POWER ELECTRONICS LAB

B.TECH
III YEAR – I SEM
2024-25

Prepared by:

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Department of Electrical & Electronics Engineering

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Recognized under 2(f) and 12 (B) of UGC ACT 1956

Affiliated to JNTUH, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – ‘A’ Grade - ISO 9001:2015 Certified) Maisammaguda, Dhulapally (Post Via. Kompally), Secunderabad – 500100, Telangana State, India

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CERTIFICATE

Department of Electrical and Electronics Engineering certified that in the bonafide Record of the work done by Mr./Miss.-- Reg.No--------------------------------of B-Tech EEE-----------YEAR---------------semester for the Academic year 20------- to 20------------- in --------------------------------- -------------------- Laboratory.

Date: **Staff In charge** **HOD**

INDEX

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activitieswith an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues andthe consequent responsibilities relevant tothe professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts,and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member andleader in a team, to manage projects and in multi disciplinary environments.
12. **Life- long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY

III YEAR B. Tech EEE– II SEM **L/T/P/C**
-/-/3/1.5

(R20A0287) POWER ELECTRONICS & SIMULATION LAB

COURSE OBJECTIVES:

The student will understand:

- The characteristics of power electronic devices.
- The operation of single-phase voltage controller, converters and Inverters circuitswith Rand RL loads. Analyze the TPS7A4901, TPS7A8300 and TPS54160 buck regulators.

Among the following experiments any 10 are to be conducted:

1. Study the Characteristics of SCR, MOSFET & IGBT
2. Single Phase half-controlled converter with R load and RL loads
3. Single Phase fully controlled bridge converter with R and RL loads
4. Single Phase AC Voltage Controller with R and RL Loads
5. Single Phase Cyclo - converters with R and RL loads
6. Single Phase series inverter with R and RL loads
7. DC Chopper with R and RL Loads
8. Speed control of PMDC motor using MOSFET
9. Three Phase half-controlled bridge converter with R- load
10. Single Phase dual converter with RL loads
11. Single-phase full converter using RLE loads using PSPICE
12. Single-phase AC voltage controller using RLE loads using PSPICE.
13. Resonant pulse commutation circuit using PSPICE.
14. Buck chopper using PSPICE.
15. Single phase Inverter with PWM control using PSPICE.

COURSE OUTCOMES:

After completion of this course, the student is able to

- Understand the operating principles of various power electronic converters.
- Use power electronic simulation packages& hardware to develop the power converters.
- Analyze and choose the appropriate converters for various applications.

INSTRUCTIONS TO STUDENTS

- ☐ Before entering the lab the student should carry the following things.
  - o Identity card issued by the college.
  - o Lab observation book
  - o Lab Manual
  - o Lab Record
- ☐ Student must sign in and sign out in the register provided when attendingthe lab session without fail.
- ☐ Come to the laboratory in time. Students, who are late more than 15 min.,will not be allowed to attend the lab.
- ☐ Students need to maintain 100% attendance in lab if not a strict action will betaken.
- ☐ All students must follow a Dress Code while in the laboratoryFoods, drinks
- ☐ are NOT allowed.
- ☐ All bags must be left at the indicated place.
- ☐ The objective of the laboratory is learning. The experiments are designed toillustrate phenomena in different areas of Physics and to expose you to measuring instruments, conduct the experiments with interest and an attitude of learning
- ☐ You need to come well prepared for the experiment.Work quietly
- ☐ and carefully
- ☐ Be honest in recording and representing your data.
- ☐ If a particular reading appears wrong repeat the measurement carefully,to get a better fit for a graph
- ☐ All presentations of data, tables and graphs calculations should be neatly andcarefully done
- ☐ Graphs should be neatly drawn with pencil. Always label graphs and the axesand display units.
- ☐ If you finish early, spend the remaining time to complete the calculationsand drawing graphs. Come equipped with calculator, scales, pencils etc. Do not fiddle with apparatus.
- ☐ Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment.

SPECIFIC SAFETY RULES FOR POWER ELECTRONICS AND SIMULATION LABORATORY

- ☐ You must not damage or tamper with the equipment or leads.
- ☐ You should inspect laboratory equipment for visible damage before using it. If there is a problem with a piece of equipment, report it to the technician or lecturer. DONOT return equipment to a storage area
- ☐ You should not work on circuits where the supply voltage exceeds 40 volts without very specific approval from your lab supervisor. If you need to work on such circuits, you should contact your supervisor for approval and instruction on how to do this safely before commencing the work.
- ☐ Always use an appropriate stand for holding your soldering iron.
- ☐ Turn off your soldering iron if it is unlikely to be used for more than 10 minutes.Never leave a hot
- ☐ soldering iron unattended.
- ☐ Never touch a soldering iron element or bit unless the iron has been disconnected from the mains and has had adequate time to cool down. Never strip insulation from a wire with your
- ☐ teeth or a knife, always usean appropriatewire stripping tool.
- ☐ Shield wire with your hands when cutting it with a pliers to prevent bits ofwire flying about the bench.

EXPERIMENT – 1 **Date:**

STUDY OF CHARACTERISTICS OF SCR, MOSFET & IGBT CHARACTERISTICS

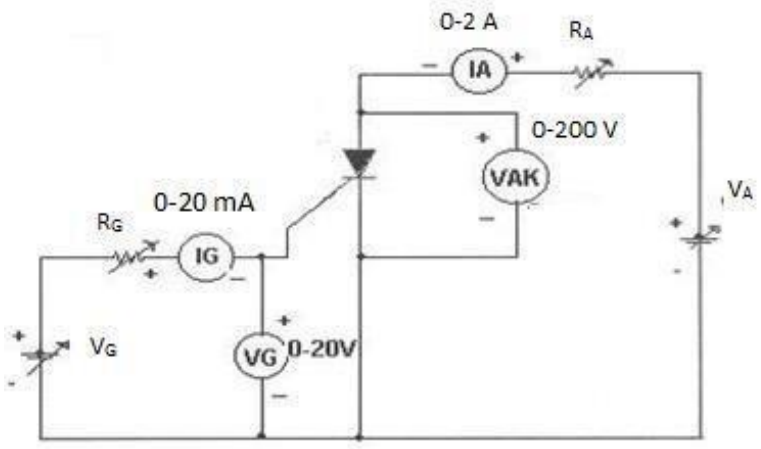
AIM:

To plot V-I Characteristics of SCR

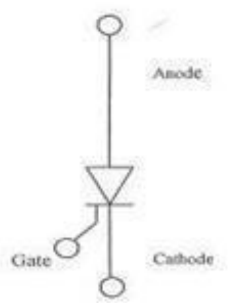
APPARATUS:

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

CIRCUIT DIAGRAM:



Symbol



Study of Characteristics of SCR

PROCEDURE:

V - I CHARACTERISTICS:

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

GATE TRIGGRING AND FINDING V_G AND I_G:-

1. Keep all positions at minimum.
2. Set Anode to Cathode voltage V_{AK} to some volts say 15V.
3. Now slowly vary the V_G voltage till the SCR triggers and note down the reading of gate current(I_G) and Gate Cathode voltage(V_{GK}) and rise of anodecurrent I_A.
4. Repeat the same for different Anode to Cathode voltage and find VAK and $I_G$values.

TO FIND LATCHING CURRENT:

1. Keep R_2 at middle position.
2. Apply 20V to the Anode to cathode by varying V_2.
3. Raise the Vg voltage by varying V_G till the device turns ON indicated by suddenrise in I_A. At what current SCR trigger it is the minimum gate current required to turn ON the SCR.
4. Now set R_A at maximum position, then SCR turns OFF, if it is not turned off reduceV_A up to turn off the device and put the gate voltage.
5. Now decrease the R_A slowly, to increase the Anode current gradually in steps.
6. At each and every step, put OFF and ON the gate voltage switches V_G. If the Anode current is greater than the latching current of the device, the device saysON even after switch OFF S1, otherwise device goes to blocking mode as soon as the gate switch is put OFF.
7. If $I_A>I_L$ then, the device remains in ON state and note that anode current as latchingcurrent.
8. Take small steps to get accurate latching current value.

TO FIND HOLDING CURRENT:

1. Now increase load current from latching current level by varying R_A & V_A.
2. Switch OFF the gate voltage switch S1 permanently (now the device is in ON state).
3. Now increase load resistance(R2), so that anode current reducing, at some anode current the device goes to turn off .Note that anode current as holdingcurrent.
4. Take small steps to get accurate holding current value.
5. Observe that $I_H<I_L$.

TABULAR COLUMN:

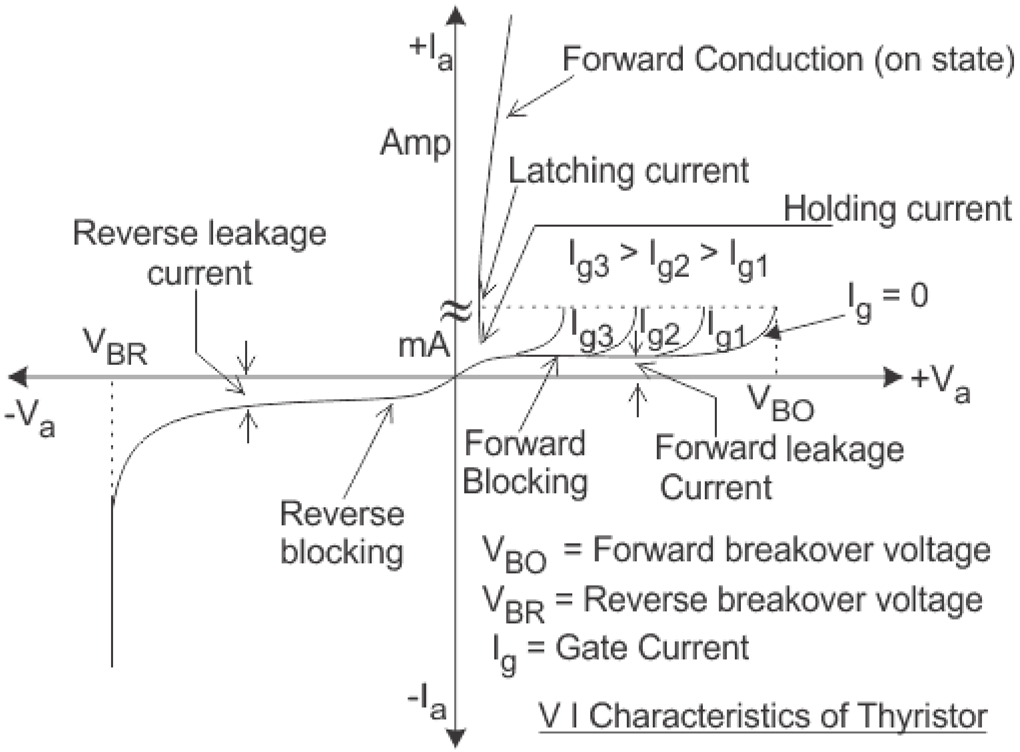
S. No	IG=	
	VAK	IA
1		
2		
3		
4		
5		

S. No	IG=	
	VAK	IA
1		
2		
3		
4		
5		

S. No	VAK =	
	VGK	IG
1		
2		
3		
4		
5		

S. No	VAK =	
	VGK	IG
1		
2		
3		
4		
5		

MODEL GRAPHS:



RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 1(B) Date:

MOSFET CHARACTERISTICS

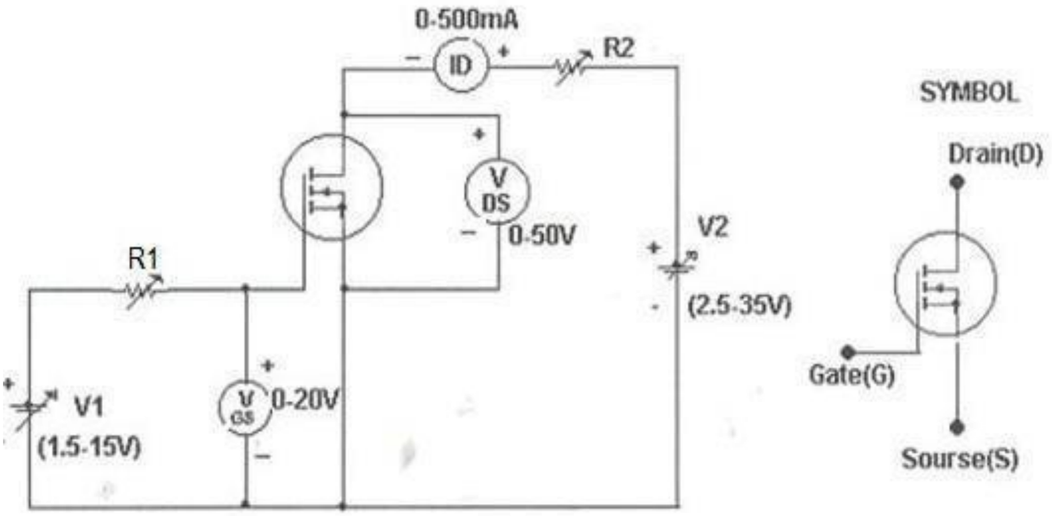
AIM:

To study the output and transfer characteristics of MOSFET

APPARATUS:

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

CIRCUIT DIAGRAM:



Study of Characteristics of MOSFET

PROCEDURE:

TRANSFER CHARACTERISTICS:

1. Make all connections as per the circuit diagram.
2. Initially keep V_1 & V_2 at minimum position and R_1 & R_2 middle position.
3. Set V_{DS} to some say10V.
4. Slowly vary Gate source voltage V_{GS} by varying V1.
5. Note down I_D and V_{GS} readings for eachstep.
6. Repeat above procedure for 20V & 30V of $V_{DS.}$ Draw Graph between I_D & V_{GS}.

