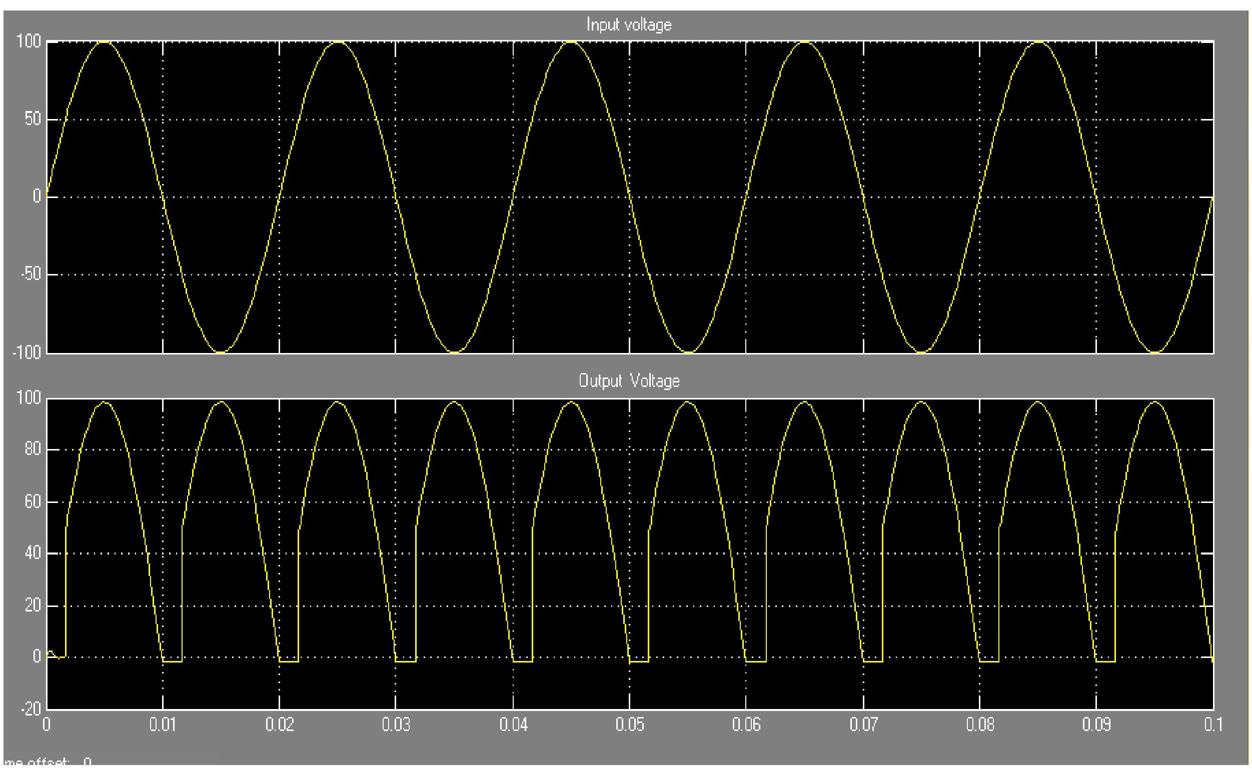
R LOAD



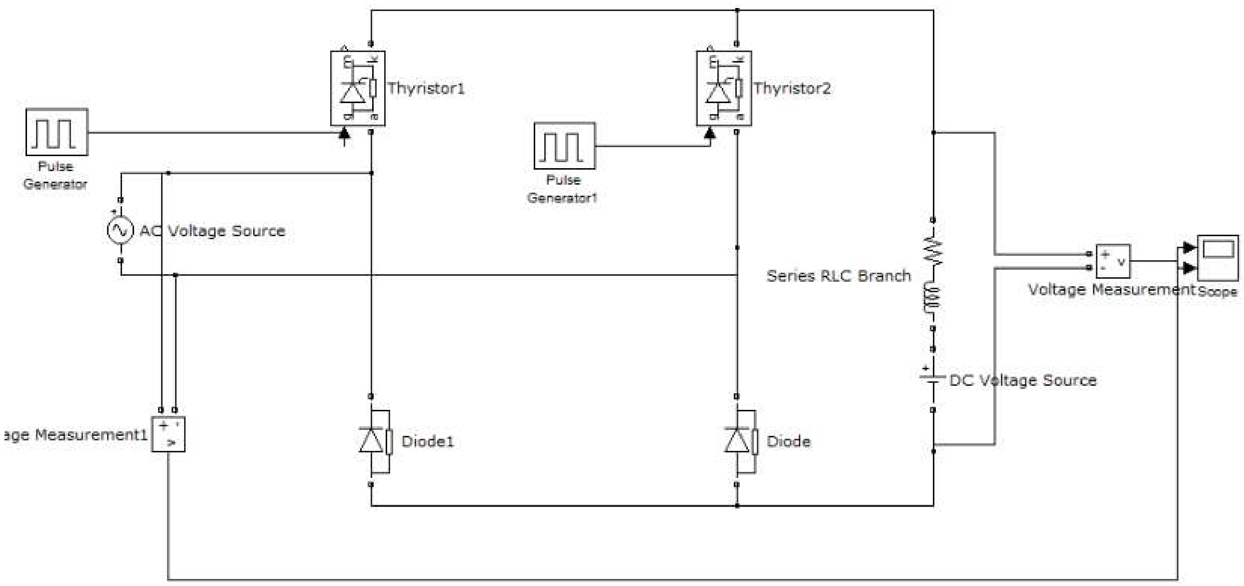


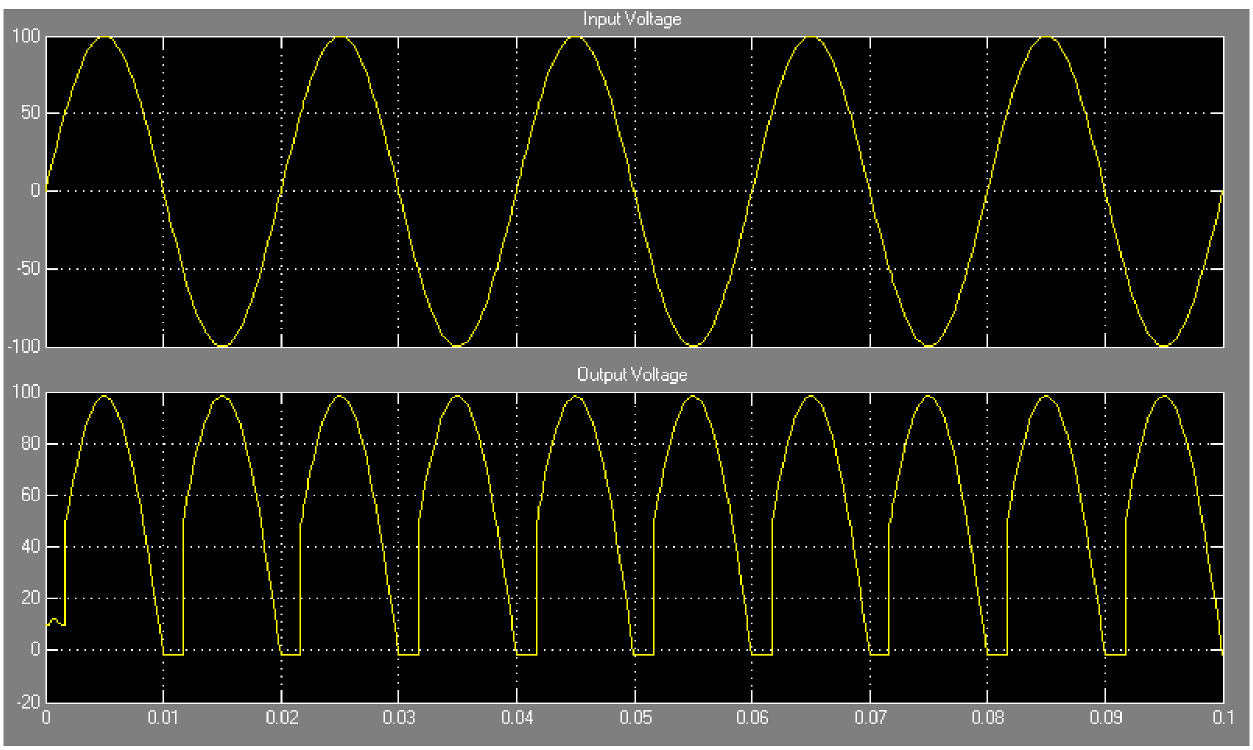
RL LOAD


Thyristor1
Thyristor2
Pulse Generator
Pulse Generator1
AC Voltage Source
Series RLC Branch
Voltage Measurement
Scope
ge Measurement1
Diode1
Diode


Input voltage
Output Voltage
100
50
0
-50
-100
80
60
40
20
-20
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1

RLE LOAD

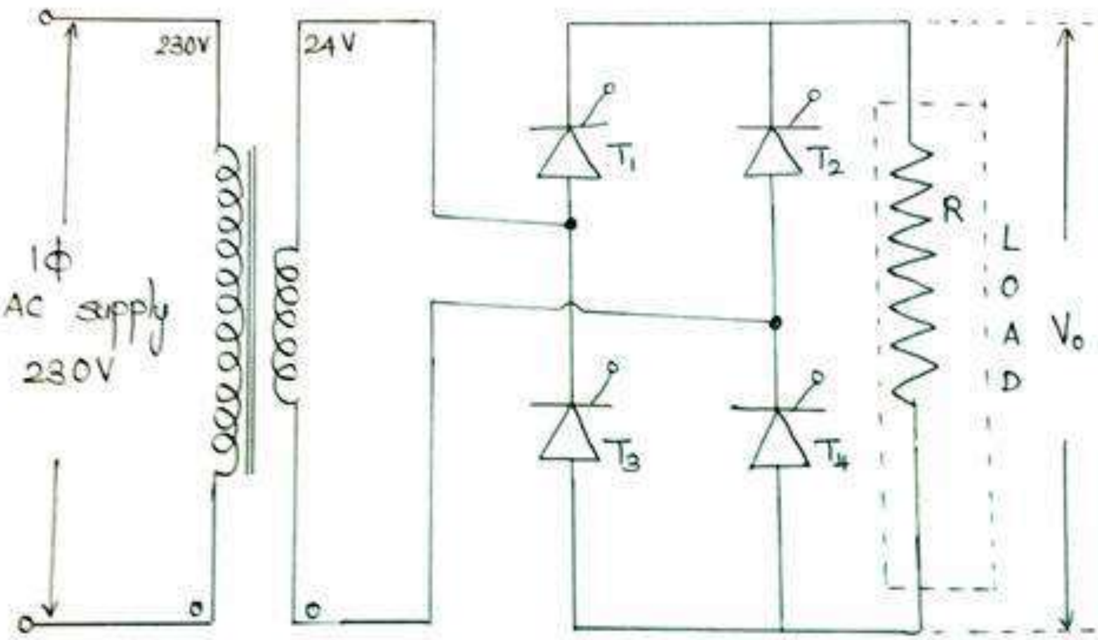

Thyristor1
Thyristor2
Pulse Generator
Pulse Generator1
AC Voltage Source
Series RLC Branch
Voltage Measurement
Scope
DC Voltage Source
age Measurement1
Diode1
Diode


Input Voltage
Output Voltage
100
50
0
-50
-100
80
60
40
20
-20
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1

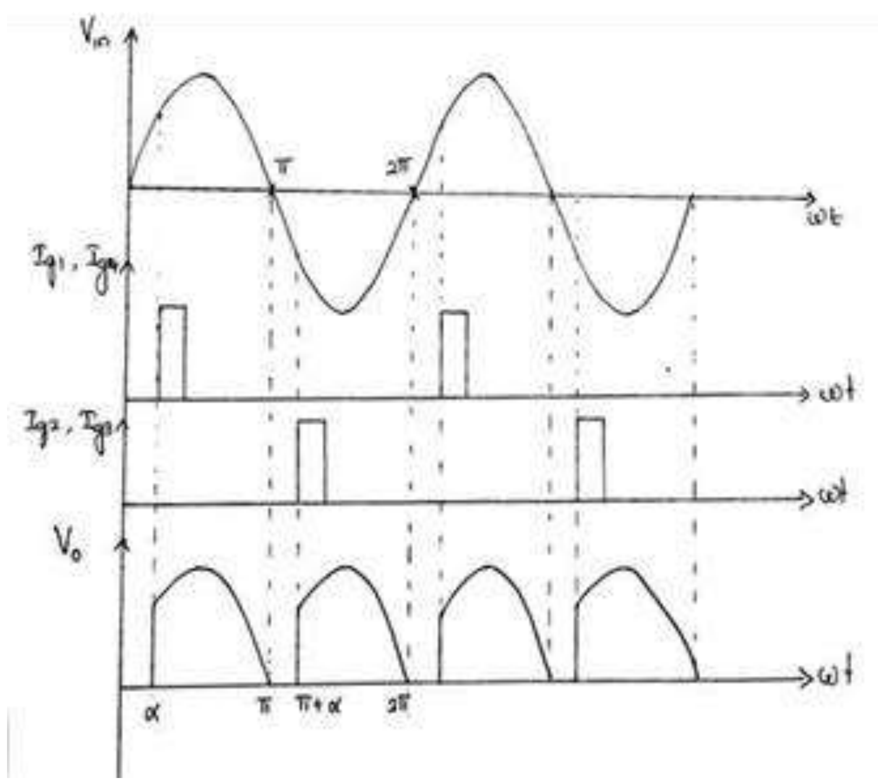
RESULT

Thus a single-phase half controlled converter was constructed and their Output waveforms were plotted.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 5 AC TO DC FULLY CONTROLLED CONVERTER

Date:

AIM

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

APPARATUS REQUIRED

S.NO	ITEM	RANGE	QUANTITY
1	Fully controlled Converter Power circuit kit	1ϕ, 230V,10A	1
2	SCR firing circuit kit	1Φ ,230V,5A	1
3	CRO	20MHz	1
4	Patch chords	-	As Required

THEORY

A single phase full converter employs four SCRs.. When an incoming SCR is turned on by triggering, it immediately reverse biases the outgoing SCR & turns it off. It can furnish two-quadrant operation. A firing angle is defined as the angle measured from the instant that gives the largest average output voltage to the instant it is triggered. Phase Control is used for controlling the load currents.

FORMULA

$V_o = 2V_m \cos\alpha / \Pi$

Where, V_o – Output voltage

V_m – Input Voltage

α - Duty Cycle

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Switch on the thyristor kit and firing circuit kit.
3. Vary the firing angle in steps.
4. Observe the waveform from the CRO & Note down the Input & Output, Amplitude & time readings.
5. Draw the Output Response.

