GUIDELINES FOR LABORATORY NOTEBOOK

The laboratory notebook is a record of all work pertaining to the experiment. This record should be sufficiently complete so that you or anyone else of similar technical background can duplicate the experiment and data by simply following your laboratory notebook. Record everything directly into the notebook during the experiment. Do not use scratch paper for recording data. Do not trust your memory to fill in the details at a later time.

Organization in your notebook is important. Descriptive headings should be used to separate and identify the various parts of the experiment. Record data in chronological order. A neat, organized and complete record of an experiment is just as important as the experimental work.

1. HEADING:

The experiment identification (number) should be at the top of each page.

2. OBJECTIVE:

A brief but complete statement of what you intend to find out or verify in the experiment should be at the beginning of each experiment

3. DIAGRAM:

A circuit diagram should be drawn and labeled so that the actual experiment circuitry could be easily duplicated at any time in the future. Be especially careful to record all circuit changes made during the experiment.

4. EQUIPMENT LIST:

List those items of equipment which have a direct effect on the accuracy of the data. It may be necessary later to locate specific items of equipment for rechecks if discrepancies develop in the results.

5. PROCEDURE:

In general, lengthy explanations of procedures are unnecessary. Be brief. Short commentaries alongside the corresponding data may be used. Keep in mind the fact that the experiment must be reproducible from the information given in your notebook.

6. DATA:

Think carefully about what data is required and prepare suitable data tables. Record instrument readings directly. Do not use calculated results in place of direct data; however, calculated results may be recorded in the same table with the direct data. Data tables should be clearly identified and each data column labeled and headed by the proper units of measure.

7. CALCULATIONS:

Not always necessary but equations and sample calculations are often given to illustrate the treatment of the experimental data in obtaining the results.

8. GRAPHS:

Graphs are used to present large amounts of data in a concise visual form. Data to be presented in graphical form should be plotted in the laboratory so that any questionable data points can be checked while the experiment is still set up. The grid lines in the notebook can be used for most graphs. If special graph paper is required, affix the graph permanently into the notebook. Give all graphs a short descriptive title. Label and scale the axes. Use units of measure. Label each curve if more than one on a graph sheet.

9. RESULTS:

The results should be presented in a form which makes the interpretation easy. Large amounts of numerical results are generally presented in graphical form. Tables are generally used for small amounts of results. Theoretical and experimental results should be on the same graph or arrange in the same table in a way for easy correlation of these results.

10. CONCLUSION:

This is your interpretation of the results of the experiment as an engineer. Be brief and specific. Give reasons for important discrepancies.

LABORATORY SAFETY INFORMATION

INTRODUCTION

The danger of injury or death from electrical shock, fire, or explosion is present while conducting experiments in this laboratory. To work safely, it is important that you understand the prudent practices necessary to minimize the risks and what to do if there is an accident.

ELECTRICAL SHOCK

Avoid contact with conductors in energized electrical circuits. Electrocution has been reported at dc voltages as low as 42 volts. Just 100ma of current passing through the chest is usually fatal. Muscle contractions can prevent the person from moving away while being electrocuted.

Do not touch someone who is being shocked while still in contact with the electrical conductor or you may also be electrocuted. Instead, press the Emergency Disconnect. This shuts off all power, except the lights.

Make sure your hands are dry. The resistance of dry, unbroken skin is relatively high and thus reduces the risk of shock. Skin that is broken, wet or damp with sweat has a low resistance.

When working with an energized circuit, work with only your right hand, keeping your left hand away from all conductive material. This reduces the likelihood of an accident that results in current passing through your heart.

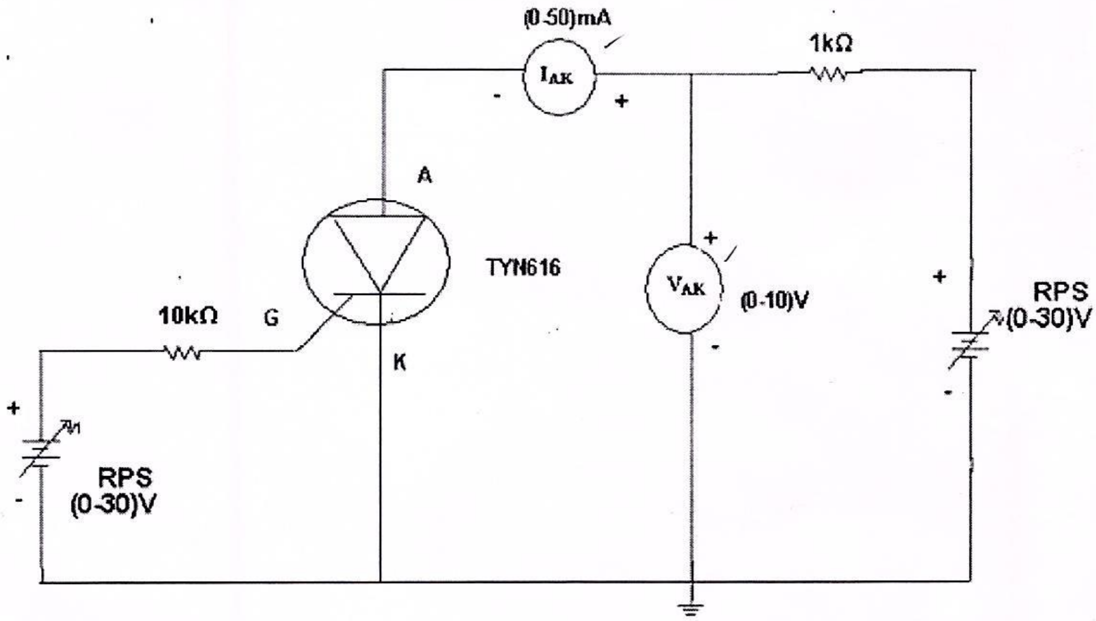
Be cautious of rings, watches, and necklaces. Skin beneath a ring or watch is damp, lowering the skin resistance. Shoes covering the feet are much safer than sandals.

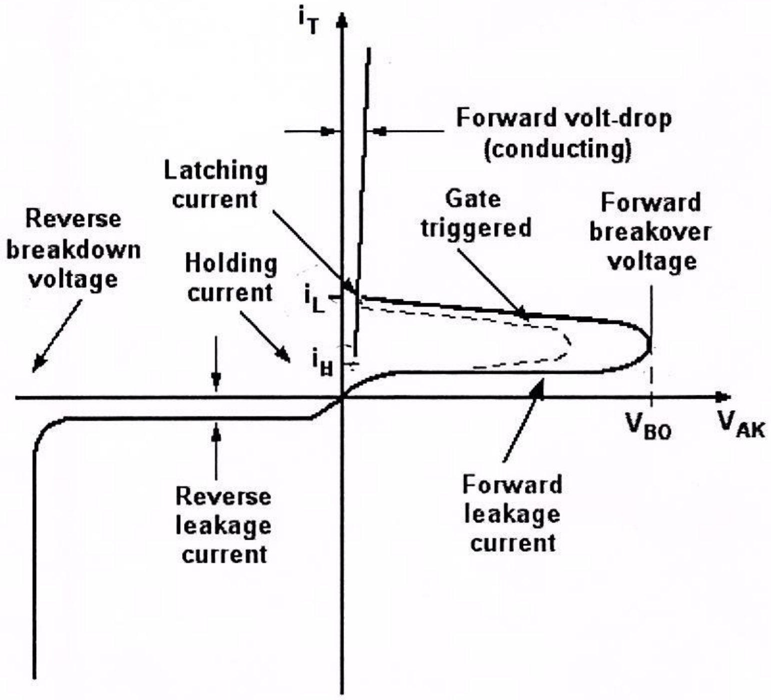
If the victim isn't breathing, find someone certified in CPR. Be quick! If the victim is unconscious or needs an ambulance, contact the Department Office for help.

LIST OF EXPERIMENTS

CIRCUIT DIAGRAM

CHARACTERISTICS OF SCR





EXP.NO: 1 **DATE:**

CHARACTERISTICS OF SCR AND TRIAC

1. A) CHARACTERISTICS OF SCR

AIM:

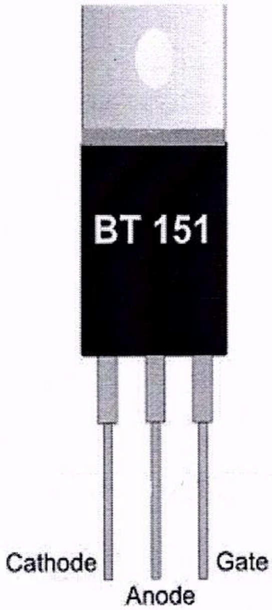
To obtain the V-I characteristics of SCR and find the break over voltage and holding current.

APPARATUS REQUIRED:

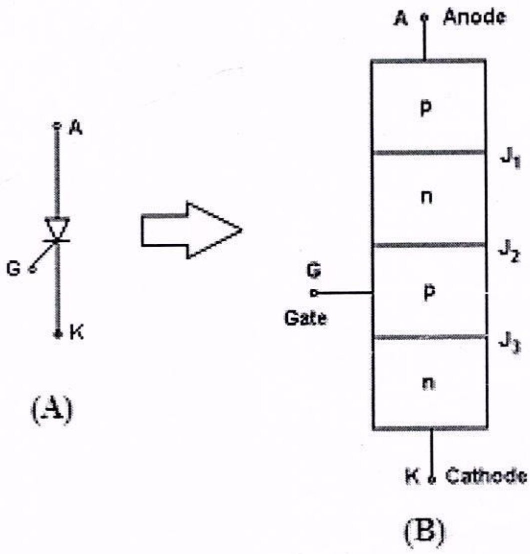
Sl.No.	NAME OF THE COMPONENTS	RANGE	QUANTITY
1	SCR (TYN 616)		1
2	Power Supplies	(0-30) V	2
3	Wattage Resistors	10 KΩ, 1 KΩ	Each 1
4	Ammeter	(0-50) mA	1
5	Voltmeter	(0-10) V	1
6	Bread Board		1
7	Connecting Wires		As Required

SILICON CONTROLLED RECTIFIER

A thyristor is a four layer PNPN semiconductor device consisting of three PN junctions. It has three terminals: an anode a cathode and a gate. When the anode voltage is made positive with respect to the cathode, junctions J_1 and J_3 are forward biased and junction J_2 is reverse biased. The thyristor is said to be in the forward blocking or off-state condition. A small leakage current flows from anode to cathode and is called the off-state current. If the anode voltage V_{AK} is increased to a sufficiently large value, the reverse biased junction J_2 would breakdown. This is known as avalanche breakdown and the corresponding voltage is called the forward breakdown voltage V_{BO}. Since the other two junctions J_1 and $J_3$are already forward biased, there will be free movement of carriers across all three junctions. This results in a large forward current. The device is now said to be in a conducting or on-state. The voltage drop across the device in the on-state is due to the



SCR



(A) SYMBOLIC REPRESENTATION
(B) SCHEMATIC DIAGRAM

ohmic drop in the four layers and is very small (in the region of 1 V). In the on-state the anode current is limited by an external impedance or resistance.

V-I CHARACTERISTICS OF SCR

The important points on this characteristic are:

- **Latching Current I_L**

  This is the minimum anode current required to maintain the thyristor in the on-state immediately after a thyristor has been turned on and the gate signal has been removed. If a gate current greater than the threshold gate current is applied until the anode current is greater than the latching current I_L then the thyristor will be turned on or triggered.

- **Holding Current I_H**

  This is the minimum anode current required to maintain the thyristor in the on-state. To turn off a thyristor, the forward anode current must be reduced below its holding current for a sufficient time for mobile charge carriers to vacate the junction. If the anode current is not maintained below I_H for long enough, the thyristor will not have returned to the fully blocking state by the time the anode-to-cathode voltage rises again. It might then return to the conducting state without an externally-applied gate current.

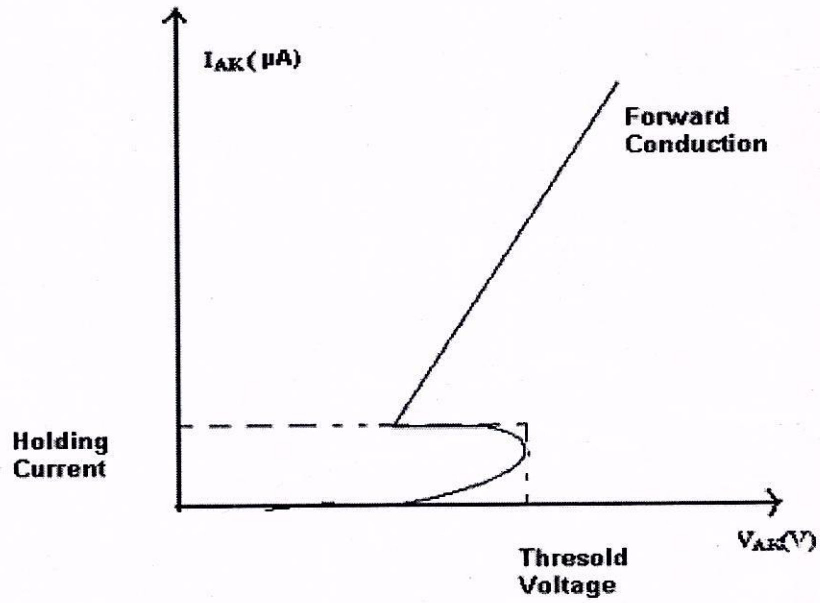
- **Reverse Current I_R**

  When the cathode voltage is positive with respect to the anode, the junction J_2 is forward biased but junctions J_1 and J_3 are reverse biased. The thyristor is said to be in the reverse blocking state and a reverse leakage current known as reverse current I_R will flow through the device.

OBSERVATION TABLE

Sl.No	Anode to cathode voltage(V_{ak}) (V)	Anode current (I_a) (A)
1		
2		
3		
4		
5		

MODEL GRAPH



- **Forward Breakover Voltage V_{BO}**

If the forward voltage V_{AK} is increased beyond V_{BO} , the thyristor can be turned on. But such a turn-on could be destructive. In practice the forward voltage is maintained below V_{BO} and the thyristor is turned on by applying a positive gate signal between gate and cathode.

Once the thyristor is turned on by a gate signal and its anode current is greater than the holding current, the device continues to conduct due to positive feedback even if the gate signal is removed. This is because the thyristor is a latching device and it has been latched to the on-state.

PROCEDURE

1. Connections are made as per circuit diagram.
2. Keep the gate supply voltage at some constant value.
3. Vary the anode to cathode supply voltage and note down the readings of voltmeter and ammeter. Keep the gate voltage at standard value.
4. A graph is drawn between V_{AK} and I_{AK}.

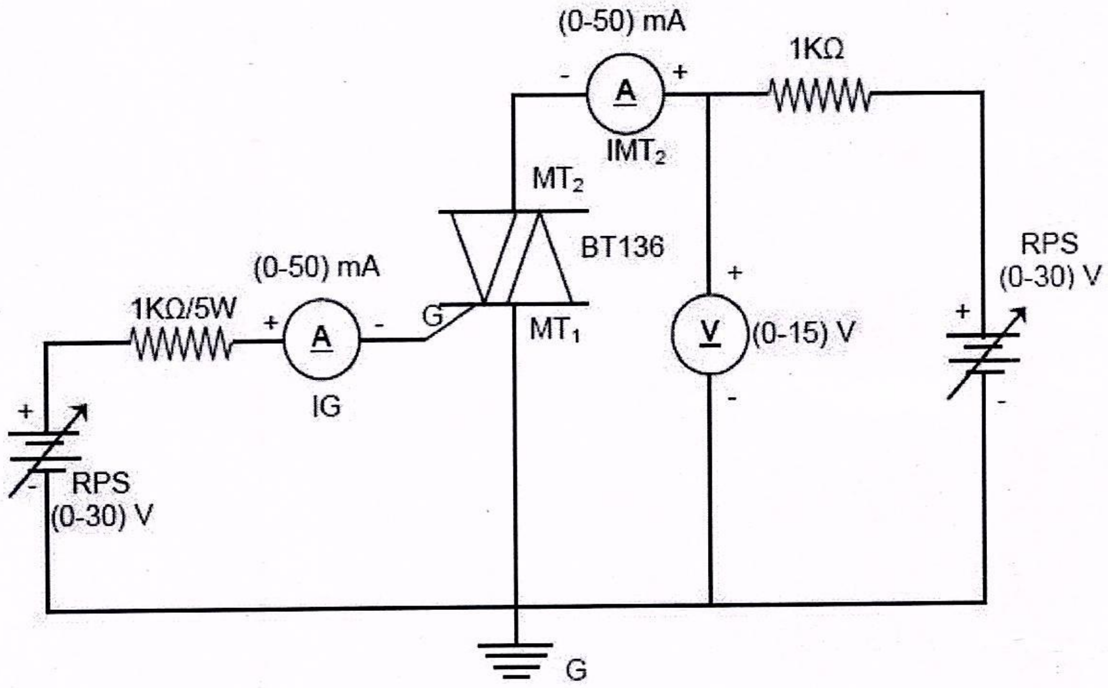
RESULT

Thus the V-I characteristics of SCR and the Break over Voltage, Holding current & latching current has been observed.

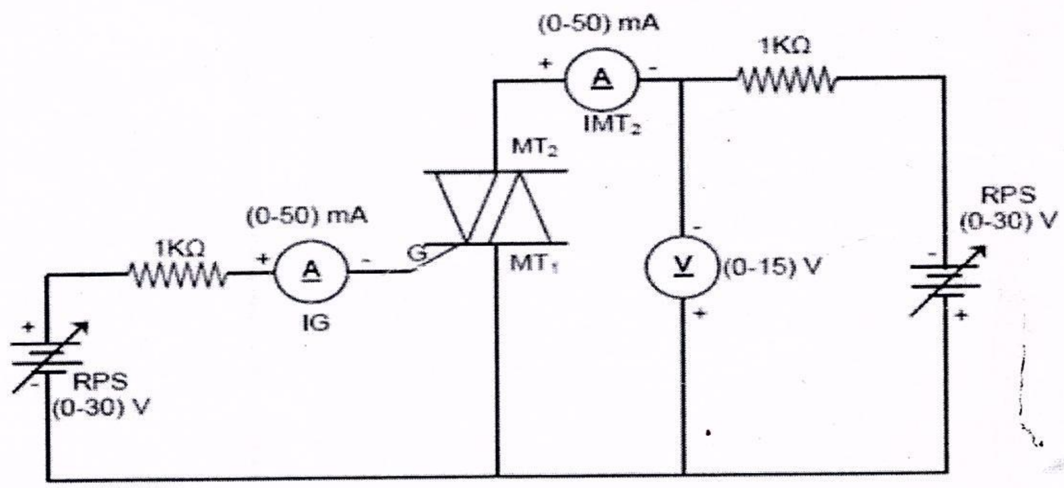
CIRCUIT DIAGRAM

CHARACTERISTICS OF TRIAC

FORWARD DIRECTION:



REVERSE DIRECTION:



1. B) CHARACTERISTICS OF TRIAC

AIM:

To obtain the V-I characteristics of TRIAC and find the break over voltage V_{BO}

APPARATUS REQUIRED:

Sl.No.	NAME OF THE COMPONENTS	RANGE	QUANTITY
1	TRIAC (BTM36)		1
2	Power Supplies	(0-30) V	1
3	Wattage Resistors	5 KΩ, 1 KΩ	Each 1
4	Ammeter	(0-50) mA	2
5	Voltmeter	(0-50) V	1
6	Voltmeter	(0-15) V	1
7	Bread Board		1
8	Connecting Wires		As Required

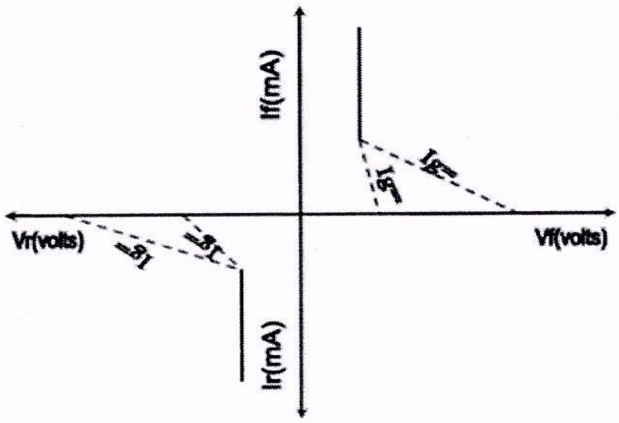
THEORY

The **TRIAC** is a three terminal semiconductor device for controlling current. It gains its name from the term TRIode for Alternating Current. It is effectively a development of the SCR or thyristor, but unlike the thyristor which is only able to conduct in one direction, the **TRIAC** is a bidirectional device.