OUTPUT CHARACTERISTICS:

1. Initially set V_{GS} to some value say 3V by varying V1.
2. Slowly vary V2 and note down I_D and V_{DS}.
3. At particular value of V_{GS} there a pinch off voltage between drain and source.
4. If $V_{DS} < V_P$ device works in the constant resistance region and I_O is directly proportional to V_{DS}. If $V_{DS} > V_P$ device works in the constant current region.
5. Repeat above procedure for different values of V_{GS} and draw graph between I_D *vs* V_{DS}.

TABULAR COLUMN:

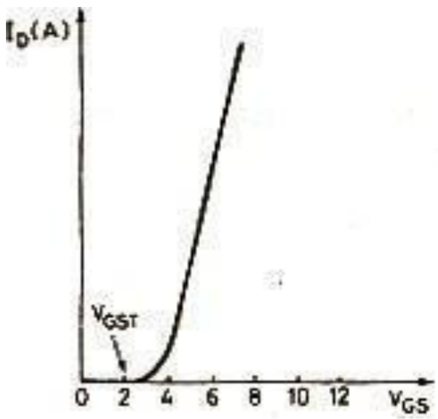
S.No.	V_{GS} = VOLTS	
	V_{DS} (Volts)	I_D (Amps)
1		
2		
3		
4		
5		

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

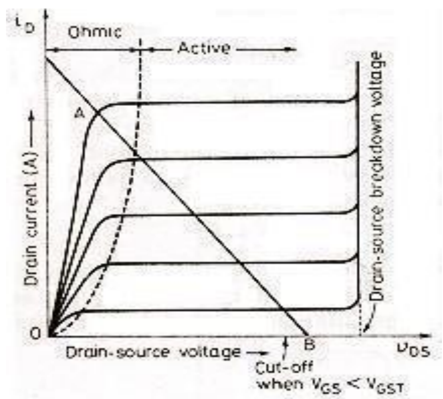
S.No	V_{DS}= (Volts)	
	V_{GS} (V)	I_D(A)
1		
2		
3		
4		
5		

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

MODEL GRAPH:



Transfer Characteristic of MOSFET



Output Characteristics of MOSFEt

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 1(C) **Date:**

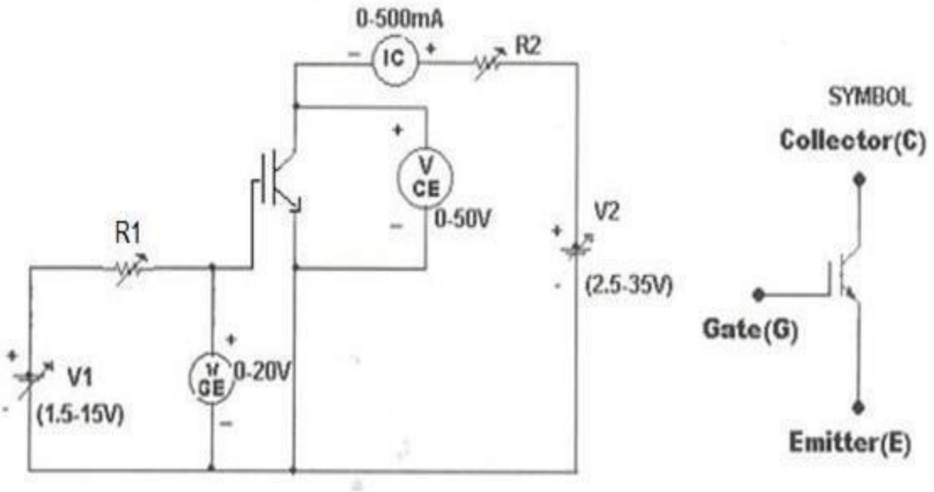
IGBT CHARACTERISTICS

AIM: To study the output and transfer characteristics of IGBT.

APPARATUS:

S. No	Equipment	Type	Range	Quantity
1	IGBT characteristics Trainer Kit			
2	Patch chords			
3	DC Voltmeter			
4	DC Ammeter			

CIRCUIT DIAGRAM:



Study of Characteristics IGBT

PROCEDURE:

TRANSFER CHARACTERISTICS:

1. Make all connections as per the circuit diagram.
2. Initially keep V_1 & V_2 at minimum position and R_1 & R_2 middle position.
3. Set V_{CE} to some say10V.
4. Slowly vary Gate Emitter voltage V_{GE} by varying V1.
5. Note down I_C and V_{GE} readings for eachstep.
6. Repeat above procedure for 20V & 25V of $V_{DS.}$ Draw Graph between I_D & V_{GS}.

OUTPUT CHARACTERISTICS:

1. Initially set V_{GE} to some value say 5V by varying V1.
2. Slowly vary V2 and note down I_C and V_{CE} readings.
3. At particular value of V_{GS} there is a pinch off voltage V_P between Collector and Emitter.
4. If $V_{CE} < V_P$ device works in the constant resistance region and I_C is directly proportional to V_{CE}. If $V_{CE} > V_P$ device works in the constant current region.
5. Repeat above procedure for different values of V_{GE} and draw graph between I_C *vs* V_{GE}.

TABULAR COLUMN:

S. No	V_{CE}	
	V_{GE}	I_C
1		
2		
3		
4		
5		

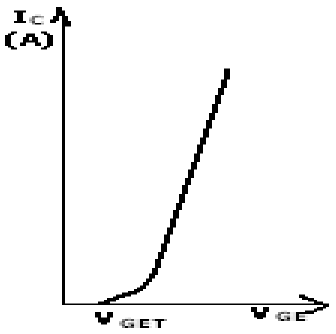
S. No	V_{CE}	
	V_{GE}	I_C
1		
2		
3		
4		
5		

S. No	V_{GE}=	
	V_{CE}	I_C
1		
2		
3		
4		
5		

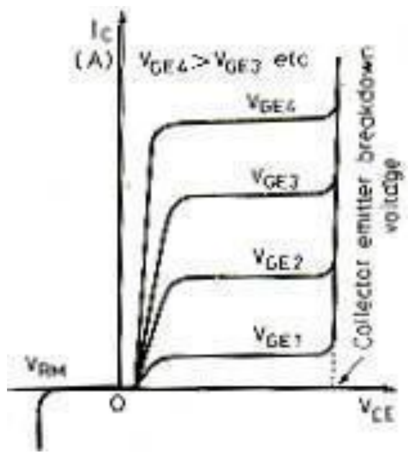
S. No	V_{GE}	
	V_{CE}	I_C
1		
2		
3		
4		
5		

MODEL GRAPH:

Transfer Characteristics of IGBT



Output Characteristics of IGBT



RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 2 Date:

SINGLE PHASE HALF CONTROLLED BRIDGE CONVERTER

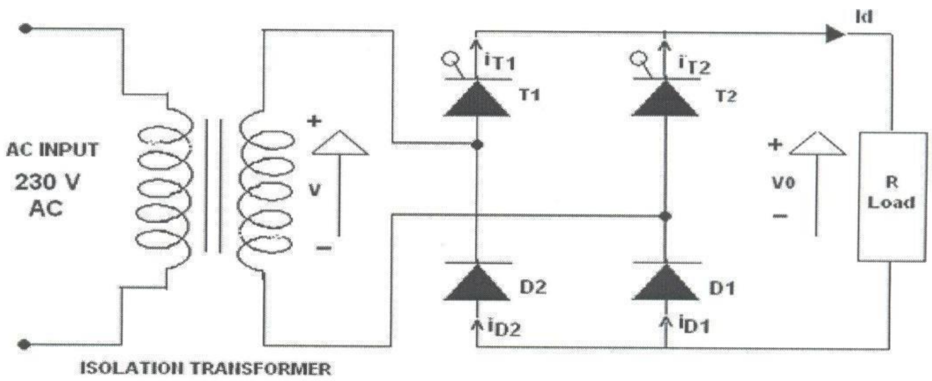
AIM:

To study the single phase half controlled bridge converter with R load

APPARATUS:

SNo	Equipment	Range	Type	Quantity
1	Single phase half controlled bridge converter power circuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Isolation Transformer			
5	Variable Rheostat			
6	Inductor			
7	DC Voltmeter			
8	DC Ammeter			

CIRCUIT DIAGRAM:



Circuit Diagram of Single Phase Half Controlled Bridge Converter

PROCEDURE:

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

5. Connect CRO probes and observe waveforms in CRO, Ch-1 or Ch-2, across loadand device in single phase half controlled bridge converter.
6. By varying firing angle gradually up to 180^0 and observe related waveforms.
7. Measure output voltage and current by connecting AC voltmeter & Ammeter.
8. Tabulate all readings for various firing angles.
9. Observe the various waveforms at different points in circuit by varying the ResistiveLoad
10. Calculate the output voltage and current by theoretically and compare with ipractically obtained values.

TABULAR COLUMN:

S. No	Input Voltage (V_{in})	Firing angle in Degrees	Output voltage (V_0)		Output Current (I_0)	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

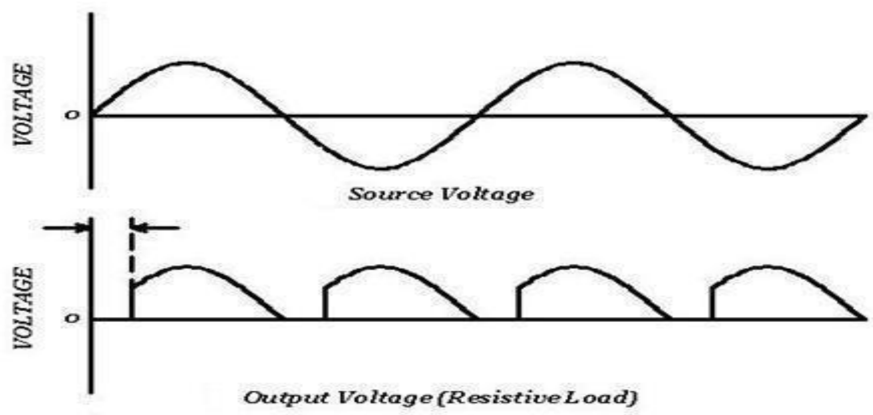
$V_0 = (\sqrt{2}V / \prod))^* (1+\cos\alpha)$

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

Firing Angle

V= RMS Value across transformer out

MODEL GRAPH:



Output Wave Forms of Single Phase Half Controlled Bridge Converter

RESULT

SIGNATURE OF FACULTY

EXPERIMENT – 3 Date:

SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER WITH R LOADS

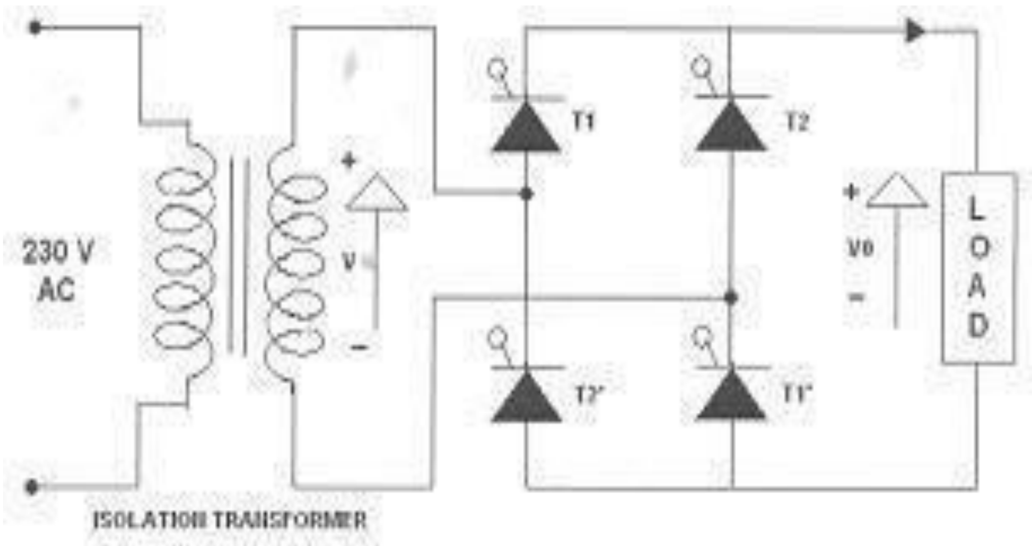
AIM:

To study the single phase fully controlled bridge converter with R Load.