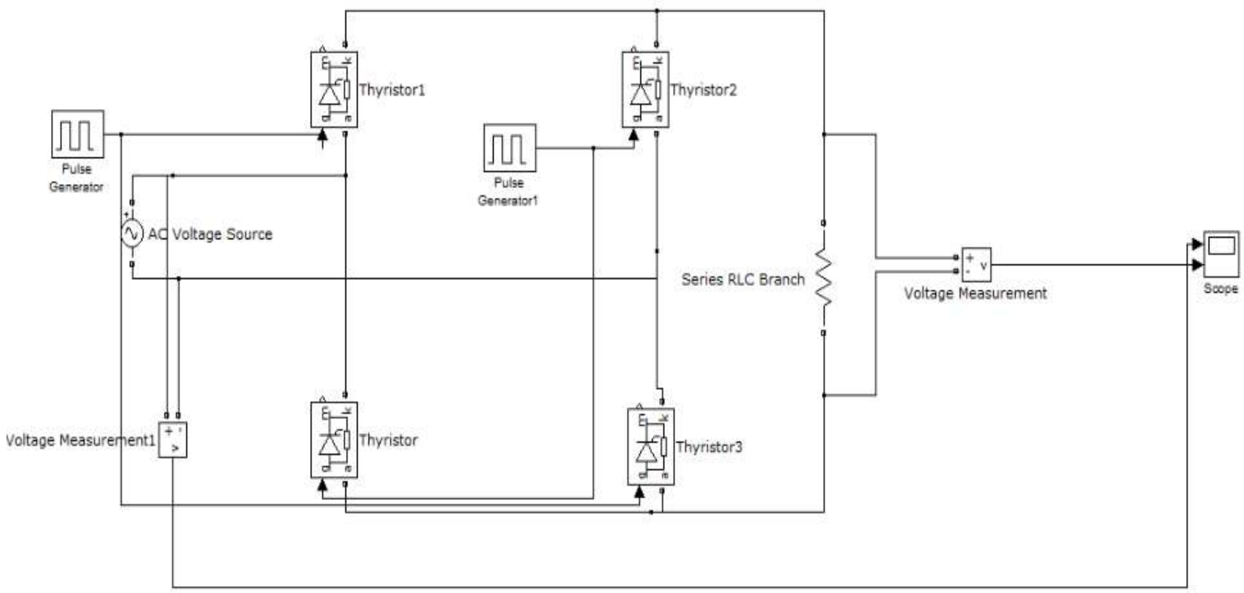
TABULATOR COLUMN

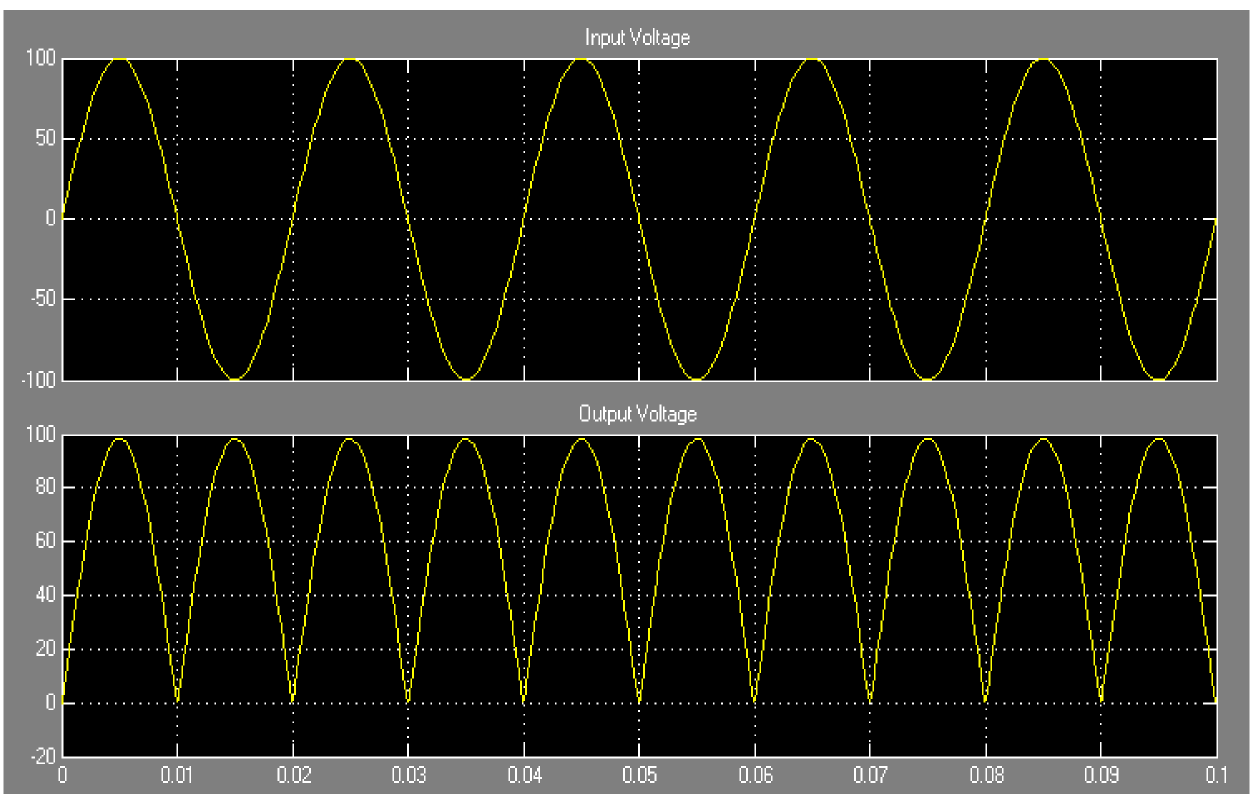
S.No.	Amplitude(V)	Time Period (mS)	Firing Angle α (Degree)	Output Voltage Vo (Volts)

SIMULATION

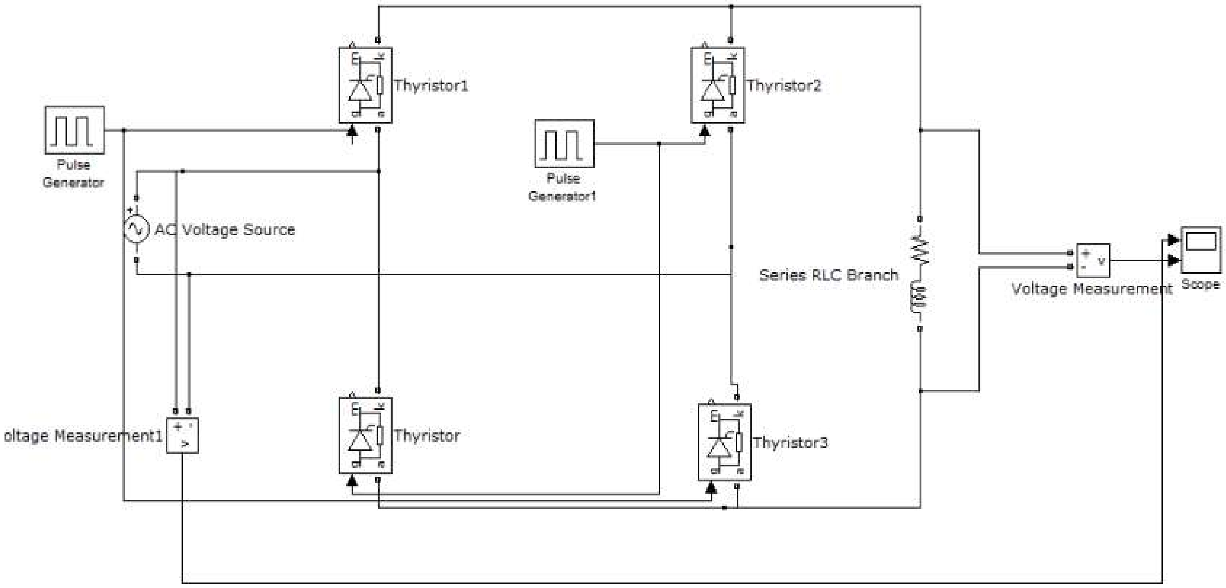
a) 1 Φ FULL CONVERTER

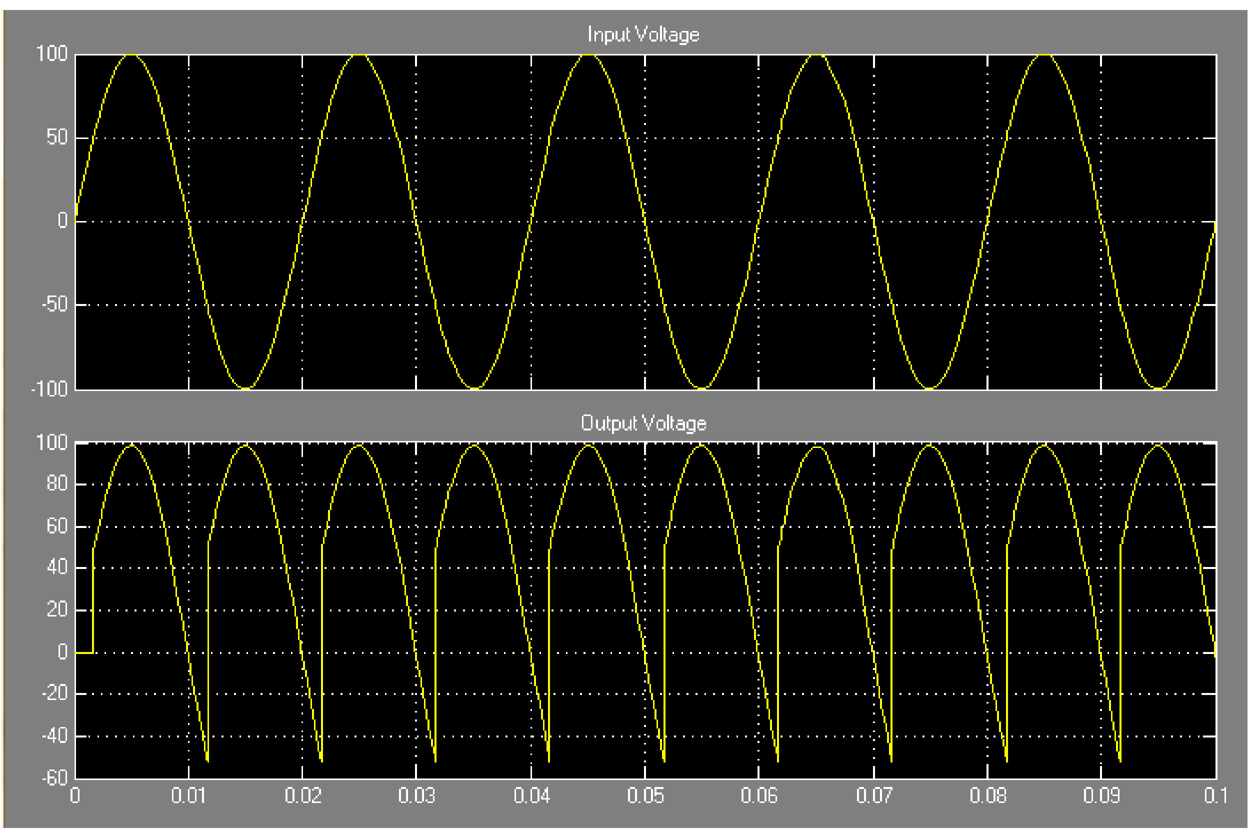
R LOAD



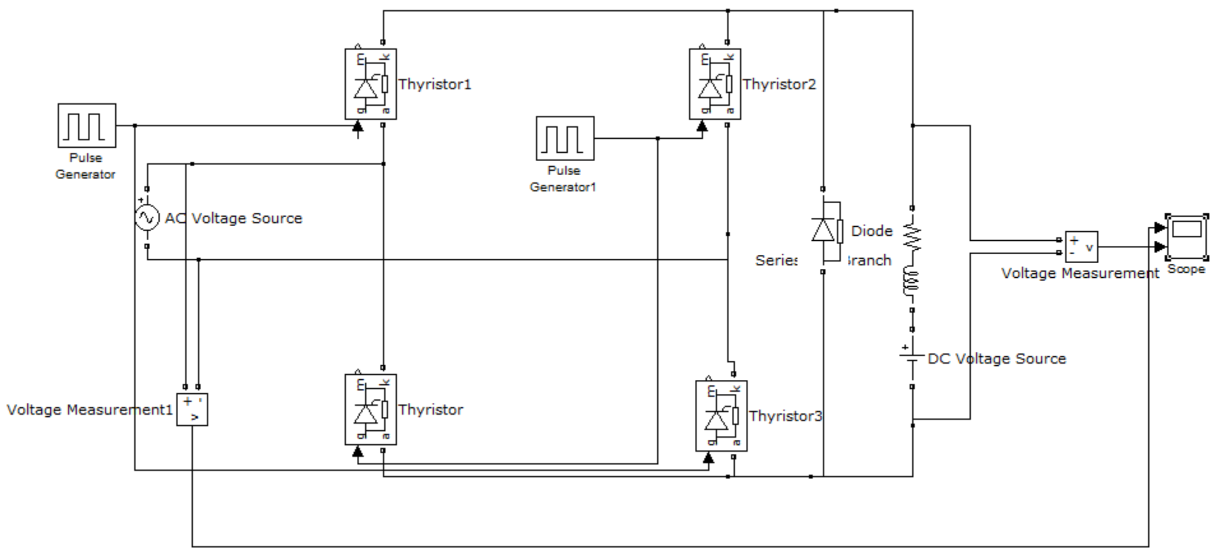


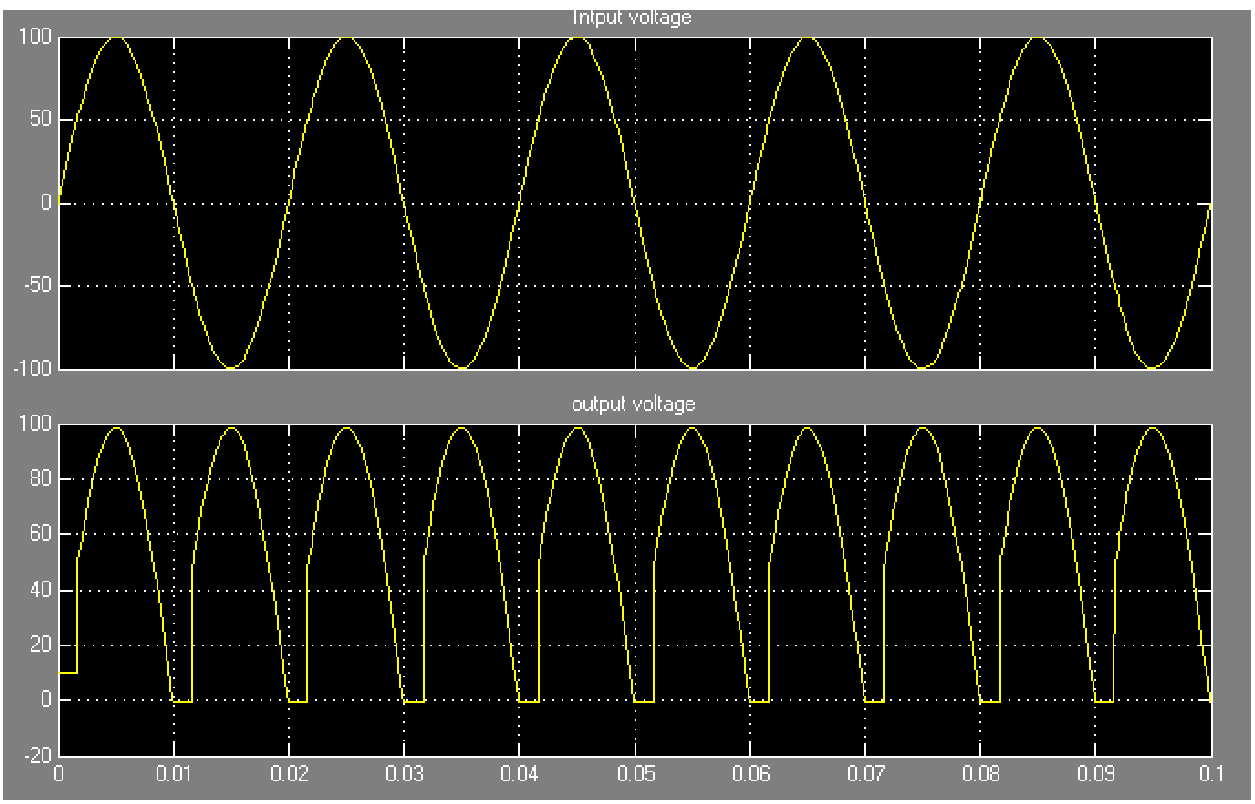
RL LOAD


Thyristor1
Thyristor2
Pulse Generator
Pulse Generator1
AC Voltage Source
Series RLC Branch
Voltage Measurement
Scope
oltage Measurement1
Thyristor
Thyristor3


