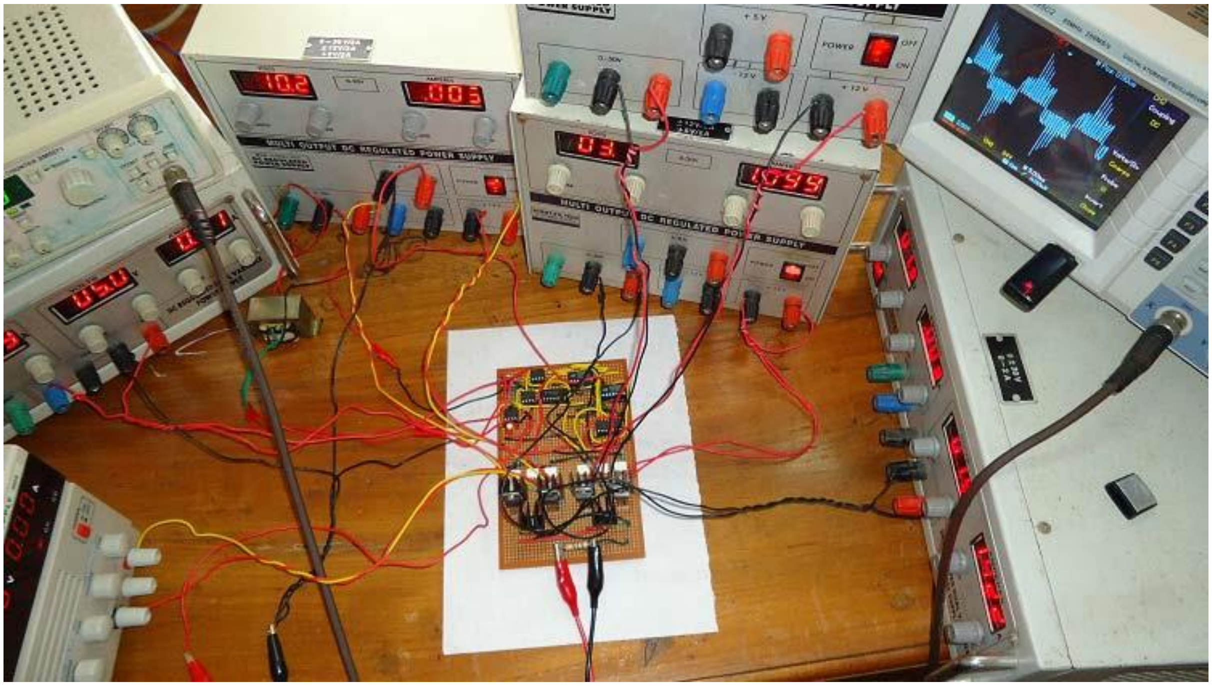
POWER ELECTRONICS LABORATORY

II B.Tech EEE-II Sem

STUDENT OBSERVATION RECORD



DEPARTMENT
OF
ELECTRICAL AND ELECTRONICS ENGINEERING

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112
(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu
Accredited by NAAC, NBA (EEE, ECE & CSE), Recognized under 2(f) &12(B) of UGC Act)

VEMU INSTITUTE OF TECHNOLOGY

DEPT.OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF THE INSTITUTE

- To be a premier institute for professional education producing dynamic and vibrant force of technocrats with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

MISSION OF THE INSTITUTE

- To create a learning environment with state-of-the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.
- To facilitate the learners to foster innovative ideas, inculcatecompetent research and consultancy skills through Industry-Institute Interaction.
- To develop hard work, honesty, leadership qualitiesand sense of direction in rural youth by providing value based education.

VISION OF THE DEPARTMENT

- To produce professionally deft and intellectually adept Electrical and Electronics Engineers and equip them with the latest technological skills, research & consultancy competencies along with social responsibility, ethics, Lifelong Learning and leadership qualities.

MISSION OF THE DEPARTMENT

- To produce competent Electrical and Electronics Engineers with strong core knowledge, design experience & exposure to research by providing quality teaching and learning environment.
- To train the students in emerging technologies through state - of - the art laboratories and thus bridge the gap between Industry and academia.
- To inculcate learners with interpersonal skills, team work, social values, leadership qualities and professional ethics for a holistic engineering professional practice through value based education.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

Programme Educational Objectives (PEOs) of B.Tech (Electrical and Electronics Engineering) **program are:**

Within few years of graduation, the graduates will

PEO 1: Provide sound foundation in mathematics, science and engineering fundamentals to analyze, formulate and solve complex engineering problems.

PEO 2: Have multi-disciplinary Knowledge and innovative skills to design and develop Electrical & Electronics products and allied systems.

PEO 3: Acquire the latest technological skills and motivation to pursue higher studies leading to research.

PEO 4: Possess good communication skills, team spirit, ethics, modern tools usage and the life-long learning needed for a successful professional career.

PROGRAM OUTCOMES (POs)

PO-1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-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.
PO-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.
PO-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.
PO-5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-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.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-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.
PO-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 and leader in a team, to manage projects and in multidisciplinary environments.
PO-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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On completion of the B.Tech. (Electrical and Electronics Engineering) degree, the graduates will be able to

PSO-1:Higher Education: Apply the fundamental knowledge of Mathematics, Science, Electrical and Electronics Engineering to pursue higher education in the areas of Electrical Circuits, Electrical Machines, Electrical Drives, Power Electronics, Control Systems and Power Systems.

PSO-2:Employment: Get employed in Public/Private sectors by applying the knowledge in the domains of design and operation of Electronic Systems, Microprocessor based control systems, Power systems, Energy auditing etc.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

II B.Tech. II-Sem(EEE)

POWER ELECTRONICS LABORATORY(20A02401P)

COURSE OUTCOMES

C227.1	**Test** the turn on – turn off characteristics of various power electronic devices.
C227.2	**Test** different types of voltage controllers ,converters and inverters with R and RL loads
C227.3	Test and analyze firing circuit of SCR
C227.4	Analyze the Performance of Commutation Circuits
C227.5	**Analyze** the performance characteristics of a single phase ac voltage controller, DC jones chopper and series inverter

Name: ______________________________

H.T.No: ______________________________

Year/Semester: ______________________________

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B. Tech II-II Sem. (EEE)	L	T	P	C
	0	0	3	1.5

POWER ELECTRONICS LABORATORY(20A02401P)

Any Eight from the following

1. Study of Characteristics of SCR, MOSFET & IGBT
2. Gate firing circuits for SCR's: (a) R triggering (b) R-C triggering
3. Single Phase AC Voltage Controller with R and RL Loads
4. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
5. DC Jones chopper with R and RL Loads
6. Single Phase Parallel, inverter with R and RL loads
7. Single Phase half controlled converter with R and RL load
8. Single Phase Fully controlled converter with R and RL load
9. Three Phase half controlled bridge converter with R -load
10. Three Phase fully controlled bridge converter with R,RL-load
11. Single Phase series inverter with R and RL loads
12. Single Phase Bridge converter with R and RL loads
13. Single Phase dual converter with RL loads

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List of Experiments to be conducted

(20A02401P) POWER ELECTRONICS LABORATORY

1. Study of Characteristics of SCR, MOSFET & IGBT
2. Gate firing circuits for SCR's: (a) R triggering (b) R-C triggering
3. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
4. DC Jones chopper with R and RL Loads
5. Single Phase Parallel, inverter with R and RL loads
6. Single Phase half controlled converter with R and RL load
7. Single Phase series inverter with R and RL loads
8. Single Phase dual converter with RL loads
9. Single Phase fully controlled converter with R and RL load
10. Three Phase half controlled bridge converter with R, RL-load
11. Operation of MOSFET based Chopper.
12. 1-Ø Bridge Inverter Using SPWM

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List of Experiments to be conducted

CONTENTS

(20A02401P) POWER ELECTRONICS LABORATORY

GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

DO‘S

1. Without Prior permission do not enter into the Laboratory.
2. While entering into the LAB students should wear their ID cards.
3. The Students should come with proper uniform.
4. Students should sign in the LOGIN REGISTER before entering into the laboratory.
5. Students should come with observation and record note book to the laboratory.
6. Students should maintain silence inside the laboratory.
7. Circuit connections must be checked by the lab-in charge before switching the supply

DONT‘S

8. Students bringing the bags inside the laboratory..
9. Students wearing slippers/shoes insides the laboratory.
10. Students scribbling on the desk and mishandling the chairs.
11. Students using mobile phones inside the laboratory.
12. Students making noise inside the laboratory.
13. Students mishandle the devices.
14. Students write anything on the devices

(20A02401P) POWER ELECTRONICS LABORATORY

SCHEME OF EVALUATION

S.No	Experiment Name	Date	Marks Awarded				Total 30(M)
			Record (10M)	Observation (10M)	Viva Voce (5M)	Attendance (5M)	
1	Study of Characteristics of SCR, MOSFET & IGBT						
2	Gate firing circuits for SCR's: (a) R triggering (b) R-C triggering						
3	Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)						
4	DC Jones chopper with R and RL Loads						
5	Single Phase Parallel, inverter with R and RL loads						
6	Single Phase half controlled converter with R and RL load						
7	Single Phase series inverter with R and RL loads						
8	Single Phase dual converter with RL loads						
9	Single Phase fully controlled converter with R and RL load						
10	Three Phase half controlled bridge converter with R, RL-load						
Additional experiments							
11	Operation of MOSFET based Chopper						
12	1-Ø Bridge Inverter Using SPWM						

Signature of Lab In-charge

EXPERIMENT N0: 01 **DATE:**

STUDY OF CHARACTERISTICS OF SCR, MOSFET & IGBT

AIM:

To plot the V - I Characteristics of SCR, MOSFET & IGBT.