APPARATUS:

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

CIRCUIT DIAGRAM:



Single Phase Fully Controlled Bridge Converter

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB andIRS switch and trigger output ON switch.
5. Connect CRO probes and observe waveforms in CRO across load and device insingle phase fully controlled bridge converter.
6. By varying firing angle gradually up to 180^0 and observe related waveforms.
7. Measure output voltage and current by connecting AC voltmeter & Ammeter.
8. Tabulate all readings for various firing angles.
9. Observe the various waveforms at different points in circuit by varying the ResistiveLoad
10. Calculate the output voltage and current by theoretically and compare with ipractically obtained values.

TABULAR COLUMN:

S.No	**Input Voltage (V_{in})**	**Firing angle in Degrees**	**Output voltage (V_0)**		**Output Current (I_0)**	
			Theoretical	**Practical**	**Theoretical**	**Practical**
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

For R-L Load:

$V_0 = (2\sqrt{2}V/\prod) * \cos\alpha;$

$I_0 = (2\sqrt{2}V/\prod R) * \cos\alpha;$

α = Firing Angle

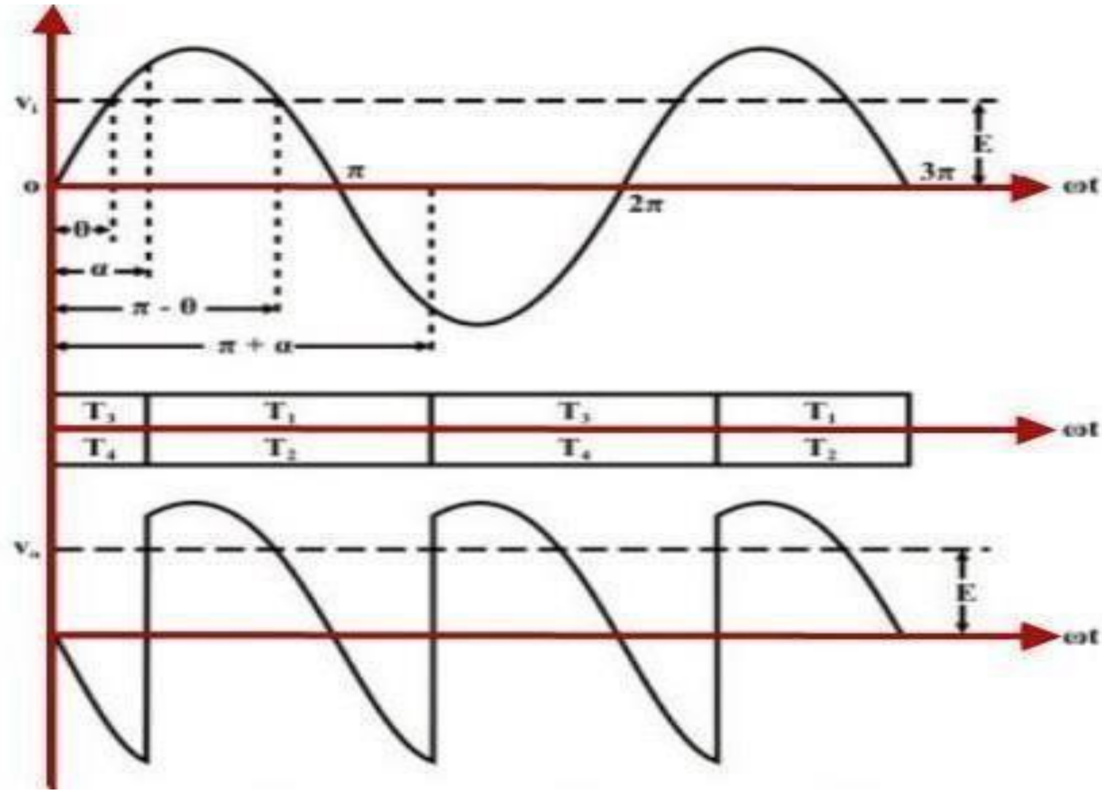
V = RMS Value across transformer output

For R Load:

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

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

MODEL GRAPH:



Single Phase Fully Controlled Bridge Converter

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 4 **Date:**

THREE PHASE HALF CONTROLLED BRIDGE CONVERTER WITH R LOAD

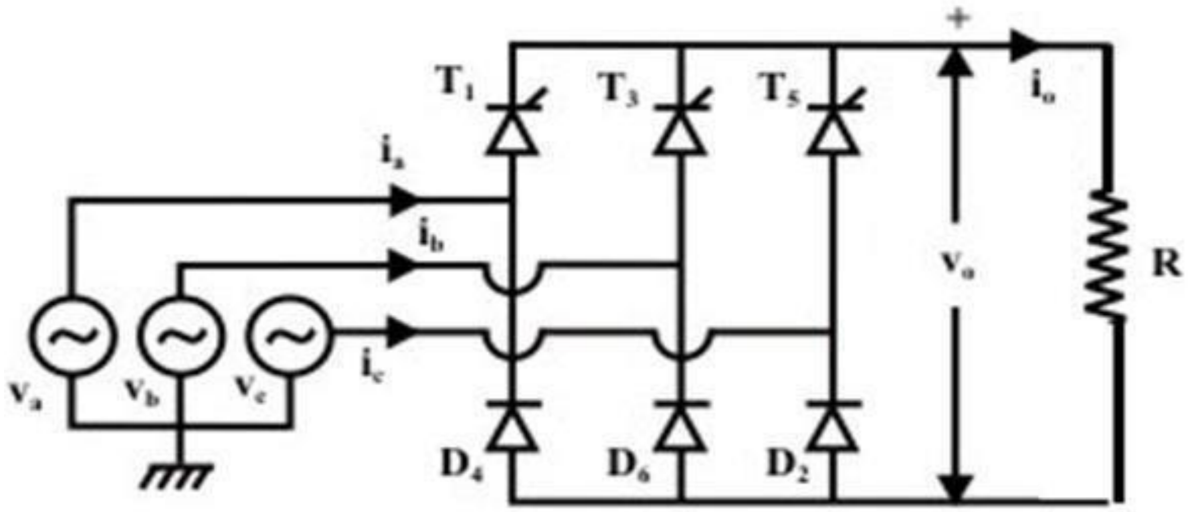
AIM:

To study the three phase half controlled bridge converter with R load.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Three phase half controlled bridge converter power circuit and firing circuit			
2	CRO with deferential MODEL			
3	Patch chords and probes			
4	Three phase transformer			
5	Rheostat			
6	DC Voltmeter			
7	DC Ammeter			

CIRCUIT DIAGRAM:



Half Controlled bridge converter with R load

PROCEDURE:

1. Make all connections as per the circuit diagram.
2. Connect firstly 3 phase AC supply from three phase transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.

4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB andIRSswitch and trigger output ON switch.
5. Connect CRO probes and observe waveforms in CRO across load and device in threephase half controlled bridge converter.
6. By varying firing angle gradually up to 180^0 and observe related waveforms.
7. Measure output voltage and current by connecting DC voltmeter & Ammeter.
8. Tabulate all readings for various firing angles.
9. Calculate the output voltage and current by theoretically and compare with itpractically obtained values.

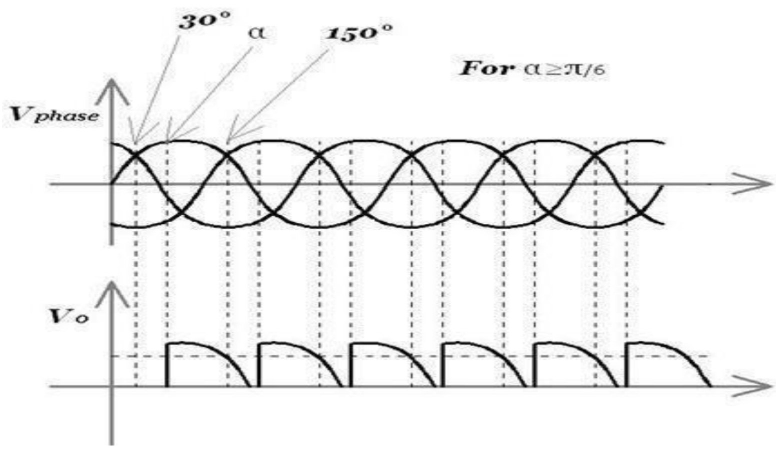
TABULAR COLUMN:

S. No	Input Voltage (V_{in})	Firing Angle in Degrees	Output voltage (V_0)		Output Current (I_0)	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

MODEL CALCULATIONS:

Vo = 3 Vml*(1+cosα)/2π Io = 3 Vml*(1+cosα)/2πR α=firing angle
Vml = line to line voltage

MODEL GRAPHS:



Input and output wave forms of a three phase half controlled bridge converter

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 5 **Date:**

SINGLE PHASE A.C. VOLTAGE CONTROLLER

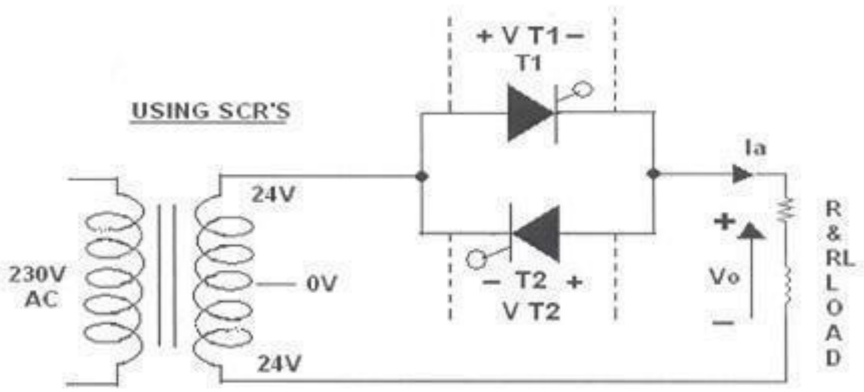
AIM:

To study the single phase AC voltage controller with R Load

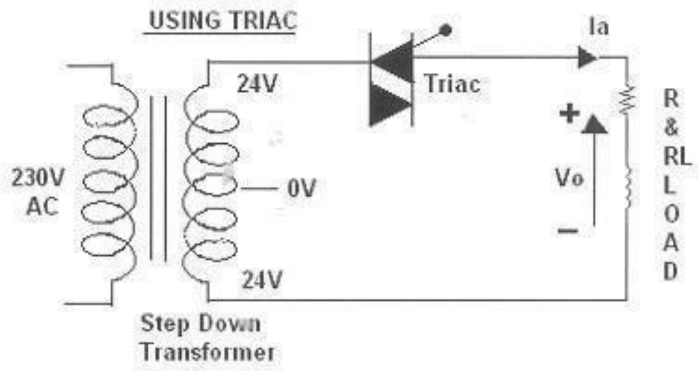
APPARATUS:

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

CIRCUIT DIAGRAM:



Single Phase AC Voltage Controller with Thyristors



Single Phase AC Voltage Controller with Traic

PROCEDURE:

AC VOLTAGE CONTROLLER WITH TWO THYRISTORS:

1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulses from firing circuit to Thyristors as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB andIRS switch and trigger output ON switch.
5. Observe waveforms in CRO, across load by varying firing angle gradually up to 180^0.
6. Measure output voltage and current by connecting AC voltmeter & Ammeter.
7. Tabulate all readings for various firing angles.
8. Observe the various waveforms at different points in circuit by varying the ResistiveLoad
9. Calculate the output voltage and current by theoretically and compare with ipractically obtained values.