Input Voltage
100
50
0
-50
-100
Output Voltage
100
80
60
40
20
0
-20
-40
-60
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1

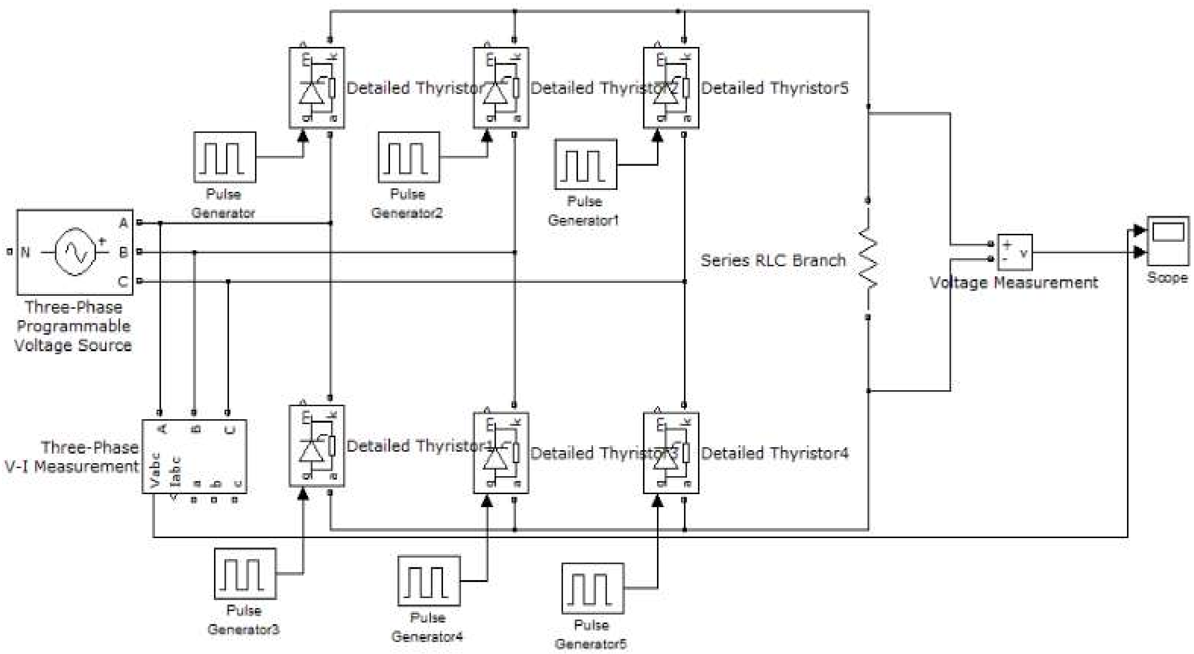
RLE LOAD


Thyristor1
Thyristor2
Pulse Generator
Pulse Generator1
AC Voltage Source
Diode
Series
ranch
Voltage Measurement
Scope
DC Voltage Source
Voltage Measurement1
Thyristor
Thyristor3