SCRCHARACTERISTICS

APPARATUS:

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

CIRCUITDIAGRAM:

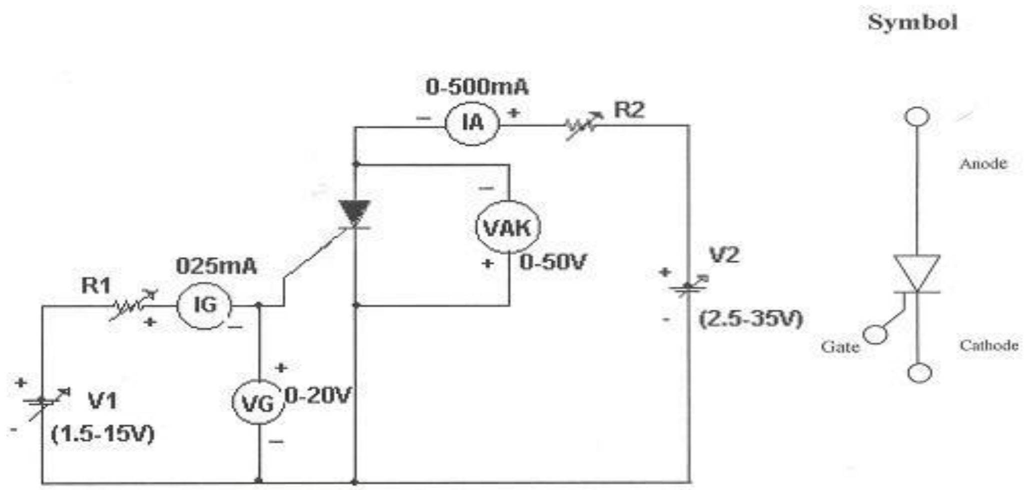


Fig – 1.1 Study of Characteristics of SCR

PROCEDURE:
V - I CHARACTERISTICS:

1. Make all connections as per the circuitdiagram.
2. Initially keep V_1& V_2 at minimum position and R_1& R_2 maximumposition.
3. Adjust Gate current I_g to some constant by varying the V_1 orR_1.
4. Now slowly vary V_2 and observe Anode to Cathode voltage V_{AK} and Anode currentI_A.
5. Tabulate the readings of Anode to Cathode voltage V_{AK} and Anode currentI_A.
6. Repeat the above procedure for different Gate currentI_g.

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 say15V.
3. Now slowly vary the V1 voltage till the SCR triggers and note down the reading of gate current(I_G) and Gate Cathode voltage(V_{GK}) and rise of anode currentI_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 middleposition.
2. Apply 20V to the Anode to cathode by varyingV_2.
3. Rise the Vg voltage by varying V1 till the device turns ON indicated by sudden rise in I_A. At what current SCR trigger it is the minimum gate current required to turn ON theSCR.
4. Now set R2 at maximum position, then SCR turns OFF, if it is not turned off reduce V2 up to turn off the device and put the gate voltage.
5. Now decrease the R2 slowly, to increase the Anode current gradually insteps.
6. At each and every step, put OFF and ON the gate voltage switches V1. If the Anode current is greater than the latching current of the device, the device says ON 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 currentvalue.

TO FIND HOLDING CURRENT:

1. Now increase load current from latching current level by varying R2 &V2.
2. Switch OFF the gate voltage switch S1 permanently (now the device is in ONstate).
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 currentvalue.
5. Observe that $I_H < I_L$.

TABULARCOLUMN:

S. No	I_G= A	
	V_{AK} (Volts)	I_A (Amps)
1		
2		
3		
4		
5		

S. No	I_G= A	
	V_{AK} (Volts)	I_A (Amps)
1		
2		
3		
4		
5		

S. No	V_{AK}= (Volts)	
	V_{GK} =V	I_G= A
1		
2		
3		
4		
5		

S. No	V_{AK}= (Volts)	
	V_{GK} =V	I_G= A
1		
2		
3		
4		
5		

MODELGRAPH:

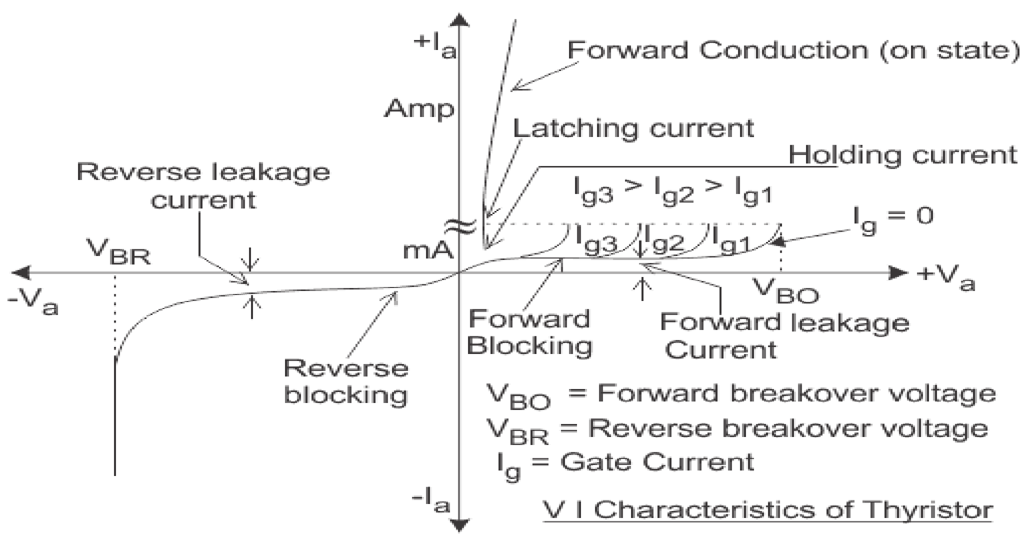


Fig - 1.2 V- I Characteristics of SCR

RESULT:

POST LAB VIVAQUESTIONS:

1. Why is V_{bo} greater thanV_{br}?
2. Why does high power dissipation occur in reverse blockingmode?
3. Why shouldn't positive gate signal be applied during reverse blockingMode?
4. Explain reverse current$I_{rev.}$.
5. What happens when gate drive isapplied?
6. Why should the gate signal be removed after turnon?
7. Is a gate signal required when reversebiased?
8. What are applications ofSCR?

EXPERIMENT N0: 1(B) **DATE:**

MOSFETCHARACTERISTICS

AIM:

To study the output and transfer characteristics of MOSFET

APPARATUS:

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

CIRCUITDIAGRAM:

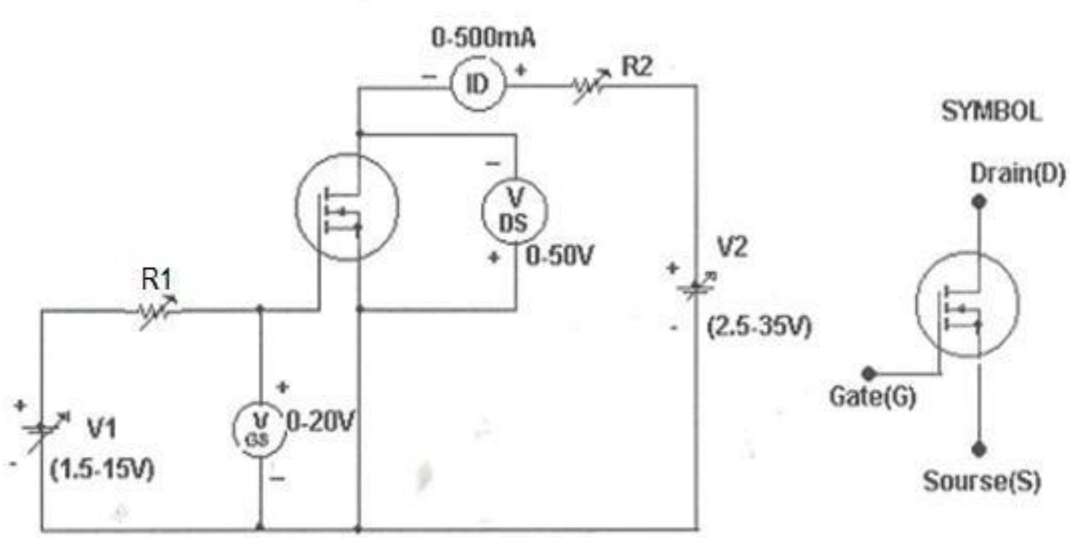


Fig – 1.2.1 Study of Characteristics of MOSFET

PROCEDURE:

TRANSFER CHARACTERISTICS:

1. Make all connections as per the circuitdiagram.
2. Initially keep V_1& V_2 at minimum position and R_1& R_2 middleposition.
3. Set V_{DS} to some say10V.
4. Slowly vary Gate source voltage V_{GS} by varyingV1.
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 varyingV1.
2. Slowly vary V2 and note down I_D andV_{DS}.
3. At particular value of V_{GS} there a pinch off voltage between drain andsource. 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.
4. Repeat above procedure for different values of V_{GS} and draw graph between I_D *vs* V_{DS}.

TABULARCOLUMN:

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

S. No	V_{GS} = V	
	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		

MODELGRAPH:

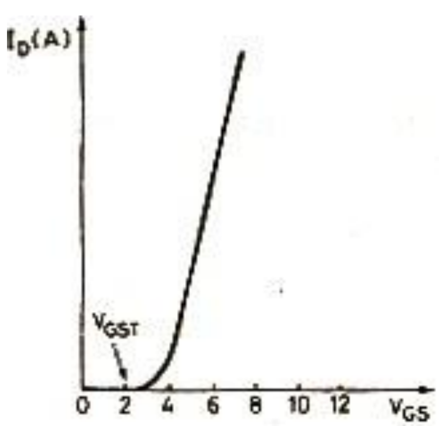


Fig - 1.2.2 Transfer CharacteristicofMOSFET

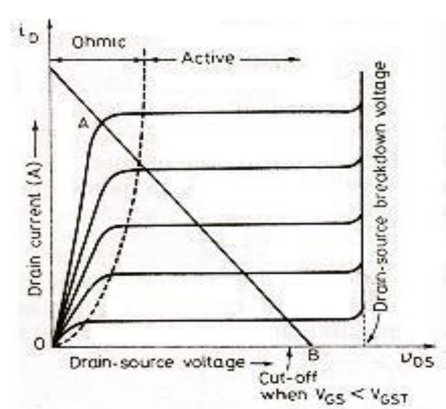


Fig - 1.2.3 Output Characteristics ofMOSFET

RESULT:

POST LAB VIVAQUESTIONS:

1. How does n - drift region affectMOSFET?
2. How MOSFET are suitable for low power high frequencyapplications?
3. What are the requirements of gate drive inMOSFET?
4. Draw the switching model ofMOSFET.
5. What is rise time and falltime?
6. In which region does the MOSFET used as aswitch?
7. Why are MOSFET’s mainly used for low powerapplications?
8. How is MOSFET turnedoff?
9. What are the advantages of vertical structure ofMOSFET?
10. What are the merits ofMOSFET?

EXPERIMENT N0: 1(C) **DATE:**

IGBTCHARACTERISTICS

AIM:

To study the output and transfer characteristics of IGBT.

APPARATUS:

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

CIRCUITDIAGRAM:

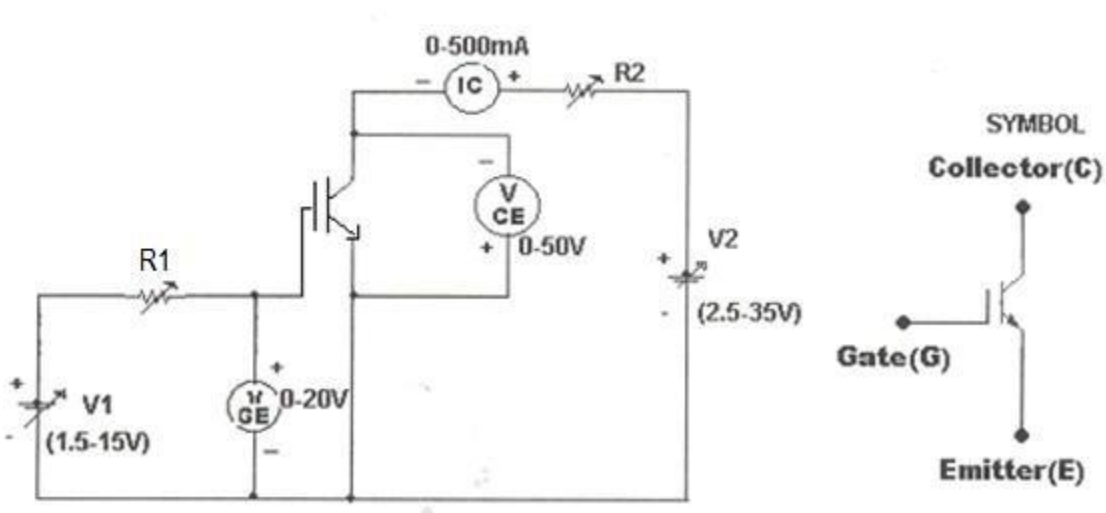


Fig – 1.3.1 Study of Characteristics IGBT

PROCEDURE:

TRANSFER CHARACTERISTICS:

1. Make all connections as per the circuitdiagram.
2. Initially keep V_1& V_2 at minimum position and R_1& R_2 middleposition.
3. Set V_{CE} to some say10V.
4. Slowly vary Gate Emitter voltage V_{GE} by varyingV1.
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 varyingV1.
2. Slowly vary V2 and note down I_C and V_{CE}readings.
3. At particular value of V_{GS} there a pinch off voltage V_P between Collector andEmitter.

   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.
4. Repeat above procedure for different values of V_{GE} and draw graph between I_C VS V_{GE}.

TABULARCOLUMN:

S. No	V_{CE} = V	
	V_{GE} (Volts)	I_C (Amps)
1		
2		
3		
4		
5		

S. No	V_{CE} =V	
	V_{GE} (Volts)	I_C (Amps)
1		
2		
3		
4		
5		

S. No	V_{GE}= (Volts)	
	V_{CE} (V)	I_C(A)
1		
2		
3		
4		
5		

S. No	V_{GE}= (Volts)	
	V_{CE} (V)	I_C(A)
1		
2		
3		
4		
5		

MODELGRAPH:

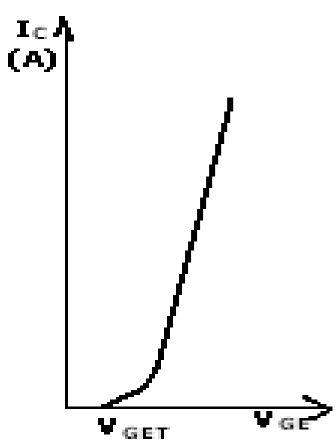


Fig – 1.3.2 Transfer CharacteristicsofIGBT

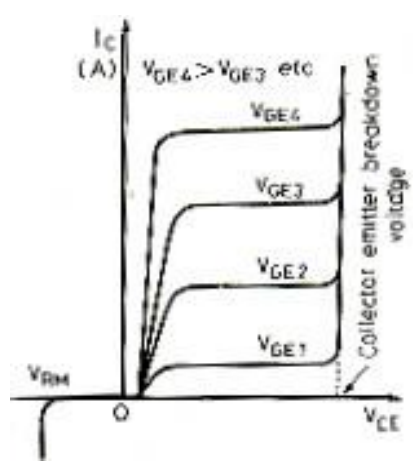


Fig - 1.3.3 Output Characteristics ofIGBT

RESULT:

POST LAB VIVAQUESTIONS:

1. What are merits ofIGBT?
2. What are demerits ofIGBT?
3. What are the applications ofIGBT's?
4. Why silicon used in all power semiconductor devices and why not?Germanium?
5. What is pinch offvoltage?
6. What is thresholdvoltage?