A.C. VOLTAGE CONTROLLER WITH TRIAC:

1. Make all connections as per the circuit diagram.
2. Connect firstly 30V AC supply from Isolation Transformer to circuit.
3. Connect firing pulse from firing circuit to TRIAC as indication in circuit.
4. Connect resistive load 200Ω / 5A to load terminals and switch ON the MCB andIRS switch and trigger output ON switch.
5. Observe waveforms in CRO, across load by varying firing angle gradually up to 180^0.
6. Measure output voltage and current by connecting AC voltmeter & Ammeter.
7. Tabulate all readings for various firing angles.
8. Observe the various waveforms at different points in circuit by varying the ResistiveLoad
9. Calculate the output voltage and current by theoretically and compare with ipractically obtained values.

TABULAR COLUMN:

S.No.	Input Voltage (V_{in})	Firing angle in Degrees	Output voltage (V_{0r})		Output Current (I_{0r})	
			Theoretical	Practical	Theoretical	Practical
1						
2						
3						
4						
5						
6						

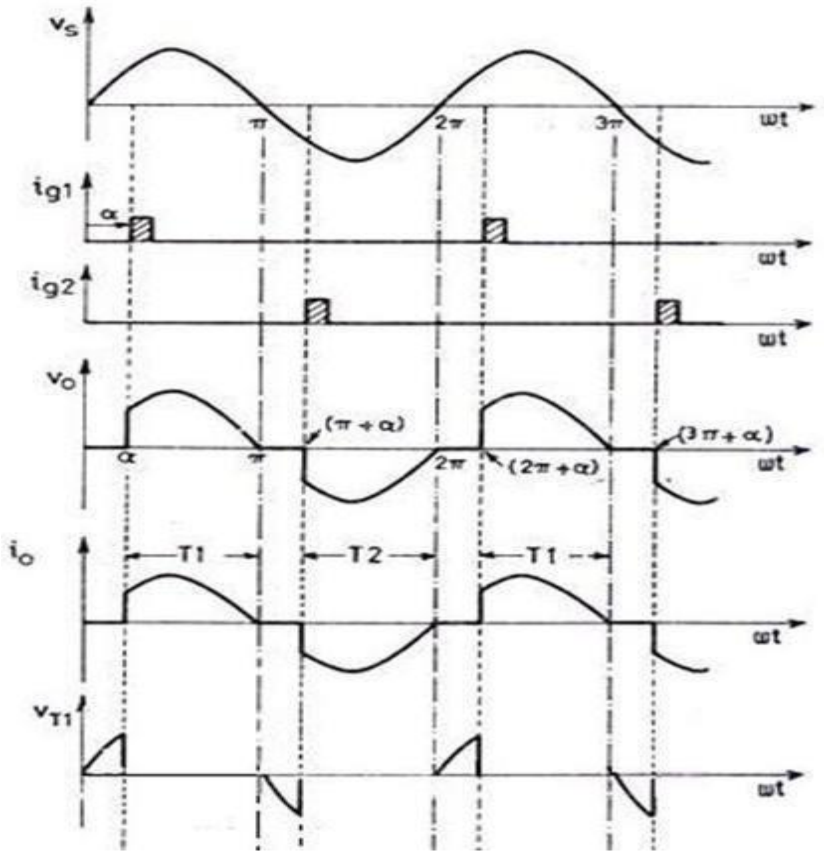
MODEL CALCULATIONS:

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

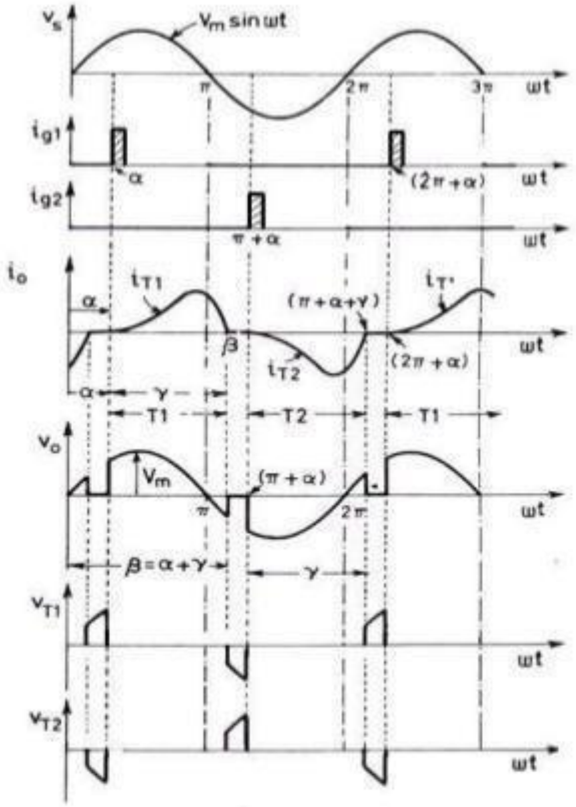
α = Firing Angle

V = RMS Value across transformeroutput

MODEL GRAPH:



Single Phase AC Voltage controller with R - Load



Single Phase AC voltage controller with RL Load

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 6 **Date:**

SINGLE PHASE CYCLO - CONVERTER WITH R LOADS

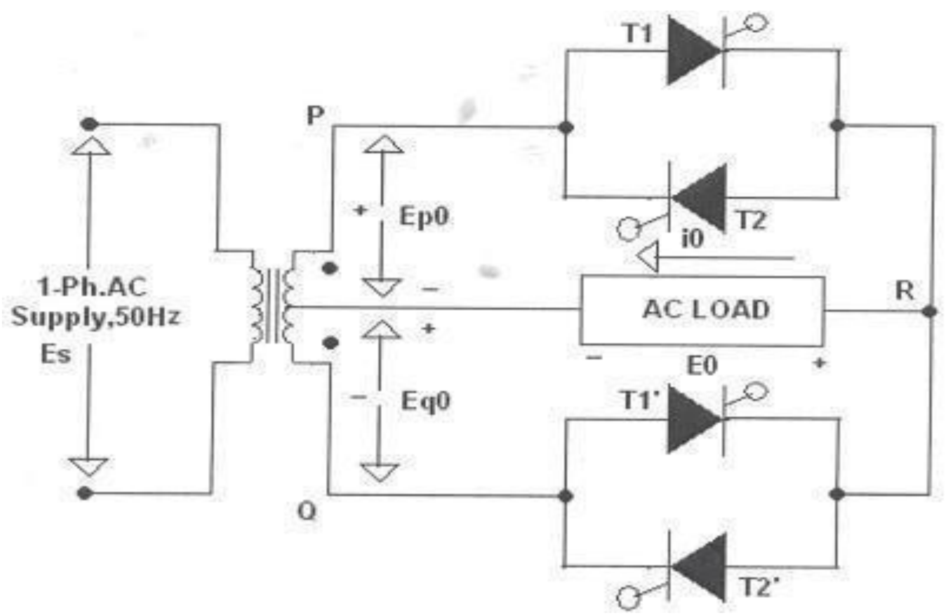
AIM:

To study the single - phase Cyclo Converter with R Load.

APPARATUS:

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

CIRCUIT DIAGRAM:



Circuit Diagram of Single Phase Cyclo Converter

PROCEDURE:

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

TABULAR COLUMN:

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

MODEL CALCULATIONS:

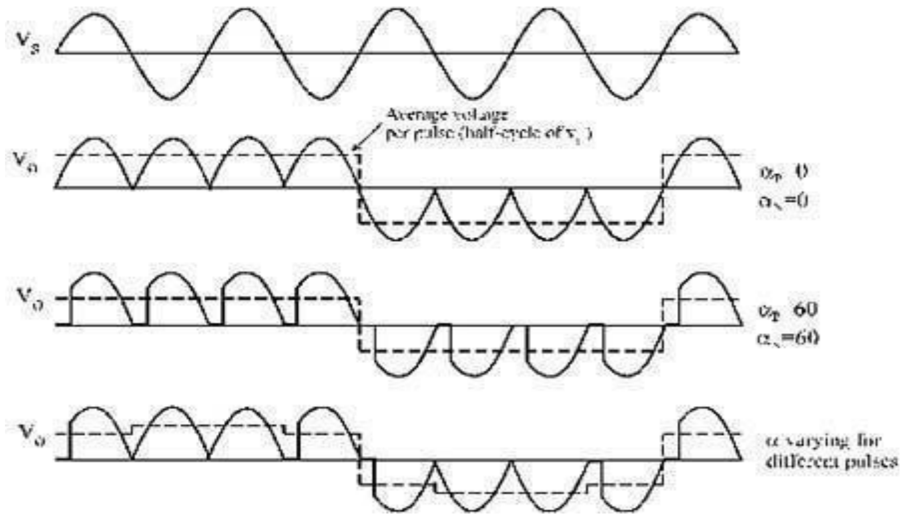
V_{0r} =

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

θ= Firing Angle

V= RMS Value across transformer output

MODEL GRAPH:



Output Wave Forms of Single Phase Cyclo Converter

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 7 **Date:**

SINGLE PHASE SERIES INVERTER WITH R LOAD

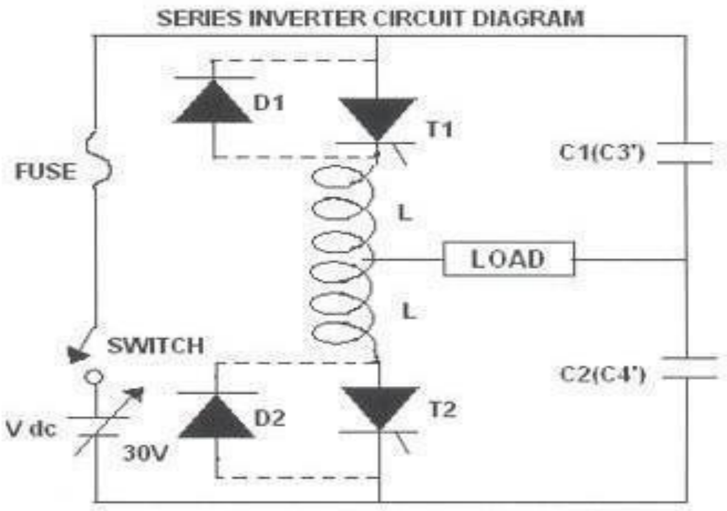
AIM:

To obtain the performance characteristics of a single phase series inverter

APPARATUS:

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

CIRCUIT DIAGRAM:



Circuit Diagram Single Phase Series Inverter

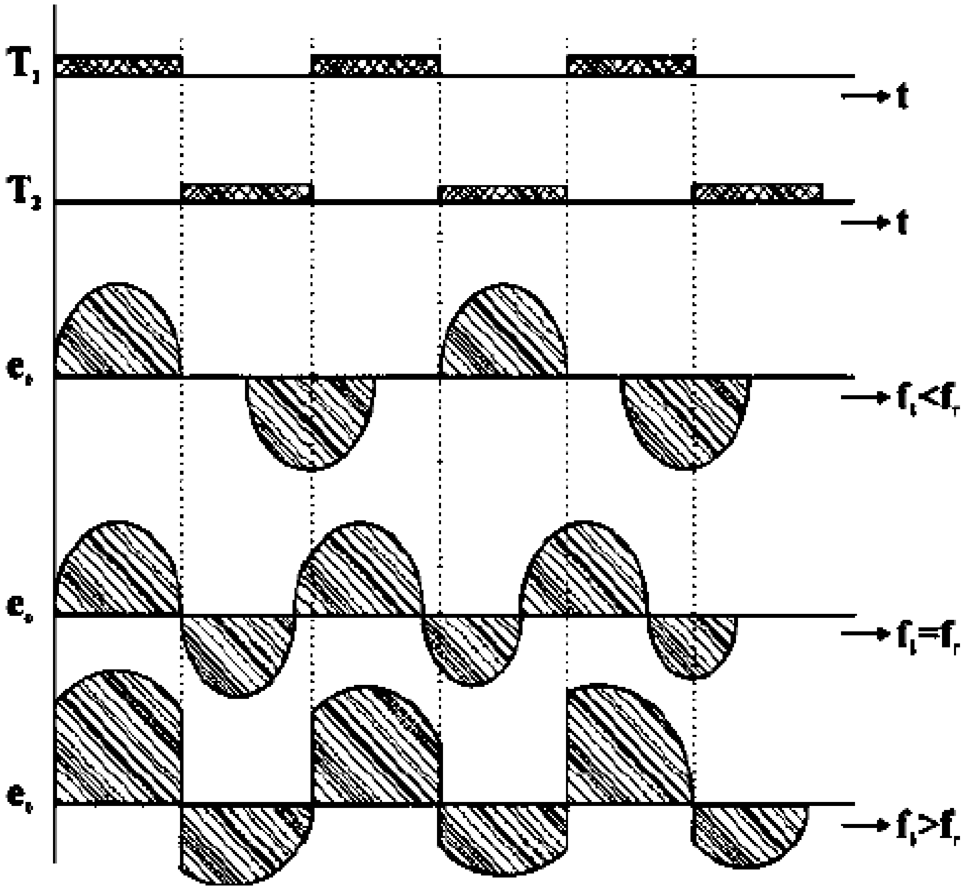
PROCEDURE:

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

commutation fails. Then switch OFF the DC supply, reduce the inverter frequency and tryagain.

7. Repeat the above same procedure for different value of L,C load and also above the wave forms with and without fly wheel diodes.
8. Total output wave forms entirely depends on the load, and after getting the perfect wave forms increase the input supply voltage up to 30V and follow the above procedure.
9. Switch OFF the DC supply first and then Switch OFF the inverter.(Switch OFF the trigger pulses will lead to short circuit)

MODEL WAVEFORMS:



Output Wave Forms of Single Phase Series Inverter

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 8 **Date:**

DC JONE'S CHOPPER

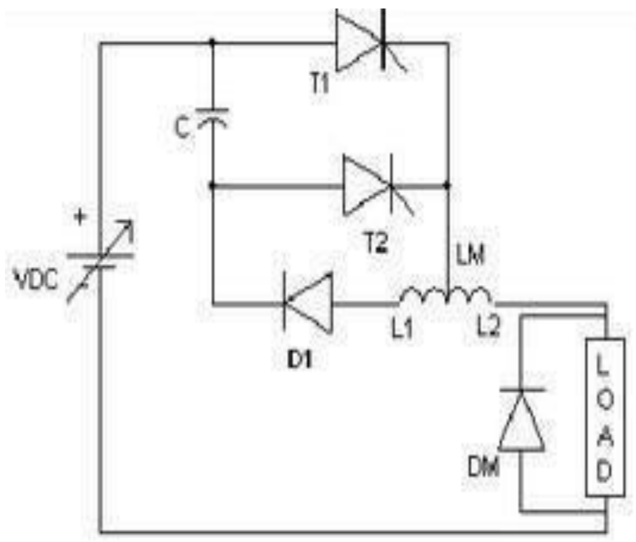
AIM:

To study the characteristics of DC Jone's Chopper.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	DC chopper power MODEL			
2	Triggering circuit (DC chopper)			
3	Rheostat			
4	Digital multimeter			
5	CRO			
6	Patch Cards			

CIRCUIT DIAGRAM:



Circuit Diagram of Jones Chopper

PROCEDURE:

For R – Load:

1. Connections are made as shown in the figure. Use 50Ω Rheostat for R -Load (Freewheeling diode (DM) is to be connected only for RL load).
2. Adjust V_{RPS} output to 10v and connect to DC chopper MODEL.
3. Switch on DC toggle switch of chopper MODEL.
4. Switch on the trigger input by pushing- in pulse switch.
5. Observe the output waveform across load on CRO.
6. Keep the duty cycle at mid position and vary the frequency from minimum tomaximum and record the output voltage readings.
7. Note down the output waveform for mid value of frequency and duty cycle.

TABULAR COLUMN:

Constant Duty Cycle

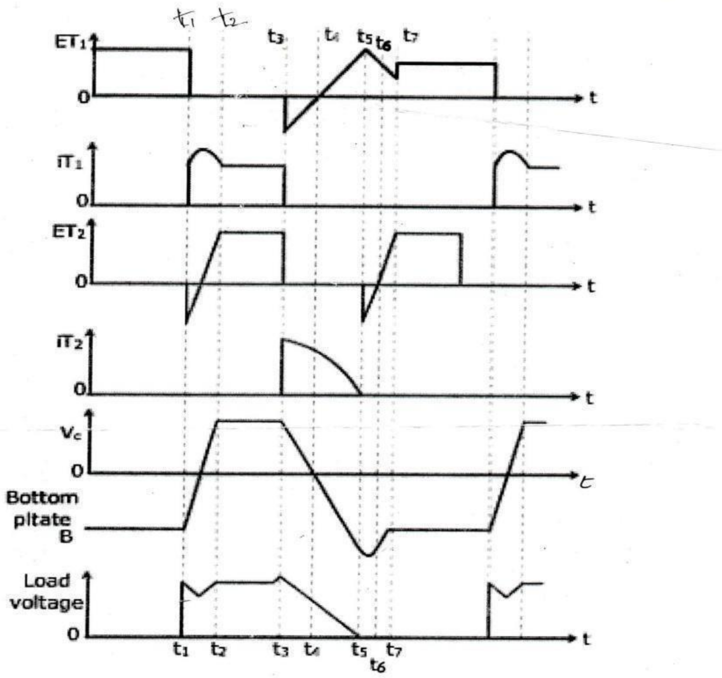
Duty Cycle: 50%, V_{IN}=10 to 15 V

S.No	Frequency(Hz)	V0(Volts)

Constant Frequency, Frequency Control

S. No	T_{ON}(sec)	T_{OFF}(sec)	Duty Cycle (%)	V_O (Volts)

MODEL GRAPH:



Output Characteristics of DC Jones Chopper

SIGNATURE OF FACULTY

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 09 **Date:**

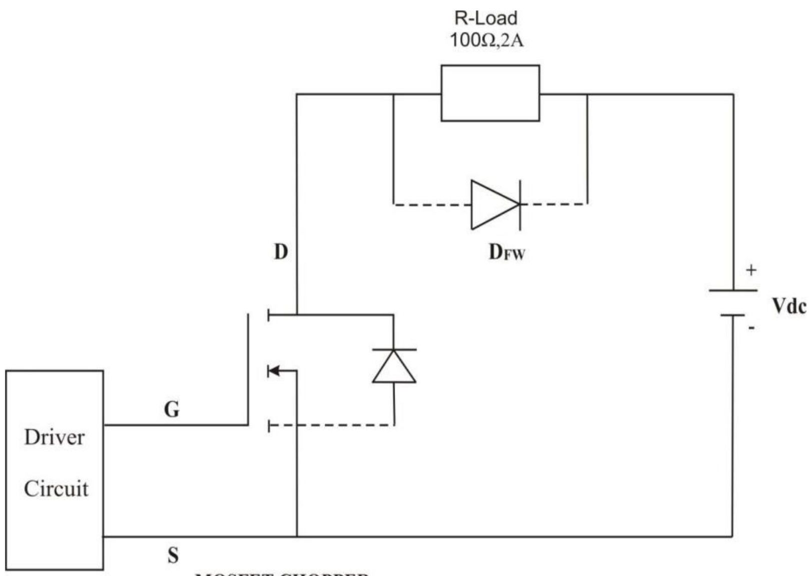
Speed control of PMDC motor using MOSFET

AIM: To study the speed control of PMDC motor by using MOSFET.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Qty
1	Power MOSFET/IGBT Module	-	1 No
2	DC Motor	-	1 No
3	Speedometer	-	1 Set
4	Connecting wires	-	1 No

CIRCUIT DIAGRAM:



MOSFET CHOPPER

PROCEDURE:

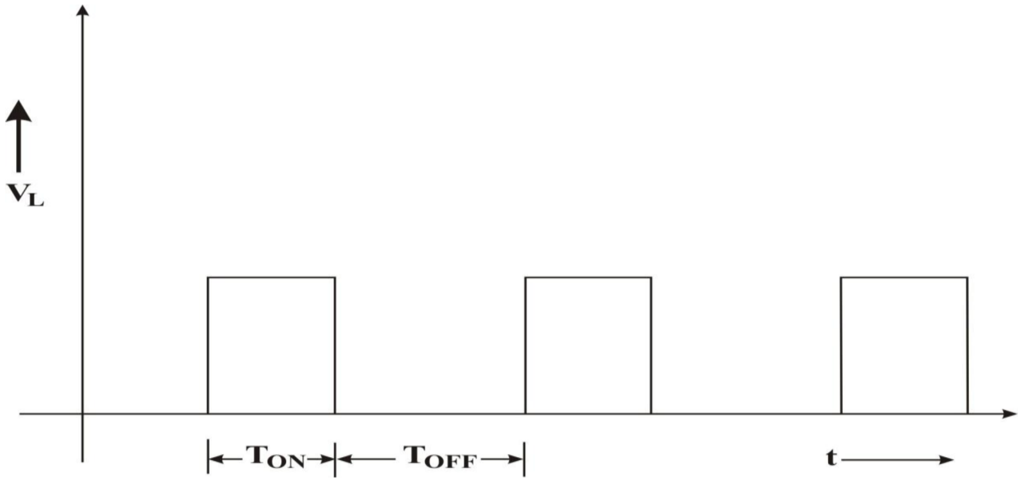
1. Keep the volt-selector switch at OFF position. Switch on the mains supply to the unit. The LCD display shows- Power MOSFET/IGBT chopper
   OFF DCY- 0 FRQ 50
   Digital voltmeter and ammeter shows 000-000
2. Measure the field voltage using digital voltmeter. It should be 220V ±10% approximately and the neon lamp glows.

3. Now keep the voltage select switch at position 1 and measure the voltage at VDC terminals. It should be 24 Volts. The output voltage should be 48 volts when VOLT- Select switch at position-2, 110 volts when the VOLT-Select switch at position-3, 220 volts when the volt select switch is at position 4 approximately.
4. Make sure that the DC supply is correct. Now observe the driver output using a CRO By varying duty cycle and frequency.
5. Make sure that the driver output is proper before connecting to the gate/emitter or gate/source of IGBT or MOSFET.
6. Now all the outputs are proper. Make the connections as given in the circuit diagram.
7. Select 48V DC.
8. Apply the driver output pulses.
9. Vary the duty cycle and observe the load voltage and tabulate the Voltmeter and Ammeter readings.
10. Now change the frequency to some other value and change the duty cycle and note down the readings.
11. Repeat the same procedure for 48Volts. 110V and 220V.
12. In case of DC shunt motor experiment, connect field supply to the field terminals before connecting to the armature supply. And the field supply should be removed only after switch OFF the armature supply.
13. Use higher value of Rheostat-470 Ohm/1Amps to work at 110V/220V DC supply.
14. External DC supply can be used as input to the chopper to get regulated DC supply.

TABULATION:

Sl.no	V_{in} Volts	Frequency Hz	Duty cycle %	V_{out} Volts	T_{on}	T_{off}

OUTPUT WAVEFORM:



RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 10 **Date:**

1-PHASE DUAL CONVERTER

AIM : To study the performance of single phase dual converter.

To prove that the dual converter works in all four quadrants.