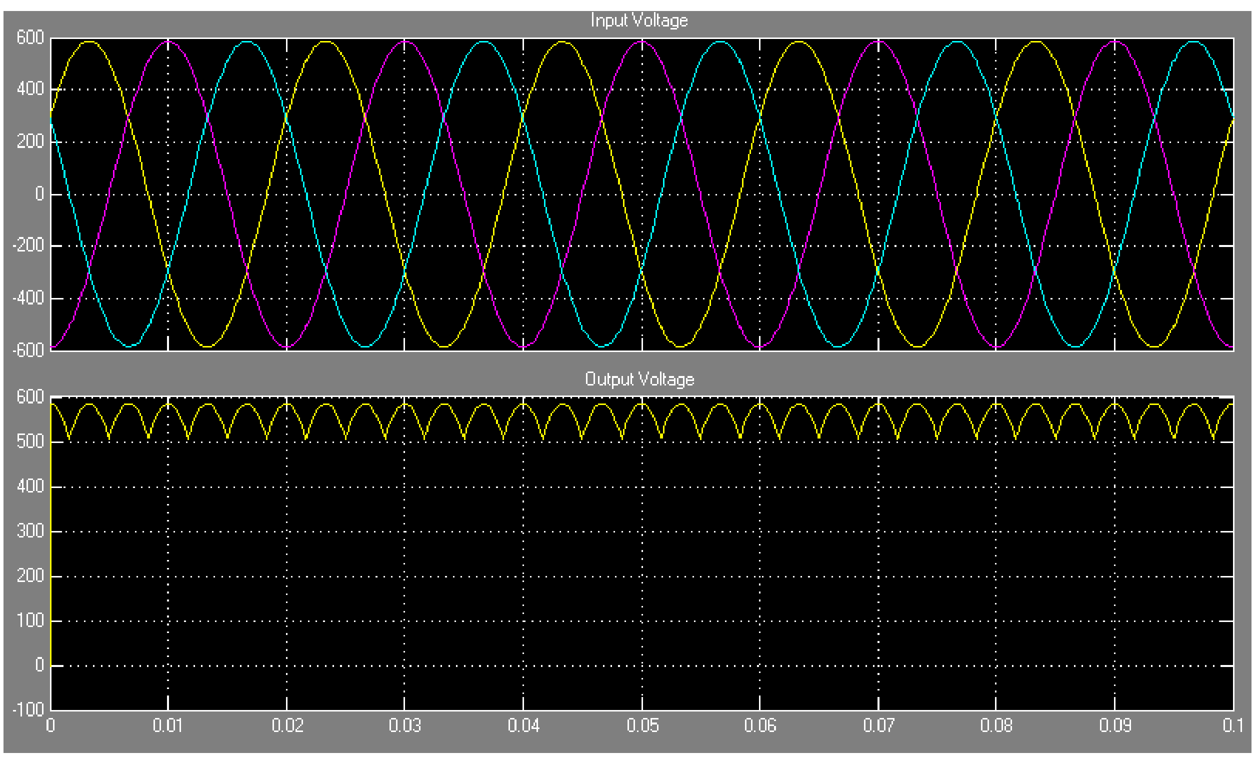

Intput voltage
output voltage

b) 3 Φ FULL CONVERTER

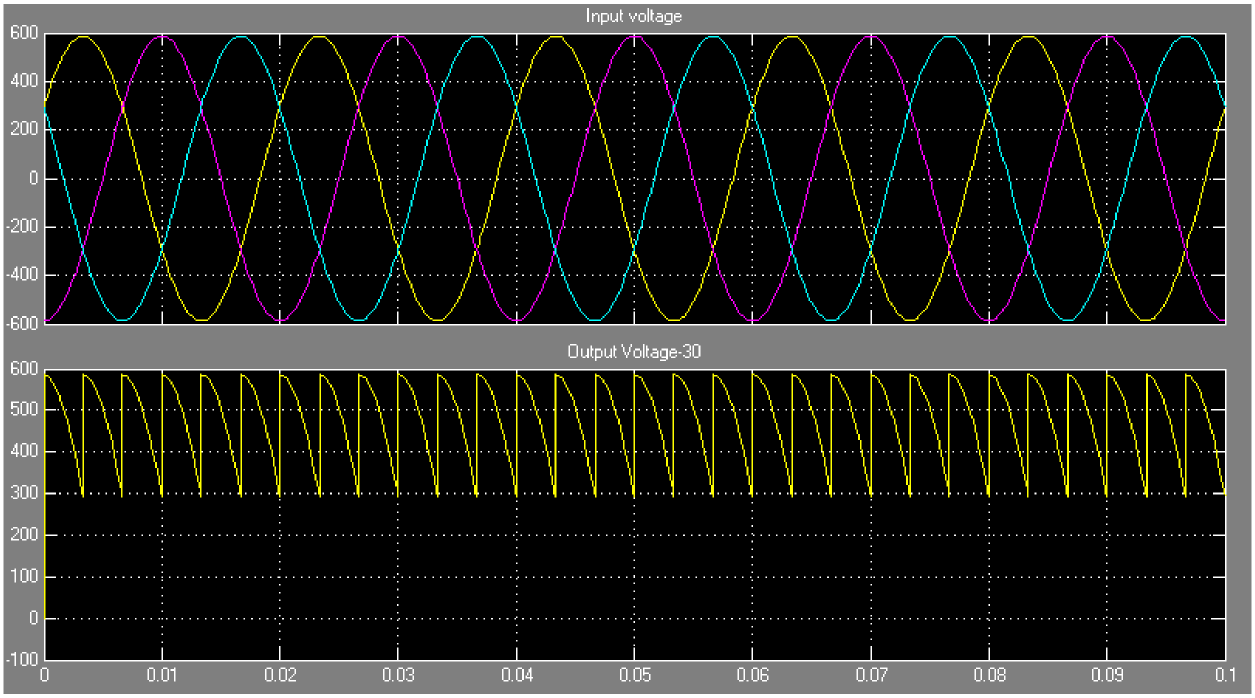
R LOAD



α = 0^0



α = 30^0

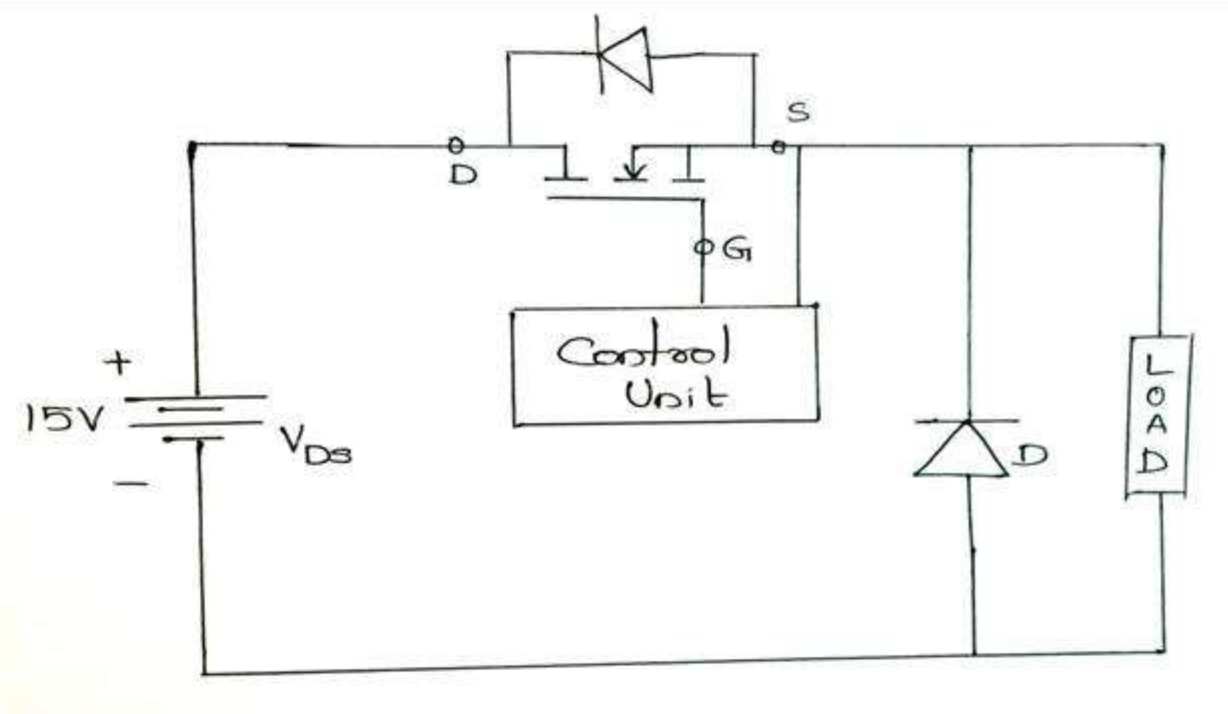


RESULT

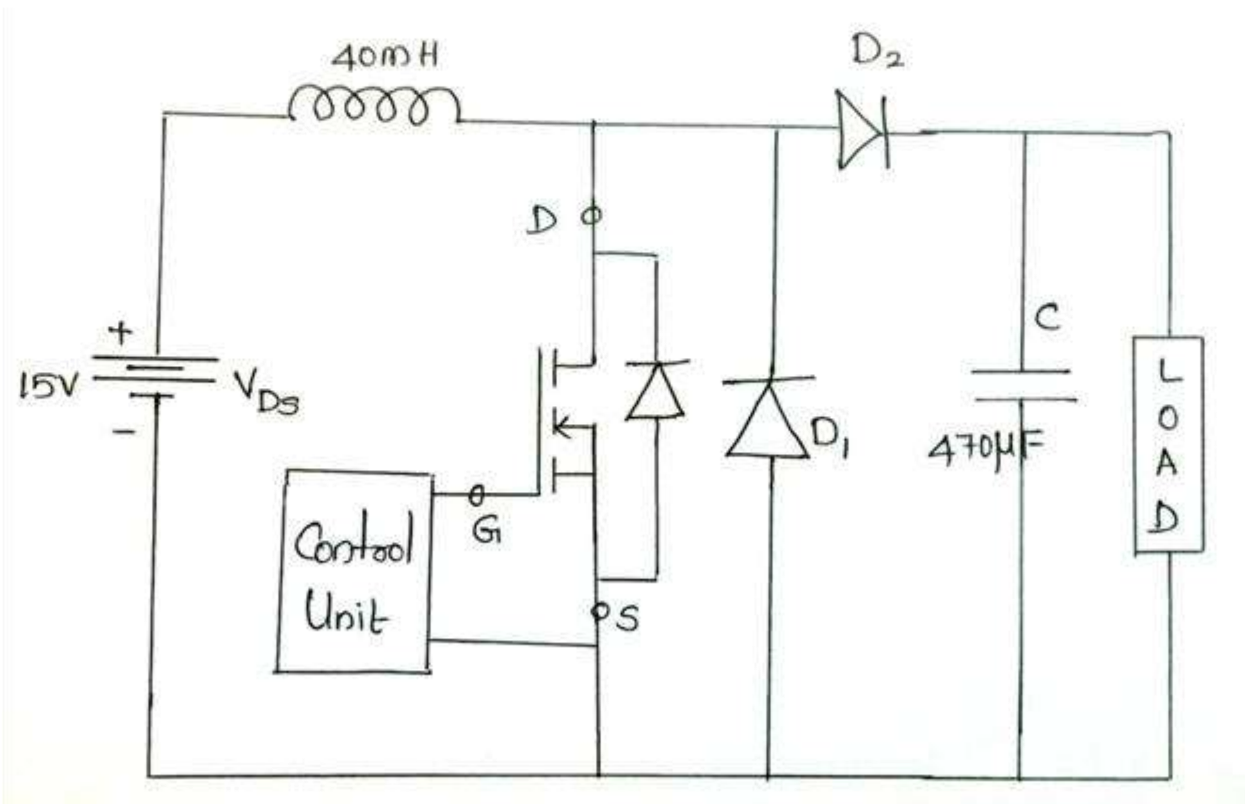
Thus a single-phase fully controlled converter was constructed and their responses were plotted.

CIRCUIT DIAGRAM

STEP DOWN CHOPPER



STEP UP CHOPPER



Ex. No. 6 STEP UP AND STEP DOWN MOSFET BASED CHOPPERS

Date:

AIM

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

APPARATUS REQUIRED

S.NO	ITEM	RANGE	QUANTITY
1	Step up & Step down MOSFET based chopper kit		1
2	RPS		1
3	Rheostat		1
4	CRO	20 MHZ	1
5	Patch chords		As required

THEORY

A chopper is a static device that converts fixed dc input voltage to a variable dc output voltage directly.

Average output voltage V_o is less than the input voltage V_s , $V_o<V_s$; This configuration is therefore called step down chopper. Average output voltage V_o greater than input voltage V_s, $V_o>V_s$; This configuration is therefore called step up chopper.

FORMULA:

STEP DOWN CHOPPER:

$$V_0=V_{in}\delta$$

STEP UP CHOPPER:

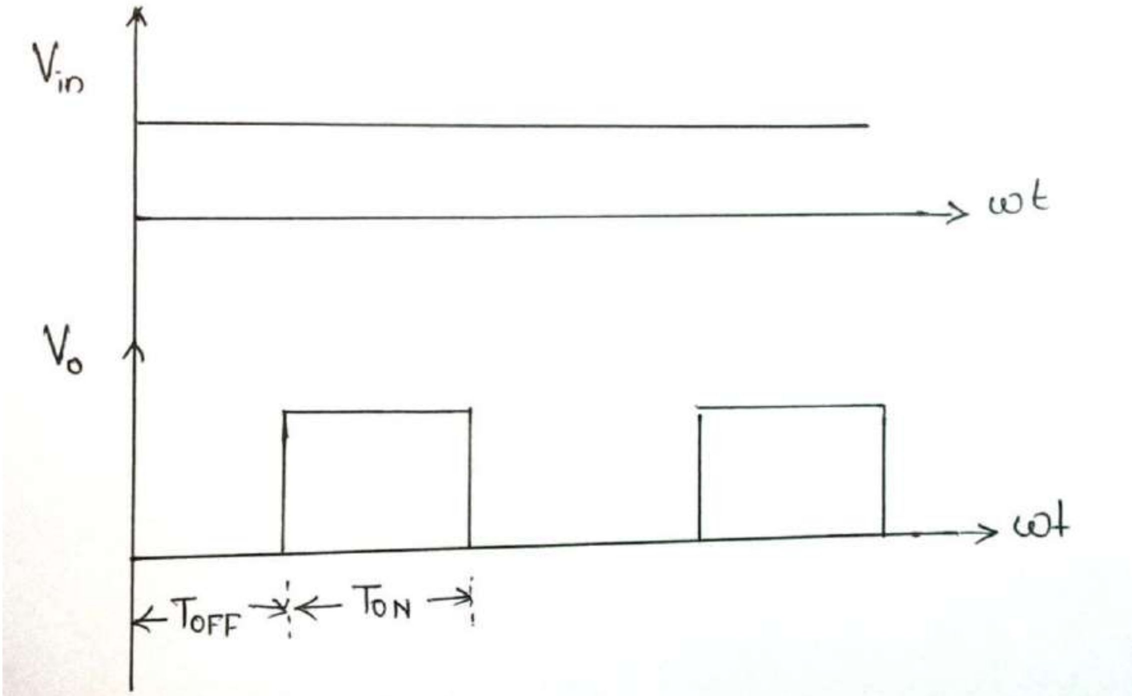
$$V_0=V_{in}/1-\delta$$

Where, V_0-Output Voltage

V_{in}-Input Voltage

δ – Duty Cycle

MODEL GRAPH



TABULAR COLUMN (STEP UP CHOPPER)

S.NO	T_{ON}	T_{OFF}	$T= T_{ON}+ T_{OFF}$	$\Delta= T_{ON}/T$	V_0 (volts) practical	$V_0=V_{in}/1-\delta$

PROCEDURE (STEP UP CHOPPER & STEP DOWN CHOPPER)

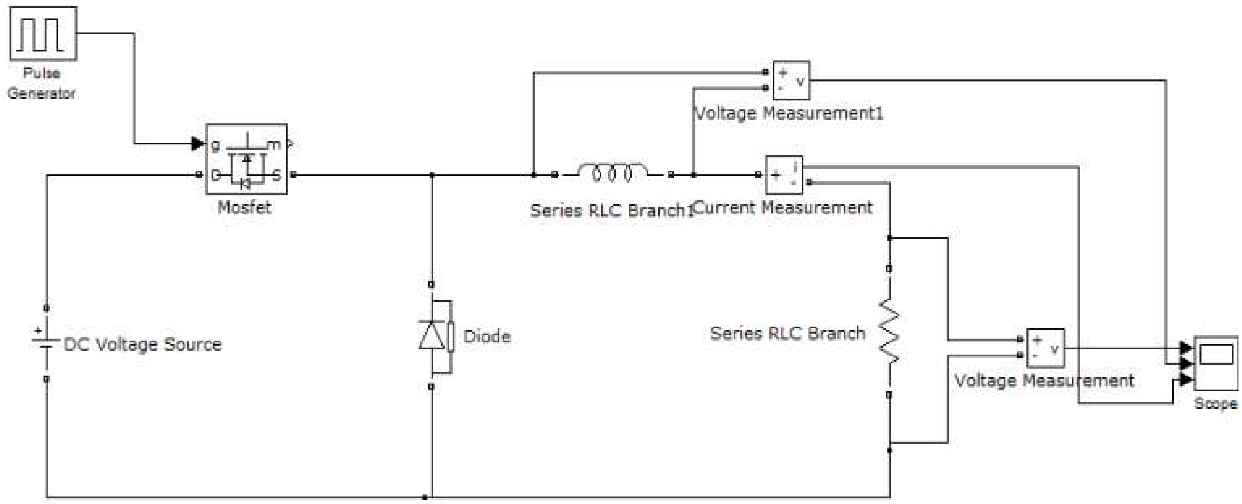
1. Make the connection as per the circuit diagram
2. Initially keep all the switches in the OFF position
3. Initially keep duty cycle POT in minimum position
4. Connect DC supply from variable DC source
5. Set the input DC supply to 10V. View the input voltage in CRO.
6. Then switch ON the driver circuit & power circuit
7. Observe the output voltage across the load
8. Draw the waveform for different duty cycle & different frequency.

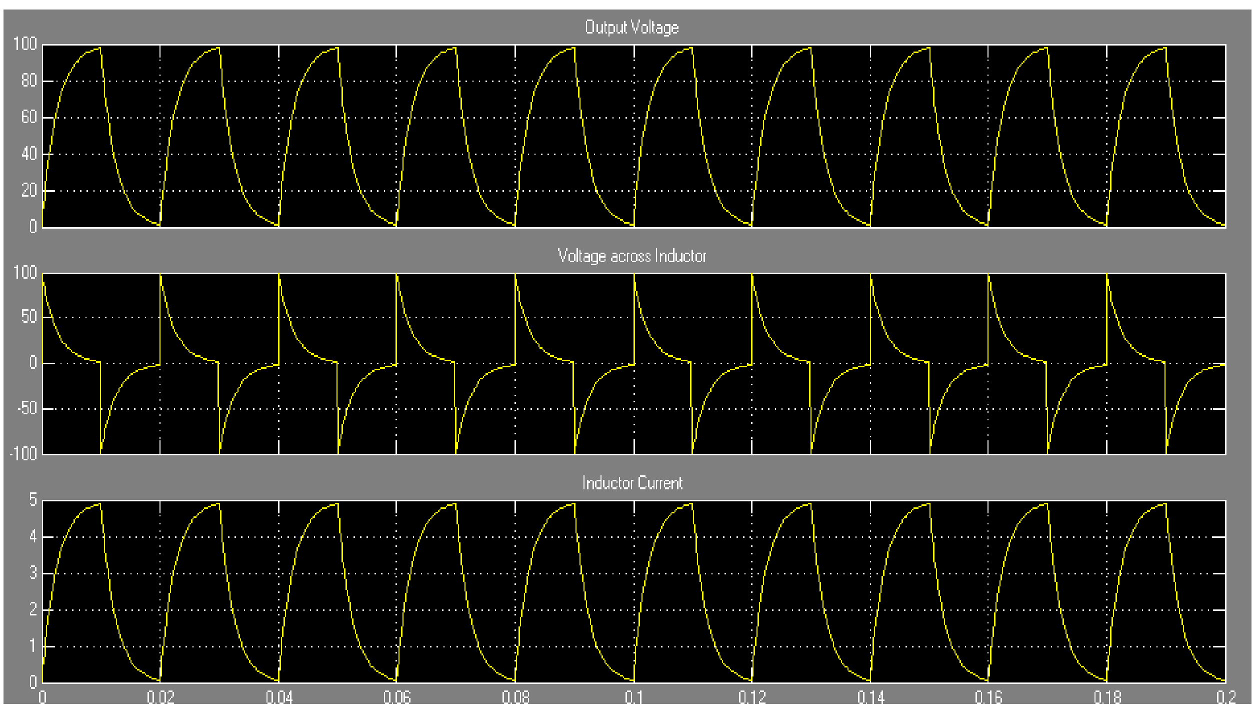
TABULAR COLUMN (STEP DOWN CHOPPER)

S.NO	T_{ON}	T_{OFF}	$T= T_{ON}+ T_{OFF}$	$\Delta= T_{ON}/T$	V_0 (volts) practical	$V_0=V_{in}\delta$