OBSERVATION TABLE

S. No	V_{MT1MT2} (V) when TRIAC is 'OFF'	I_G (mA)	V_{MT1MT2} when TRIAC is 'ON	I_{MT2} (mA)

MODEL GRAPH



PROCEDURE

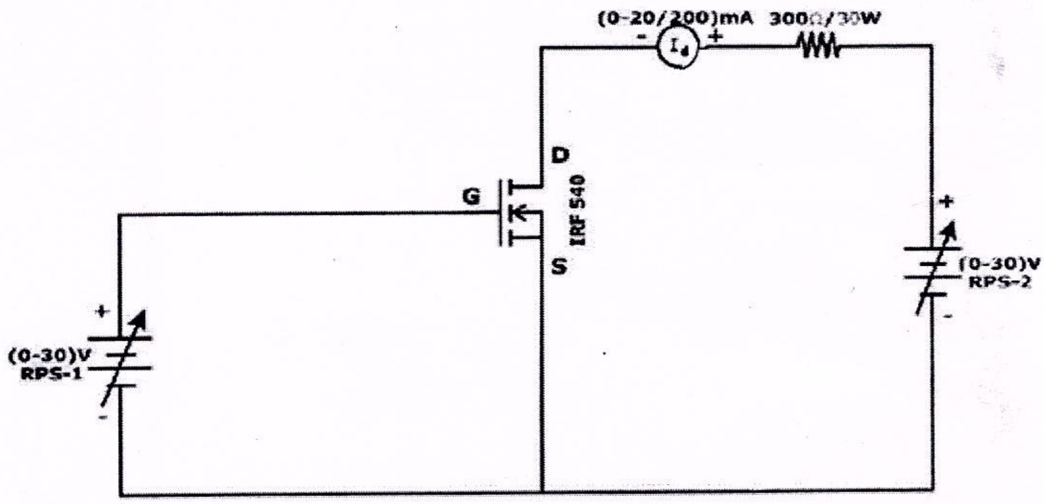
1. The connections are made as shown in the circuit diagram.
2. The TRIAC is connected in forward direction and supply is witched 'ON'.
3. V_{MT1MT2} is constant by varying RPS_2 and then varying I_G by varying RPS_1.
4. The corresponding ammeter and voltmeter readings are noted and tabulated.
5. Next the TRIAC is connected in reverse direction.
6. The above process is repeated.

RESULT

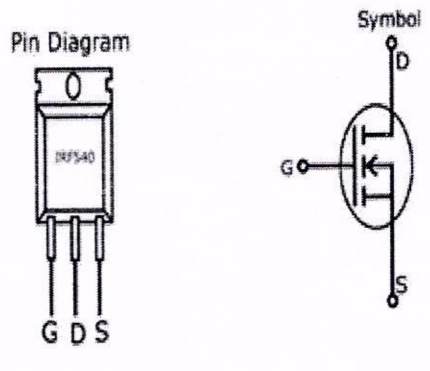
Thus the V-I characteristics of TRIAC was obtained and graph was drawn.

CIRCUIT DIAGRAM

CHARACTERISTICS OF MOSFET



TRANSFER AND DRAIN CHARACTERISTICS OF MOSFET



EXP.NO: 2 **DATE:**

CHARACTERISTICS OF MOSFET AND IGBT

2. A) CHARACTERISTICS OF MOSFET

AIM:

To conduct an experiment to plot the transfer characteristics and output characteristics of an MOSFET and to find the transconductance and drain resistance.

APPARATUS REQUIRED:

Sl.No.	NAME OF THE COMPONENTS	RANGE	QUANTITY
1	MOSFET (IRF 540)	-	1
2	Ammeter	0-20/200mA	1
3	Multimeter	-	1
4	Resistor	300Ω	1
5	Regulated power supply	0-30V	2
6	Bread Board	-	1
7	Connecting Wires		As Required

THEORY

MOSFET stands for metal-oxide semiconductor field-effect transistor. It is a special type of field-effect transistor (FET). Unlike BJT which is „current controlled", the MOSFET is a voltage controlled device. The MOSFET has "gate", "Drain" and "Source" terminals instead of a "base", "collector", and "emitter" terminals in a bipolar transistor. By applying voltage at the gate, it generates an electrical field to control the current flow through the channel between drain and source, and there is no current flow from the gate into the MOSFET. A MOSFET may be thought of as a variable resistor, where the Gate-Source voltage difference can control the Drain-Source Resistance. When there is no applying voltage between the Gate Source, the Drain-Source resistance is very high, which is almost

OBSERVATION:

Transfer Characteristics

V_{DS1} = ________________ V

V_{GS} (V)	I_D (mA)

V_{DS2} = ________________ V

V_{GS} (V)	I_D (mA)

Output/Drain characteristics:

V_{GS1} = ________________ V

V_{DS} (V)	I_D (mA)

V_{GS2} = ________________ V

V_{DS} (V)	I_D (mA)

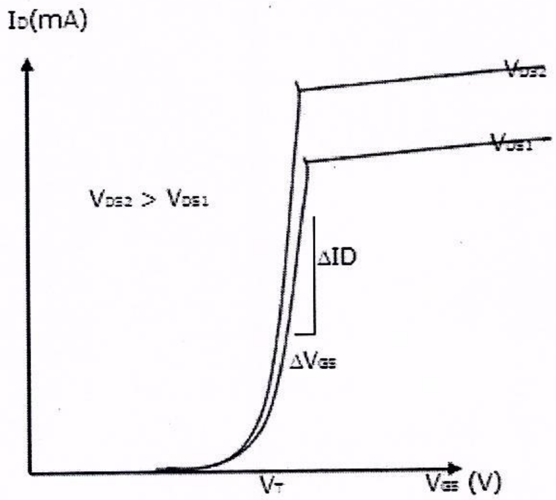
like a open circuit, so no current may flow through the Drain-Source. When Gate-Source potential difference is applied, the Drain-Source resistance is reduced, and there will be current flowing through Drain-Source, which is now a closed circuit. In a nutshell, a FET is controlled by the Gate-Source voltage applied (which regulates the electrical field across a channel), like pinching or opening a straw and stopping or allowing current flowing. Because of this property, FETs are great for large current flow, and the MOSFET is commonly used as a switch.

PROCEDURE

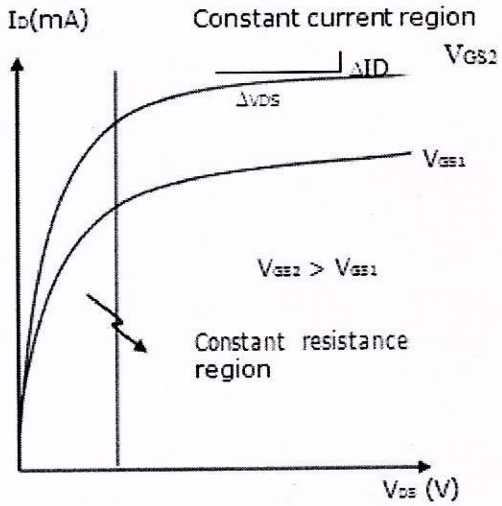
Transfer Characteristics

1. Check the components/equipments of their correctness
2. Connections are made as per the circuit diagram.
3. Initially both RPS-1 and RPS-2 are kept at zero output position.
4. By varying the RPS-2, set VDS around 3V
5. Now increase VGS by varying the RPS-1 gradually and note down the corresponding drain current.
6. Repeat the steps 4 and 5 for some other VDS value
7. Draw the graph between V_{GS} and I_D

Transfer Characteristics:



Drain Characteristics



CALCULATIONS:

Trans conductance gm = □ID / □VGS mho

Drain Resistance RD = □VDS / □ID Ω

Output Characteristics

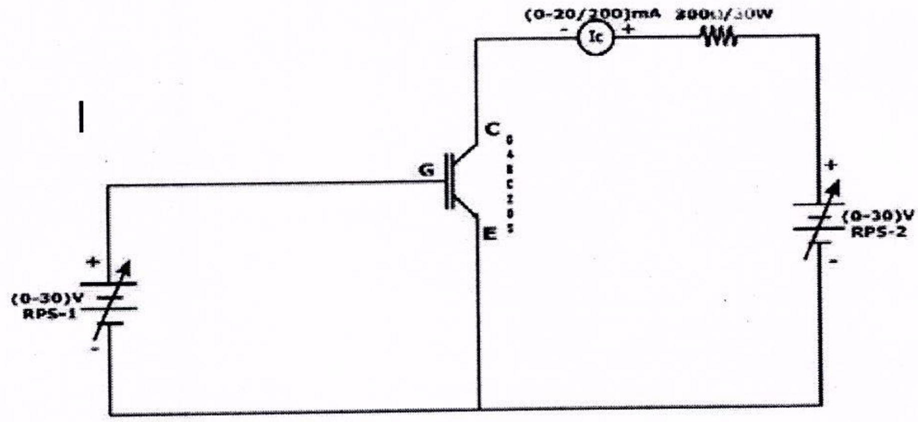
1. Check the components/equipments of their correctness
8. Connections are made as per the circuit diagram.
2. Both RPS-1 and RPS-2 should be in zero output position and supply switch is ON
3. By varying RPS-1, set V_{GS} to some value (slightly greater than the Threshold voltage determined from the transfer characteristics)
4. Now increase the V_{DS} by varying the RPS-2 gradually and note down the corresponding drain current.
5. Repeat the steps 4 and 5 for some other V_{GS} value.
6. Graph between V_{DS} Vs I_D is plotted

RESULT

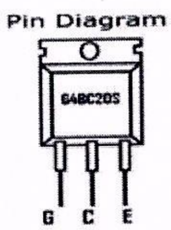
1. The transconductance gm = ______________ mho
2. The drain resistance RD = ______________ Ω

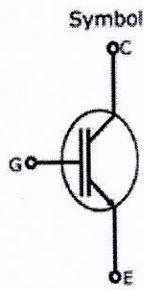
CIRCUIT DIAGRAM

CHARACTERISTICS OF IGBT



TRANSFER AND OUTPUT CHARACTERISTICS OF IGBT





2 B) CHARACTERISTICS OF IGBT

AIM:

To conduct an experiment on IGBT to plot the transfer characteristics and output characteristics and to find the transconductance and output resistance.

APPARATUS REQUIRED:

Sl.No.	NAME OF THE COMPONENTS	RANGE	QUANTITY
1.	IGBT-G4BC20S	-	1
2.	Ammeter	0-20/200mA	1
3.	Multimeter	-	1
4.	Resistor	300Ω	1
5.	Regulated power Supply	0-30V	2
6	Bread Board	-	1
7	Connecting Wires	-	As Required

THEORY

IGBT: The IGBT (insulated gate bipolar transistor) is a three-terminal electronic component, and these terminals are termed as emitter, collector and gate. Two of its terminals namely collector and emitter are associated with a conductance path and the remaining terminal „G" is associated with its control. The sum of amplification is achieved by the IGBT is a radio between its input and output signal. For a conventional BJT, the amount of gain is almost equal to the radio to the o/p current to the i/p current that is called a beta.

Transfer Characteristics

V_{CE1} = ______________ V

V_{GE} (V)	I_C (mA)

V_{CE2} = ______________ V

V_{GE} (V)	I_C (mA)

Output Characteristics

V_{GE1} = ______________ V

V_{CE} (V)	I_C (mA)

V_{GE2} = ______________ V.

V_{CE} (V)	I_C (mA)

PROCEDURE

Transfer Characteristics

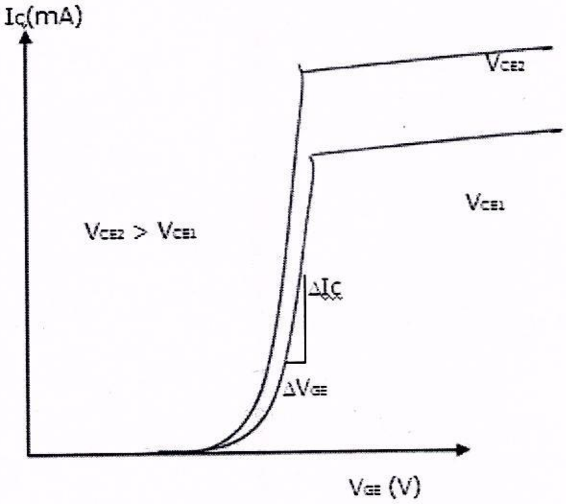
1. Check the components/equipments of their correctness.
2. Connections are made as per the circuit diagram.
3. Initially both RPS-1 and RPS-2 are kept at zero output position.
4. By varying the RPS-2, set V_{CE} around 1V.
5. Now increase V_{GE} by varying the RPS-1 gradually and note down the corresponding collector current.
6. Repeat the steps 4 and 5 for some other V_{CE} value.
7. Draw the graph between V_{GE} and Ic.

Output Characteristics

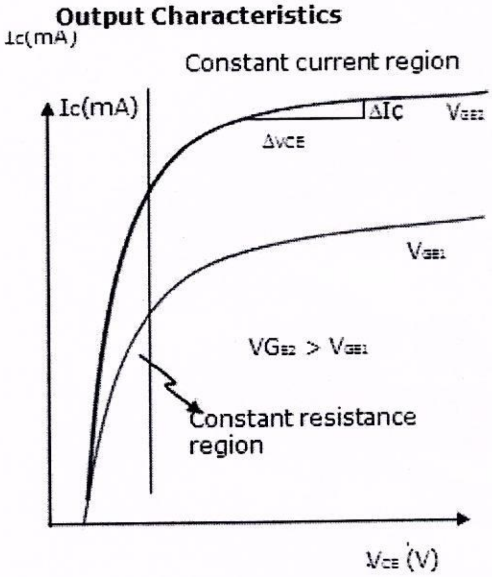
1. Check the components/equipments of their correctness.
2. Connections are made as per the circuit diagram.
3. Both RPS-1 and RPS-2 should be in zero output position and supply switch is ON.
4. By varying RPS-1, set V_{GE} to some value (slightly greater than the Threshold voltage determined from the transfer characteristics).
5. Now increase the V_{CE} by varying the RPS-2 gradually and note down the corresponding collector current.
6. Repeat the steps 4 and 5 for some other V_{GE} value
7. Graph between V_{CE} Vs Ic is plotted

Ideal Graph:

Transfer Characteristics:



Output Characteristics



.Calculations

Trans Conductance $gm = \Delta I_c / \Delta V_{GE}$ mho

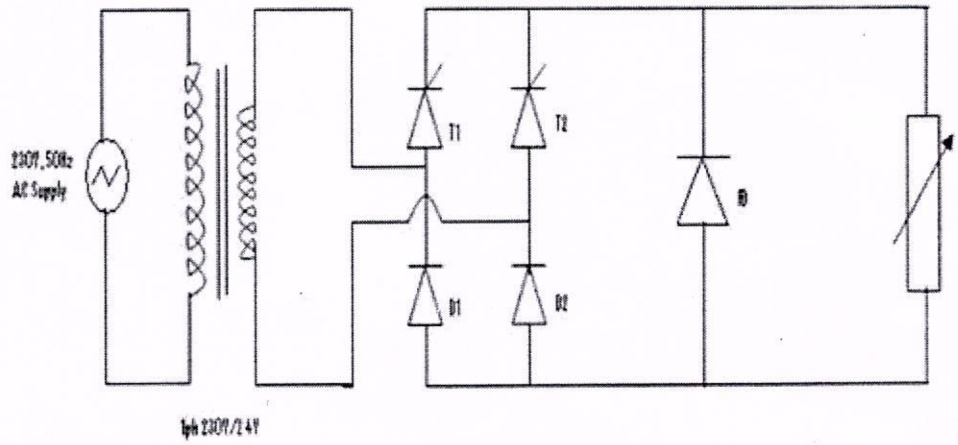
Output Resistance $Ro = \Delta V_{CE} / \Delta I_c$ Ω

RESULT

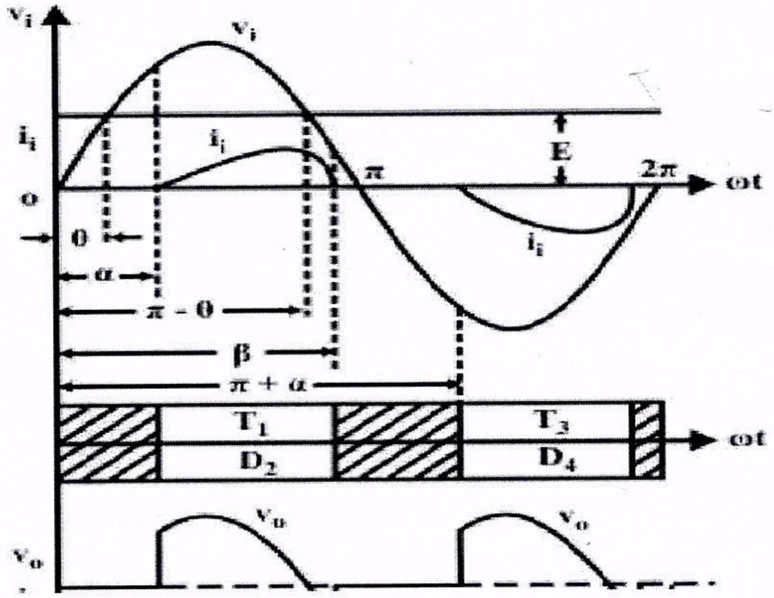
1. The transconductance gm = ____________ mho
2. The output resistance Ro = ____________ Ω

CIRCUIT DIAGRAM

Single Phase Half Controlled Converter



WAVEFORM



EXP.NO: 3 **DATE:**

AC TO DC HALF & FULLY CONTROLLED CONVERTER

3. A) SINGLE PHASE HALF CONTROLLED CONVERTER

AIM:

To study the operation of single phase half controlled converter using R load and to observe the output waveforms.

APPARATUS REQUIRED:

1. Power Thyristors.
2. Rheostat.
3. CRO
4. Transformer (1-phase) 230V/24V.
5. Connection wires.

THEORY

A semi converter uses two diodes and two thyristors and there is a limited control over the level of dc output voltage. A semi converter is one quadrant converter. A one-quadrant converter has same polarity of dc output voltage and current at its output terminals and it is always positive. It is also known as two-pulse converter. Figure shows half controlled rectifier with R load. This circuit consists of two SCRs T1 and T2, two diodes D1 and D2. During the positive half cycle of the ac supply, SCR T1 and diode D2 are forward biased when the SCR T1 is triggered at a firing angle $\omega t = \alpha$, the SCR T1 and diode D2 comes to the on state. Now the load current flows through the path L - T1- R load –D2 - N. During this period, we output voltage and current are positive. At $\omega t = \pi$, the load voltage and load current reaches to zero, then SCR T1 and diode D2 comes to off state since supply voltage has been reversed. During the negative half cycle of the ac supply, SCR T2 and diode D1 are forward biased. When SCR T2 is triggered at a firing angle $\omega t = \pi + \alpha$, the SCR T2

OBSERVATION TABLE

Serial No.	Triggering angle 'α' degree	Output voltage Vo (volt) (measured)	Time Period(ms)
1			
2			
3			

CALCULATIONS

$$V_{out} = (\sqrt{2}V_s)(1+\cos\alpha)/\pi$$

and diode D1 comes to on state. Now the load current flows through the path N - T2- R load – D1 -L. During this period, output voltage and output current will be positive. At $\omega t = 2\pi$, the load voltage and load current reaches to zero then SCR T2 and diode D1 comes to off state since the voltage has been reversed. During the period ($\pi + \alpha$ to 2π) SCR T2 and diode D1 are conducting.