To study simultaneous mode & non simultaneous mode of dual converterTo observe the magnitude & wave forms of input and output in CRO To draw the wave forms of input and output drawn on graph sheet

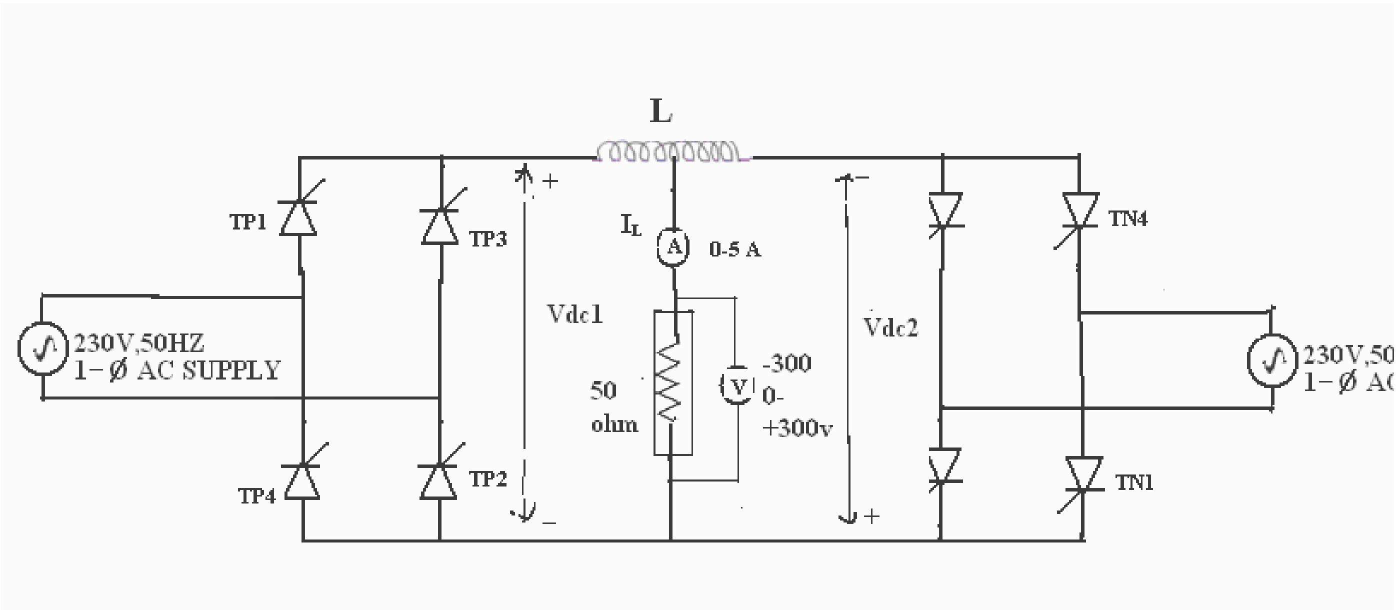
APPARATUS :

1. Single phase dual converter kit
2. Single phase dual converter firing kit
3. Thyristors-TYN612-8 no
4. Rheostat-50 ohms
5. Loading inductor
6. Ammeter 0-5A
7. dual volt meter 300V-0-300V
8. CRO
9. Connecting wires

CIRCUIT DIAGRAM :

SINGLE PHASE DUAL CONVERTER WITH NON SIMULTANEOUS MODE

SINGLE PHASE DUAL CONVERTER WITH SIMULTANEOUS MODE

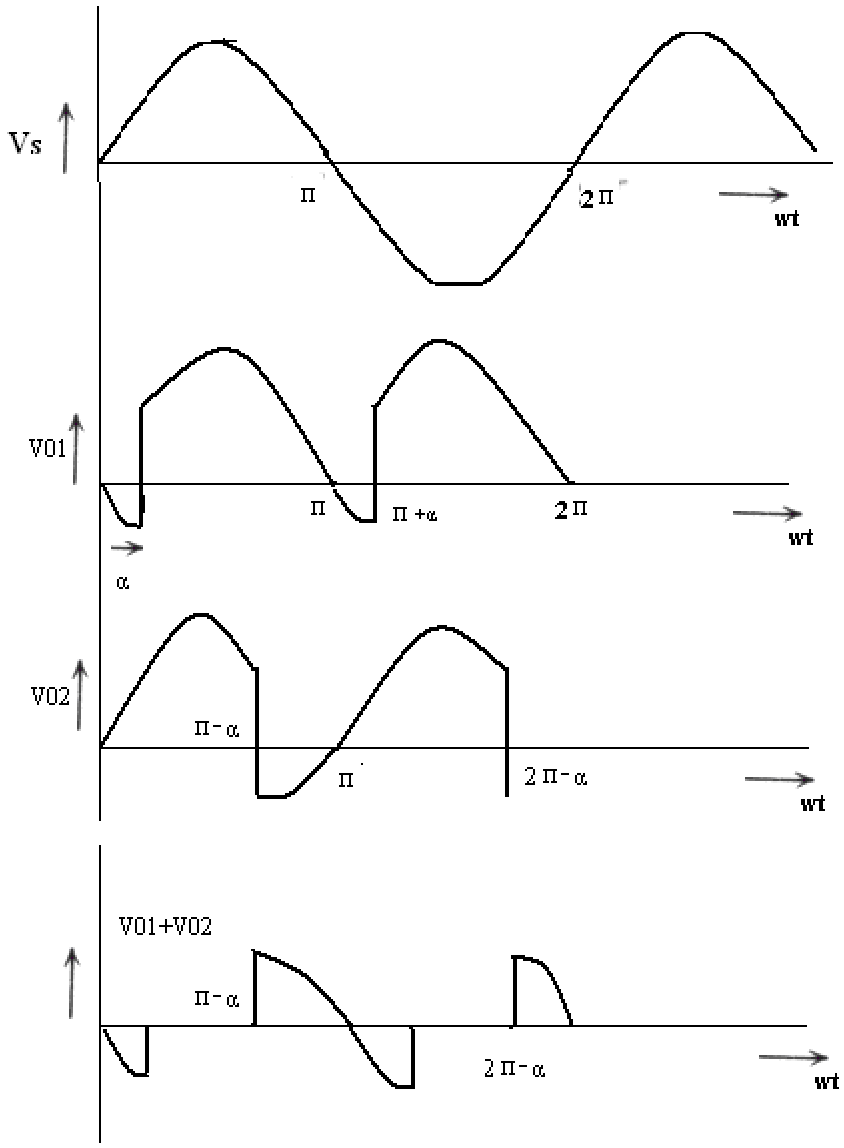


TABULAR COLUMN :

V_m = _______

S.NO	FIRING ANGLE (α)	$V_{dc\,1}$ (Theoretical)	$V_{dc\,1}$ (Practical)	$V_{dc\,2}$ (Theoretical)	$V_{dc\,2}$ (Practical)	I_L
1						
2						
3						
4						
5						
6						

WAVE FORMS :



THEORETICAL CALICULATIONS :

$$V_{d.c1} = V_{avg} = \frac{1}{T}\int_{\alpha}^{\pi+\alpha} V_m\, Sin\omega t.d\omega t$$

$$= \frac{2V_m}{\pi} Cos\alpha$$

$$V_{d.c2} = V_{avg} = \frac{1}{T}\int_{\alpha}^{\pi+\alpha} V_m\, Sin\omega t.d\omega t$$

$$= 2V_m\, Cos\alpha\pi$$

PRECAUTIONS:

1. Check all the SCR's for the performance before making connections.
2. Check the firing circuit trigger outputs and its relative phase sequence.
3. Make fresh connections before you make a new experiment.
4. Preferably work at low voltages (30-40V) for every new connections after careful verification raised to the max. ratings.
5. Keep all knobs at min. position before you switch ON the supply.
6. Show connections to the lab faculty before you start the experiment.

PROCEDURE :

Non simultaneous mode (non circulating current mode):

1. Connections are made as per the circuit diagram.
2. Firing pulses are applied for the respective SCR's from the firing circuit.
3. The main supply is switched ON and triggering circuit is sitched ON
4. Observe out put wave forms across load.
5. Wave forms across the load are observed in CRO,Volt meter ,Ammeter values are noteddown and tabulated for different firing angles.
6. The out put wave forms are plotted on the graph sheet

simultaneous mode (circulating current mode):

1. Connections are made as per the circuit diagram.
2. Firing pulses are applied for the respective SCR's from the firing circuit
3. The main supply is switched ON and triggering circuit is sitched ON
4. Observe out put wave forms across load.
5. Wave forms across the load are observed in CRO,Volt meter ,Ammeter values are noteddown and tabulated for different firing angles.
6. The out put wave forms are plotted on the graph sheet

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 11 **Date:**

PSPICE SIMULATION OF SINGLE PHASE FULL WAVE RECTIFIER USING RLELOADS

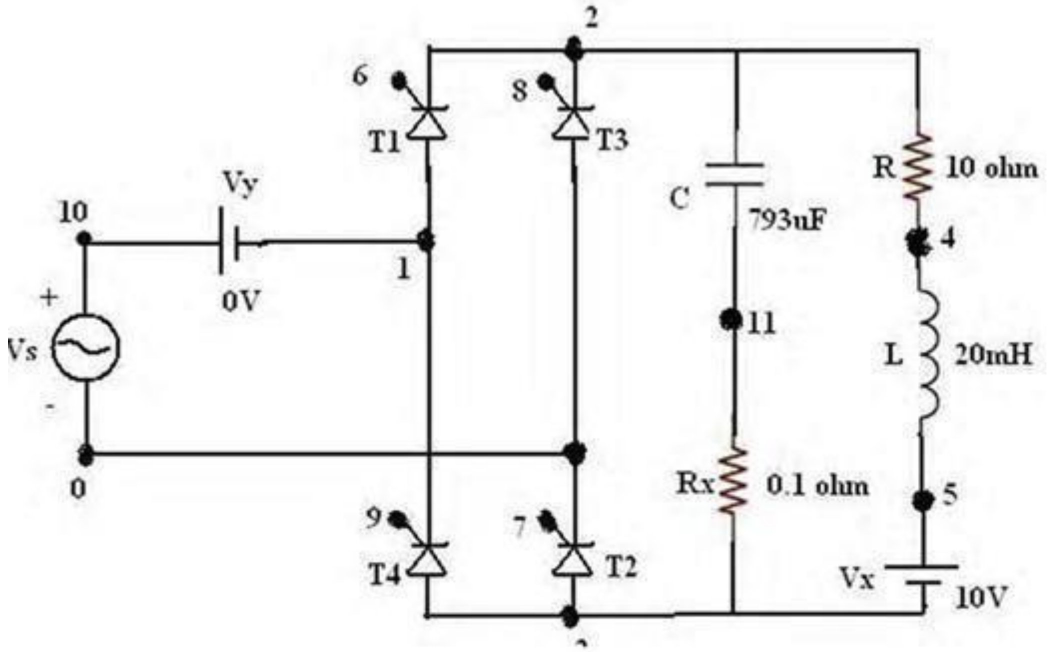
AIM:

To obtain the performance characteristics of Single Phase Semi converter for R, RL, RLE LoadsUsing MATLAB / Simulink

APPARATUS:

S. No.	Name of the Equipment
1.	PC With Desktop
2.	Matlab / Simulink

CIRCUIT DIAGRAM:



Circuit Diagram of PSPICE Simulation of Single Phase Full Wave Rectifier

PROCEDURE:

1. Represent the nodes for a given circuit.
2. Write spice program by initializing all the circuit parameter as per given flow chart.
3. From desktop of your computer click on “START” menu followed by “programs” and then clicking appropriate program group as “DESIGN LAB EVAL8 followed by “DESIGN MANAGER”.
4. Open the run text editor from microsim window & start writing pspice program.
5. Save the program with .cir extension.
6. Open the run spice A / D window from microsim window

7. Open file menu from run spice A / D window then open saved circuit file.
8. If there are any errors, simulates will be displayed with statement as "simulationerror occurred".
9. To see the errors click on o/p file icon and open examine o / p.
10. To make changes in the program open the circuit file, modify, save & Run the program.
11. If there are no errors, simulation will be completed & it will be displayed with astatement as "simulation completed".
12. To see the o / p click on o / p file icon & open examine o / p then note down thevalues.
13. If probe command is used in the program, click on o / p file icon &open run probe. Select variables to plot on graphical window and observe the o / p plots then take print outs of that.