EXPERIMENT N0: 02 **DATE:**

GATE FIRING CIRCUITS FOR SCR'S

AIM:

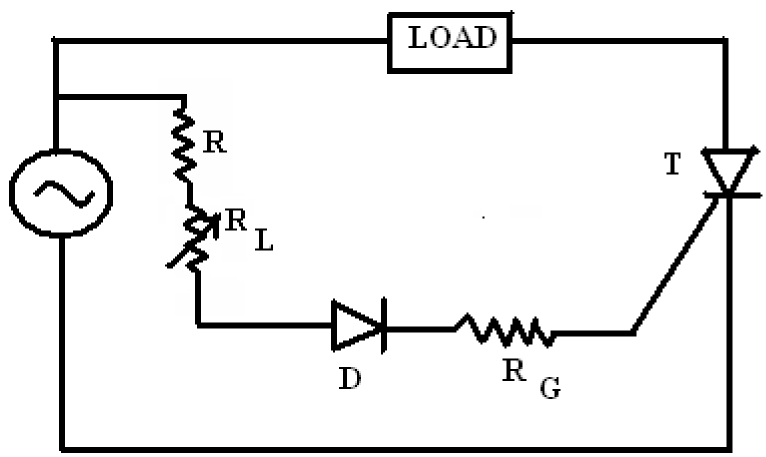
To study the operation of SCR using R & RC gate firing circuits.

APPARATUS:

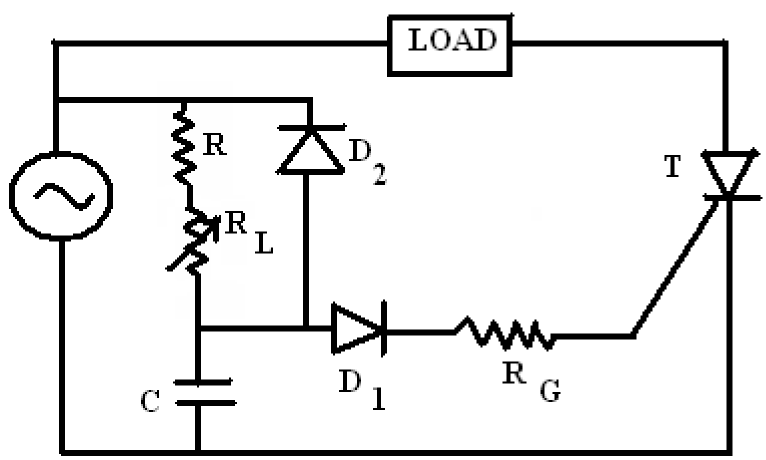
S.No.	Apparatus	Range	Quantity
1	R & RC Gate Firing Circuits Kit	---	1
2	CRO	(0-30)MHz	1
3	BNC Adaptors	---	1
4	R Load	47Ω/25W	1
5	Patch Cords	---	Some

Circuit Diagrams:

(a)R Firing Circuit:



(b)RC Firing Circuit:



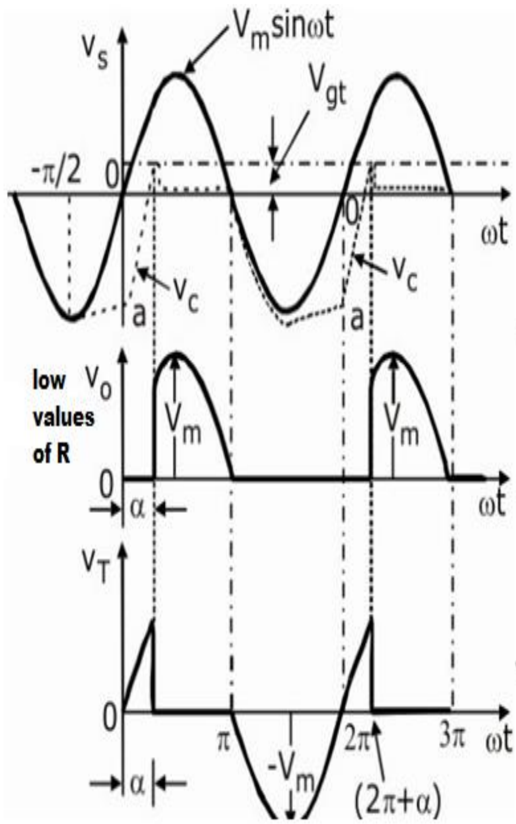
Precautions:

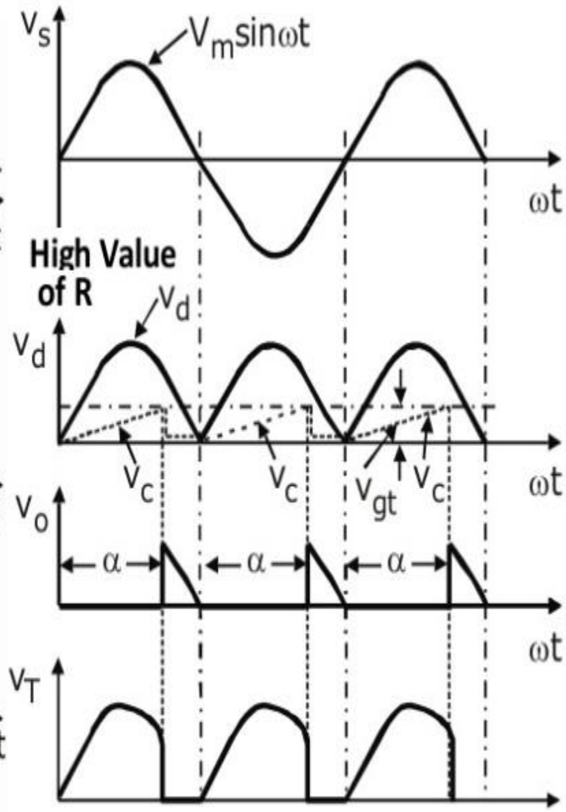
1) Connections should be right and tight.
2) Keep the potentiometers in the minimum firing angle position at the beginning of the experiment.
3) To reset the kit switch OFF all the main supply switches.

Procedure:

1) Connect the circuit as shown in circuit diagram.
2) Follow the precautions and switch ON the supply.
3) By varying the firing angle from 0^0 to 90^0, observe the input voltage, output voltage, gate pulses and voltage across the thyristors.
4) Compare the practical values of output voltage with theoretical values and tabulate them.
5) Plot the graphs for input voltage, output voltage, gate pulses and voltage across the thyristors for different values of firing angle.
6) Repeat the same procedure for RC firing by varying the firing angle from 0^0 to 180^0 approximately.
7) Follow the precautions and switch OFF the supply.

Model Waveforms:





R Firing Circuits Waveforms **RC Firing Circuits**

Calculations:

Result:

Viva Questions:

1.How many methods of gate controls are available for triggering SCRs?

2.What are methods of gate controls are available for triggering SCRs?

3. Why UJT is useful for pulse generation? What are the other devices available for the same purpose? Name them?

4. What is the purpose of using pulse transformer? What is its turns ratio? Will it influence the quality of gate signal?

5. Which is the best firing circuit suitable one for1-phase fully control bridge converter? Suggest the circuit with reasons?

6. What are the different Pulse triggering methods?

7. What are the turn-on methods of SCR ?

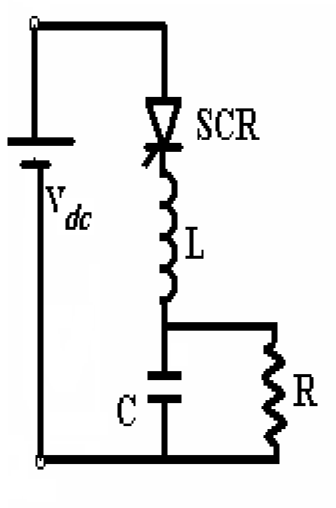
8. What are the turn-off methods of SCR ?

9. What are the different modes of operation of SCR ?

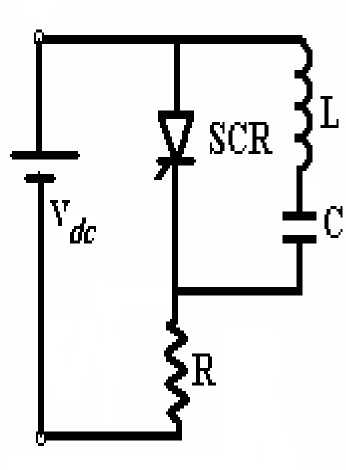
10. Name the different types Power Electronic Devices?