PROCEDURE

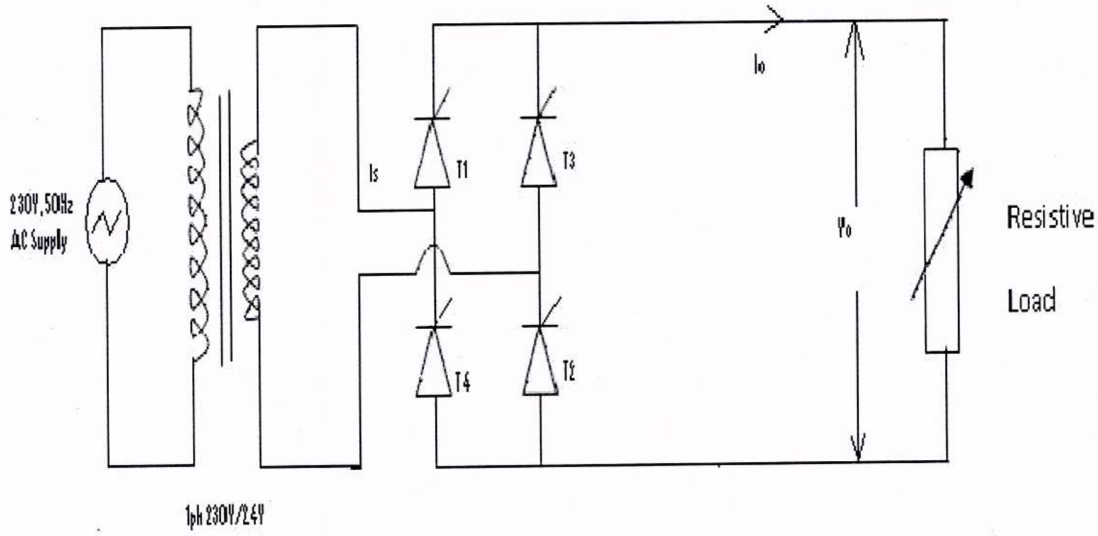
1. Make the connections as per the circuit diagram.
2. Connect CRO and voltmeter across the load.
3. Keep the potentiometer at the minimum position.
4. Switch on the step down ac source.
5. Check the gate pulses at G1-K1 & G2-K2, respectively.
6. Observe the wave form on CRO and note the triggering angle 'α' and
7. Note the corresponding reading of the voltmeter. Also note the value of Maximum amplitude Vm from the waveform.
8. Set the potentiometer at different positions and follow the step given in (6) for every position.
9. Tabulate the readings in the observation column.

RESULT

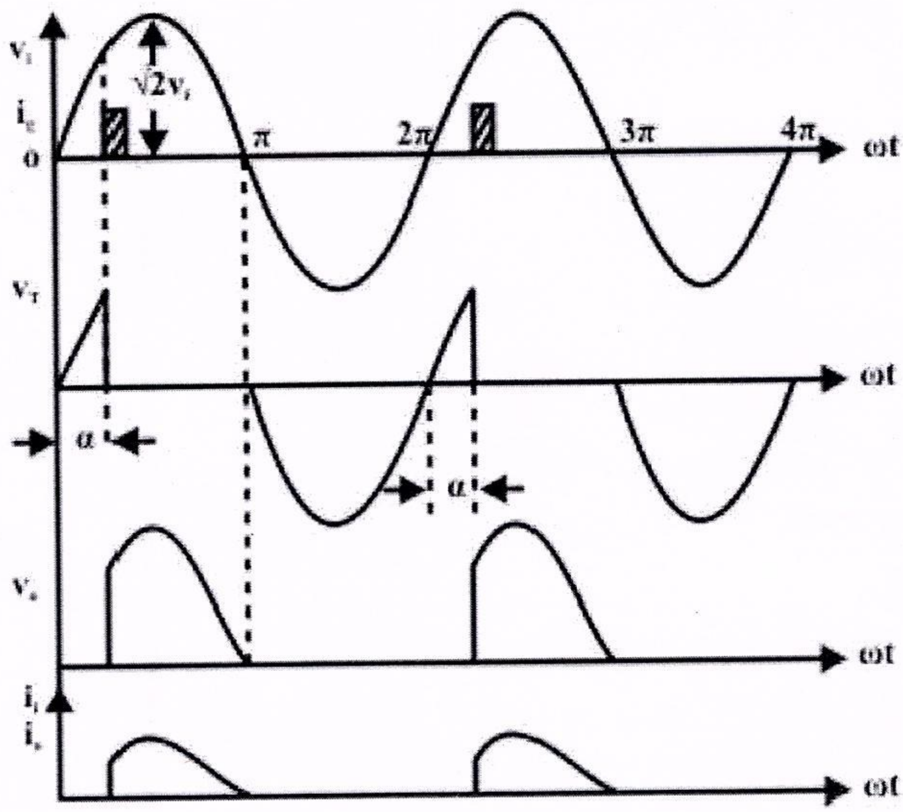
Thus the operation of single phase half controlled converter using R and RL load has studied and the output waveforms has been observed.

CIRCUIT DIAGRAM

Single Phase Fully Controlled Converter



MODEL GRAPH



3. B) SINGLE PHASE FULLY CONTROLLED CONVERTER

AIM:

To study the operation of single phase fully controlled converter using R and to observe the output waveforms.

APPARATUS REQUIRED:

1. Power Thyristors
2. Rheostat
3. CRO
4. Transformer (1-phase) 230V/24V
5. Connection wires

THEORY

A fully controlled converter or full converter uses thyristors only and there is a wider control over the level of dc output voltage. With pure resistive load, it is single quadrant converter. Here, both the output voltage and output current are positive. With RL- load it becomes a two-quadrant converter. Here, output voltage is either positive or negative but output current is always positive. Figure shows the quadrant operation of fully controlled bridge rectifier with R-load. Fig shows single phase fully controlled rectifier with resistive load. This type of full wave rectifier circuit consists of four SCRs. During the positive half cycle, SCRs T1 and T2 are forward biased. At $\omega t = \alpha$, SCRs T1 and T3 are triggered, and then the current flows through the L – T1- R load – T3 – N. At $\omega t = \pi$, supply voltage falls to zero and the current also goes to zero. Hence SCRs T1 and T3 turned off. During negative half cycle (π to 2π). SCRs T3 and T4 forward biased. At $\omega t = \pi + \alpha$, SCRs T2 and T4 are triggered, then current flows through the path N – T2 – R load- T4 – L. At $\omega t = 2\pi$, supply voltage and current goes to zero, SCRs T2 and T4 are turned off. The Fig-3, shows the current and voltage waveforms for this circuit. For large power dc loads, 3-phase ac to dc converters are commonly used. The various types of three-phase phase-controlled converters are 3 phase half-wave converter, 3-phase semi converter, 3-

OBSERVATION TABLE:

Serial No.	Triggering angle 'α' degree	Output voltage Voav (volt) (measured)	Time period(ms)
1			
2			
3			

CALCULATIONS:

$$V_{out}=(2V_s)(\cos\alpha)/\pi \qquad I_{avg}=V_{avg}/R$$

phase full controlled and 3-phase dual converter. Three-phase half-wave converter is rarely used in industry because it introduces dc component in the supply current. Semi converters and full converters are quite common in industrial applications. A dual is used only when reversible dc drives with power ratings of several MW are required. The advantages of three phase converters over single-phase converters are as under: In 3-phase converters, the ripple frequency of the converter output voltage is higher than in single-phase converter. Consequently, the filtering requirements for smoothing out the load current are less. The load current is mostly continuous in 3-phase converters. The load performance, when 3- phase converters are used, is therefore superior as compared to when single-phase converters are used.

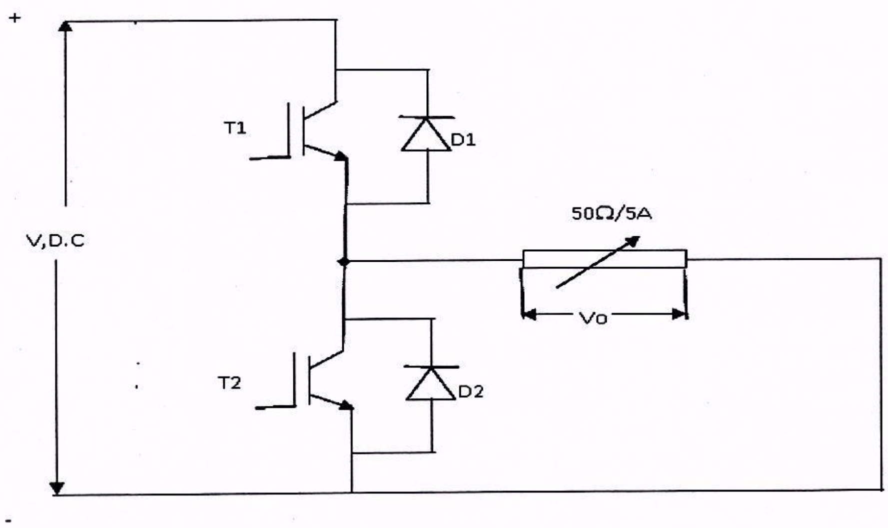
PROCEDURE:

1. Single Phase Fully Controlled Bridge Rectifier
2. Connect CRO and multimeter (in dc) across the load.
3. Keep the potentiometer (Ramp control) at the minimum position (maximum resistance).
4. Switch on the step down ac source.
5. Check the gate pulses at G1-K1, G2-K2,G3-K3,& G4-K4 respectively.
6. Observe the waveform on CRO and note the triggering angle 'α' and note the corresponding reading of the multimeter. Also note the value of maximum amplitude Vm from the waveform.
7. Set the potentiometer at different positions and follow the step given in (6) for every position.
8. Tabulate the readings in observation column.
9. Draw the waveforms observed on CRO.

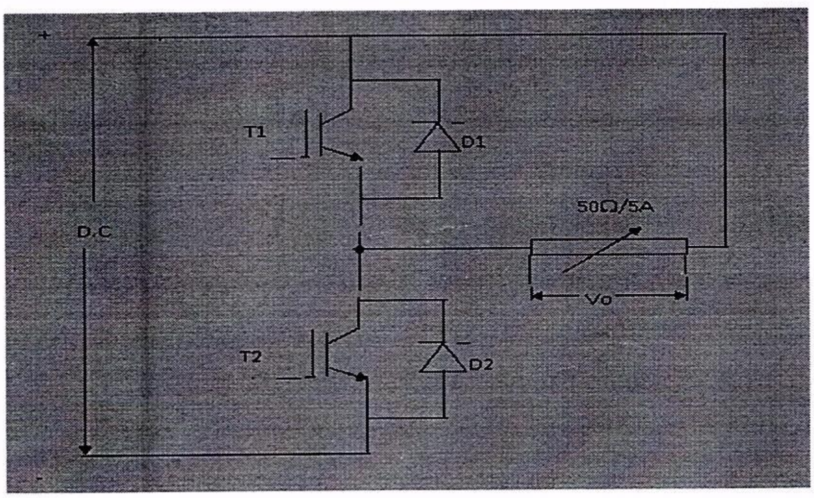
RESULT

Thus the operation of single phase fully controlled converter using R load has been studied and the output waveforms has been observed.

CIRCUIT DIAGRAM OF IGBT CHOPPER (I & IV QUADRANT OPERATION)



CIRCUIT DIAGRAM OF IGBT CHOPPER (II & III QUADRANT OPERATION)



EXP.NO: 4 **DATE:**

IGBT BASED CHOPPERS

AIM:

To conduct the operation of four quadrants IGBT chopper with bipolar switching and uni polar switching.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	IGBT module			
2	Chopper control module			
3	CRO			
4	Rheostat			
5	Multimeter			

THEORY

The type of chopper is obtained by connectivity type A type B chopper is parallel. The output voltage Vo is always positive because of the presence of freewheeling diode across the load. When chopper CH2 ON freewheeling diode conduct output voltage Vo=0 and incase chopper CH2 is ON or diode.

TABULATION: FIRST AND FOURTH QUADRANT

S.NO	Vo	Ton (ms)	T (ms)	α = Ton/T	Vo=

TABULATION: SECOND AND THIRD QUADRANT

S.NO	Vo	Ton (ms)	T (ms)	α = Ton/T	Vo=

PROCEDURE

For bipolar switching

1. Using the chopper module, and referring to the mimic diagram, connect the circuit as per the circuit diagram.

    i) Connect B11 to V+1 using patch chords.

    ii) Connect B12 to B21 using patch chords.

    iii) Connect B23 to V-1 using patch chords.

    iv) Connect V+2 to B31 using patch chords.

    v) Connect B32 to B41 using patch chords.

    vi) Connect V-2 to B43 using patch chords.

2. Connect the R-load between B12 to B33.

3. Connect the gating signals from the chopper control module to the chopper module using the signal cable provided.

4. Connect the power cables for both the modules.

5. Select bipolar voltage switching mode, mode III by setting SW3 in the control module at position.

6. Keeping pulse release ON/OFF switch SW4, in the control module in the off position. Switch ON ac mains to the CRO, control module and chopper module.

7. Switch ON SW! in chopper module to establish dc link voltage.

8. Release the gating signals by switching on SW$ in the control module.

9. Observe the load voltage waveforms through CRO.

10. Vary the duty cycle ratio and measure Ton, Toff, average dc output voltage and tabulate them.

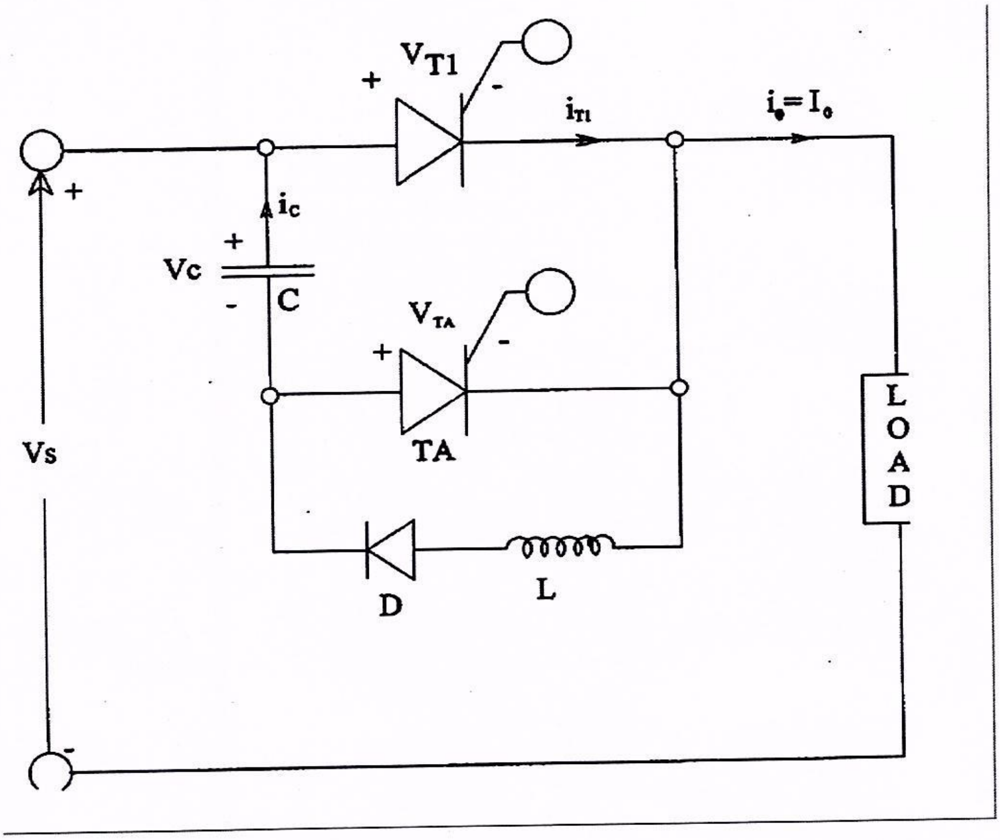
For unipolar voltage switching

1. Follow the steps 1 to 4 in bipolar voltage switching.
2. Select the unipolar switching mode, by setting the mode switch SW3 at position IV in the chopper control module.
3. Follow the remaining steps.

RESULT

Thus the four quadrant chopper was constructed and the operation of the chopper has been obtained from the output waveform.

CIRCUIT DIAGRAM: SCR DC VOLTAGE COMMUTATED CHOPPER



EXP.NO: 5 **DATE:**

SCR DC VOLTAGE COMMUTATED CHOPPER

AIM:

To observe the operation of class D commutated technique.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Force commutation trainer kit			
2	Patch cards			
3	CRO			

THEORY:

MODE-1

Main SCR is triggered to make source current to flow in two path one is load current and other path with triggering of SCR load get connected to supply and load voltage.

MODE-2

At a desired instant the auxiliary SCR is to be triggered for turning OFF the main SCR T1 with the switch ON, T2 reverse capacitance voltage appears across T1 which reverse biases it and turn it OFF.

MODE-3

SCR T2 turn OFF since the capacitance is slightly changed after the freewheeling diode set frequently forward biased.

OBSERVATION TABLE:

S.NO	Vs in volts	T auxiliary time	
		Ton (ms)	Toff (ms)

S.NO	Amplitude	T auxiliary time	
		Ton (ms)	Toff (ms)

NOTATIONS USED

Ig- gate current
It- thyristor current
Ic- capacitor current
Vc- capacitor voltage
Vt- thyristor voltage
Vo- output voltage
Ita- auxiliary thyristor current

PROCEDURE:

1) Patch the voltage commutated chopper as per the circuit diagram
2) Connect the CRO probe across the commutated chopper
3) Give the input dc voltage (0-30)v, 2amps from the external power supply.
4) Switch ON the trainer then switch ON the input dc supply circuit breaker.
5) After then switch ON the trigger OFF-ON position
6) From the load output waveform we can measure the turn on time and turn off time of main SCR as well as auxiliary SCR
7) Verify the unity and frequency of the triggering circuit using parts provided on the triggering circuit.
8) Also observe the voltage across main SCR and auxiliary SCR and load
9) Take the turn on and turn off time at main so auxiliary SCR from the capacitor waveform at various values of unity cycle and frequency and tabulate them
10) Also find out the peak value of current through the load.
11) Patch the voltage commutated chopper as per the circuit diagram
12) Connect the CRO probe across the commutated chopper
13) Give the input dc voltage (0-30)v, 2amps from the external power supply.
14) Switch ON the trainer then switch ON the input dc supply circuit breaker.
15) After then switch ON the trigger OFF-ON position
16) From the capacitor output waveform we can measure the turn on time and turn off time of main SCR as well as auxiliary SCR
17) Verify the unity and frequency of the triggering circuit using parts provided on the triggering circuit.
18) Also observe the voltage across main SCR and auxiliary SCR and load
19) Take the turn on and turn off time at main so auxiliary SCR from the capacitor waveform at various values of unity cycle and frequency and tabulate them
20) Also find out the peak value of current through the capacitor.
21) Patch the voltage commutated chopper as per the circuit diagram
22) Connect the CRO probe across the commutated chopper
23) Give the input dc voltage (0-30)v, 2amps from the external power supply.