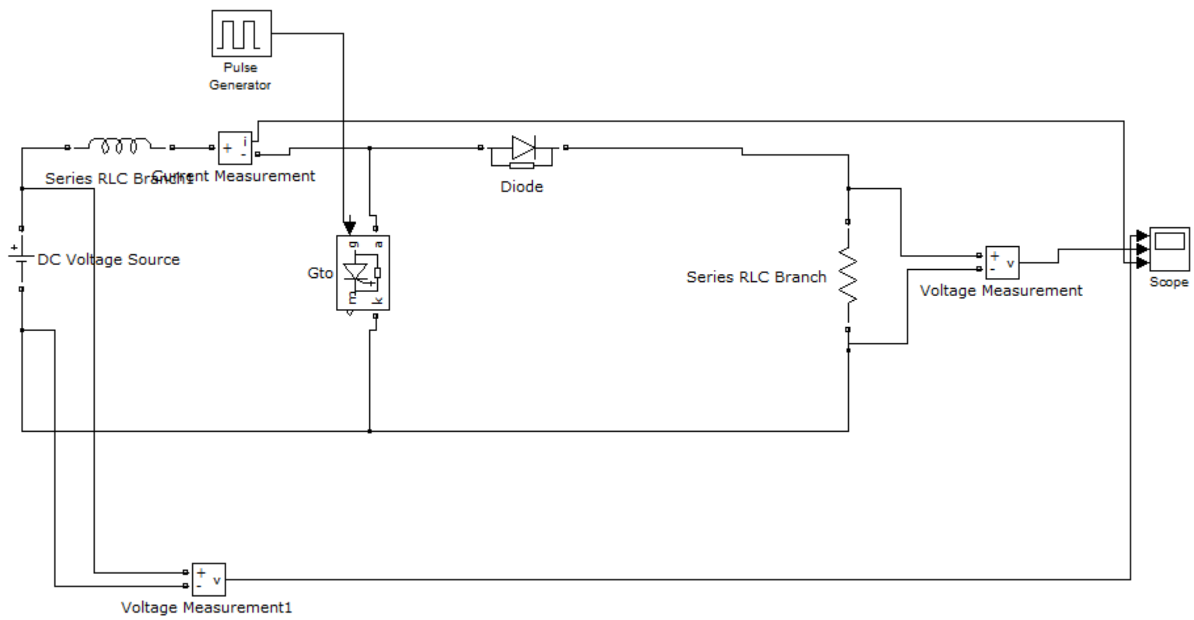
SIMULATION

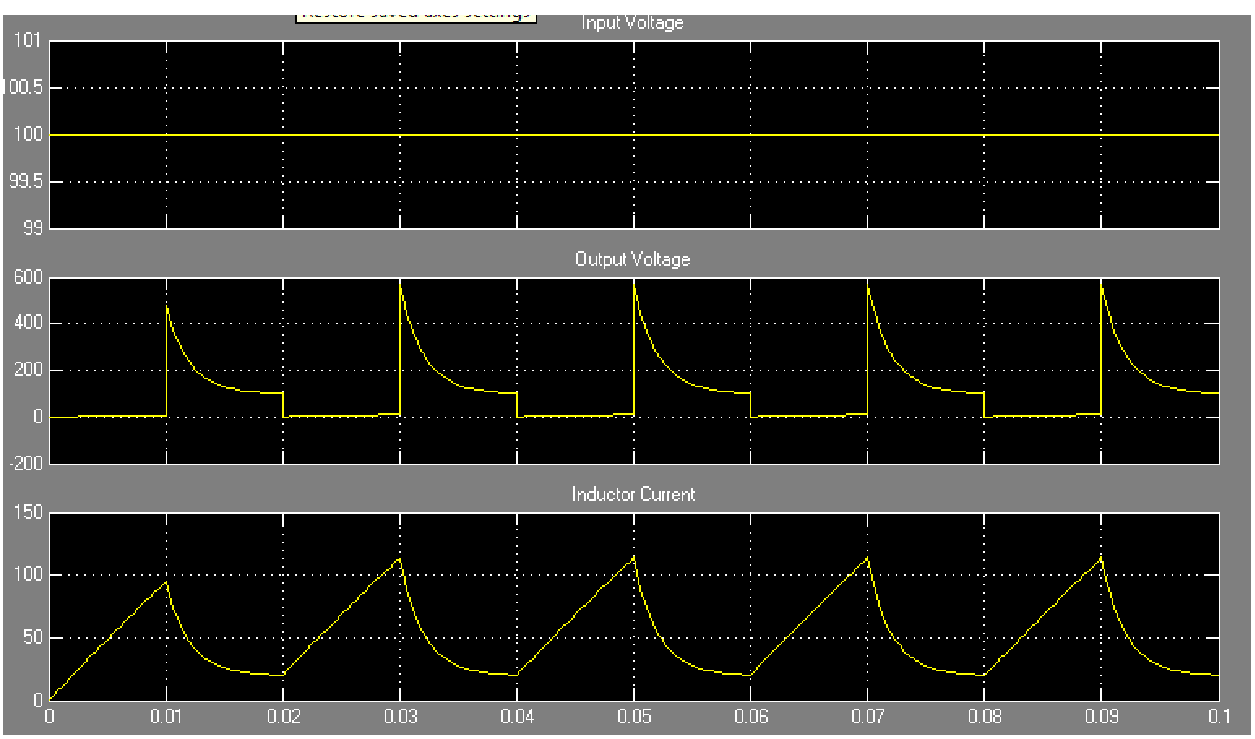
a) STEP DOWN CHOPPER





a) STEP UP CHOPPER

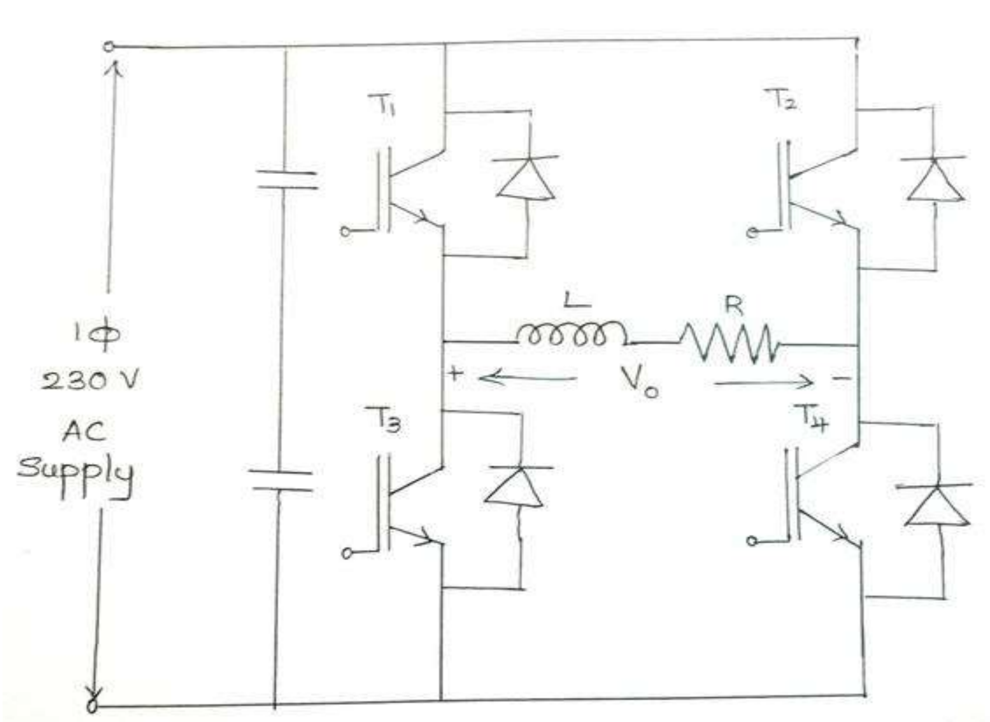




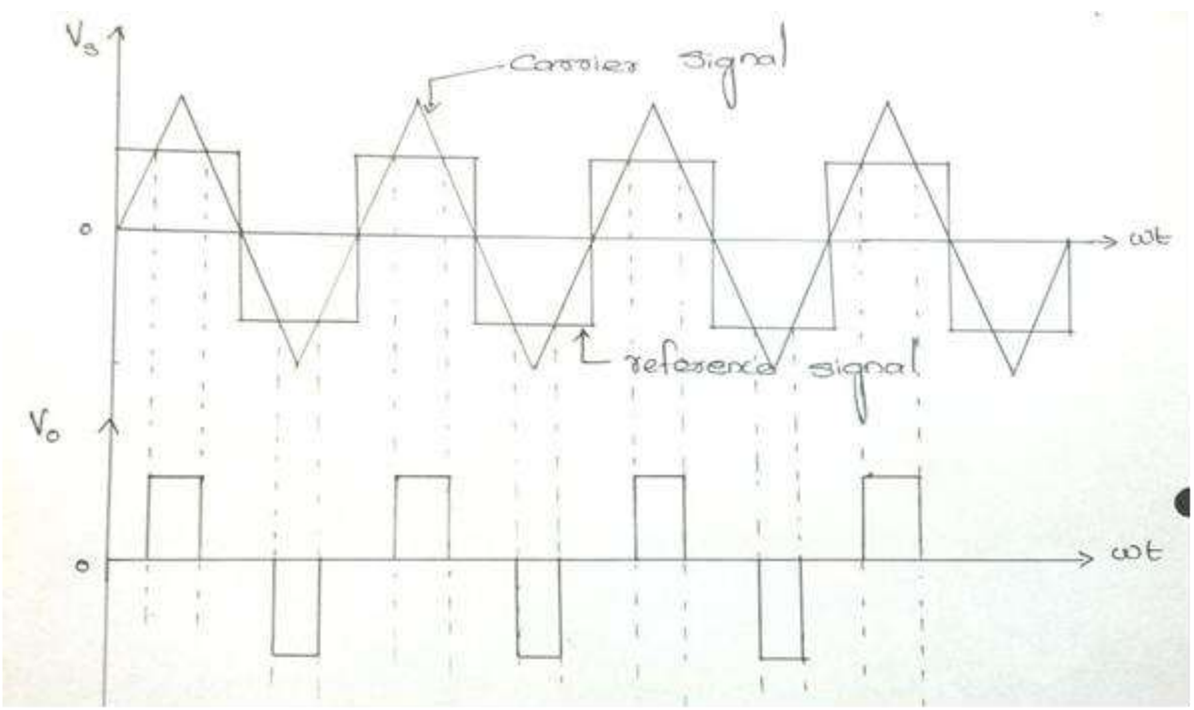
RESULT

Thus the operation of a step up & step down MOSFET based chopper was determined.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 7 IGBT BASED SINGLE PHASE PWM INVERTER

Date:

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	Inverter Control Module		PEC16MIA	1
3	CRO	20MHZ		1
4	Load rheostat	50Ω/5A		1
5	Patch Chord			As required

THEORY

PWM inverters are characterized by constant amplitude pulses. The width of these pulses is modulated to obtain inverter output voltage control & to reduce its harmonic content.

A fixed dc input voltage is given to inverter & a controlled ac output voltage is obtained by adjusting on & off periods of the inverter components. Pulse Width Modulation is the most popular method of controlling the output voltages.

FORMULA

Modulation Index, $M=A_r/A_c$ or V_r/V_c

Output Voltage, $V_o=V_{in}*M$

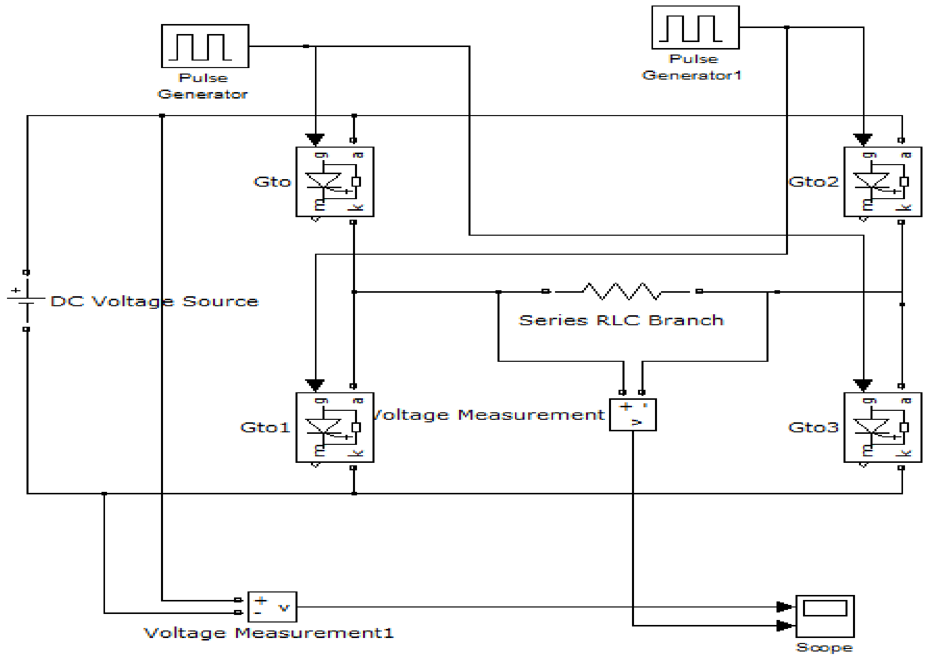
PROCEDURE

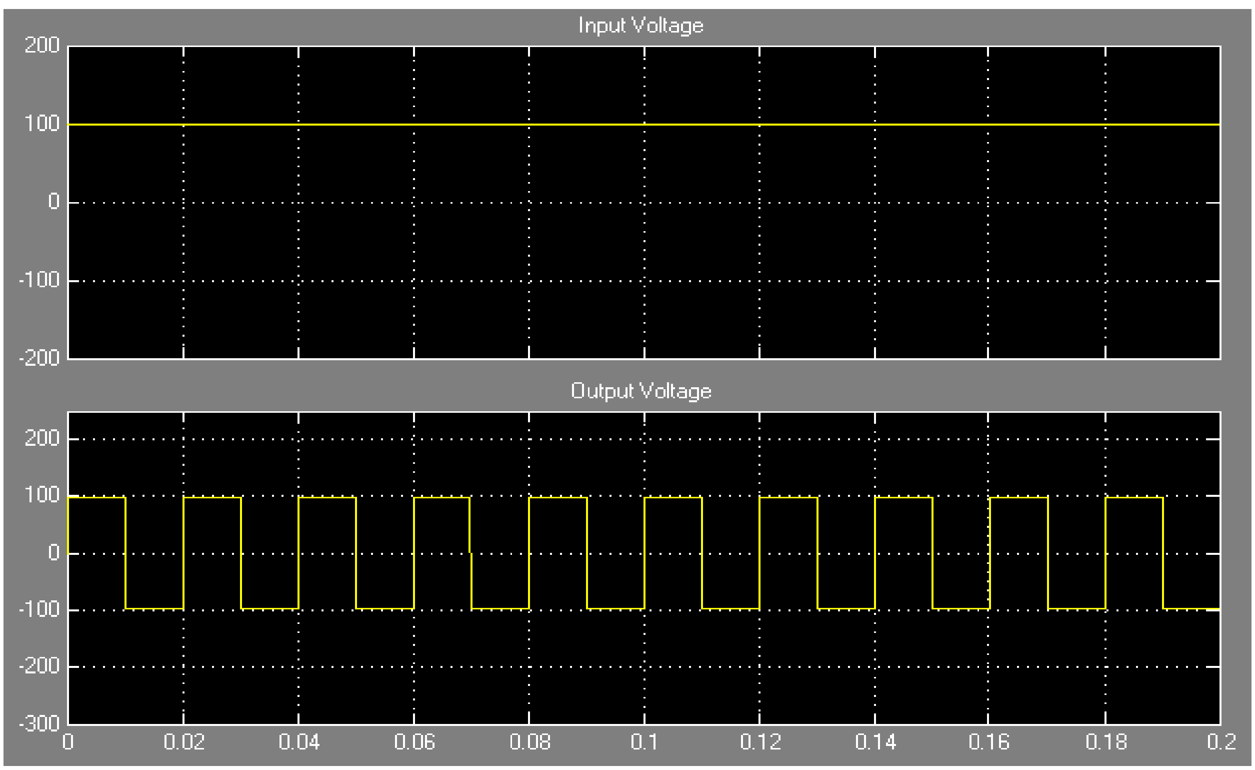
1. Make the connection as per the circuit diagram.
2. Connect the gating signal from the inverter module.
3. Switch ON D.C 24 V.
4. Keep the frequency knob to particulars frequency.
5. Observe the rectangular and triangular carrier waveforms on the CRO.
6. Obtain the output waveform across the load Rheostat.