Circuit Diagrams:

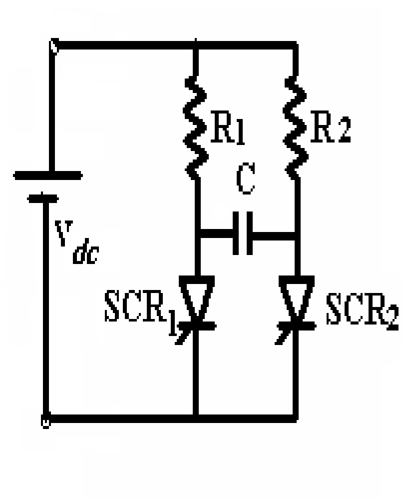
Class A:



Class B:



Class C:

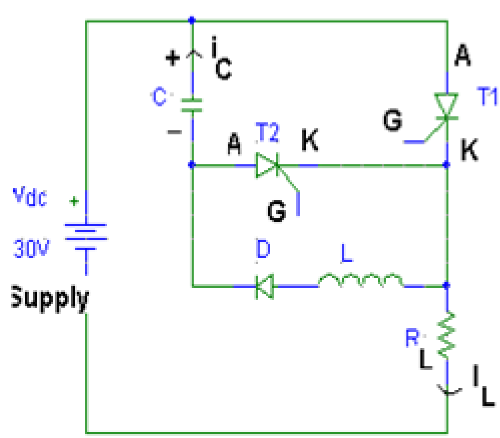


Specifications:

Commutation Inductance: L_1 = 250mH, L_2 = 500mH, L_3 = 1H

Commutation Capacitance: C_1 = 4.7mF, C_2 = 10mF

CLASS D



EXPERIMENT N0: 03 **DATE:**

FORCED COMMUTATION CIRCUITS (CLASS A, B, C & D)

AIM:

To study the different commutation circuits (Class A, Class B, Class C, Class D).

APPARATUS:

S.No.	Apparatus	Range	Quantity
1	Forced Commutation Study Kit	---	1
2	Rheostat	50Ω/2A(WW)	2
3	CRO	(0-30)MHz	1
4	BNC Adaptors	---	1
5	Patch Cords	---	Required some

PRECAUTIONS:

1) Connections should be right and tight.
2) Keep the rheostats in maximum resistance position.
3) Keep the potentiometers in the minimum frequency & minimum duty cycle position at the beginning of the experiment.
4) For Class A and Class B commutation, duty cycle is of no use.
5) To reset the kit switch OFF all the main supply switches.

PROCEDURE:

For Class A Commutation:

1) Connect the circuit as shown in circuit diagram.
2) Follow the precautions switch ON the DC supply.
3) By varying the frequency potentiometer observe the voltage waveforms across the load.
4) Repeat the same for L, C & R.
5) Follow the precautions and switch OFF the supply.

For Class B Commutation:

1) Connect the circuit as shown in circuit diagram.
2) Follow the precautions switch ON the DC supply.
3) By varying the frequency potentiometer observe the voltage waveforms across the load.
4) Repeat the same for L, C & R.
5) Follow the precautions and switch OFF the supply.

For Class C Commutation:

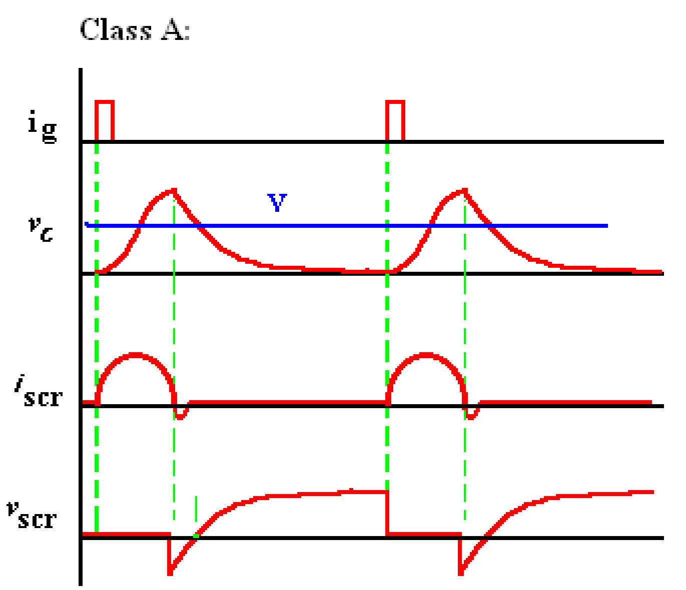
1) Connect the circuit as shown in circuit diagram.
2) Follow the precautions switch ON the DC supply.
3) By varying the frequency and duty cycle potentiometers observe the voltage waveforms across the R_1, R_2, C.
4) Repeat the same for different values of C.
5) Follow the precautions and switch OFF the supply.

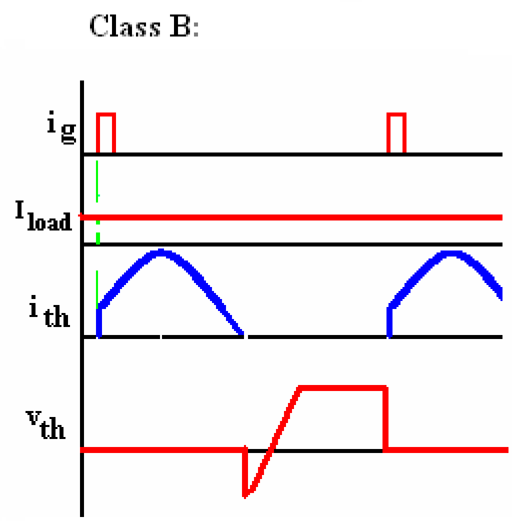
For Class D Commutation:

1). This is again the same set-up as expt.4

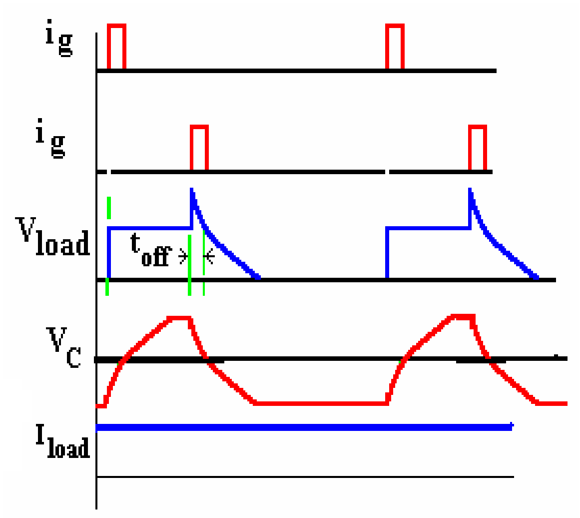
2). The circuit then has chopper configuration and has been used to control DC motor of a battery powered vehicle.

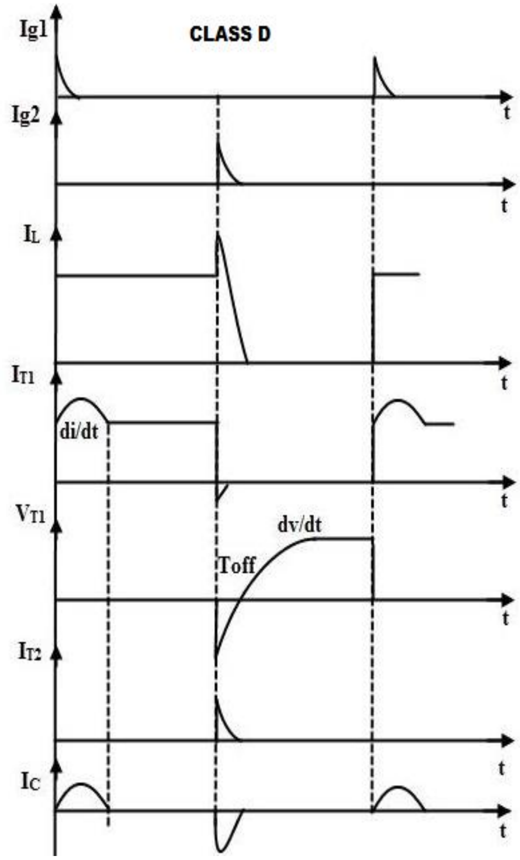
Model Waveforms:





Class C:





Calculations:

Result:

Viva Questions:

1 .What is the difference between Forced and natural commutation?

2. What is principle of self commutation?

3. What are the differences between Voltage and current commutation?

4. What is the purpose of commutation circuit?

5. Why should be the reverse bias time greater than the turn-off time of an SCR?
6. How the voltage of commutation capacitor is reversed in a commutation circuit ?

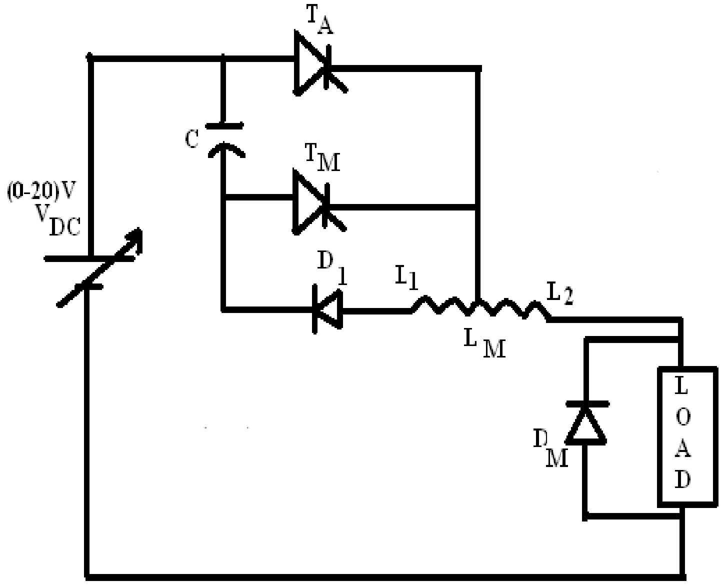
7. What is load commutation?