OBSERVATION TABLE:

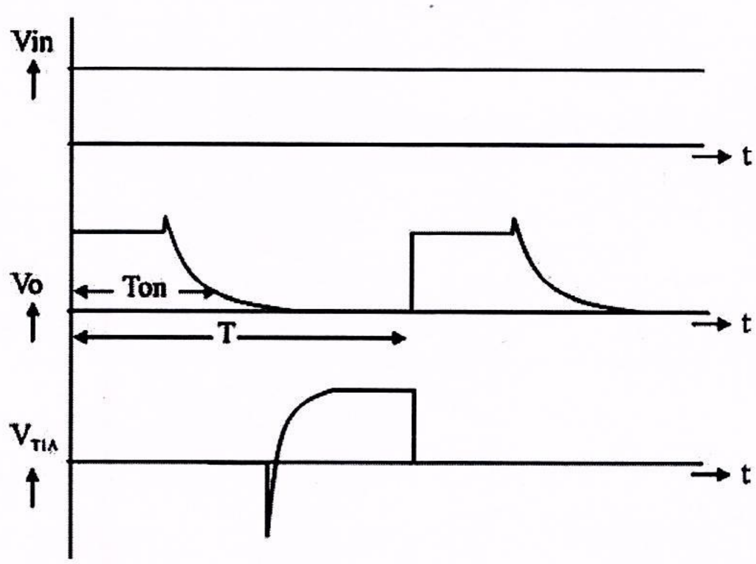
OUTPUT ACROSS CAPACITOR

S.NO	Vs (volts)	Ip=VsVl/L	Main SCR turn on time	Main SCR turn off time

OUTPUT ACROSS LOAD

S.NO	Vs (volts)	Ip=VsVl/L	Main SCR turn on time	Main SCR turn off time

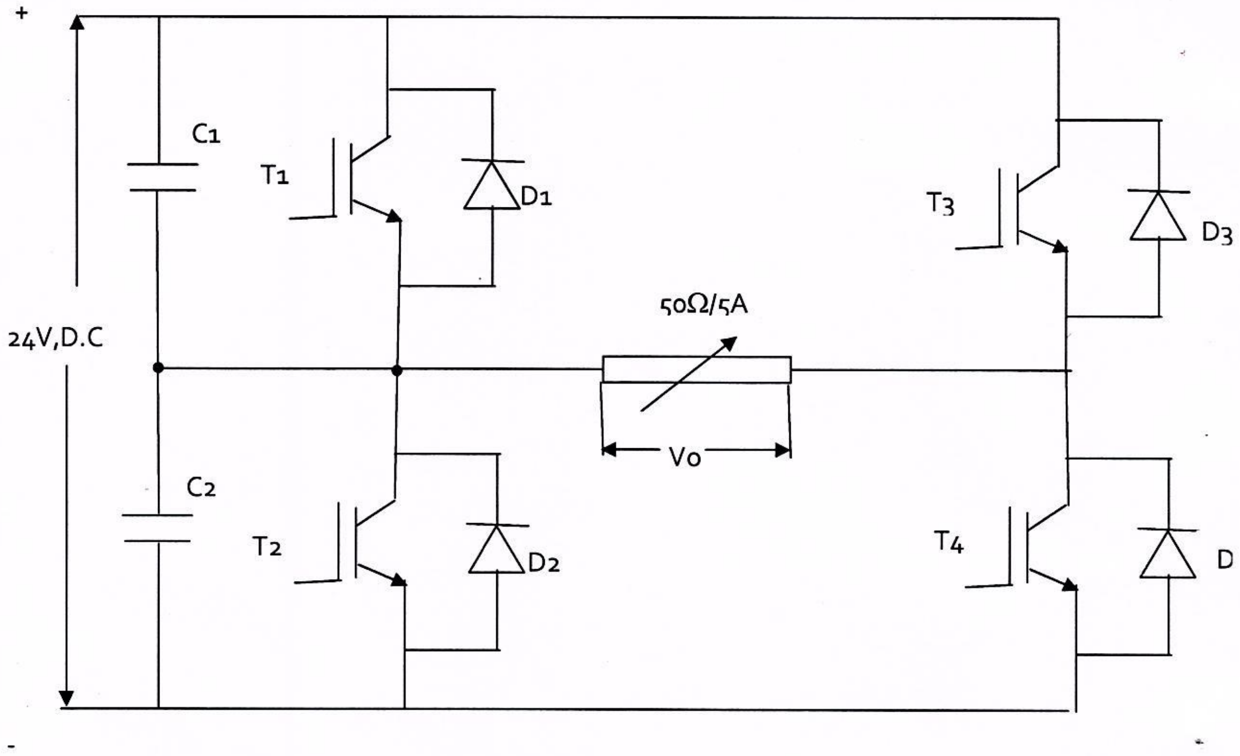
WAVEFORM:



RESULT:

Thus the operation of class D commutated technique has been obtained.

CIRCUIT DIAGRAM



TABULAR COLUMN:

S.no	Output voltage (v)	Time (ms)

EXP NO: 6 **DATE:**

IGBT BASED CHOPPER

AIM:

To study the behavior of IGBT based single-phase full-bridge inverter connected to R load.

PARATUS REQUIRED:

SI.NO	APPARATUS REQUIRED	RANGE	QUANTITY	
1.	PWM module			
2.	Multi meter			
3.	CRO			
4.	Connecting probes			

MODULE DETAILS:

This unit consists of two parts:
(a) Control Circuit and
(b) Power Circuit.

A) CONTROL CIRCUIT:

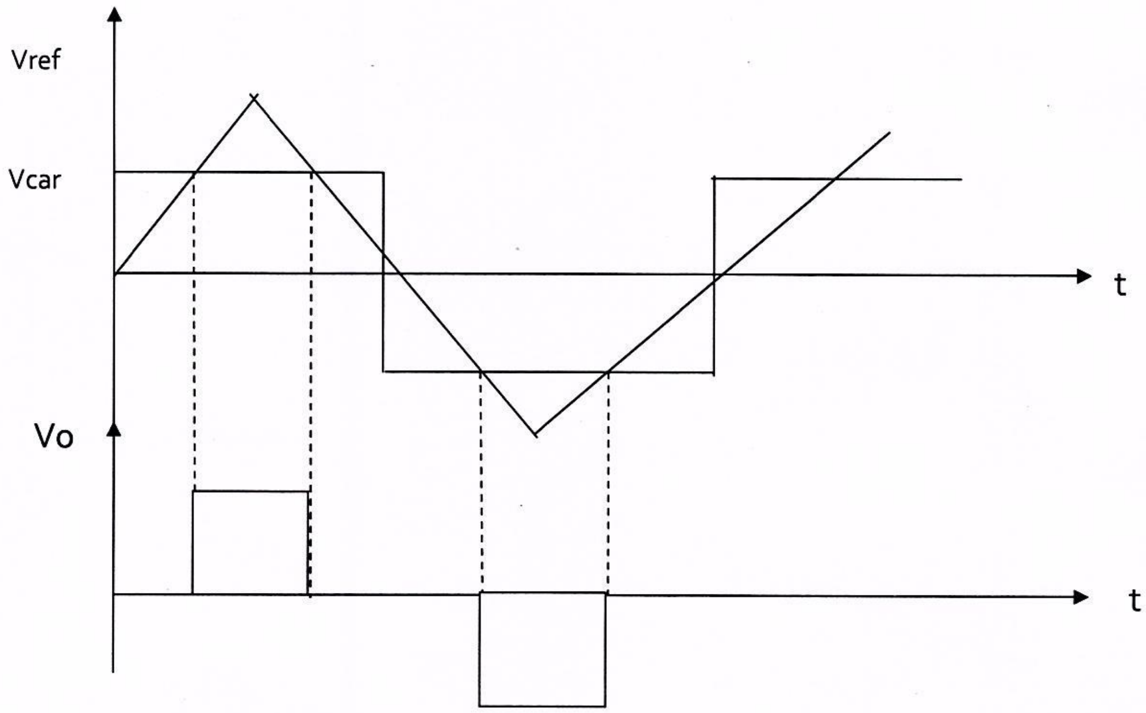
This is based on 89C52 Microcontroller. 2 X 16 line LCD display to indicate and monitor the Parameters and type of modulation. The following modulation techniques are incorporated:

a) Single pulse modulation
b) Sine triangle modulation
c) Multi pulse modulation
d) Trapezoidal modulation
d) Trapezoidal modulation
e) Stair case modulation

B) POWER CIRCUIT:

This unit consists of 4 IGBT's unit built in diodes of rating 19A/600V. All the devices are mounted on proper heat-sink and protected by snubber circuit and fuse. All the terminals are brought out on the front panel. In the input side a switch and a fuse are provided for DC input 24V @ 2A. The frequency can be varied from 20Hz to 100Hz. The duty can be varied from 0% to 100%. Carrier frequency – 9 pulses per each half cycle 5 keys: SET, INC, DEC, FRQ/DTY and RUN/STOP to vary and set the parameters. opto coupler based isolation circuit to drive 4 IGBTs connected as 1-ph. Bridge Inverter.

Model graph



PROCEDURE

A. CONTROL CIRCUIT

1. Switch ON the mains supply of the controller unit. The LCD display shows 1-ph PWM inverter with modulation type and M- (Duty cycle or modulation index) 00 and F-100 Hz and in OFF position.
2. When M-00 Blinks, press INC key to set the duty cycle from 00- 100%.
3. Press FRQ/DTY key and select F-100. When F-100 blinks, use INC and DEC key to increase or decrease the frequency from 20Hz to 100Hz.
4. After setting the duty cycle and frequency, press RUN/STOP key. Now the driver O/Ps pulses are available at O/Ps are comes to OFF with soft stop.
5. Set the modulation type to other type and check the outputs
6. Check the driver outputs for different types of modulation. Make sure that the driver outputs are proper before connecting to the power circuit.

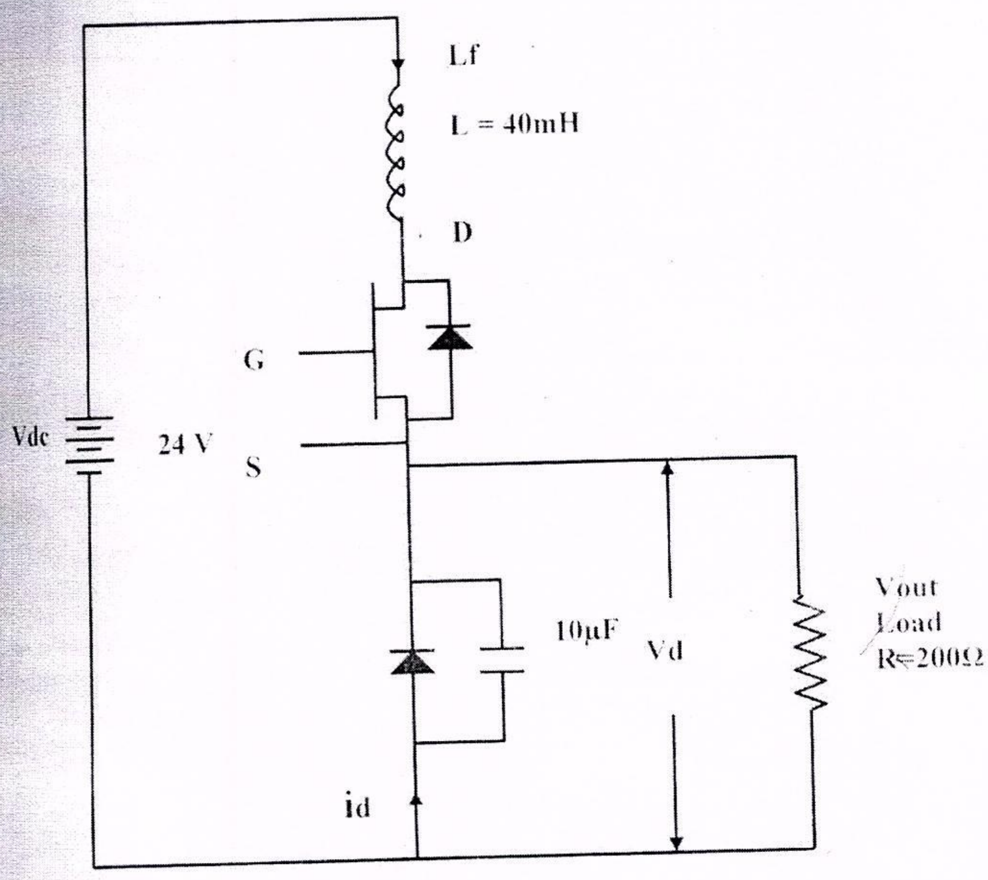
NOTE: The SET key works only when it is in OFF position. This is to avoid change of modulation type when the power circuit is ON.

B. POWER CIRCUIT

1. Make the connections as given in the circuit diagram.
2. Connect DC supply from 30V/2A regulated power supply unit.
3. Connect a resistive load – 50 ohms or 100 ohms 2 Amps Rheostat at load terminals.
4. Connect driver output signals to the Gate and Emitter of corresponding IGBTs.
5. Switch ON the DC supply.
6. Switch ON the driver outputs and observe the output voltage across the load.

RESULT

The behavior of IGBT based single phase full bridge inverter was studied.



Specifications :

Resonant DC –DC Buck converter with ZCS (24V)

EXP NO:7 **DATE:**

RESONANT DC TO DC CONVERTER

AIM:

To study the operation of DC to DC resonant converter

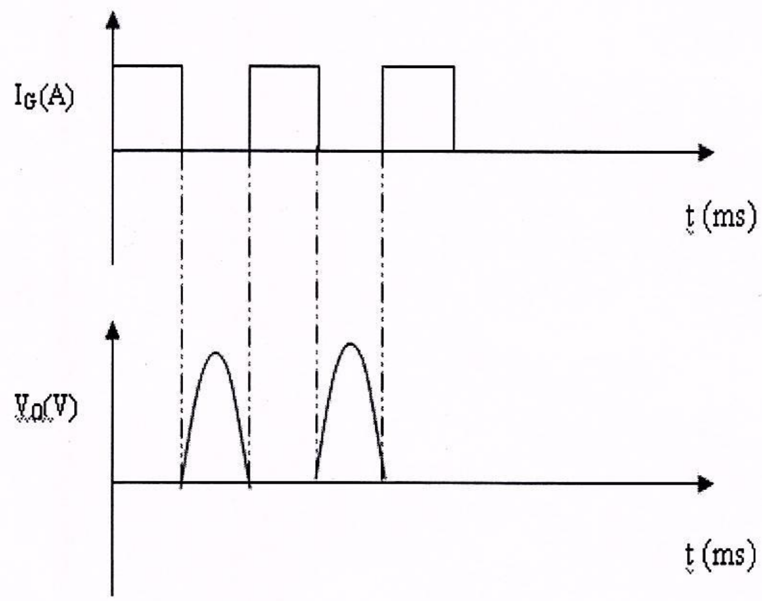
APPARATUS REQUIRED:

Sl.No.	NAME OF THE APPARATUS	RANGE	QUANTITY
1.	Resonant DC to DC converter triggering module		
2.	Resonant DC to DC converter power module		
3.	CRO		
4.	CRO probes		
5.	Patch cards		

OBSERVATION TABLE:

S.NO	Vdc (Input voltage) v	Vd (Peak voltage) V	Vd (on-Time) T sec	Vgs (on-time) T sec

MODEL GRAPH:



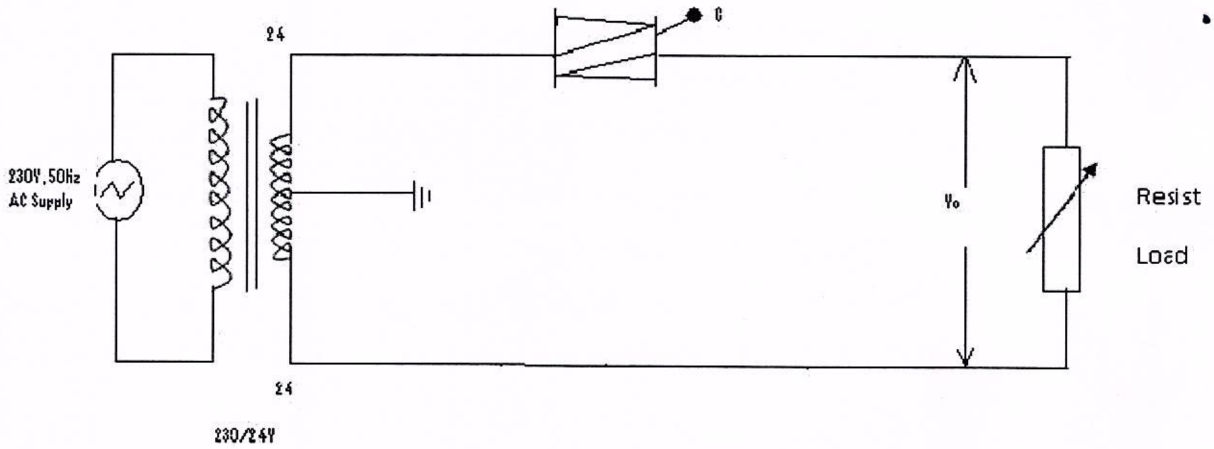
PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Switch ON the triggering module.
3. Set the carrier wave switching frequency is equal to resonant frequency.
4. Switch ON the power module.
5. Observe the output voltage and current waveforms.
6. By varying the reference signal the output voltage control is achieved.
7. Switch OFF the trainer. Change the LC value and observe the voltage waveforms.

RESULT:

Thus the operation of DC to DC resonant converter has been studied.

CIRCUIT DIAGRAM



OBSERVATION:

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

EXP NO: 8 **DATE:**

AC VOLTAGE CONTROL USING TRIAC

AIM:

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

APPARATUS REQUIRED:

i) Lamp – 60W
ii) Resistor - 100Ω / 1W
iii) Potentio meter – 100KΩ
iv) Capacitor – 0.1μF / 400V
v) Resistor – 1KΩ
vi) DIAC – DB3
vii) TRIAC BT 136
viii) Unearthed oscilloscope

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).

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

   the triac turning triac to ON – state there lamp glows with maximum intensity.
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 to is

   not triggered hence lamp doesnot glow.

3. When potentiometer is in medium position a small voltage is available across capacitor hence lamp glows with minimum intensity.

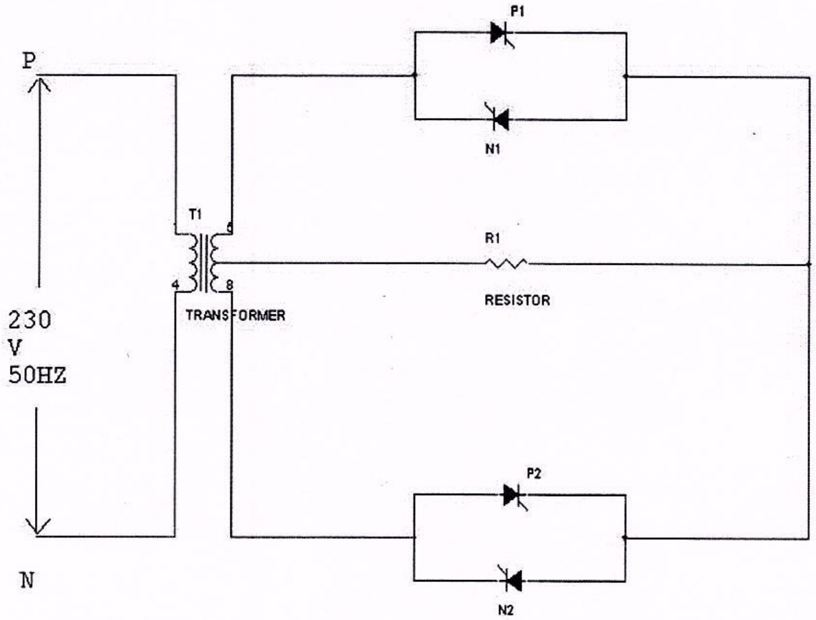
PROCEDURE

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.