TABULAR COLUMN

V_{in}	V_{ref}		$V_{carrier}$		M= V_r/V_c	Output	
	Amplitude	Time	Amplitude	Time		V_o (Practical)	V_o (Theoretical)

SIMULATION

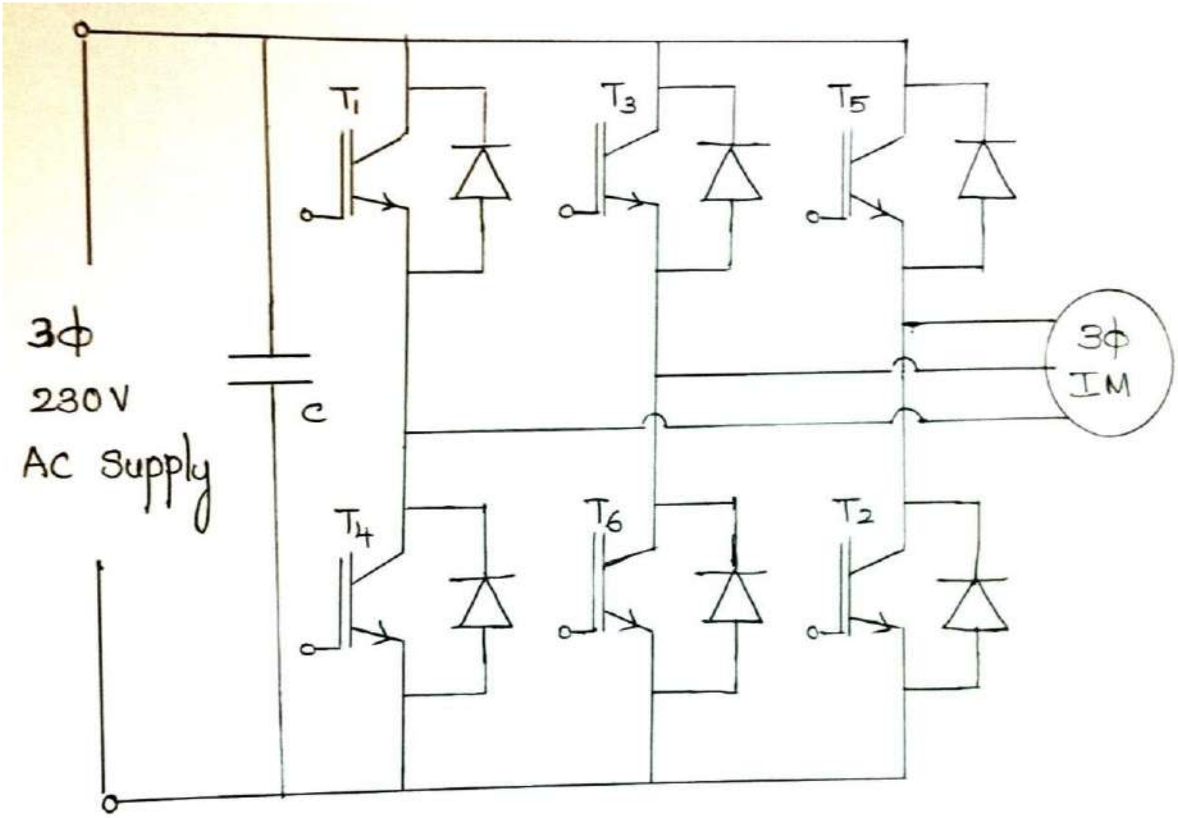




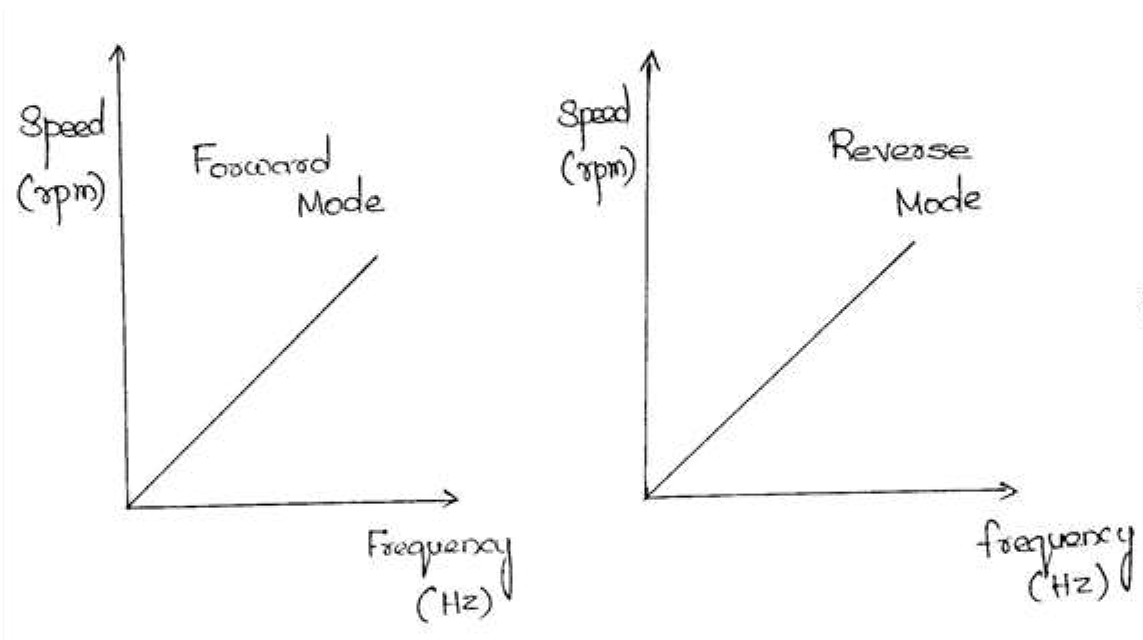
RESULT

Thus the operation of a IGBT based Single phase PWM modulation was determined.

CIRCUIT DIAGRAM



MODEL GRAPH



Ex. No. 8 IGBT BASED THREE PHASE PWM INVERTER

Date:

AIM

To operate forward & reverse mode three phase induction motor using IGBT based on three phase PWM inverter.

APPARATUS REQUIRED

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	IGBT Based PWM inverter Kit	230V	3ϕ	1
2	Three Phase Induction Motor	230V	3ϕ	1
3	Tachometer			1
4	Patch Chord			As required

THEORY

A device that converts dc power into ac power at desired output voltage & frequency is called an inverter. For providing adjustable frequency power to industrial applications, three phase inverters are more common than single phase inverters.

A three phase inverter is a six step bridge inverter. It uses a minimum of six thyristors. A step is defined as a change in the firing from one thyristor to the next thyristor in proper sequence.

PROCEDURE

1. Make the connection as per the circuit diagram.
2. Switch ON the supply
3. Select the forward rotation mode
4. By varying the frequency for regulated interval, note down the speed of IM using tachometer.
5. Then select the reverse rotation mode
6. By varying the frequency for regulated interval, note down the speed of IM using tachometer.
7. The graph is plotted for forward mode & reverse mode.

TABULAR COLUMN (FORWARD MODE)

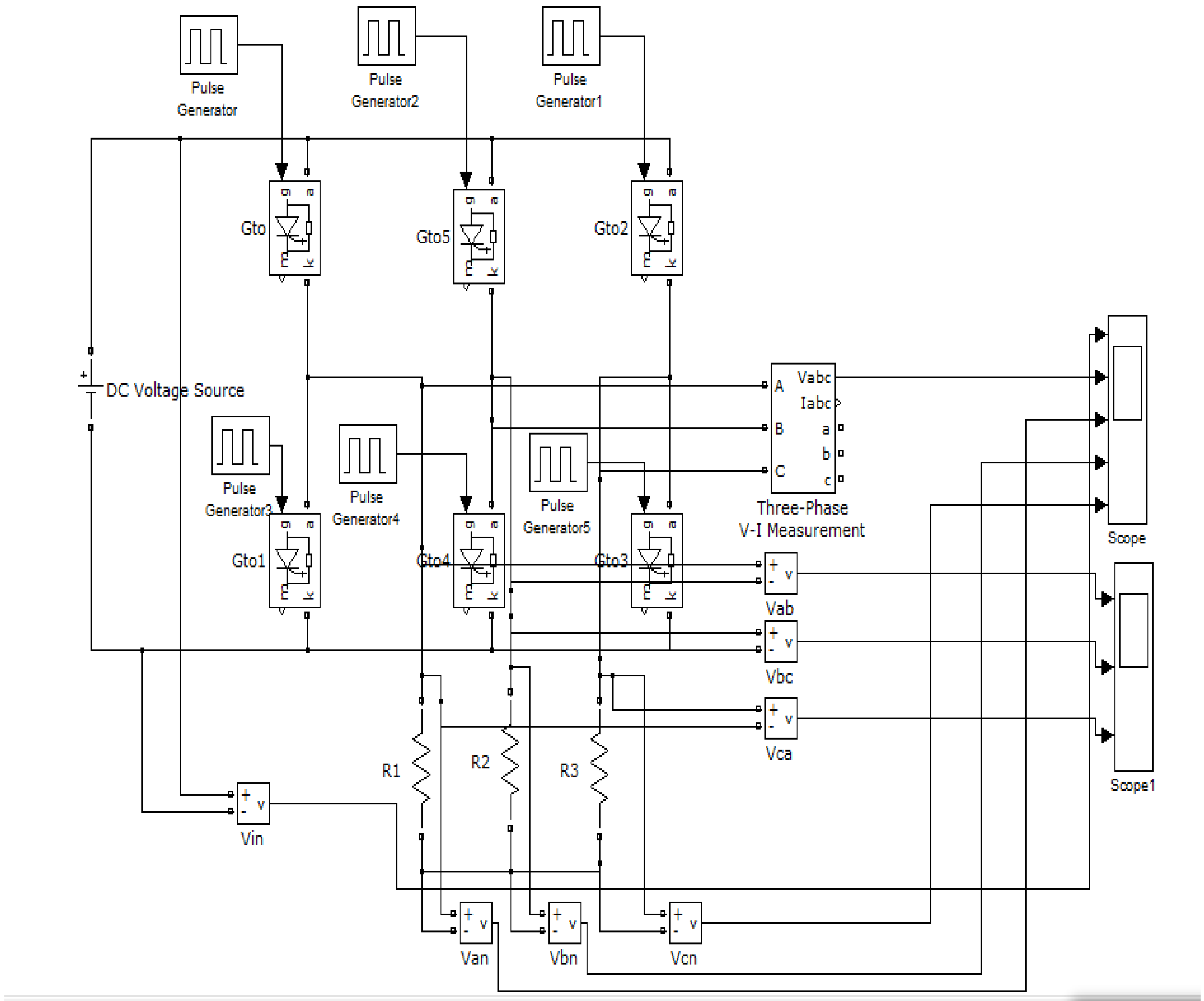
S.No.	Speed (N)	Frequency(Hz)

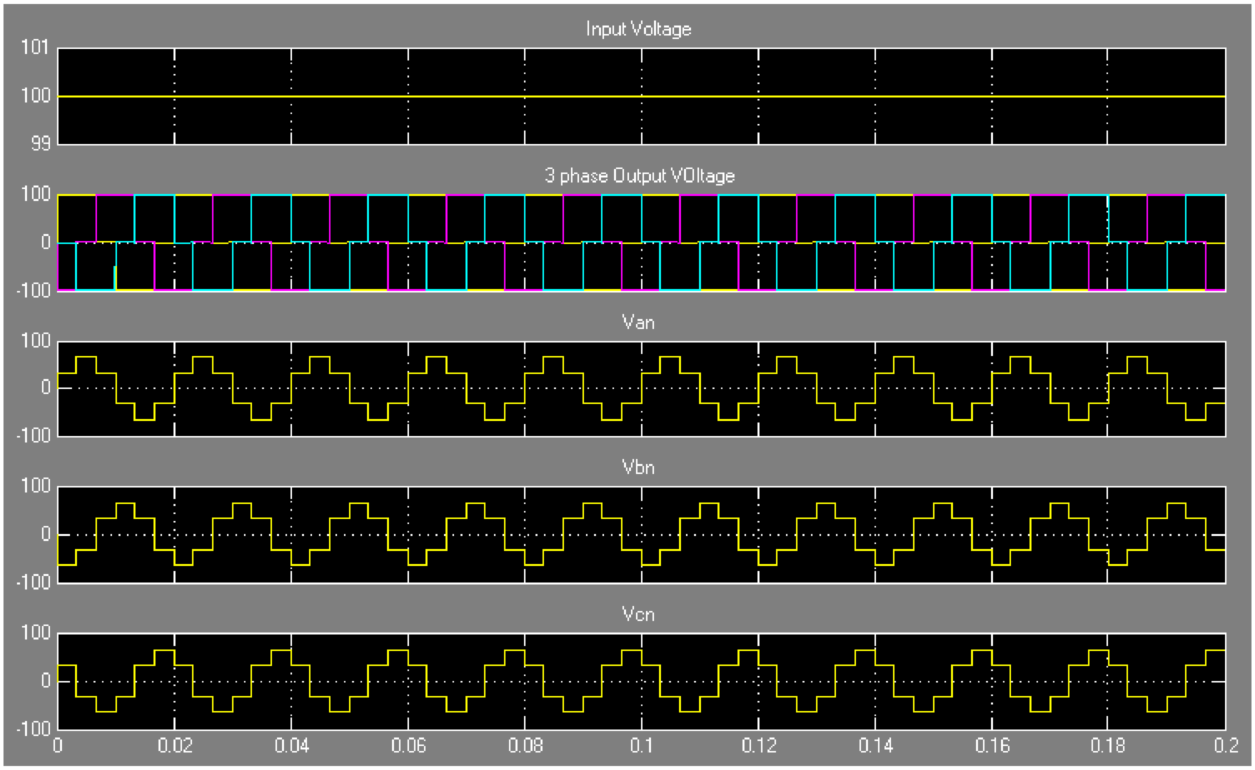
TABULAR COLUMN (REVERSE MODE)

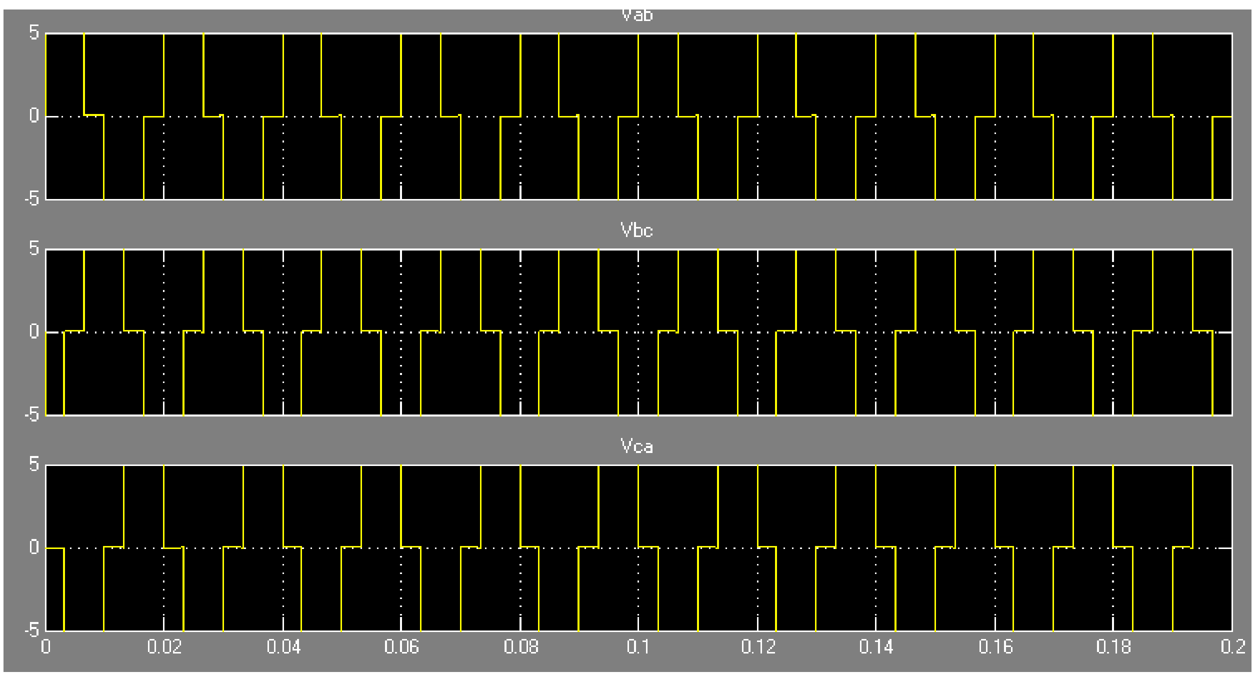
S.No.	Speed (N)	Frequency(Hz)