8. What is voltage commutation?

9. What is current commutation?

10. What is complementary commutation?

Circuit Diagram:



EXPERIMENT N0: 04 **DATE:**

D.C JONES CHOPPER WITH R & RL LOADS

AIM:

To study SCR based D.C Jones chopper Circuit.

APPARATUS:

S.No.	Apparatus	Range	Quantity
1	D.C Jones Chopper Firing Unit	---	1
2	D.C Jones Chopper Kit	---	1
3	Rheostat	50Ω/2A(WW)	1
4	Inductor	(0-150)mH/2A	1
5	CRO	(0-30)MHz	1
6	Regulated Power Supply	(0-30)V/2A	1
7	BNC Adaptors	---	1
8	Patch Cords	---	Some

PRECAUTIONS:

1) Connections should be right and tight.
2) Keep the rheostat in maximum resistance position.
3) Keep the potentiometers in the minimum position at the beginning of the experiment.
4) To reset the kit switch OFF all the main supply switches.

PROCEDURE:

For R Load:

1) Connect the circuit as shown in circuit diagram.
2) By observing the precautions switch ON the supply.
3) By varying the duty cycle and frequency (by keeping any one of them as constant), observe the input voltage, output voltage and voltage across the thyristors.
4) Compare the practical values of output voltage with theoretical values and tabulate them.
5) Plot the graphs for input voltage, output voltage and voltage across the thyristors.
6) Observing the precautions switch OFF the supply.

For RL Load:

1) Connect a 150mH/2A inductor in series with R Load and repeat the steps from 2 to 6.

TABULARCOLUMN:

Constant Duty Cycle

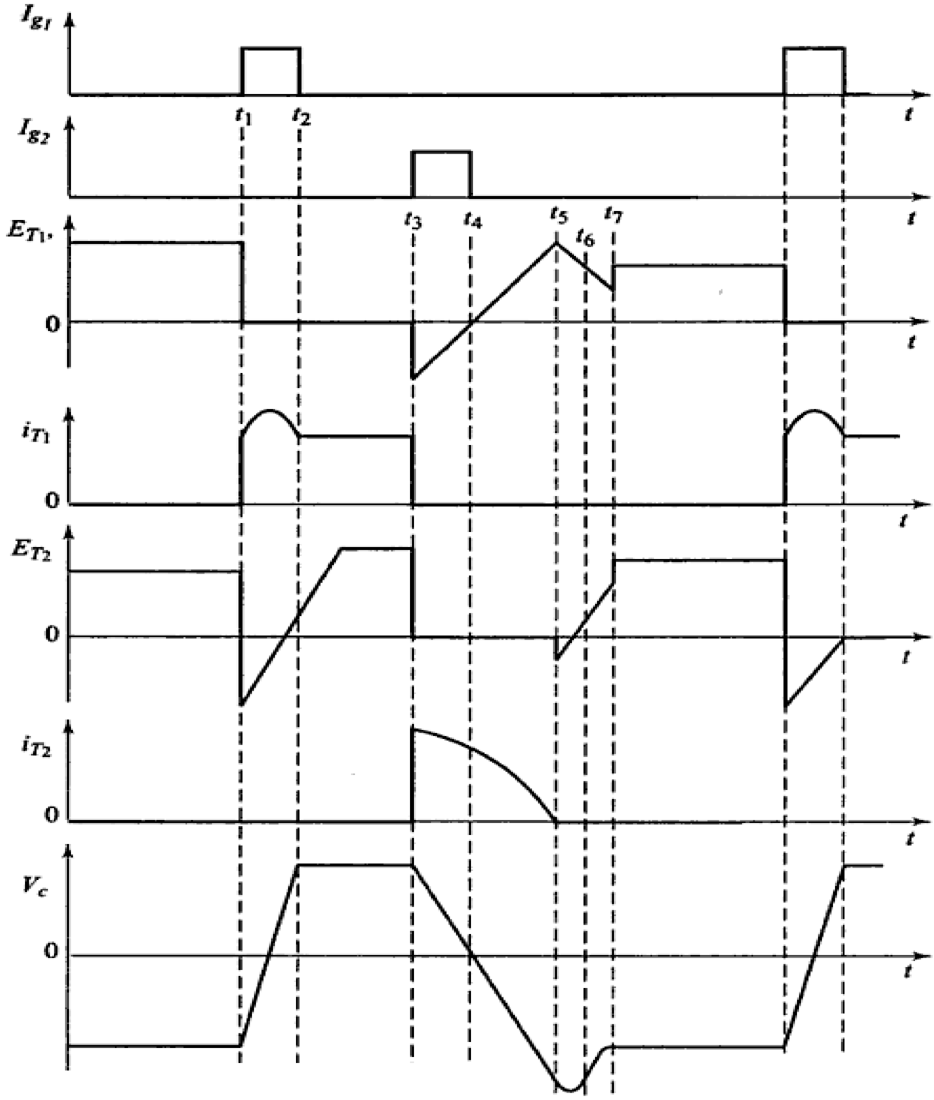
Duty Cycle: 50%, V_{IN}=10 to 15 V

S. No	Frequency(Hz)	V0(Volts)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Constant Frequency, Frequency Control

S. No	T_{ON}(sec)	T_{OFF}(sec)	Duty Cycle (%)	V_O (Volts)
1				
2				
3				
4				
5				
6				
7				
8				
9				

Model Waveforms:

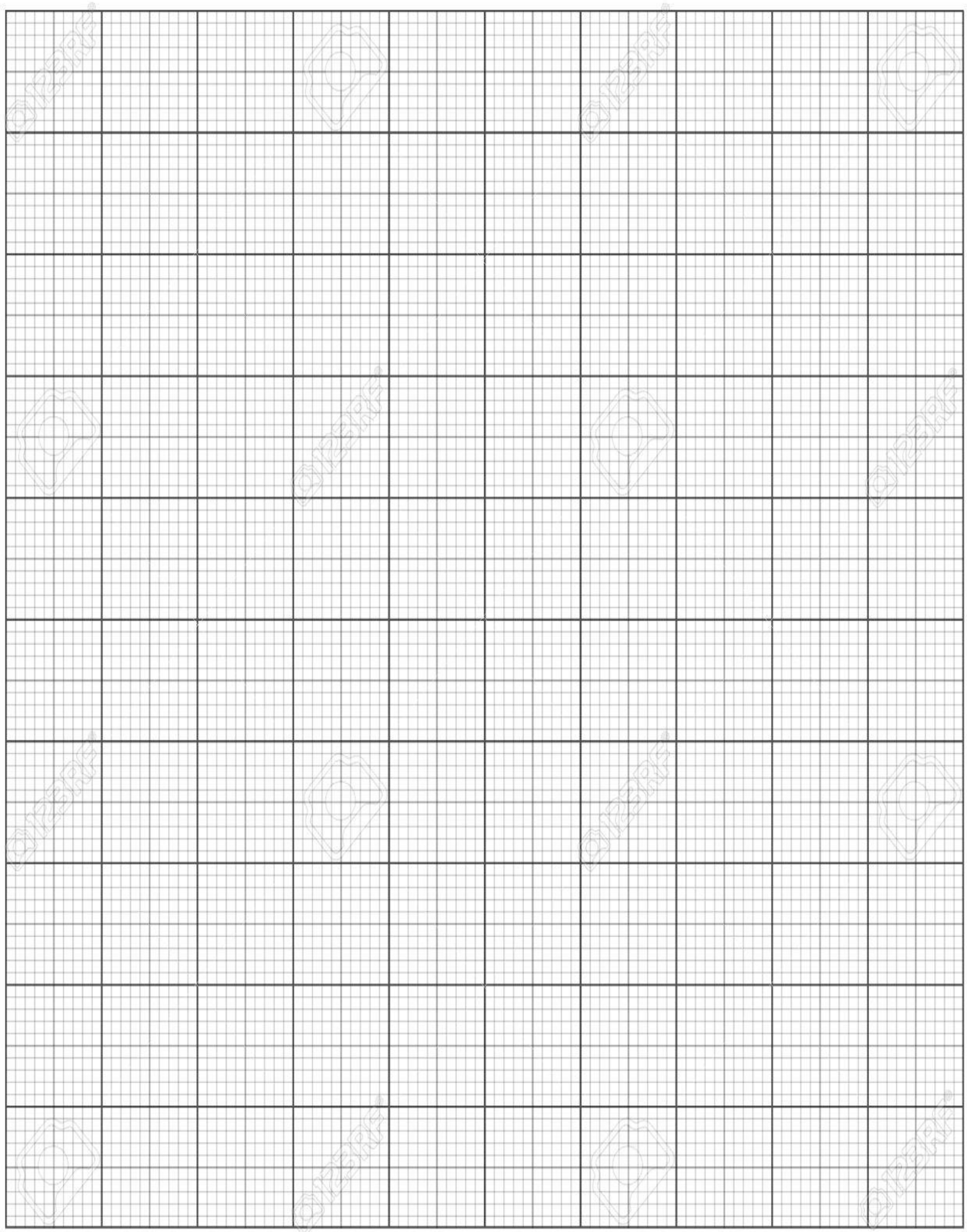


Calculations:

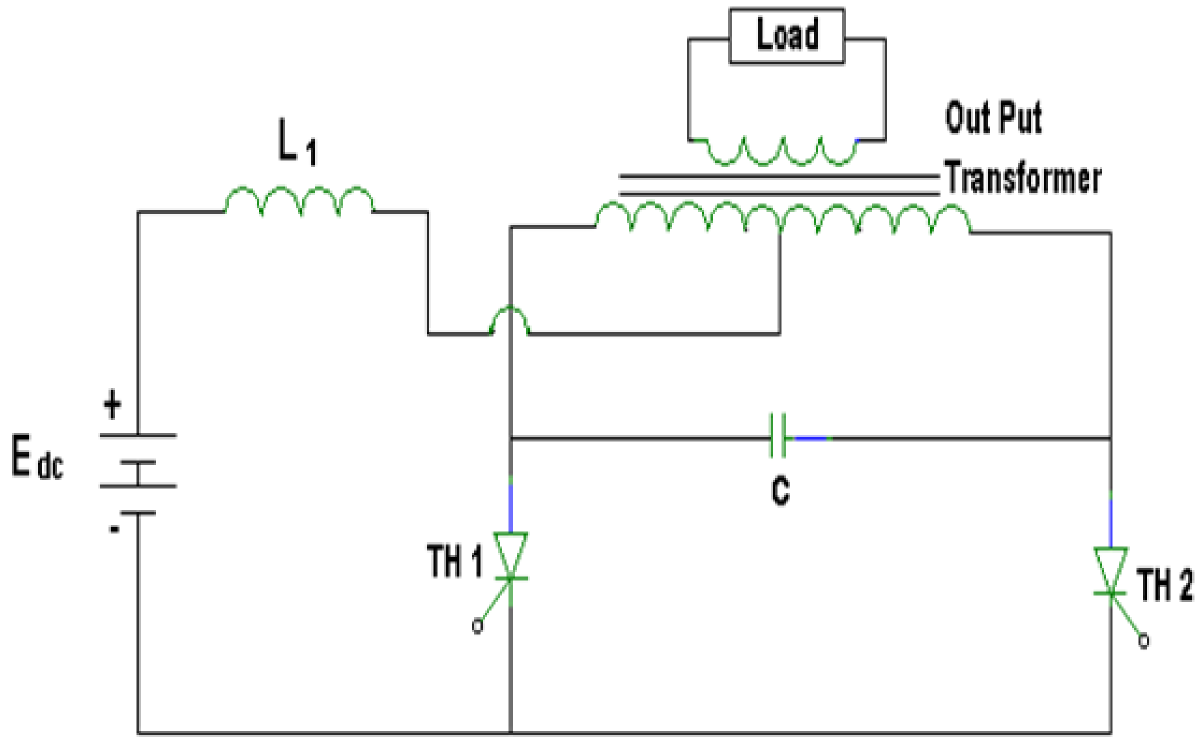
Result:

Viva Questions:

1. What is a DC Chopper?
2. What is frequency modulation control of a chopper?
3. What is pulse-width modulation control of a chopper?
4. What is the purpose of diode in the commutation circuit of Jones Chopper?
5. What are the applications of a chopper?
6. What is the purpose of a commutation circuit in a chopper?
7. What is difference between the circuit turn off and turn-off time of a thyristor?
8. Why does a commutation capacitor gets over charged?
9. What are the advantages and disadvantages of variable frequency chopper?
10. What is the type of commutation used in Jones Chopper?
11. What is the principle of operation of step down and step up chopper?



CIRCUIT DIAGRAM:



EXPERIMENT N0: 05 **DATE:**

SINGLE PHASE PARALLEL INVERTER

AIM:

To study module and waveforms of a 1- ϕ parallel inverter power circuit with R and RL loads.

APPARATUS REQUIRED:

1. 1- ϕ parallel inverter firing circuit and power circuit unit
2. Inductor : 300mH, 2A.
3. Capacitor : 6.8µf, 100V.
4. Output transformer : Primary- 30V-25V-0-25V-30V Secondary- 0-30V2A
5. Loading Rheostat : 50 Ohms 2 A.
6. Loading Inductor : 50 mH, 2A
7. 20 MHz dual trace oscilloscope with 1:10 BNC probes

SPECIFICATIONS:

1. Input : 230V, 50Hz, 1- ϕ AC supply
2. Load : Rand RL
3. Thyristors : 10 A, 600V.
4. Diodes : 10A, 600V.
5. Capacitor : 6.8µf, 100V.
6. Inductor : 300 µH, 2A.
7. Fuses : 2A Glass fuse

PRECAUTIONS:

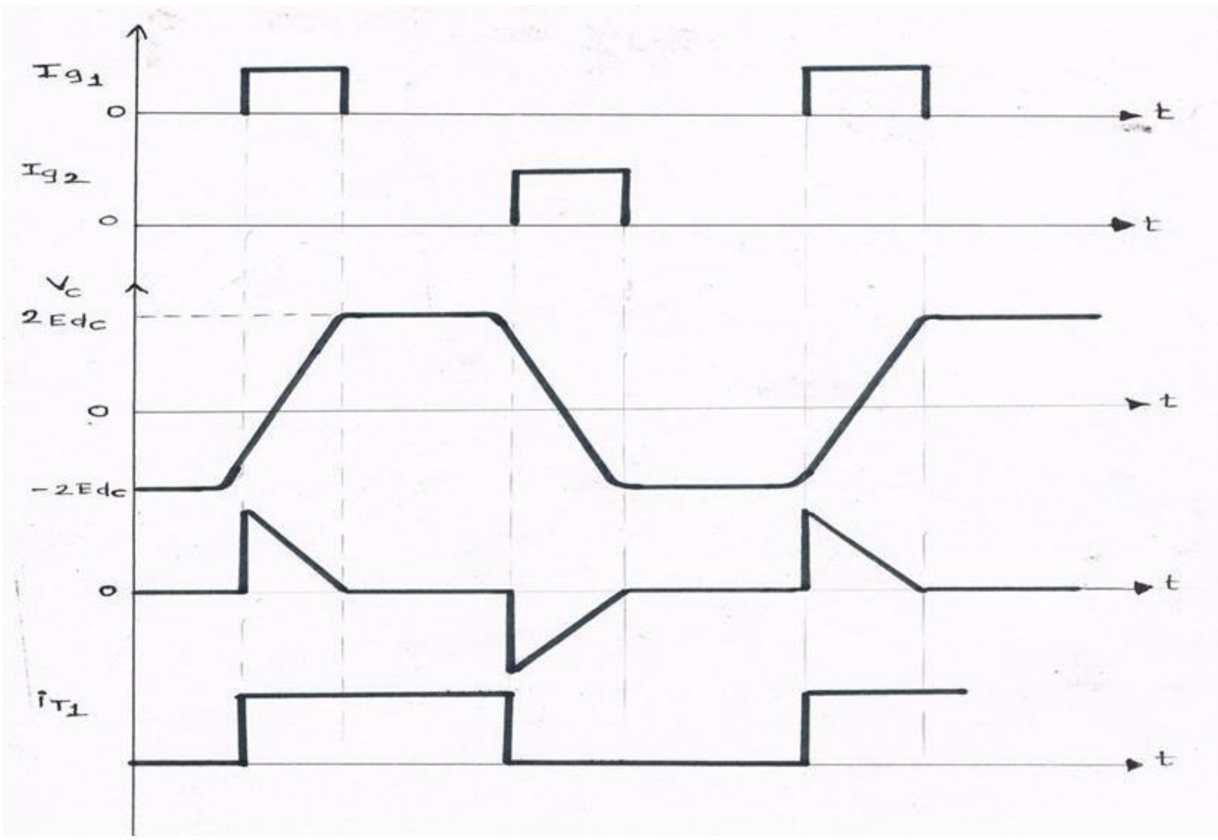
1. Make sure all the connecting links are tightly fixed.
2. Ensure all the controlling knobs in fully counter clock wise position before starting experiment.
3. Handle everything with care.
4. Make sure the firing pulses are proper before connecting to the power circuit.
5. Make sure to connect firing pulses from the firing circuit to their respective SCRs in the power circuit.
6. Ensure switch OFF the input supply first and then trigger pulses to avoid short circuit.