RESULT

Thus the operation and performance of the 1-phase AC voltage control using.

CIRCUIT DIAGRAM: - SINGLE PHASE CYCLOCONVERTER



EXP NO: 9 **DATE:**

SINGLE PHASE CYCLO CONVERTER

AIM:

To study the operation of single phase Cycloconverter.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Cycloconverter module			
2	Loading rheostat			
3	CRO			
4	Inductance			
5	probes			

THEORY:

Cycloconverter directly changes frequency changes that convert ac power at one frequency to ac power at another frequency by ac to ac conversion without an intermediate conversion link. The majority of Cycloconverter are naturally commutated. Some Cycloconverter need forced commutatory circuit.

1) Step-down Cycloconverter→Natural commutation.

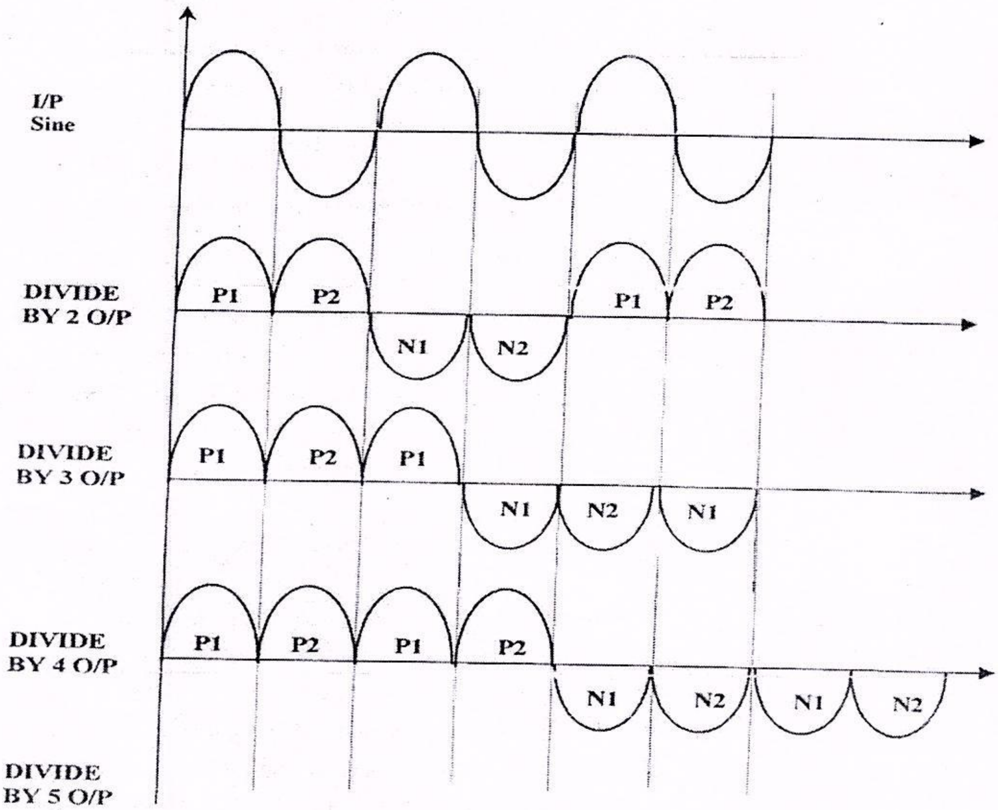
2) Step-up Cycloconverter→Forced commutation.

The Principle of operation of Single phase Cycloconverter can be explained with the circuit diagram. The SCR T_1 and T_2 form positive polarity of output voltage and T3, T4 produce negative polarity of the load voltage. The positive group SCR's T_1 and T_2 are gated together depending upon polarity one of them will conduct Dc output voltage of impulse Cycloconverter.

OBSERVATION:

Sl.No	Amplitude (V)	Frequency(Hz)	Ton(ms)	Toff(ms)

CYCLOCONVERTER FREQUENCY DIVIDER OUTPUTS:



DIVIDE
BY 5 O/P

DIVIDE
BY 6 O/P = DIVIDE
BY 7 O/P

DIVIDE
BY 8 O/P

DIVIDEB
BY 9 O/P

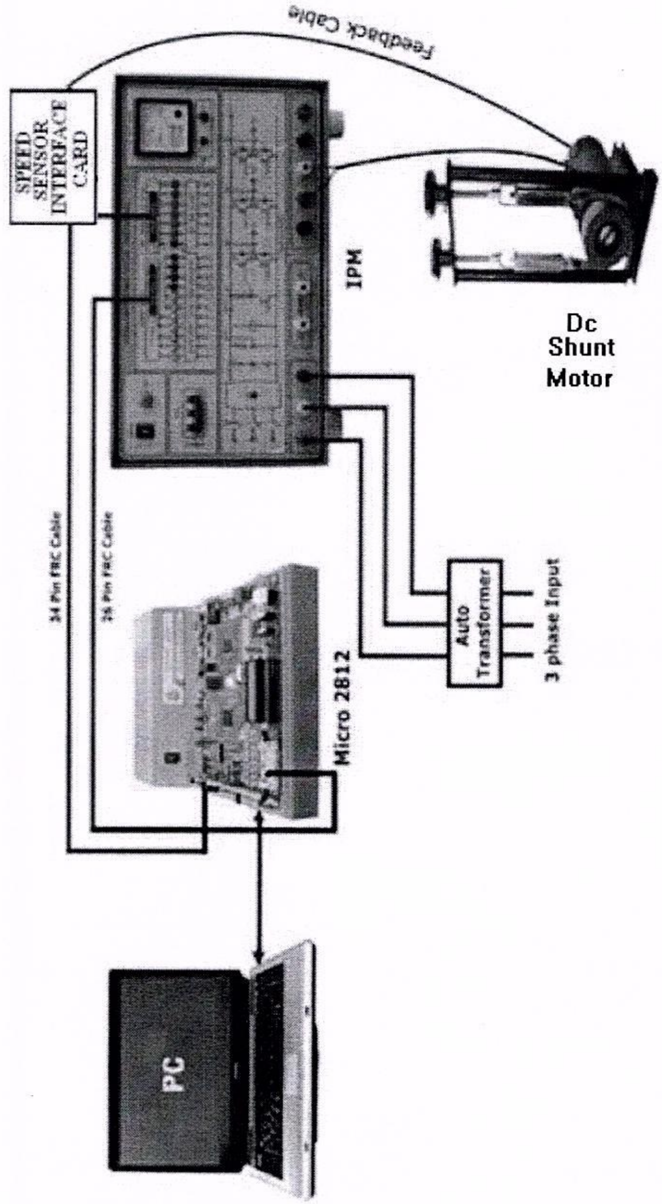
PROCEDURE:

1. Patch the firing circuit unit as per the Patching diagram.
2. Switch on the Firing circuit unit through the power on Indicator switch providing the front panel.
3. Verifying the test point through the CRO Whether it is Proper or not.
4. Then press soft start switch.
5. Study and observe the various stages of waveform through the appropriate test point.
6. Observe the firing pulse output and their phase sequence through the corresponding terminal using dual in CRO.
7. Now switch off the firing circuit and patch the power circuit as show in the patching diagram, also interlink the firing unit and power unit as Shown in the patching diagram.
8. Connect the CRO probe across the load Resistor (It may be a fixed or Variable Resistor)
9. Switch on both the firing and power unit and observe the Cycloconverter output in the CRO and change the firing angle through the firing angle variation (0-180°) pot meter
10. Repeat the experiment for the various values frequency divider output, Observe and trace the Cyclo converter output and note down the voltage and current reading for various value of R.

RESULT

Thus the output waveform of the single phase midpoint Cycloconverter was studied and observed.

SPEED CONTROL OF DC SHUNT MOTOR USING IPM AND MICRO 2812



EXP. NO: 10 **DATE:**

CONVERTER FED DC MOTOR DRIVE

AIM:

To study the open loop and closed loop speed control of DC Shunt Motor by using MICRO 2812 and IPM.

APPARATUS REQUIRED:

1. Intelligent Power Module.
2. MICRO - 2812 (DSP trainer)
3. DC Shunt Motor
4. Proximity signal conditioning card
5. CRO
6. Cables
   i. 34 pin FRC 1 to 1 to 1
   ii. 26 pin FRC 1 to 1.
   iii. Feedback connector cable (9 pin D cable).
   iv. PC to PC cable (Serial port cable) (9 pin male to male connector).

THEORY:

IPM POWER MODULE:

IPM based power module work as DC - DC Converter (Chopper) or DC-AC Converter (Inverter). It works using an IGBT based IPM and works on basis of software from DSP Processor. The power module can be used for studying the operation of chopper, three phase inverter, single phase inverter and speed control of three phase induction motor, single phase induction motor. Intelligent Power Modules (IPMs) are advanced hybrid power devices that combine high speed, low loss IGBTs with optimized gate drive and protection circuitry. Highly effective over-current and short-circuit protection is realized through the use of advanced current sense IGBT chips that allow continuous monitoring of power device current. System reliability is further enhanced by the IPM's integrated over temperature and under voltage lock out protection. The built in gate drive and protection has been carefully designed to minimize the components required for the user supplied interface circuit.

DC SHUNT MOTOR:

A shunt motor has slightly different operating characteristics than a series motor. Since the shunt field coil is made of fine wire, it cannot produce the large current for starting. This means that the shunt motor has very low starting torque, which requires that the shaft load be rather small.

When voltage is applied to the motor, the high resistance of the shunt coil keeps

TABULATION:

OPEN LOOP:

Sl.no	Modulation Index (M)	Output Voltage (V)	Speed (RPM)	Torque(Nm)	Load (kg)	
					S1	S2

CLOSED LOOP:

Sl.no	Modulation Index (M)	Output Voltage (V)	Speed (RPM)	Torque(Nm)	Load (kg)	
					S1	S2

the overall current flow low. The armature for the shunt motor is similar to the series motor and it will draw current to produce a magnetic field strong enough to cause the armature shaft and load to start turning. Like the series motor, when the armature begins to turn, it will produce back EMF. The back EMF will cause the current in the armature to begin to diminish to a very small level. The amount of current the armature will draw is directly related to the size of the load when the motor reaches full speed. When the motor reaches full rpm, its speed will remain fairly constant.

PROCEDURE:

1. Connect the 34 pin cable from the MICRO - 2812 to power module (IPM) along with the proximity signal conditional card.
2. Connect the 26 pin cable from the MICRO - 2812 to power module (IPM).
3. Connect the feedback cable between motor and proximity signal conditional card.
4. Connect the serial port cable between the PC and the DSP trainer.
5. Connect the motor terminals A, AA, F, FF to the A, AA, F, FF terminals in "Intelligent Power Module".
6. Verify the connections as per the connection procedure and Wiring Diagram.
7. Switch ON the MICRO - 2812 DSP trainer kit.
8. Power ON the Intelligent Power Module and MCB.
9. Check whether shutdown LED "SD" glows or not. If 'SD' LED glows, press the Reset switch, the LED gets OFF.
10. Download the program to the MICRO - 2812 Kit by following the downloading procedure.
11. Perform Open loop control and take the readings by applying load.
12. Perform Closed loop control and take the readings by applying load.

OPEN LOOP CONTROL

1. Verify the PWM waveform and proximity sensor output which are terminated in the power module.
2. After ensuring all the connection, apply the input voltage to the intelligent power module (DC rail voltage (600V), which is shown in the power module voltmeter).
3. By using the switches increment (S2) and decrement (S3) set the speed of the motor.

4. Now the motor starts to rotate in the set speed.

5. The actual speed of the motor will be displayed in the LCD and PC.

CLOSED LOOP CONTROL

1. Verify the PWM waveform and proximity sensor output which are terminated in the power module.

2. After ensuring all the connection, apply the input voltage to the intelligent power module (DC rail voltage (600V), which is shown in the power module voltmeter).

3. By using the switches increment (S2) and decrement (S3) set the speed of the motor.

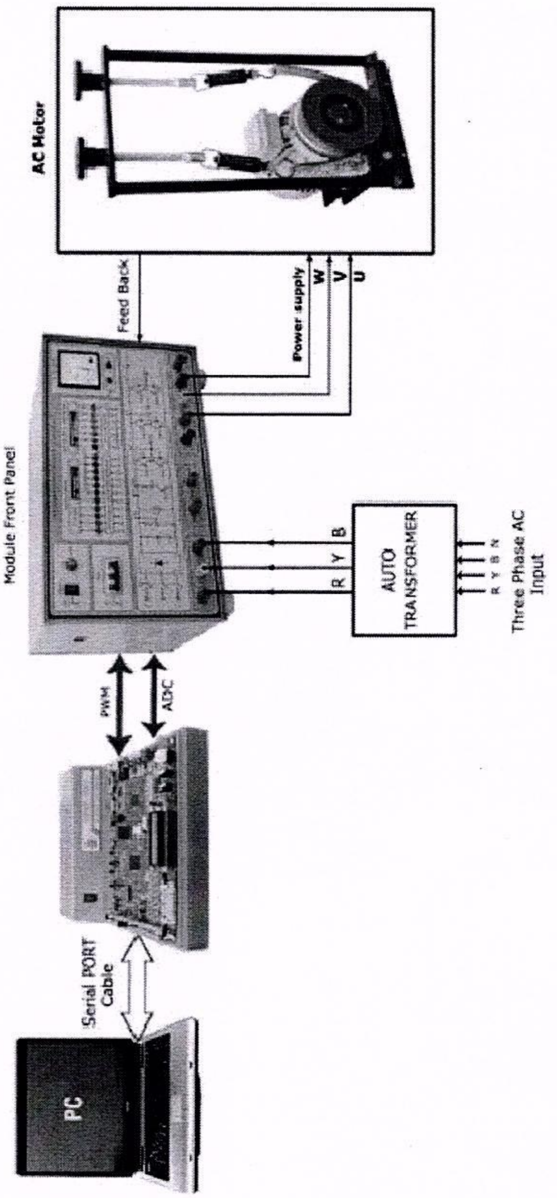
4. Now the motor starts to rotate in the set speed.

5. The actual speed of the motor will be displayed in the LCD and PC.

6. Now apply the load to the motor at rated current rating and analyze the performance of the closed loop control.

RESULT:

Thus the open and closed loop speed control of DC Shunt motor was done using Intelligent Power Module.



MOTOR SPECIFICATIONS:

Number of poles : 4, Phase : 3, Rated Power : 0.75 KW
Rated Voltage : 415 V (Star), Rated Current : 1.8 A
Supply frequency: 50, Hz Rated
Speed : 1395 rpm Power
Factor : 0.81
Weight : 14 Kg

EXP NO: 11 **DATE:**

INVERTER FED INDUCTION MOTOR DRIVE

AIM:

To study the open loop and closed loop speed control of AC Motor by using MICRO 2812 and PEC16DSMO1(IPM)module.

APPARATUS REQUIRED:

1. INTELL
2. MICRO - 2812 (DSP trainer)
3. AC Motor
4. QEP or proximity signal conditioning card
5. CRO
6. Cable
   i. 34 pin FRC 1 to 1 to1 .
   ii. 26 pin FRC 1 to 1.
   iii. Feedback connector cable (9 pin D cable).
   iv. PC to PC cable (Serial port cable) (9 pin male to male connector).

THEORY:

In every industry there are processes some form that require adjustment for normal operation. Such adjustments are usually accomplished with variable speed drive and it consists of

* Controller
* Power Converter
* Electric Motor

Controller : The controller generates PWM signal to the converter & hence forms the heart of the Variable speed system.(VSDs)

Power Converter : It controls the power flow from an AC supply to the motor by appropriate control of power semiconductor switches (part of power Converter).

Electric Motor : It is connected directly/indirectly to the load.

TABULATION:

OPEN LOOP:

Sl.no	Modulation Index (M)	Output Voltage (V)	Speed (RPM)	Torque(Nm)	Load (kg)	
					S1	S2

CLOSED LOOP:

Sl.no	Modulation Index (M)	Output Voltage (V)	Speed (RPM)	Torque(Nm)	Load (kg)	
					S1	S2

PRECAUTIONS:

1. Don't connect the CRO probe at the output terminal of the IPM without isolation
2. If user wants to see the high voltage waveform using CRO, please connect one isolation transformer between auto transformer and IPM otherwise remove the earth terminal of the CRO power card.
3. If the protection circuit LED in the IPM is glow during the operation, user must reset the trainer kit first and then reset the power module.
4. Please do not insert any add-on card while the trainer is powered ON.
5. Please do not tamper with any of the components in the trainer.
6. Please do not solder any wire from connectors when the power is ON.
7. Wires are to be soldered only from the solder side of the board in unavoidable conditions.
8. The headers should be used only with cables and not with wires soldered from the pins.

PROCEDURE:

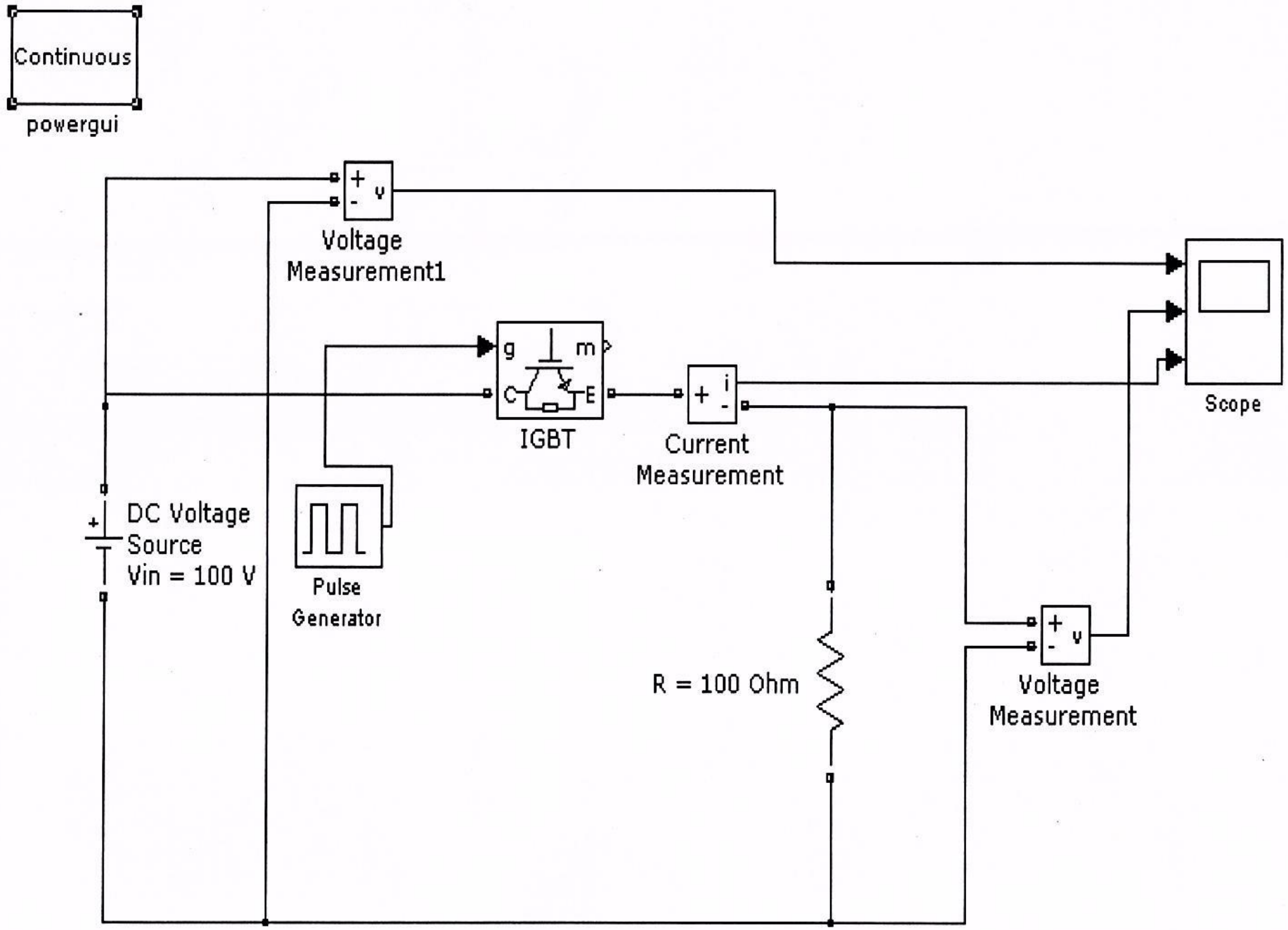
1. Connect the 34 pin cable from the MICRO - 2812 to power module(IPM) along with the QEP or proximity signal conditioning card.
2. Connect the 26 pin cable from the MICRO - 2812 to power module(IPM).
3. Connect the feed back cable between motor and QEP or proximity signal conditioning card.
4. Connect the serial port from the PC to 9 - pin termination of the DSP trainer.
5. Connect the motor terminals R, Y, B to the U, V, W terminals in "IPM Power Module"
6. Verify the connections as per the connection procedure and Wiring Diagram.
7. Switch ON the MICRO - 2812 DSP trainer kit.
8. Power ON the IPM (PEC16DSM01) and MCB.
9. Check whether shut down LED "SD" glows or not. If 'SD' LED glows, press the Reset switch, the LED gets OFF.
10. Download the program to the MICRO - 2812 Kit by following the downloading procedure.