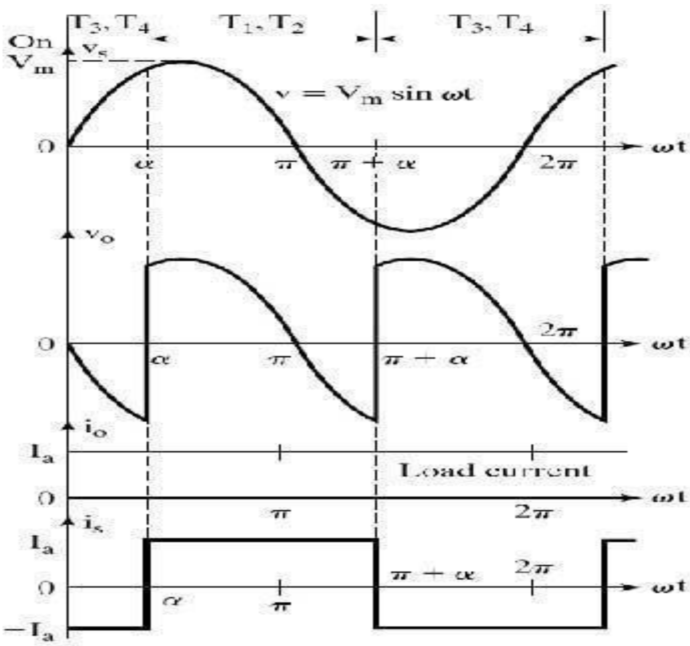
PROGRAM CODE:

```
CLC
VS 10 0 SIN (0 325V 50HZ)
VG1 6 2 PULSE (0V 10V 2500US 1NS 1NS 100US 20000US)
VG2 7 0 PULSE (0V 10V 2500US 1NS 1NS100US
20000US) VG3 8 2 PULSE (0V 10V 12500US 1NS 1NS
100US 20000US)VG4 9 1 PULSE (0V 10V 12500US 1NS
1NS 100US 20000US)R 2 4 10
L 4 5 20MH
VX 5 3 DC 10V
VY 10 1 DC 10V
C 2 11 793UF
RX 11 3 0.1
XT1 1 2 6 2 SCR
XT2 3 0 7 0 SCR
XT3 0 2 8 2 SCR
XT4 3 1 9 1 SCR
.SUBCKT SCR 1 2 3 2
S1 1 5 6 2 SMOD
RG 3 4 50
VX 4 2 DC 0V
VY 5 7 DC 0V
DT 7 2 DMOD
RT 6 2 1
CT 6 2 10UF
F1 2 6 POLY (2) VX VY 0 50 11
```

```
.MODEL SMOD VSWITCH (RON=0.0105 ROFF=10E+5 VON=0.5V VOFF=0V)
.MODEL DMOD D (IS=2.2E-15 BV=1200V TT=0 CJO=0)
.ENDS SCR
.TRAN 50US 100MS 50MS 50US
.PROBE
.OPTIONS ABSTOL=1.00N RELTOL=1.0M VNTOL=0.1 ITL5=20000
.FOUR 50HZ I(VY)
.END
```

Plot v (2)

MODEL WAVEFORMS:



Output Wave Forms of PSPICE Simulation of Single Phase Full WaveRectifier

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 12 Date:

PSPICE SIMULATION OF SINGLE PHASE AC VOLTAGE CONTROLLER USING RLE LOADS

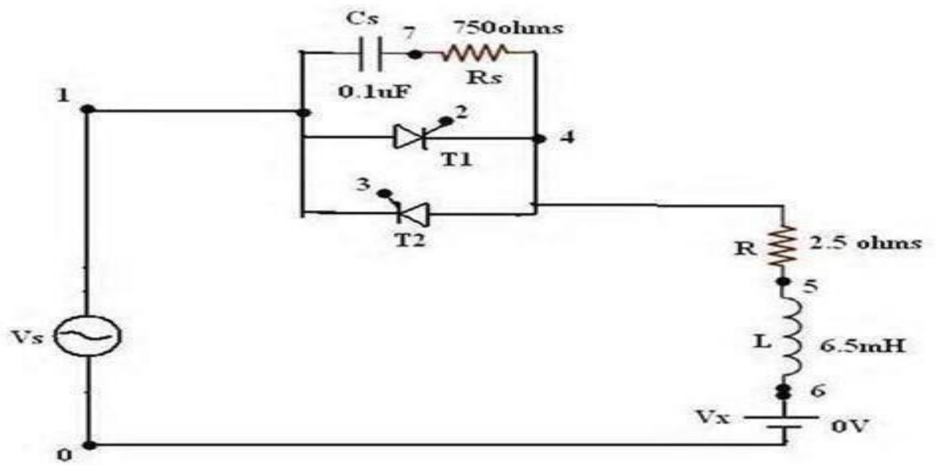
AIM:

To obtain the performance characteristics of Single Phase for R, RL, RLE Loads UsingMATLAB / Simulink

APPARATUS:

S. No.	Name of the Equipment
1.	PC With Desktop
2.	MATLAB / Simulink

CIRCUIT DIAGRAM:



Circuit Diagram of PSPICE Simulation of Single Phase Ac Voltage Controller

PROCEDURE:

1. Represent the nodes for again circuit.
2. Write PSPICE program by initializing all the circuit parameters as per given flow chart From desktop of your computer click “start” menu followed “PROGRAMS” & then clicking appropriate program group as “DESIGN LAB tv 218” followed by design manager.
3. Open the Run text editor from microsim window & start writing PSPICE program.
4. Save the program with .cir extension. (Ex: DA.cir).
5. Open the RUN SPICE A / D window from microsim window.
6. Open file menu from RUN SPICE A / D window then open saved circuit file.
7. If there are any errors, simulation will be displayed with statement as “simulation error

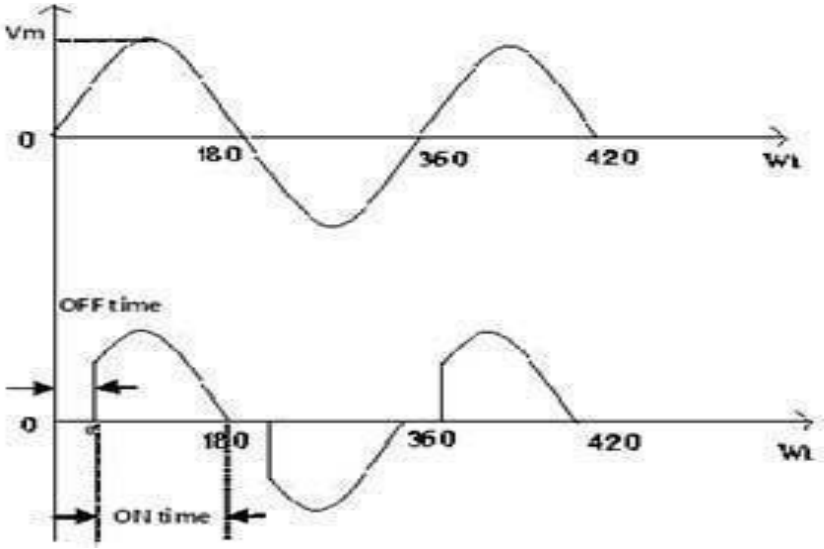
occurred.

8. To see the errors click on output file icon & open examine output.
9. To make changes in the program open the circuit file modifies & run theprogram.
10. If there are no errors simulation modifies be displayed with a statement as "simulation completed".To see the output click on the output file icon & open examine output then notedown the values.
11. If probe command is used in the program click on output file icon & open Run probe selectvariable to plot on graphical window &observe the plots then the printouts of that.

PROGRAM CODE:

```
CLC
VS 1 0 SIN (0 325V 50HZ)
VG1 2 4 PULSE (0V 10V 2500US 1NS 1NS 100US 20000US)
VG2 3 1 PULSE (0V 10V 2500US 1NS 1NS 100US 20000US)R 4 5 2.5
L 5 6 6.5MH
VX 6 0 DC 10V
XT1 1 4 2 4 SCR
XT2 4 1 3 1 SCR
.SUBCKT SCR 1 2 3 2
S1 1 5 6 2 SMOD
RG 3 4 50
VX 4 2 DC 0V
VY 5 7 DC 0V
DT 7 2 DMOD
RT 6 2 1
CT 6 2 100F
F1 2 6 POLY (2) VX VY 0 50 11
.MODEL SMOD VSWITCH (RON=0.0105 ROFF=10E+5 VON=0.5V VOFF=0V)
.MODEL DMOD D (IS=2.2E-15 BV=1200V TT=0 CJO=0)
.ENDS SCR
.TRAN 50US 100MS 50MS 50US
.PROBE
.FOUR 50HZ I(VX)
.END PLOT V (2)
```

MODEL WAVEFORMS:



Output Wave Forms of PSPICE Simulation of Single Phase AcVoltage Controller

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 13 Date:

PSPICE SIMULATION OF RESONANT PULSE COMMUTATION CIRCUIT

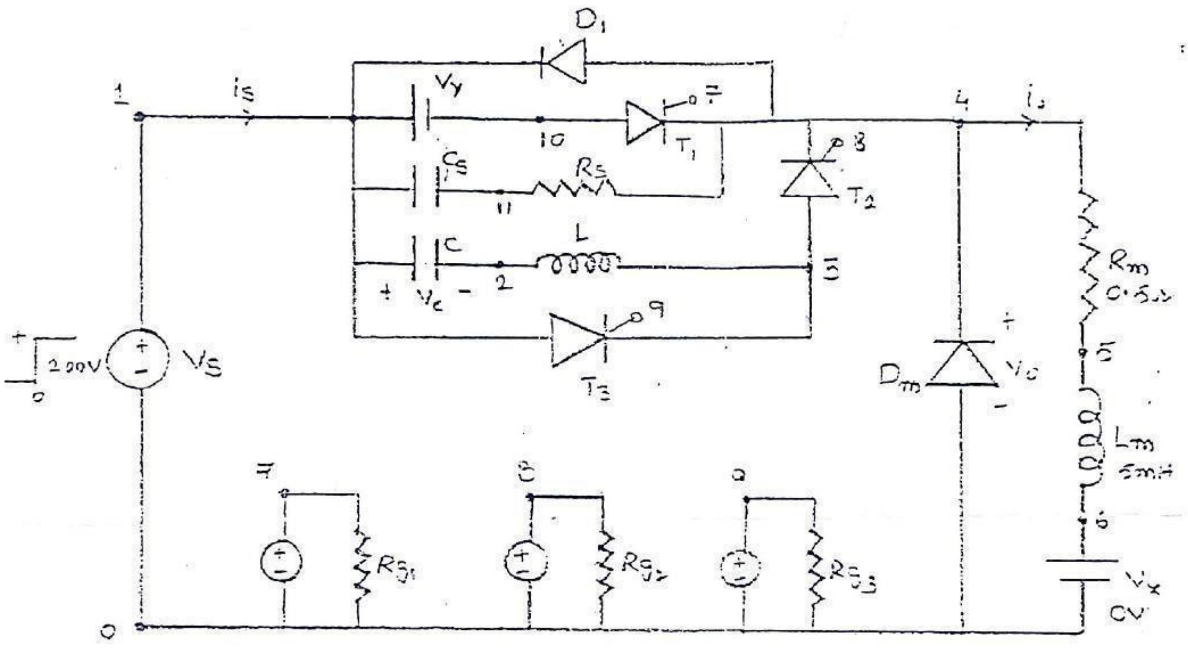
AIM:

To obtain the performance characteristics of a Resonant Pulse Commutation Circuit

APPARATUS:

S. No.	Name of the Equipment
1.	PC With Desktop
2.	MATLAB / Simulink

CIRCUIT DIAGRAM:



Circuit Diagram of PSPICE Simulation of Resonant PulseCommutation Circuit

PROCEDURE:

1. Represent the nodes for a given circuit.
2. Write spice program by initializing all the circuit parameter as per given flowchart.
3. From desktop of your computer click on "START" menu followed by"programs" and then clicking appropriate program group as "DESIGN

LAB EVAL8 followed by "DESIGN MANAGER."