SIMULATION

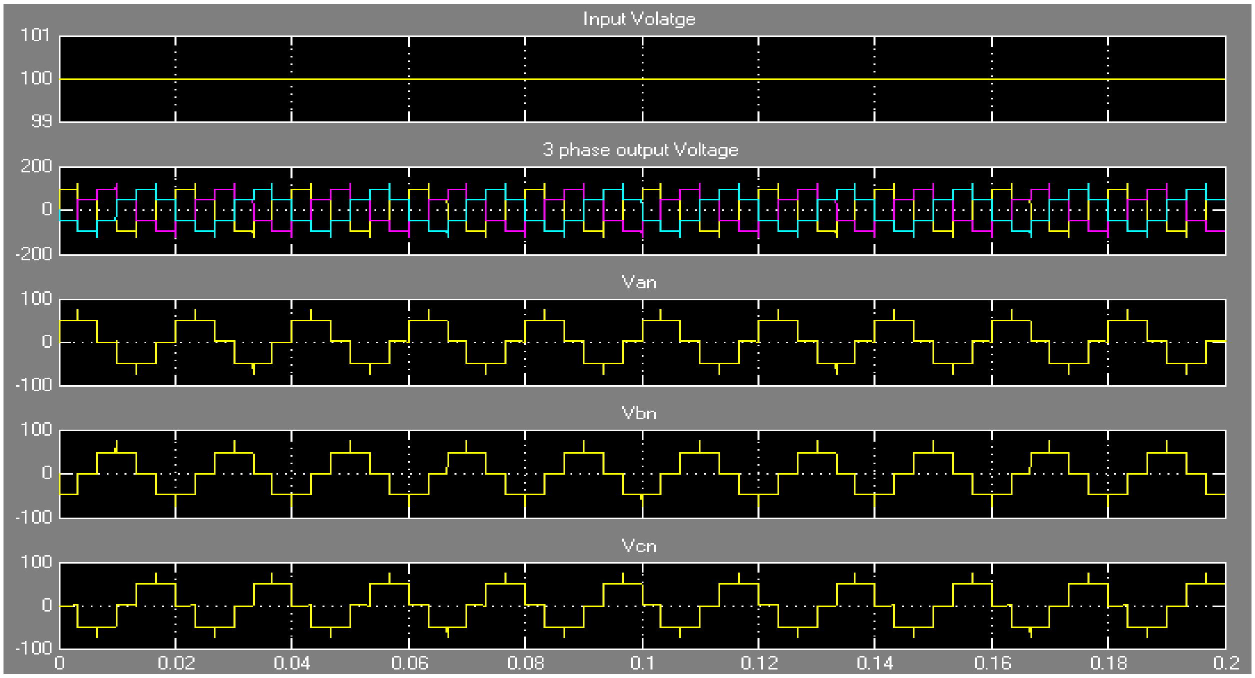
a) THREE PHASE INVERTER-180

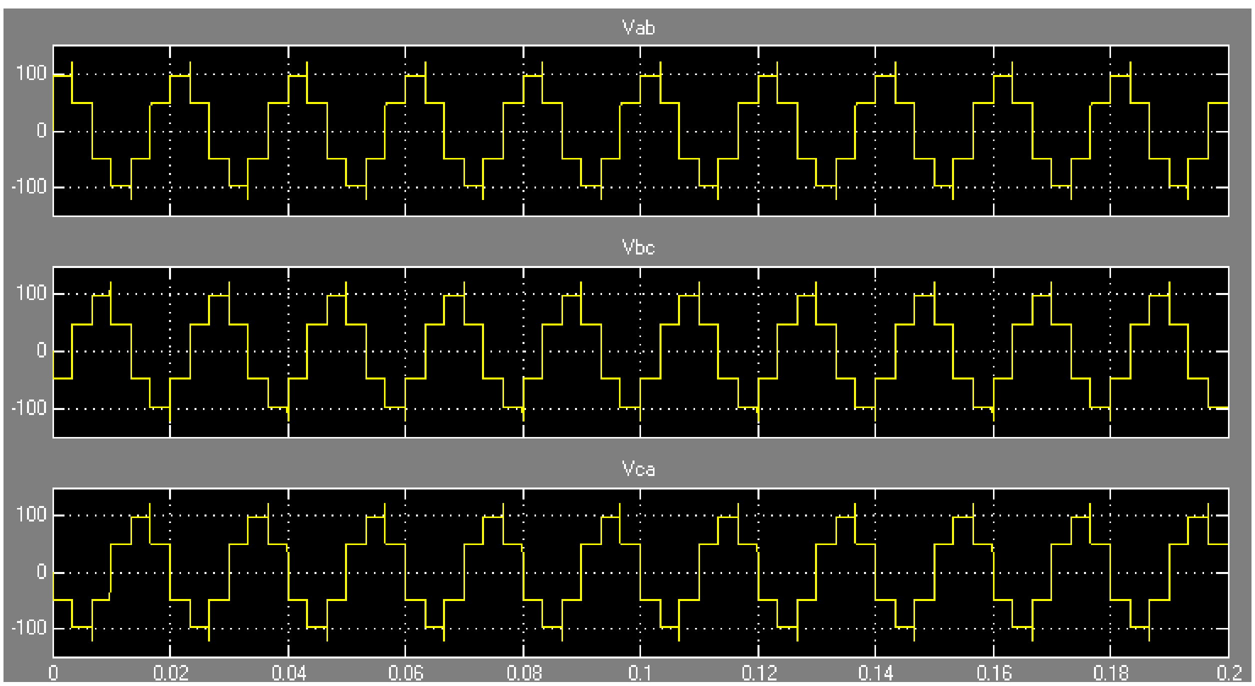



Input Voltage
3 phase Output VOltage
Van
Vbn
Vcn


Vab
Vbc
Vca

b) THREE PHASE INVERTER-120



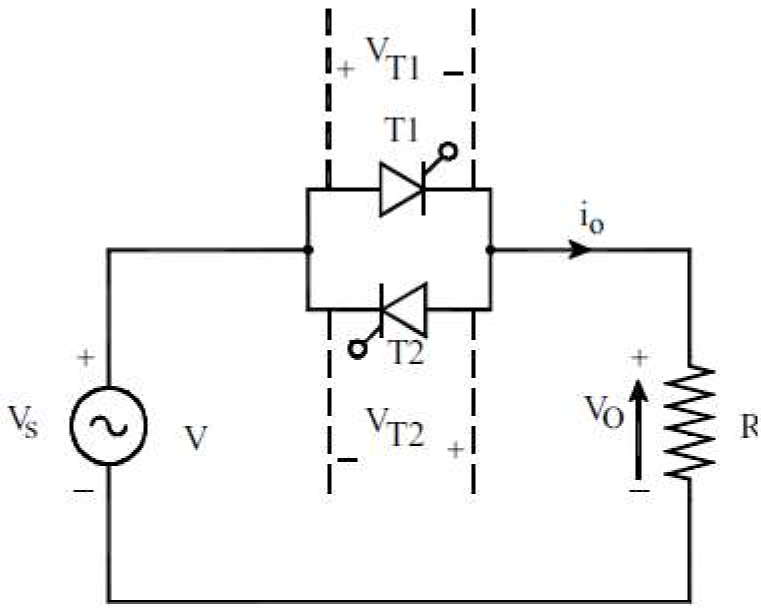


RESULT

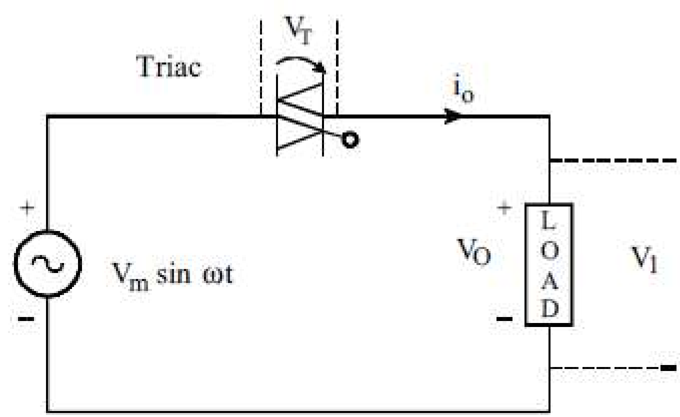
Thus the forward & reverse mode of three phase Induction motor using IGBT based PWM inverter was obtained.

CIRCUIT DIAGRAM

AC Phase Control using SCR



AC Phase Control using TRIAC & DIAC



Ex. No. 9 AC Phase Control using SCR, TRIAC & DIAC

Date:

AIM

To control the output voltage by AC phase control using SCR, TRIAC & DIAC.

APPARATUS REQUIRED

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	Trainer Kit		PEC14M22	1
2	Voltmeter	0-230V	MC	1
3	CRO & Lamp			1
4	Patch Chord			As required

THEORY

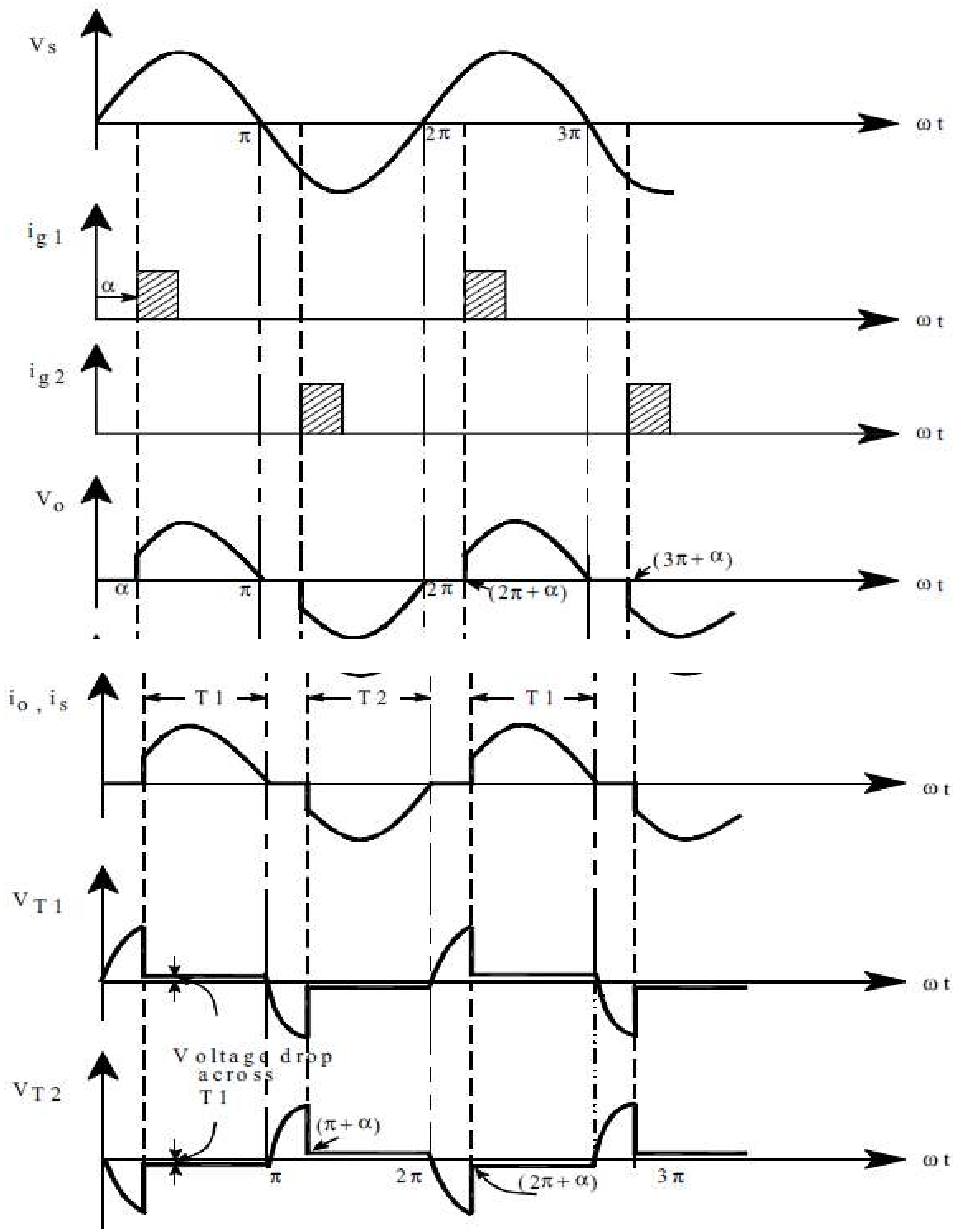
AC Phase control using SCR

Two SCRs connected in antiparallel. T1 & T2 are forward biased during positive & negative half cycles respectively. During first half cycle , T1 is triggered at firing angle α.T1 starts conducting and source voltage is applied to load from α to β. At both V_0& I_o are all to zero. Just afterse T1 is subjected to reverse biased and is therefore turned OFF. During negative half cycle, T2 is triggered at α+β. T2 conducts from (α+π) to 2π. Soon after 2π, T2 is subjected to reverse biased and is therefore commutated.

AC Phase control using TRIAC & DIAC

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).

MODEL GRAPH


Vs
ω t
π
2π
3π
ig 1
α
ω t
ig 2
ω t
Vo
α
π
2π
(2π + α)
(3π + α)
ω t
io , is
T 1
T 2
T 1
ω t
VT 1
ω t
Voltage drop
across
T 1
VT 2
(π + α)
π
2 π
(2π + α)
3 π
ω t

AC Phase control using SCR

CONNECTION PROCEDURE

1. Connect P3 TO P5 & P4 to P6.
2. Connect cathode and gate of SCR 1 & 2(G1, K1 & G2, K2) to pulse 1 and pulse 2 respectively.
3. Connect the P23 to P24, P1 to P15, P2 TO P16, P19 to P17 & P20 to P18.
4. Connect the input with 230 V power supply and the output with the load.
5. Insert a lamp in the lamp holder.
6. Connect the voltmeter across the load.