11. Perform Open loop control and take the readings by applying load.
12. Perform closed loop control and take the readings by applying load.

RESULT:

Thus the open and closed loop speed control of three phase induction using IGBT based PWM Inverter was done.

SIMULATION DIAGRAM OF STREP DOWN CHOPPER-R LOAD



EXP NO: 12 **DATE:**

SIMULATION OF STEP DOWN CHOPPER

AIM:

To simulate and study the Class A Chopper (Step Down Chopper) with R and RL Load for different firing angles.

APPARATUS REQUIRED:

Sl. No.	Description	Quantity
01	Computer	01
02	Printer	01

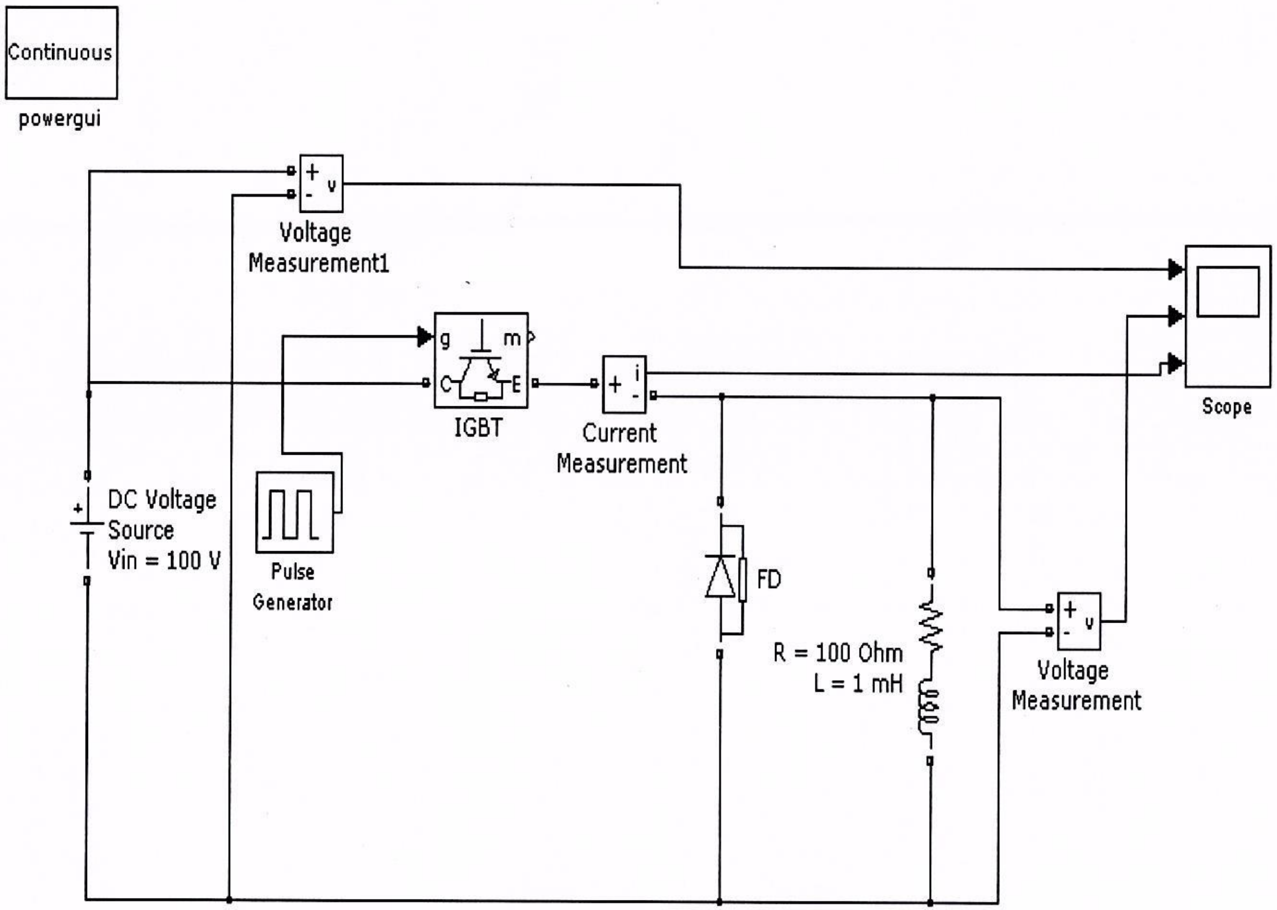
SOFTWARE REQUIRED

MATLAB 6.1 or above.

THEORY

Many industrial applications require power from dc voltage sources. Several of these applications, perform better in case there are fed from variable dc voltage sources. Examples of such dc systems are subway cars, trolley buses, battery-operated vehicles, battery-charging, etc. From ac supply systems, variable dc output voltage can be obtained through the use of phase-controlled converters or motor-generator sets. The conversion of fixed dc voltage to an adjustable dc output voltage, through the use of semiconductor devices, can be carried out by the use of two types of dc to dc converters. A chopper is a static device that converts fixed dc input voltage to a variable dc output voltage directly. A chopper may be brought of as dc equivalent of an ac transformer since they behave in an identical manner. As choppers involve one stage conversion, these are more efficient. The power semiconductor devices used for a chopper circuit can be power BJT, power MOSFET, GTO or force-commutated thyristor. These devices, in general, can be represented by a switch SW with an arrow. When the switch is OFF, no current can flow. When the switch is ON, current flows in the direction of arrow only. The power semiconductor devices have on-state voltage drops of 0.5 V to 2.5 V across them. For the sake of simplicity, the voltage drop across these devices is neglected. As a chopper is dc equivalent to an ac transformer having continuously variable turns ratio, like a transformer, it can be used to step down or step up the fixed dc input voltage. A chopper is a high speed ON/OFF semiconductor switch. It

SIMULATION DIAGRAM OF STREP DOWN CHOPPER-RL LOAD



connects source to load and disconnects the load from source at a fast speed. Thus, a chopped load voltage is obtained from a constant dc supply of magnitude V_s. In the circuit diagram, chopper is represented by a switch SW inside a dotted rectangle, which may be turned-ON or turned-OFF as desired. For the sake of highlighting the principle of operation, the circuitry used for controlled the ON, OFF periods of this switch is not shown.

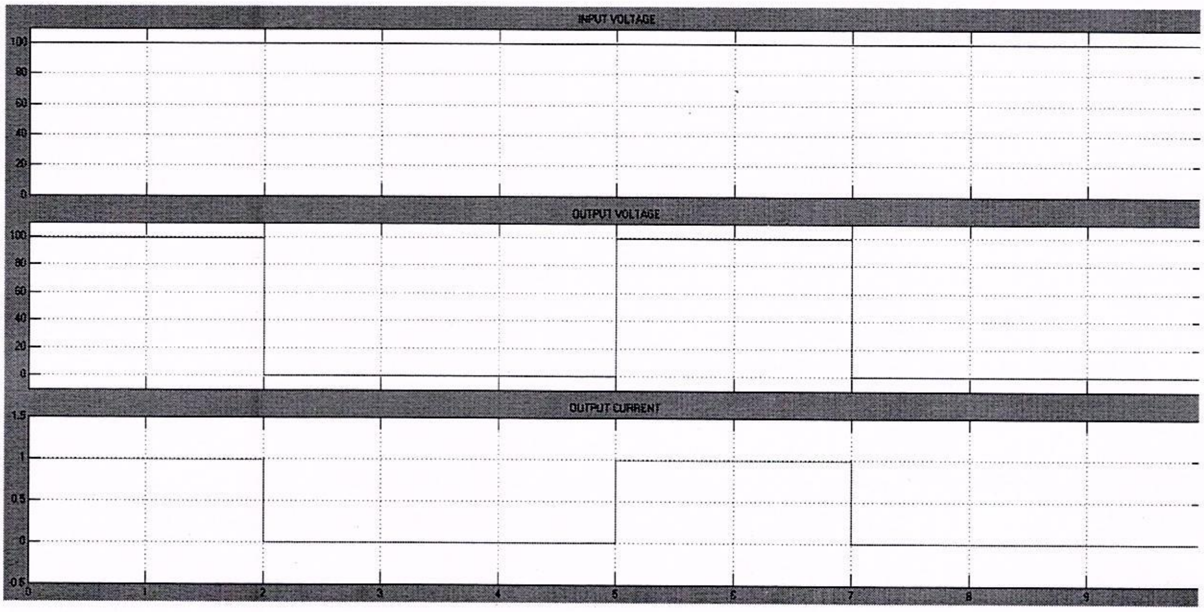
During the period T_{on}, chopper is ON and load voltage is equal to source voltage V_s. During the interval T_{off}, chopper is OFF, load current flows through the freewheeling diode FD. As a result, load terminals are short circuited by FD and load voltage is therefore zero during T_{off}. In this manner, a chopped dc voltage is produced at the load terminals. The load current is continuous. The load voltage can be controlled by varying the duty cycle $\alpha = \frac{T_{ON}}{T}$ and is independent of load current.

PROCEDURE FOR R LOAD:

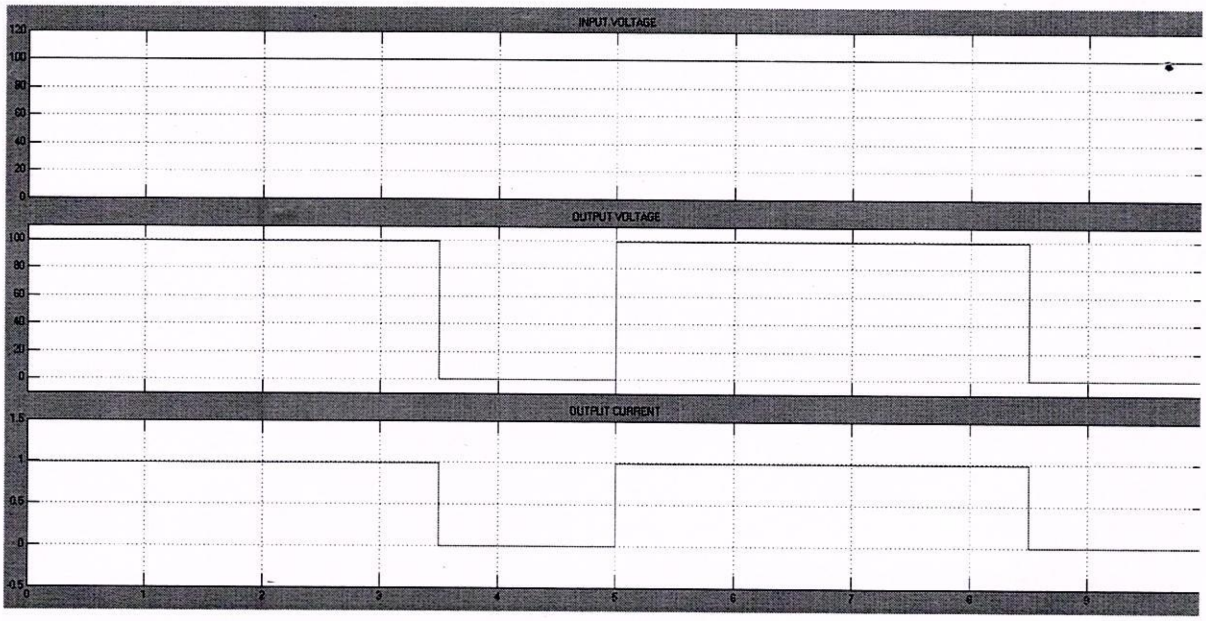
1. Study the circuit diagram, operation and model waveforms of a Class A Chopper (Step Down Chopper).
2. Open the MATLAB software by double-clicking the MATLAB icon on the desktop and click the shortcut "Simulink" to open the "Simulink Library Browser".
3. Create a new model and click on "SimPowerSystems" block in "Simulink Library Browser".
4. Drag the "powergui" block in SimPowerSystems submenu to the new model.
5. Double click on the "Electrical Source" block in SimPowerSystems submenu to select the DC Voltage supply source "DC Voltage Source" and drag it to the new model. Set the input voltage as 100 Volts.
6. In the SimPowerSystems submenu, select "Power Electronics" block to pick the "IGBT" and drag them to the new model.
7. In the SimPowerSystems submenu, select "Elements" block to pick the load "Series RLC branch" and drag it to the new model. Set the type of load as R load by double-clicking on the load.
8. In the SimPowerSystems submenu, select "Measurements" block to pick the "Voltage Measurement" and "Current Measurement" blocks and drag them to the new model.
9. In the Simulink submenu, select "Commonly Used Blocks" to pick the "SCOPE" and drag it to the new model.
10. In the Simulink submenu, select "Sources" to pick the "Pulse Generator" for IGBT and drag them to the new model.
11. Arrange the components as per the circuit diagram and connect them.
12. Set the pulse generator parameters such as pulse type, amplitude, period, pulse width, phase delay, etc. as period of 2 msec, pulse width of 40%, phase delay of 0.

WAVEFORMS OF R LOAD: - (Time period = 5 Sec, amplitude = 1)

1) For duty cycle α = 0.4 or 40% (Pulse width)



2) For duty cycle α = 0.7 or 70% (Pulse width)



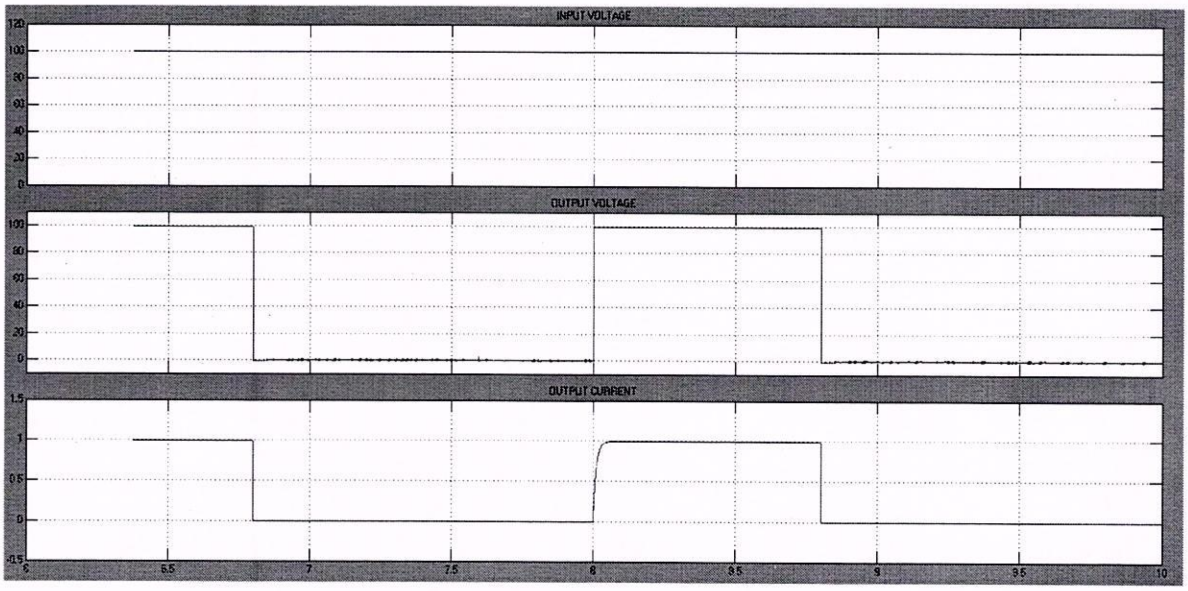
13. Set the scope axis as per the circuit requirements like input voltage, output voltage, output current, etc.
14. Set the load resistance value as 100 ohms.
15. Simulate the circuit and take the output waveforms in the scope.

PROCEDURE FOR RL LOAD:

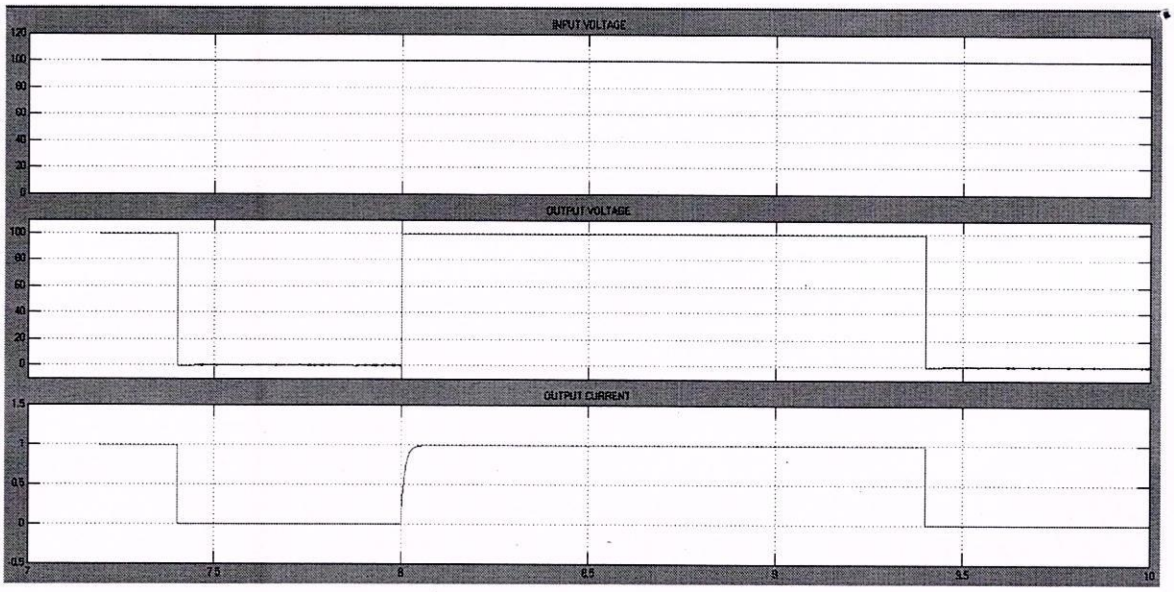
1. Study the circuit diagram, operation and model waveforms of a Class A Chopper (Step Down Chopper).
2. Open the MATLAB software by double-clicking the MATLAB icon on the desktop and click the shortcut "Simulink" to open the "Simulink Library Browser".
3. Create a new model and click on "SimPowerSystems" block in "Simulink Library Browser".
4. Drag the "powergui" block in SimPowerSystems submenu to the new model.
5. Double click on the "Electrical Source" block in SimPowerSystems submenu to select the DC Voltage supply source "DC Voltage Source" and drag it to the new model. Set the input voltage as 100 Volts.
6. In the SimPowerSystems submenu, select "Power Electronics" block to pick the "IGBT" and "Diode" and then drag them to the new model.
7. In the SimPowerSystems submenu, select "Elements" block to pick the load "Series RLC branch" and drag it to the new model. Set the type of load as RL load by double-clicking on the load.
8. In the SimPowerSystems submenu, select "Measurements" block to pick the "Voltage Measurement" and "Current Measurement" blocks and drag them to the new model.
9. In the Simulink submenu, select "Commonly Used Blocks" to pick the "SCOPE" and drag it to the new model.
10. In the Simulink submenu, select "Sources" to pick the "Pulse Generator" for IGBT and drag them to the new model.
11. Arrange the components as per the circuit diagram and connect them.
12. Set the pulse generator parameters such as pulse type, amplitude, period, pulse width, phase delay, etc. as period of 2 msec, pulse width of 40%, phase delay of 0.
13. Set the scope axis as per the circuit requirements like input voltage, output voltage, output current, etc.
14. Set the load resistance and inductance values as 100 ohms and 1 mH.