4. Open the run text editor from microsim window & start writing pspiceprogram.
5. Save the program with .cir extension.
6. Open the run spice A / D window from microsim window.
7. Open file menu from run spice A / D window then open saved circuit file.
8. If there are any errors, simulates will be displayed with statementas "simulation error occurred".
9. To see the errors click on o/p file icon and open examine o / p.
10. To make changes in the program open the circuit file, modify, save & Run theprogram.
11. If there are no errors, simulation will be completed & it will bedisplayed with a statement as "simulation completed".
12. To see the o / p click on o / p file icon & open examine o / p then note downthevalues.
13. If .probe command is used in the program, click on o / p file icon &open run probe. Select variables to plot on graphical window andobserve the o / p plots then take print outs of that.

PROGRAM CODE:

```
CLC
VS 1 0 DC 200V
VG1 7 0 PULSE (0V 100V 0 1US 1US 0.4MS
1MS) VG2 8 0 PULSE (0V 100V
0.4MS 1US 1US 0.6MS 1MS) VG3 9 0
PULSE (0V 100V 0.1US 1US 1US 0.2MS
1MS) RG1 7 0 10MEG
RG2 8 0 10MEG
RG3 9 0 10MEG
CS 10 11 0.1UF
RS 11 4 750
C 1 2 31.2UF IC=200V
L 2 3 6.4UH
D1 4 1 DMOD
DM 0 4 DMOD
.MODEL DMOD
D(IS=1E-25 BV=1000V)RM
4 5 0.5
```

```
LM 5 6 5MH
VX 6 0 DC 0V
VY 1 10 DC 0V
XT1 10 4 7 0 DCSCR
XT2 3 4 8 0 DCSCR
XT3 1 3 9 0 DCSCR
.SUBCKT DCSCR 1 2 3 4
DT 5 2 DMOD
ST 1 5 3 4 SMOD
.MODEL DMOD D (IS=1E-25 BV=1000V)
.MODEL SMOD VSWITCH (RON=0.1 ROFF=10E+6 VON=10 VOFF=5V)
.ENDS DCSCR
.TRAN 0.5US 3MS 1.5MS 0.5US
.PROBE
.END
```

PLOT I (C) AND V(2)

SIGNATURE OF FACULTY

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 14 Date:

PSPICE SIMULATION OF BUCK CHOPPER

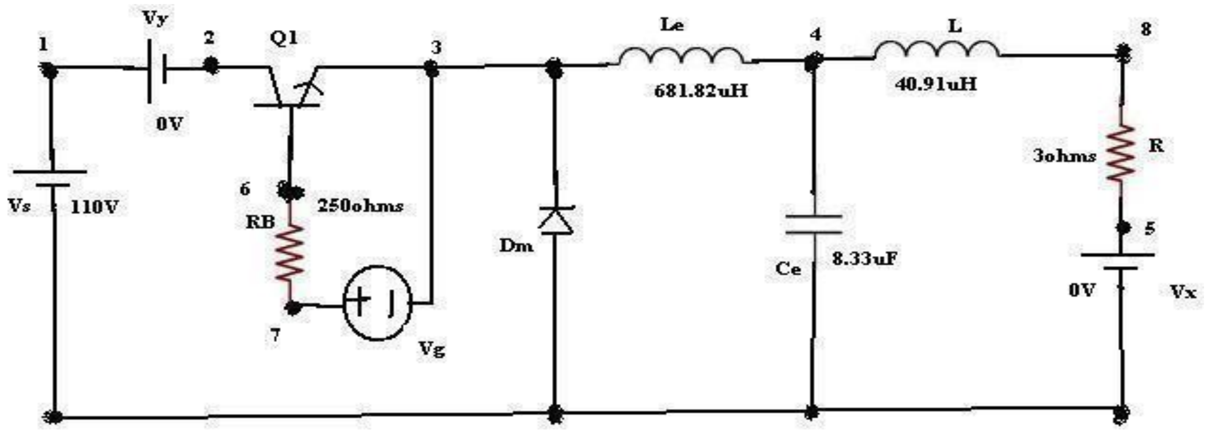
AIM:

To obtain the performance characteristics of BUCK CHOPPER

APPARTUS:

S. No.	Name of the Equipment
1.	PC With Desktop
2.	PSPICE

CIRCUIT DIAGRAM:



Circuit Diagram of PSPICE Simulation of Buck Chopper

PROCEDURE:

1. Represent the nodes for a given circuit.
2. Write spice program by initializing all the circuit parameter as per given flow chart.
3. From desktop of your computer click on " START " menu followed by " programs " and then clicking appropriate program group as " DESIGN LAB EVAL8 followed by " DESIGN MANAGER."
4. Open the run text editor from microsim window & start writing pspiceprogram.
5. Save the program with .cir extension.
6. Open the run spice A / D window from microsimwindow.
7. Open file menu from run spice A / D window then open saved circuit file.

8. If there are any errors, simulates will be displayed with statementas “simulation error occurred”.
9. To see the errors click on o / p file icon and open examine o / p.
10. To make changes in the program open the circuit file, modify, save & Run theprogram.
11. If there are no errors, simulation will be completed & it will bedisplayed with a statement as “simulation completed”.
12. To see the o / p click on o / p file icon & open examine o / p then note downthevalues.
13. If .probe command is used in the program, click on o / p file icon &open run probe. Select variables to plot on graphical window andobserve the o / p plots then take print outs of that.

PROGARM CODE:

```
CLC
VS 1 0 DC 110V
VY 1 2 DC 0V
VG 7 3 PULSE (0V 20V 0 0.1NS 0.1NS
27.28US 50US) RB 7 6 250
LE 3 4 681.82UH
CE 4 0 8.33UF IC=60V
L 4 8 40.91UH
R 8 5 3
VX 5 0 DC 0V
DM 0 3 DMOD
.MODEL DMOD D (IS=2.2E-15
BV=1800V TT=0) Q1 2 6 3 QMOD
.MODEL QMOD NPN (IS=6.734F BF=416.4 BR=0.7371
CJC=3.638P CJE=4.493P TR=239.5N TF=301.2P)
.TRAN 1US 1.6MS 1.5MS 1US UIC
.PROBE
.FOUR 20KHZ I (VY)
.END
PLOT I (LE) I(VX) V4
```

RESULT:

SIGNATURE OF FACULTY

EXPERIMENT – 15 Date:

PSPICE SIMULATION OF SINGLE PHASE INVERTER WITH PWM CONTROL

AIM:

To obtain the performance characteristics of single phase inverter with PWM control.

APPARATUS:

S. No	Name of the Equipment
1.	PC With Desktop
2.	PSPICE

CIRCUIT DIAGRAM:

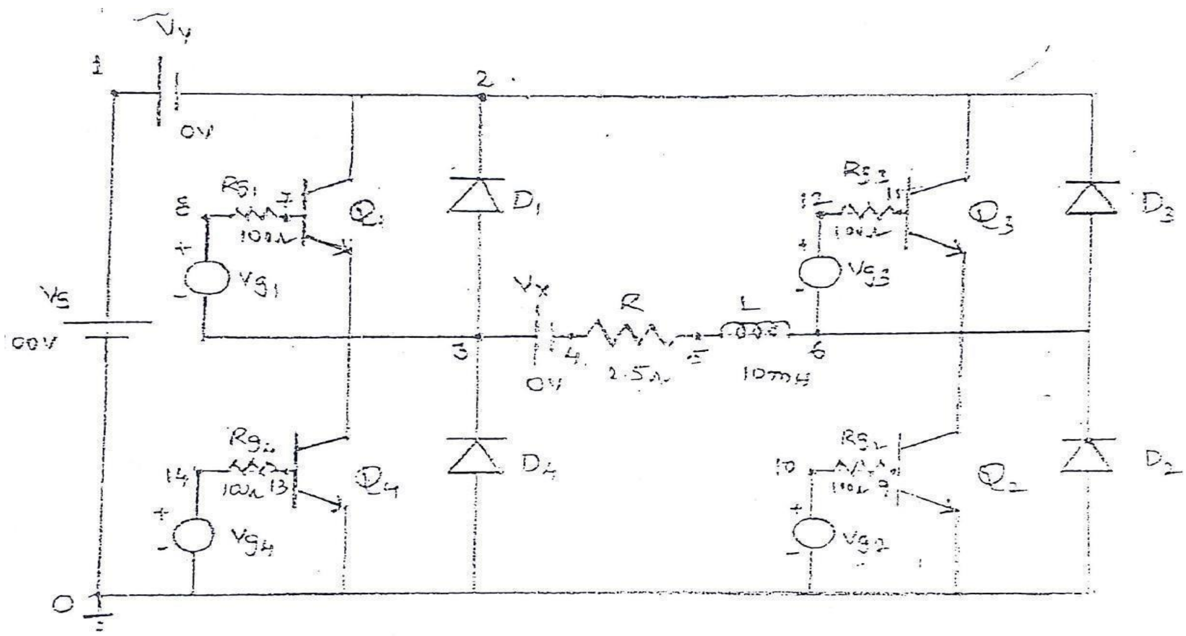


Fig - 17.1 Circuit Diagram of PSPICE Simulation of Single Phase Inverter

PROCEDURE:

1. Represent the nodes for a given circuit.
2. Write spice program by initializing all the circuit parameter as per given flow chart.
3. From desktop of your computer click on " START " menu followed by " programs " and then clicking appropriate program group as " DESIGN LAB EVAL8 followed by " DESIGN MANAGER."
4. Open the run text editor from microsim window & start writing PSPICE program.

5. Save the program with .cir extension.
6. Open the run spice A / D window from microsim window.
7. Open file menu from run spice A / D window then open saved circuit file.
8. If there are any errors, simulates will be displayed with statementas “simulation error occurred”.
9. To see the errors click on o / p file icon and open examine o/p.
10. To make changes in the program open the circuit file, modify, save & Run theprogram.
11. If there are no errors, simulation will be completed & it will bedisplayed with a statement as “simulation completed”.
12. To see the o / p click on o / p file icon & open examine o / p then note downthevalues.
13. If .probe command is used in the program, click on o / p file icon &open run probe. Select variables to plot on graphical window andobserve the o / p plots then take print outs of that.

PROGRAM CODE:

```
VS 1 0 DC 100V
VT 17 0 PULSE (50V 0V 0 833.33US 833.33US 1NS
1666.67US) RT 17 0 2MEG VC1 15 0 PULSE (0 -30V
1NS 1NS 8333.33US
1666.67US) RC1 15 0 2MEG
VC3 16 0 PULSE (0 -30V 8333.33US 1NS 1NS
8333.33US 16666.67US) RC3 16 0 2MEG
R 4 5 2.5
L 5 6 10MH
VX 3 4 DC 0V
VY 1 2 DC 0V
D1 3 2 DMOD
D2 0 6 DMOD
D3 6 2 DMOD
D4 0 3 DMOD
.MODEL DMOD D(IS=2.2E-15
BV=1800V TT=0) Q1 2 7 3 QMOD
```

```
Q2 6 9 0 QMOD
Q3 2 11 6  QMOD
Q4 3 13 0  QMOD
.MODEL QMOD NPN(IS=6.74F BF=416.5
CJC=3.638P CJE=4.451P) RG1 8 7 100

RG2 10 9 100
RG3 12 11 100
RG4 14 13 100
*SUBCKT CALL FOR PWM
CONTROL XPW1 17 15 8 3PWM
XPW2 17 15 10 0 PWM
XPW3 17 16 12 6 PWM
XPW4 17 16 14 0 PWM
.SUBCKT PWM 1 2 3 4
*model ref carrier
+control - control R11 5
1K
R2 2 5 1K
RIN 5 0 2MEG
RF 5 3 100K
R0 6 3 75
C0 3 4 10PF
E1 6 4 0 5 2E+5
.ENDS PWM
.TRAN 10US 16.67MS 0 10US
.PROBE
.options abstol=1.00n reltol=0.01 vntol=0.1 itl5=20000
.FOUR 60HZ V(3,6)
.END
 PLOT V (14) I(VX) I (vy)V(10)
```

SIGNATURE OF FACULTY

RESULT:

SIGNATURE OF FACULTY