EXPERIMETAL PROCCEDURE

1. Switch ON the power supply by switching ON S1.
2. View test signals on the CRO.
3. By varying the firing angles and note down the corresponding readings of voltmeter.
4. Variation of voltage can be indicated by the dimness and brightness of the lamp.

AC Phase control using TRIAC & DIAC

CONNECTION PROCEDURE

1. Connect the P23 to P24, P1 to P21, P2 TO P22, P19 to P26&P20 to P25.
2. Connect the input with 230 V power supply and the output with the load.
3. Insert a lamp in the lamp holder.
4. Connect the voltmeter across the load.

EXPERIMETAL PROCCEDURE

1. Switch ON the power supply.
2. View test signals on the CRO.
3. By varying the firing angles and note down the corresponding readings of voltmeter.
4. Variation of voltage can be indicated by the dimness and brightness of the lamp.

TABULAR COLUMN

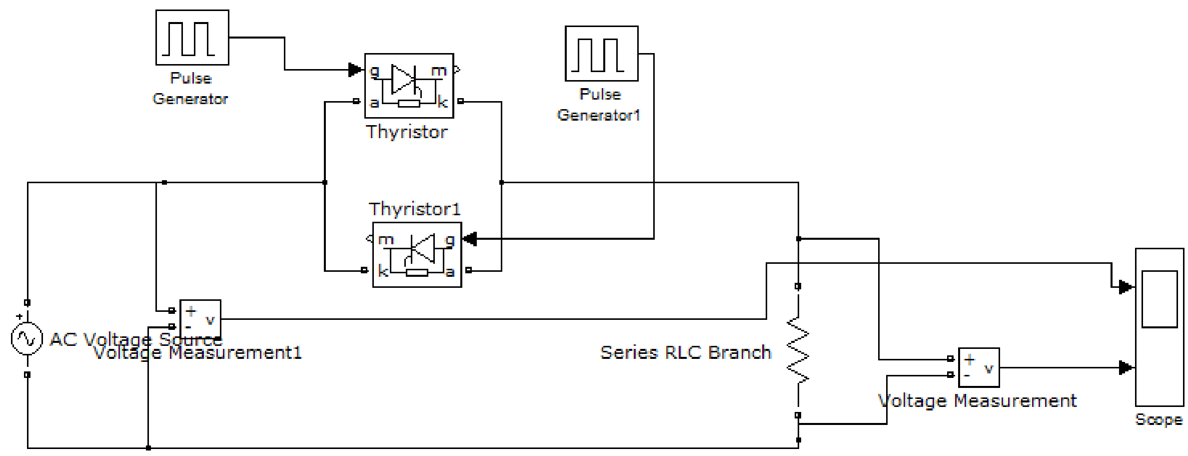
AC PHASE CONTROL USING SCR

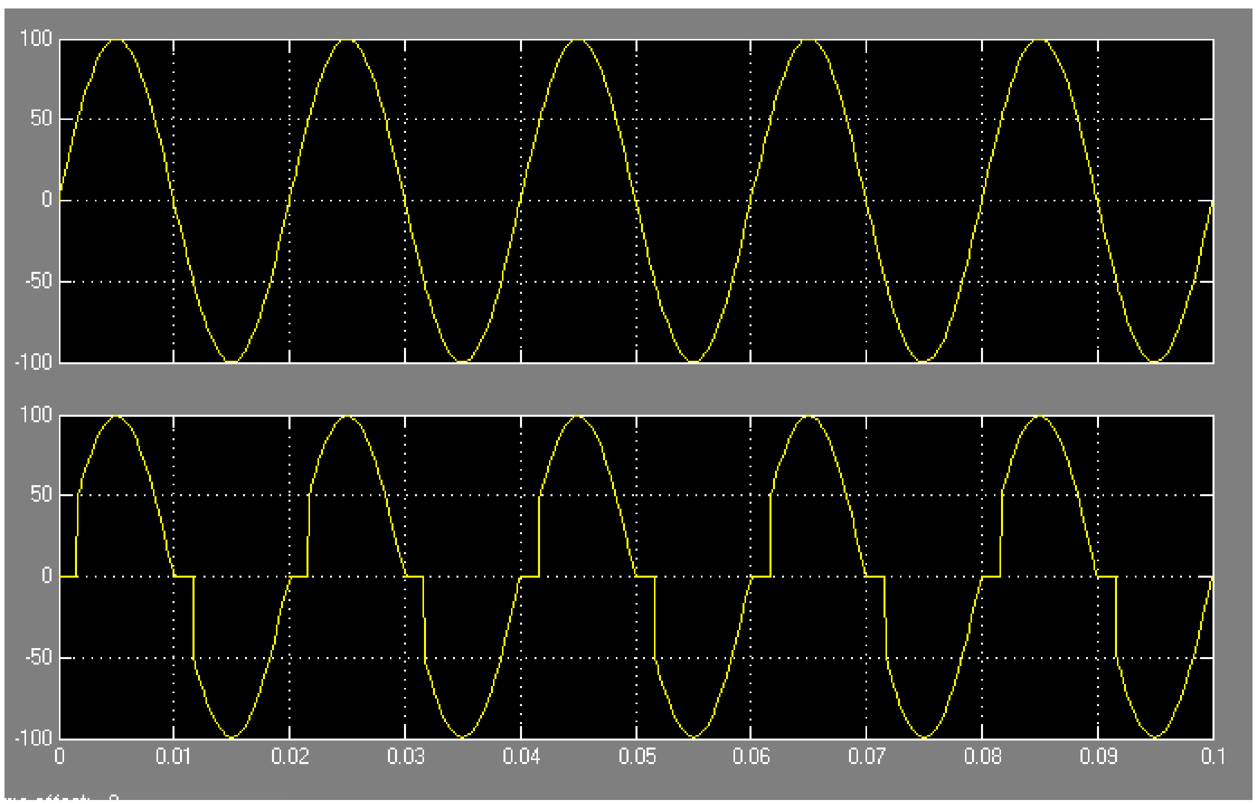
S.no	Firing angle (α)	Output voltage (volts)

AC PHASE CONTROL USING TRIAC & DIAC

S.no	Firing angle (α)	Output voltage (volts)

SIMULATION



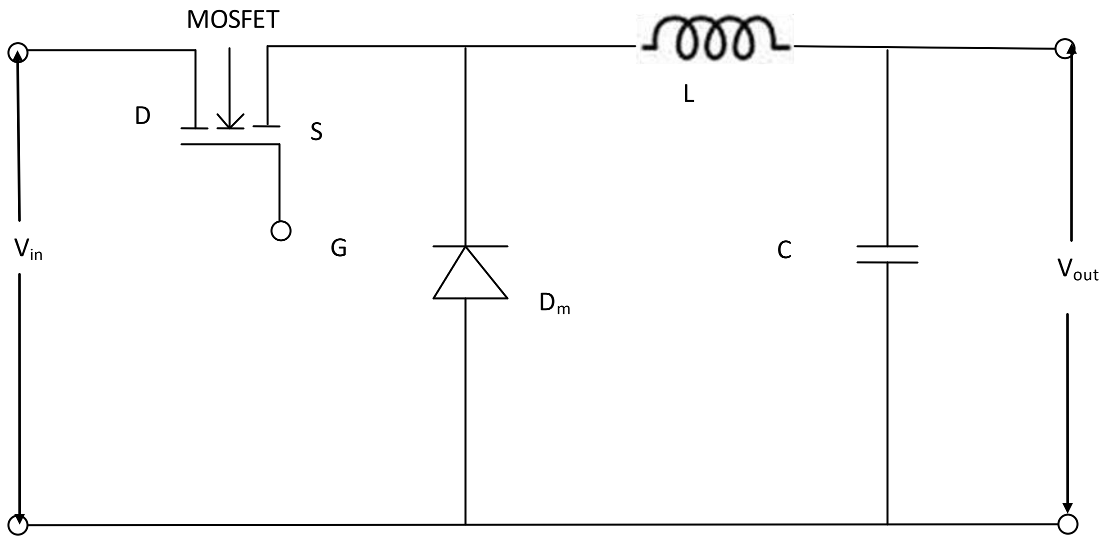


RESULT

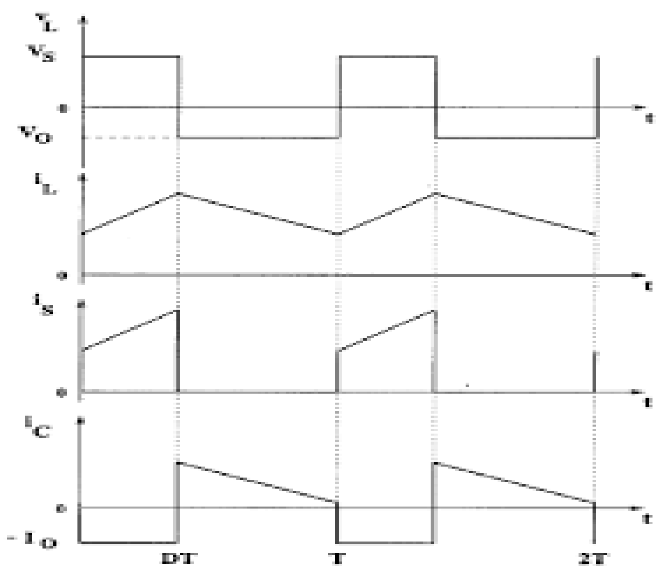
Thus the output can be controlled by AC phase control using SCR, TRIAC DIAC & the waveforms will be plotted.

CIRCUIT DIAGRAM

BUCK CONVERTER



MODEL GRAPH



Ex. No. 10 SWITCHED MODE POWER CONVERTERS
Date:

AIM

To design and draw the input and output waveform for Buck & Boost Converter.

APPARATUS REQUIRED

S.No.	ITEM	RANGE	TYPE	QUANTITY
1	SMPS Kit			1
2	CRO			1
3	Patch Chord			As required

THEORY

BUCK CONVERTER

A **buck converter** is a voltage step down and current step up converter. With the switch open (off-state), the current in the circuit is zero. When the switch is first closed (on-state), the current will begin to increase. Over time, the rate of change of current decreases, and the voltage across the inductor also then decreases, increasing the voltage at the load. During this time, the inductor stores energy in the form of a magnetic field. If the switch is opened while the current is still changing, then there will always be a voltage drop across the inductor, so the net voltage at the load will always be less than the input voltage source.

BOOST CONVERTER

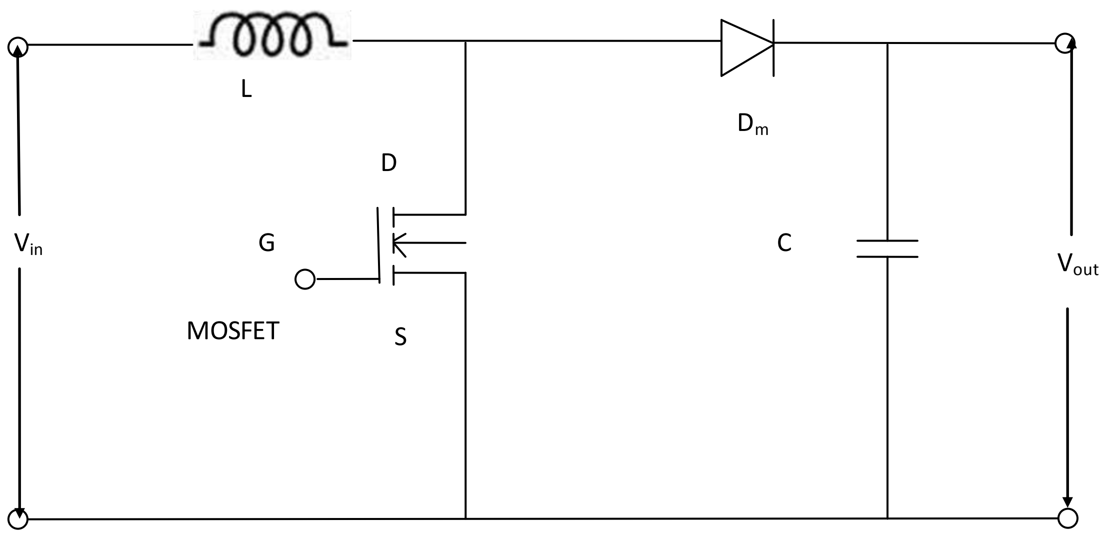
A **boost converter** (**step-up converter**) is a DC-to-DC power converter with an output voltage greater than its input voltage.

(a) When the switch is closed, electrons flow through the inductor in clockwise direction and the inductor stores some energy by generating a magnetic field. Polarity of the left side of the inductor is positive.

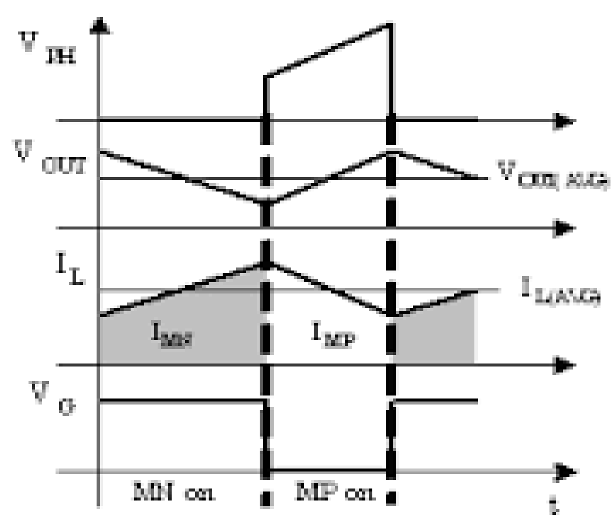
(b) When the switch is opened, current will be reduced as the impedance is higher. The magnetic field previously created will be destroyed to maintain the current towards the load. Thus the polarity will be reversed. As a result two sources will be in series causing a higher voltage to charge the capacitor through the diode D.

CIRCUIT DIAGRAM

BOOST CONVERTER



MODEL GRAPH



PROCEDURE

1. Give the triggering circuit connections as per the patching diagram.
2. Switch ON the main supply.
3. Connect the CRO to the output terminals to study the waveform.
4. Set the carrier wave frequency between 5 KHz to 10 KHz using frequency knob.
5. Vary the duty cycle and observe the output.

TABULAR COLUMN:

Buck Converter

S.No	V_{in}	T_{ON}	T_{OFF}	$\delta = T_{ON}/T$	$V_o = \delta V_s$	
					Theoritical	Practical

Boost Converter

S.No	V_{in}	T_{ON}	T_{OFF}	$\delta = T_{ON}/T$	$V_o = \delta V_s$	
					Theoritical	Practical

Result

Thus the design and Input/output waveforms for Buck & Boost converter are drawn.