WAVEFORMS OF RL LOAD (With FD):- (Time period = 2 Sec, amplitude = 1)

1) For duty cycle $\alpha = 0.4$ or 40% (Pulse width):

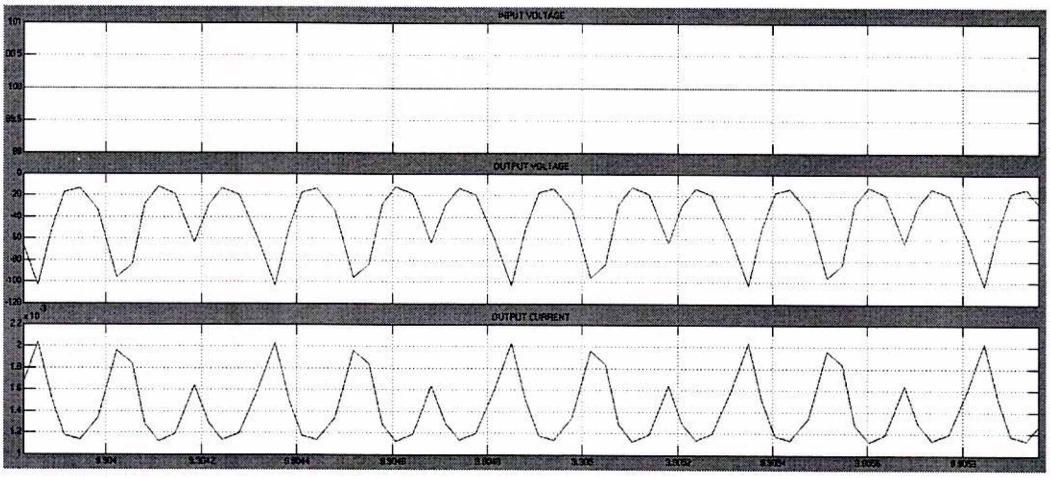


2) For duty cycle $\alpha = 0.7$ or 70% (Pulse width):

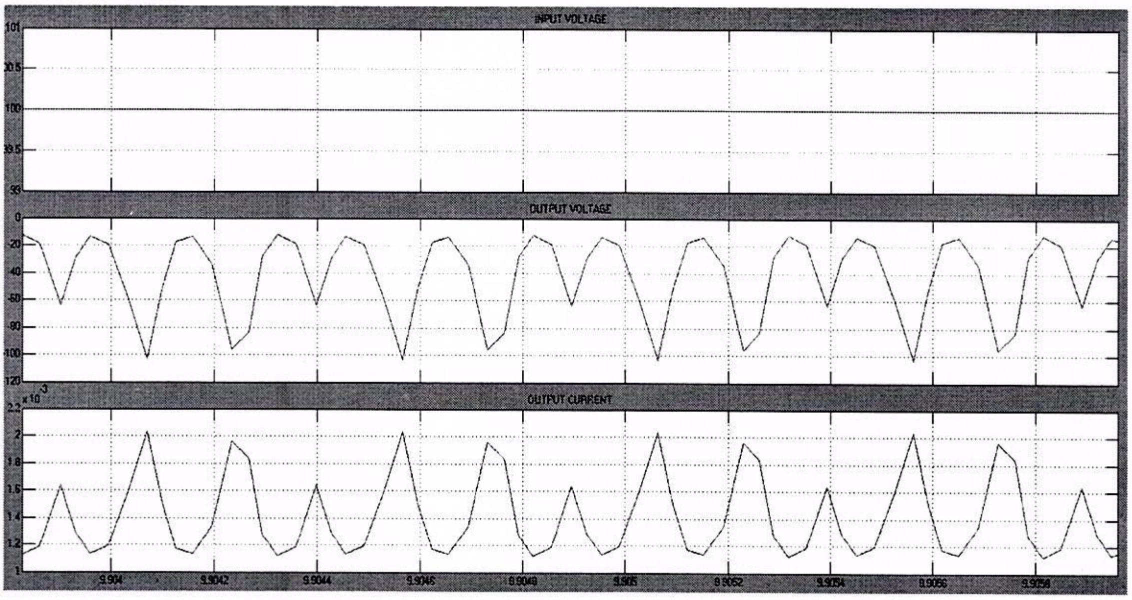


WAVEFORMS OF RL LOAD (Without FD):- (Time period = 2 Sec, amplitude = 1)

1) For duty cycle α = 0.4 or 40% (Pulse width):



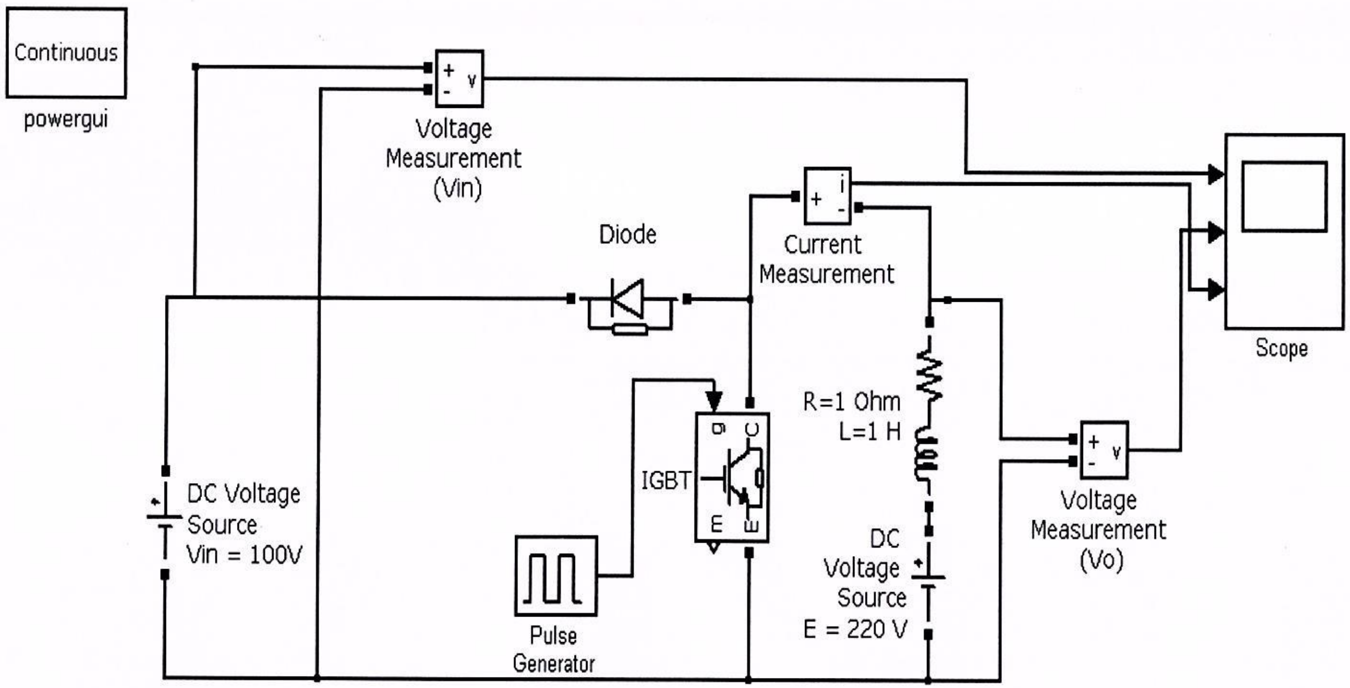
2) For duty cycle α = 0.7 or 70% (Pulse width):



RESULT

Thus the Class A chopper (Step Down Chopper) was simulated with R and RL load of resistance of 100 ohms and inductance of 1 mH for duty cycles of 40% (0.4) and 70% (0.7) and the related waveforms were obtained.

SIMULATION OF STEP UP CHOPPER WITH RLE LOAD (E>V)



EXP NO: 13 **DATE:**

SIMULATION OF STEP UP CHOPPER

AIM: -

To simulate and study the Class B Chopper (Step Up Chopper) with RLE Load for different firing angles.

APPARATUS REQUIRED: -

Sl. No.	Description	Quantity
01	Computer	01
02	Printer	01

SOFTWARE REQUIRED: -

MATLAB 6.1 or above.

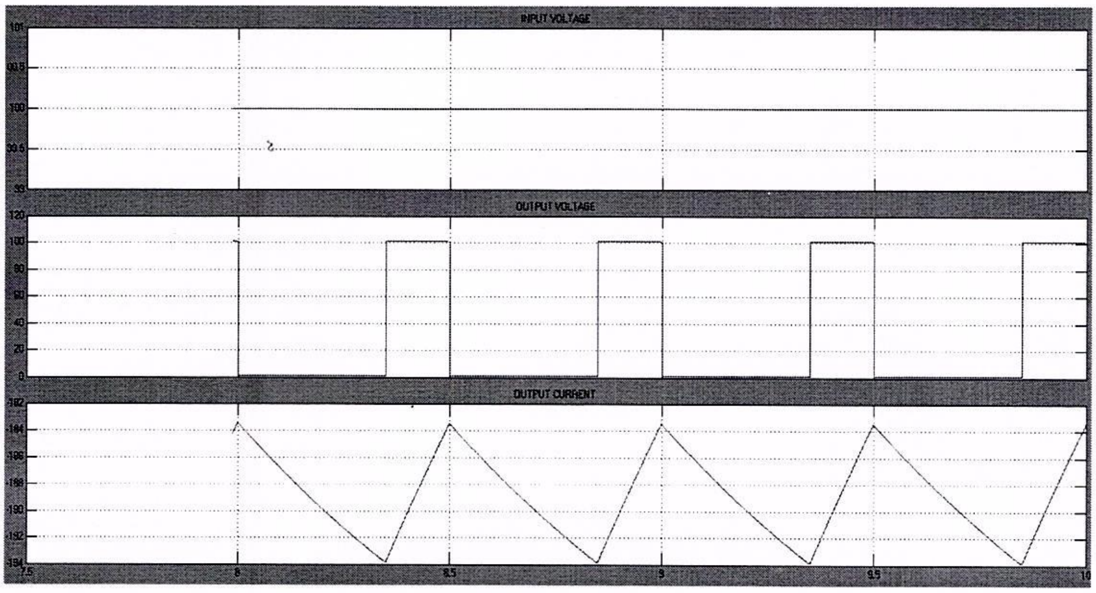
THEORY:-

Step up chopper is a type of chopper which provides the average output voltage V_o greater than the input voltage V_s. The elementary circuit for the step up chopper is shown below in the circuit diagram. In this chopper, a large inductor L in series with the source voltage V_s is essential. When the chopper CH is ON, the closed current path is formed with supply, inductor, diode and load. The inductor stores the energy during T_{ON} period. When the chopper CH is OFF, as the inductor current cannot die down instantaneously, this current is forced to flow through the diode and load for a time T_{OFF}. As the current tends to decrease, polarity of the emf induced in L is reversed. As a result, voltage across the load, given by, $V_o = V_s + L\frac{di}{dt}$, exceeds the source voltage V_s. In this manner, the circuit acts as a step-up chopper and the energy stored in L is released to the load.

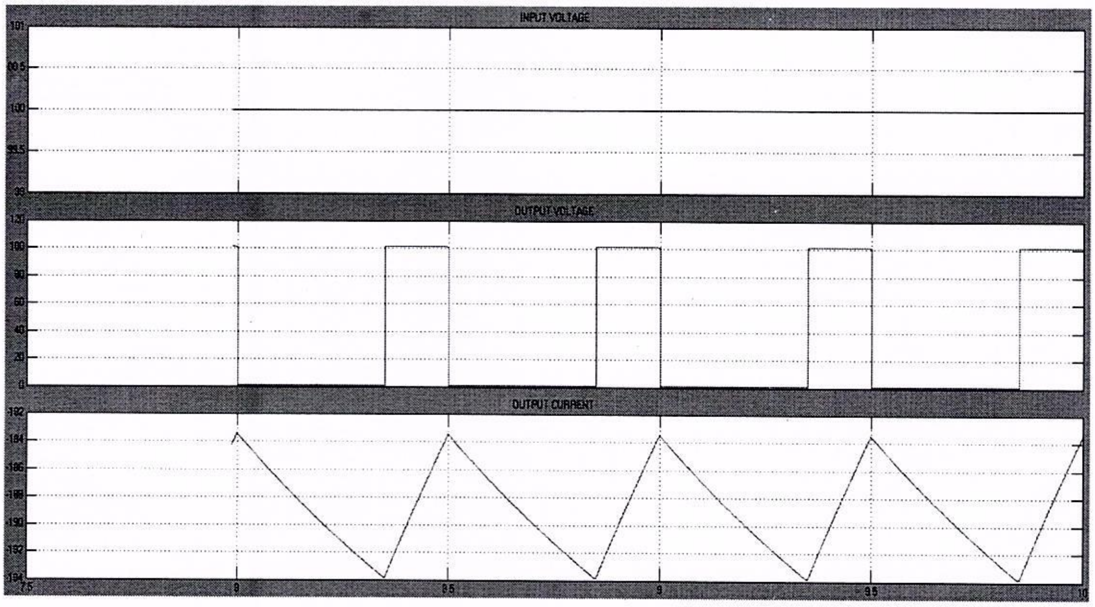
The average voltage across the load can be stepped up by varying the duty cycle. The principle of step up chopper can be employed for the regenerative braking of dc motors. If V_s represents the motor armature voltage and V_o represents the dc source voltage, the power

WAVEFORMS OF RLE LOAD (E>V): - (Time period = 0.5 Sec, amplitude = 1)

1) For duty cycle α = 0.4 or 40% (Pulse width)



2) For duty cycle α = 0.7 or 70% (Pulse width)



can be fed back to the dc source in case, $\frac{V_s}{(1-\alpha)}$ is more than V_o. In this manner, regenerative braking of dc motor occurs. Even at decreasing motor speeds, regenerative braking can be made to take place provided duty cycle α is so adjusted that $\frac{V_s}{(1-\alpha)}$ exceeds the fixed source voltage V_o.

FORMULAE USED:-

1. The average load voltage is, $V_0 = V_S \frac{1}{1-\alpha} = V_S \frac{T}{T-T_{ON}}$ in volts

2. The average load current $I_0 = \frac{V_0}{R}$ in amperes for R Load

Where, V_s is the value of the input voltage in volts.

$\alpha = \frac{T_{ON}}{T}$ is the duty cycle of the chopper.

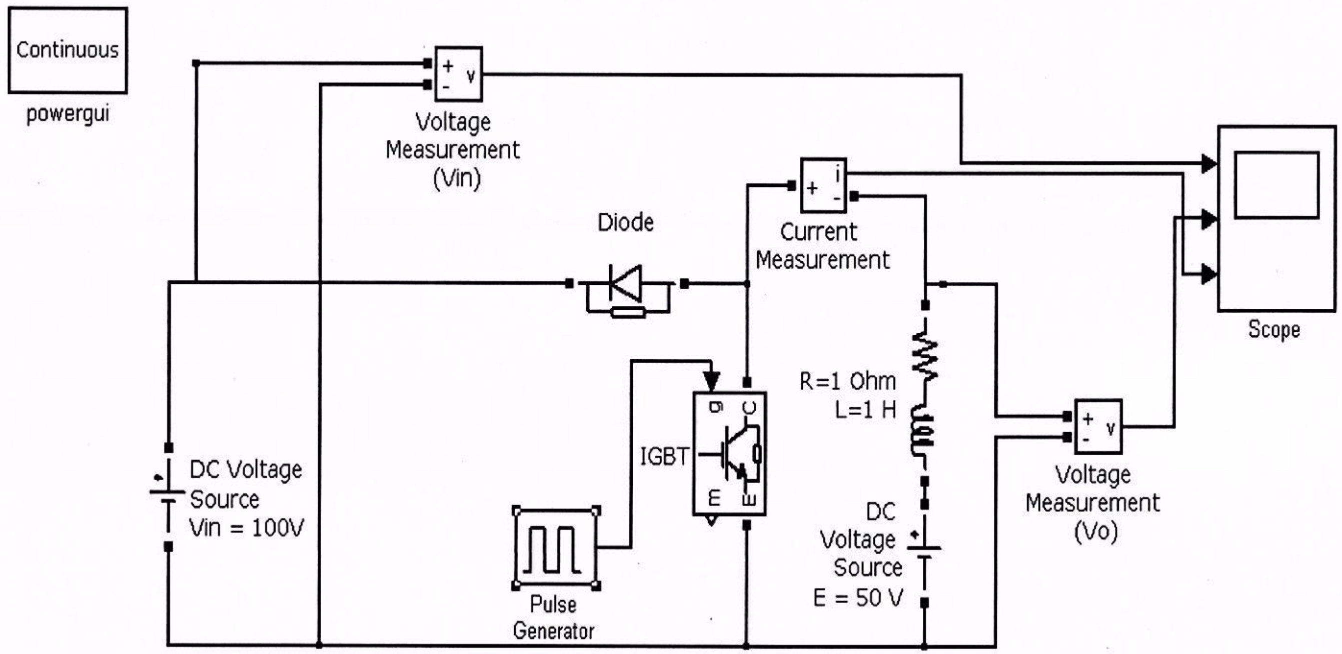
T_{ON} is the ON–Time period of the chopper in sec.

T_{OFF} is the OFF–Time period of the chopper in sec.

$T = T_{ON} + T_{OFF}$ is the Total time period of the chopper in sec.

$f = \frac{1}{T}$ is the chopping frequency of the chopper in sec.

SIMULATION OF STEP UP CHOPPER WITH RLE LOAD (E<V)

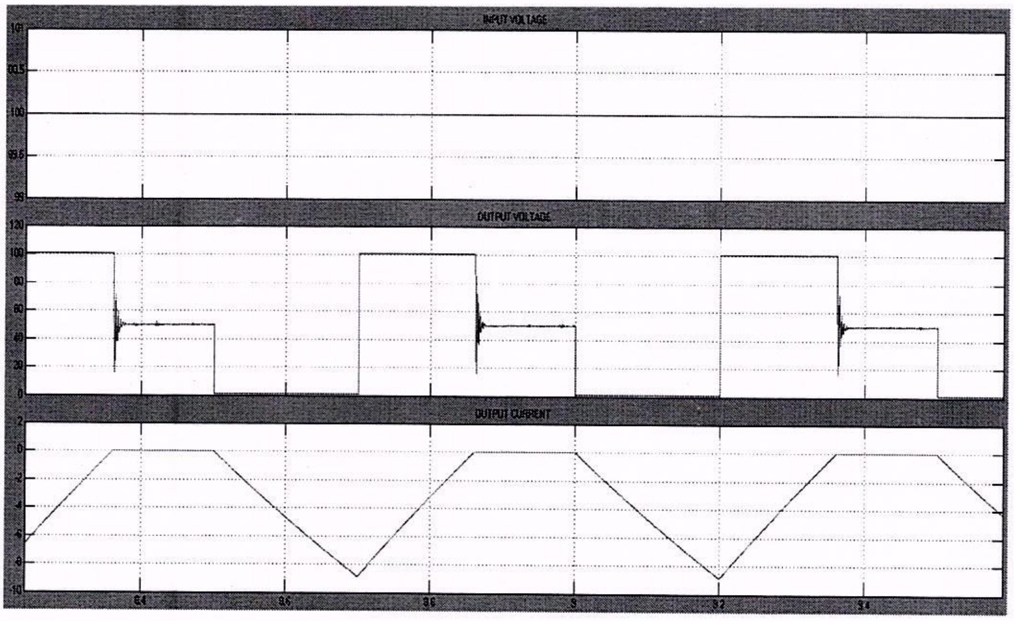


PROCEDURE FOR RLE LOAD (E>V and E<V): -

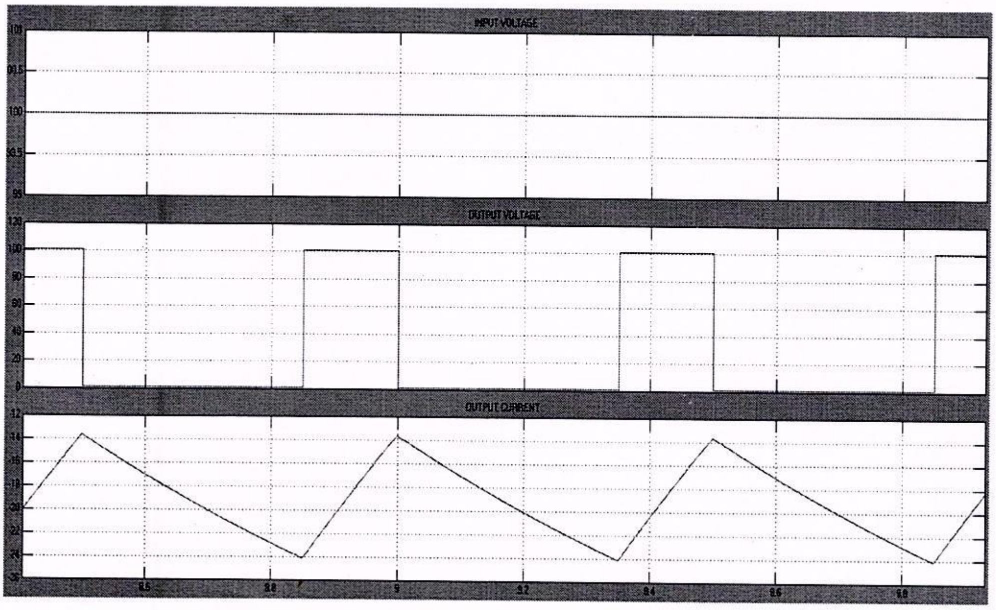
1. Study the circuit diagram, operation and model waveforms of a Class B Chopper (Step Up Chopper).
2. Open the MATLAB software by double-clicking the MATLAB icon on the desktop and click the shortcut "Simulink" to open the "Simulink Library Browser".
3. Create a new model and click on "SimPowerSystems" block in "Simulink Library Browser".
4. Drag the "powergui" block in SimPowerSystems submenu to the new model.
5. Double click on the "Electrical Source" block in SimPowerSystems submenu to select the DC source "DC Voltage Source" and drag it to the new model. Set the input voltage as 100 Volts.
6. In the SimPowerSystems submenu, select "Power Electronics" block to pick the "IGBT" and "Diode" and then drag them to the new model.
7. In the SimPowerSystems submenu, select "Elements" block to pick the load "Series RLC branch" and drag it to the new model. Set the type of load as RL load by double-clicking on the load.
8. In the SimPowerSystems submenu, select "Measurements" block to pick the "Voltage Measurement" and "Current Measurement" blocks and drag them to the new model.
9. In the Simulink submenu, select "Commonly Used Blocks" to pick the "SCOPE" and drag it to the new model.
10. In the Simulink submenu, select "Sources" to pick the "Pulse Generator" for IGBT and drag them to the new model.
11. Arrange the components as per the circuit diagram and connect them.
12. Set the pulse generator parameters such as pulse type, amplitude, period, pulse width, phase delay, etc. as period of 2 msec, pulse width of 40%, phase delay of 0.
13. Set the scope axis as per the circuit requirements like input voltage, output voltage, output current, etc.
14. Set the load resistance and inductance values as 1 Ω & 1 H and the DC voltage as $E = 220$ V for $E > V$ and $E = 50$ V for $E < V$.
15. Simulate the circuit and take the output waveforms in the scope.

WAVEFORMS OF RLE LOAD (E<V):- (Time period = 0.5 Sec, amplitude = 1)

1) For duty cycle α = 0.4 or 40% (Pulse width):



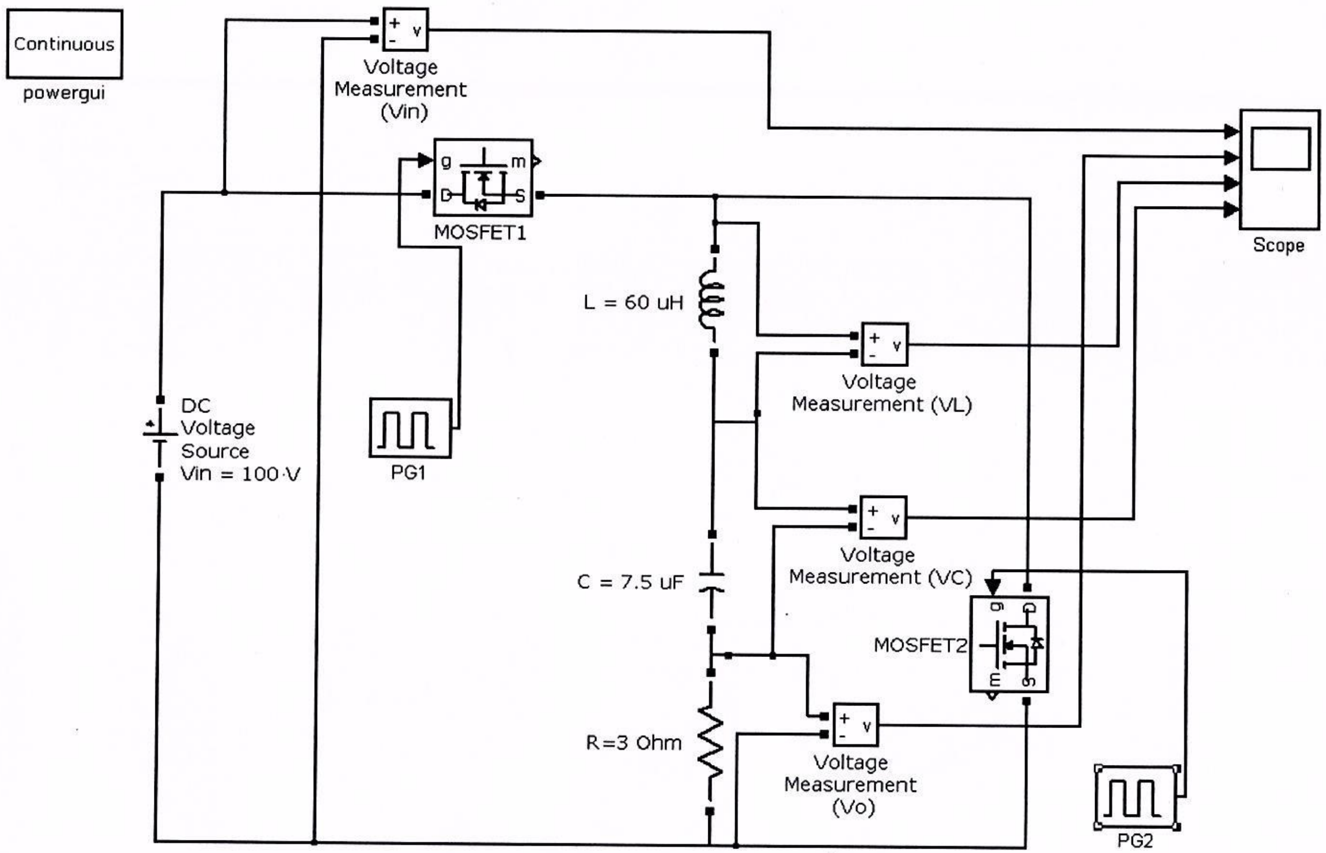
2) For duty cycle α = 0.7 or 70% (Pulse width):



RESULT

Thus the Class B chopper (Step Up Chopper) was simulated with RLE load of resistance of 1 ohms, inductance of 1 H and Load emf of 220 V (E>V) and 50 V (E<V) for duty cycles of 40% (0.4) and 70% (0.7) and the related waveforms were obtained.

SIMULATION OF BASIC SERIES INVERTER



EXP NO: 14 **DATE:**

SIMULATION OF BASIC SERIES INVERTER

AIM:

To study and simulate the Basic Series Inverter circuits with R Load for different firing angles.

APPARATUS REQUIRED:

Sl. No.	Description	Quantity
01	Computer	01
02	Printer	01

SOFTWARE REQUIRED:

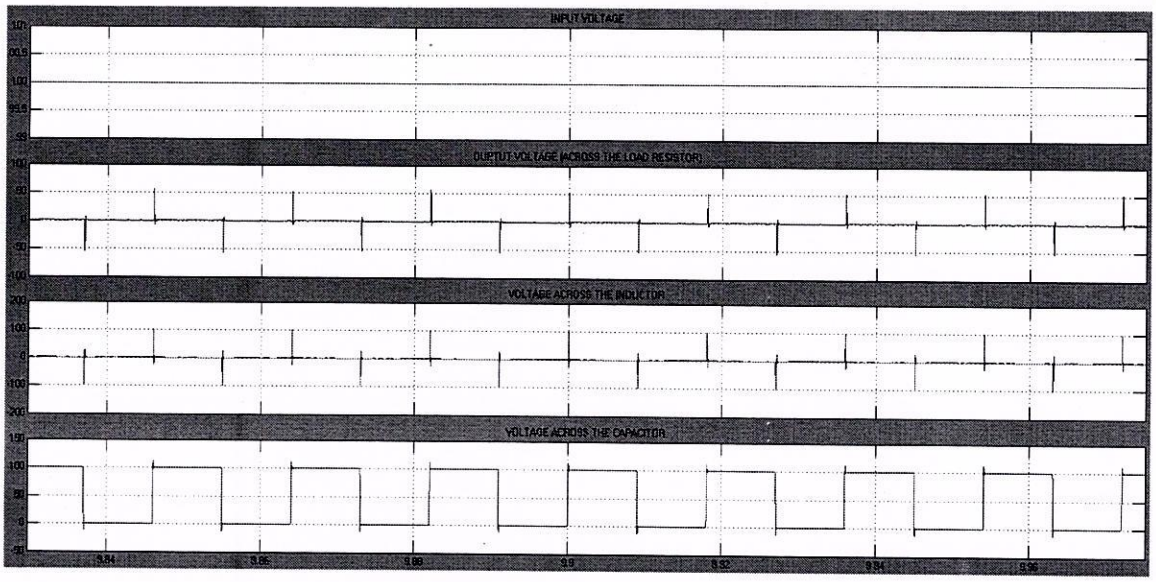
MATLAB 6.1 or above.

THEORY

Inverters in which commutating components are permanently connected in series with the load are called series inverters. The series circuit so formed must be under damped. As the current attains zero value due to the nature of the series circuit, series inverters are also classified as self-commutated inverters or load-commutated inverters. These inverters operate at high frequencies (200 Hz to 100 kHz), therefore, the size of the commutating components is small. These inverters are used extensively in ultrasonic generators, induction heating, sonar transmitter, fluorescent lighting, etc.

The circuit diagram for a basic series inverter is shown below (under the circuit diagram column). It consists of load resistance R in series with commutating components L and C. The values L and C are so chosen that the series RLC circuit forms an under damped circuit. Two thyristors T_1 and T_2 are turned on appropriately so that the output voltage of desired frequency can be obtained.

WAVEFORMS OF BASIC SERIES INVERTER WITH R LOAD:



When thyristor T_1 is turned ON, with T_2 turned OFF, current i starts building up in the RLC circuit. As the circuit is under damped, the load current, after reaching some peak value, decays to zero at a point *a*. At point *a*, as the load current tends to reverse, SCR T_1 is turned OFF. After instant *a*, some minimum time $t_{q,min}$ must elapse for T_1 to regain its forward blocking capability. The time interval between the instant T_1 is turned OFF and the instant T_2 is turned ON, is T_{OFF}, where, $T_{OFF} > t_{q,min}$. After thyristor T_1 has commutated, upper plate of capacitor attains positive polarity. Now, when T_2 is turned ON at the instant *b*, capacitor begins to discharge and load current in the reversed direction builds up to some peak negative value and then decays to zero at instant *c*. After this point *c*, time $T_{OFF} = cd$ must elapse for T_2 to recover. At point *d*, T_1 is again turned ON and the process repeats. In this manner, dc is converted to ac with the help of series inverter. The capacitor stores charge during one half cycle and releases the same amount of charge during the next half cycle. As a consequence, the positive half cycle of current is identical with the negative half cycle of load current.

The basic series inverter has the following drawbacks.

(i) The load voltage waveform has more distortion due to the time delay. This distortion is specially high for frequencies less than the resonance frequency.

(ii) The maximum inverter frequency is limited to a value that is slightly less than the circuit ringing frequency. If the inverter frequency exceeds the circuit ringing frequency, the d.c. source will be short-circuited.

(iii) The commutating components must have high rating because these components carry the load current continuously and the capacitor supplies the load current in every alternate half-cycles.

(iv) Load current is drawn from the d.c. source only during one half-cycle and this increases the peak current rating of the d.c. source. Since, the current drawn from the d.c. source is not continuous in nature, more ripples are present in it.

(v) The peak amplitude and duration of the load current in each half-cycle depends on load parameters, resulting in poor output regulation for the inverter.

Some of the above limitations can be overcome by the modified series inverter.

PROCEDURE FOR BASIC SERIES INVERTER WITH R LOAD: -

1. Study the circuit diagram, operation and model waveforms of a basic series inverter.
2. Open the MATLAB software by double-clicking the MATLAB icon on the desktop and click the shortcut "Simulink" to open the "Simulink Library Browser".
3. Create a new model and click on "SimPowerSystems" block in "Simulink Library Browser".
4. Drag the "powergui" block in SimPowerSystems submenu to the new model.
5. Double click on the "Electrical Source" block in SimPowerSystems submenu to select the DC source "DC Voltage Source" and drag it to the new model. Set the input voltage as 100 Volts.
6. In the SimPowerSystems submenu, select "Power Electronics" block to pick the "MOSFET" (2 Nos.) and then drag them to the new model.
7. In the SimPowerSystems submenu, select "Elements" block to pick the "Series RLC branch" for commutating components L & C and for R load and then drag them to the new model. Set the type of load as R load by double-clicking on the load.
8. In the SimPowerSystems submenu, select "Measurements" block to pick the "Voltage Measurement" blocks of 4 Nos. and then drag them to the new model.
9. In the Simulink submenu, select "Commonly Used Blocks" to pick the "SCOPE" and drag it to the new model.
10. In the Simulink submenu, select "Sources" to pick the "Pulse Generator" for IGBT and drag them to the new model.
11. Arrange the components as per the circuit diagram and connect them.
12. Set the pulse generator parameters such as pulse type, amplitude, period, pulse width, phase delay, etc. as period of 18 ms, pulse width of 50%.
13. Set the scope axis as per the circuit requirements like input voltage, output voltage, voltage across commutating components, etc.
14. Set the load resistance value as 3Ω.
15. Simulate the circuit and take the output waveforms in the scope.

DESIGN FORMULAE USED:-

1. The commutating component Inductance value L is, $L=\dfrac{-R}{8\,f_r\,\ln(A.F.)}$ in H

2. The commutating component Capacitance value C is, $C=\dfrac{1}{L}\left[\dfrac{1}{\omega_r^2+\dfrac{R^2}{4L^2}}\right]$ in F.

Where, R is the value of the load resistor in ohms.

f_r is the resonant frequency of the series inverter in Hz.

ω_r is the resonant frequency of the series inverter in rad/sec.

A.F. is the attenuation factor whose optimum value is 0.5.

RESULT

Thus the Basic series inverters were simulated with R load of resistance of 3 ohms and the related waveforms were obtained.

VIVA QUESTIONS

1. What is the delay angle control of converters?
2. What is natural or line commutation?
3. What is the principle of phase control?
4. What is extinction angle?
5. Can a freewheeling diode be used in this circuit and justify the reason?
6. What is conduction angle?
7. What are the effects of adding freewheeling diode in this circuit?
8. What are the effects of removing the freewheeling diode in single phase semi converter?
9. Why is the power factor of semi converters better than that of full converters?
10. What is the inversion mode of converters?
11. State the type of commutation used in this circuit?
12. What will happen if the firing angle is greater than 90 degrees?
13. What are the performance parameters of rectifier?
14. What are the advantages of three phase rectifier over a single phase rectifier?
15. What is the difference between half wave and full wave rectifier?
16. If firing angle is greater than 90 degrees, the inverter circuit formed is called as?
17. What is displacement factor?
18. What is Dc output voltage of single phase full wave controller?
19. What are the effects of source inductance on the output voltage of a rectifier?
20. What is commutation angle of a rectifier?
21. What are the advantages of three phase rectifier over a single phase rectifier?
22. Why should the two trigger sources be isolated?
23. What are the advantages and the disadvantages of phase control?
24. What is phase control?
25. What are the advantages of bidirectional controllers?
26. What is meant by duty cycle in ON-OFF control method?
27. What type of commutation is used in this circuit?
28. What are the effects of load inductance on the performance of AC voltage controllers?
29. What is extinction angle?
30. What are the disadvantages of unidirectional controllers?
31. What are the advantages of ON-OFF control?
32. What is the dead zone of an inverter?
33. Up to what maximum voltage will the capacitor charge during circuit operation?
34. What is the amount of power delivered by capacitor?
35. What is the purpose of coupled inductors in half bridge resonant inverters?
36. Types of resonant pulse inverters?
37. Explain the working operation of VI characteristics of S.C.R.
38. Define Holding current, Latching current, Break down voltage.
39. Explain the working operation of S.C.R. characteristics by using two transistors Analogy.

40. What is meant by forward leakage current?
41. Mention the applications of S.C.R.
42. What is IGBT?
43. What are the applications of IGBT?
44. Compare MOSFET, BJT & IGBT?
45. Explain the working principle of IGBT
46. Explain o/p & transfer characteristics of IGBT.
47. Explain the principle of dc chopper operation
48. Describe the various types of chopper configuration
49. What is meant by IGBT CHOPPER?
50. Explain the working of IGBT chopper
51. Where we are using this two quadrant IGBT chopper.
52. What is meant by commutation?
53. What are all the methods of commutation?
54. What is meant by voltage commutation?
55. Explain the working of voltage commutated chopper.
56. What are all the advantages and disadvantages of voltage commutated chopper
57. What is meant by inverter?
58. What are the two main types of inverter?
59. Discuss how output power in single-phase full bridge inverter is doubled than that of single phase half bridge inverter.
60. How to overcome the problem of half-bridge using full bridge
61. What is meant by resonant converter?
62. What is the need for resonant converter?
63. Give the classification of ZCS.
64. Explain the working of ZCS.
65. Give the advantages & limitations of ZCS.