PROCEDURE:

1. Switch ON the main supply to the firing circuit. Observe the trigger outputs in the firing circuit by varying frequency potentiometer and by operating ON/OFF switch. Make sure the firing pulses are proper before connecting to the power circuit.
2. Make the connections as per the circuit diagram.
3. Connect the firing pulses from the firing circuit to the respective SCRs in the power circuit.
4. Connect the DC input from 30V, 2A regulated power supply.
5. Switch ON the DC supply, set input voltage to 15 V and switch ON the trigger pulses by Operating ON/OFF/ switch in the firing circuit.
6. Observe the voltage waveform across load using oscilloscope.
7. Vary the frequency, load and observe the voltage waveform across load with and without freewheeling diode.
8. Draw the waveforms in the graph at different frequencies.

9. To switch OFF the inverter, switch OFF the input supply first and then trigger pulses.
10. Since the parallel inverter works on forced commutation, there is a chance of failure. If the commutation fails, switch OFF the DC supply and then trigger outputs. Check the connections and try again.

MODEL WAVE FORMS:

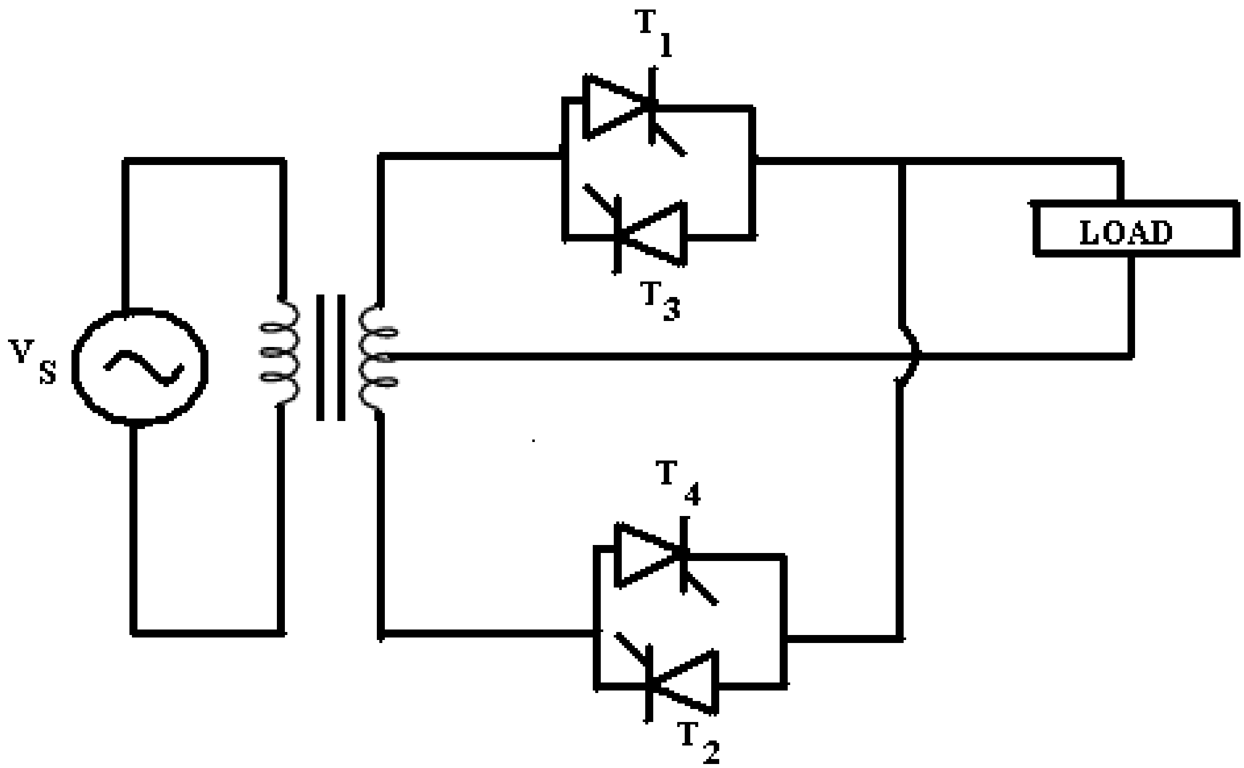


RESULT:

VIVA QUESTIONS:

1. What is parallel inverter? Why is it called so?
2. What is the purpose of capacitor in the parallel inverter?
3. What is the purpose of transformer in the parallel inverter?
4. Is the parallel inverter naturally commutated or force commutated?
5. What are the advantages of parallel resonant inverters?

Circuit Diagram:



EXPERIMENT N0: 06 **DATE:**

SINGLE PHASE CYCLOCONVERTER WITH R & RL LOADS

AIM:

To study the operation of Single Phase Cycloconverter using R Load for different firing angles and frequency divisions.

APPARATUS:

S.No.	Apparatus	Range	Quantity
1	Single Phase Cycloconverter Kit	---	1
2	Single Phase Cycloconverter Firing Unit	---	1
3	Single Phase Isolation Transformer (Center Tap Type)	Primary: 230V, Secondary: (0-30-60-115-230)V	1
4	Rheostat	150Ω/5A(WW)	1
5	CRO	(0-30)MHz	1
6	BNC Adaptors	---	1
7	Patch Cords	---	Required some

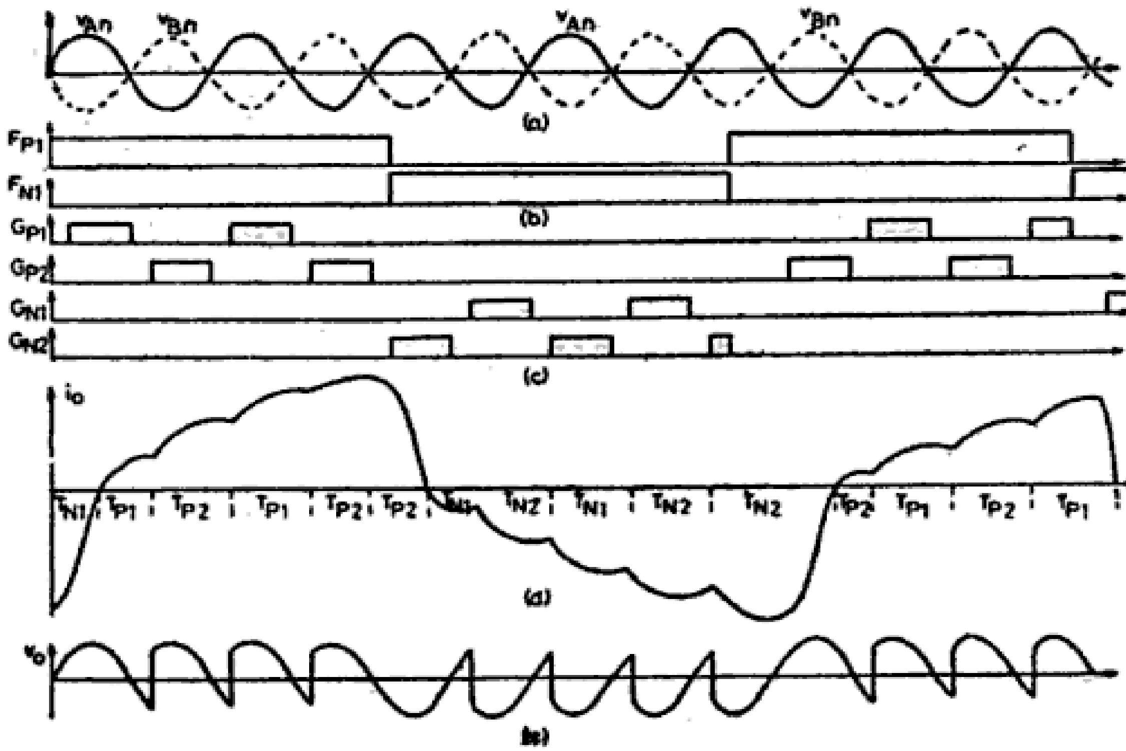
PRECAUTIONS:

1) Connections should be right and tight.
2) Keep the potentiometers in the minimum firing angle position at the beginning of the experiment.
3) Keep the rheostat in maximum resistance position.
4) To reset the kit switch OFF all the main supply switches.

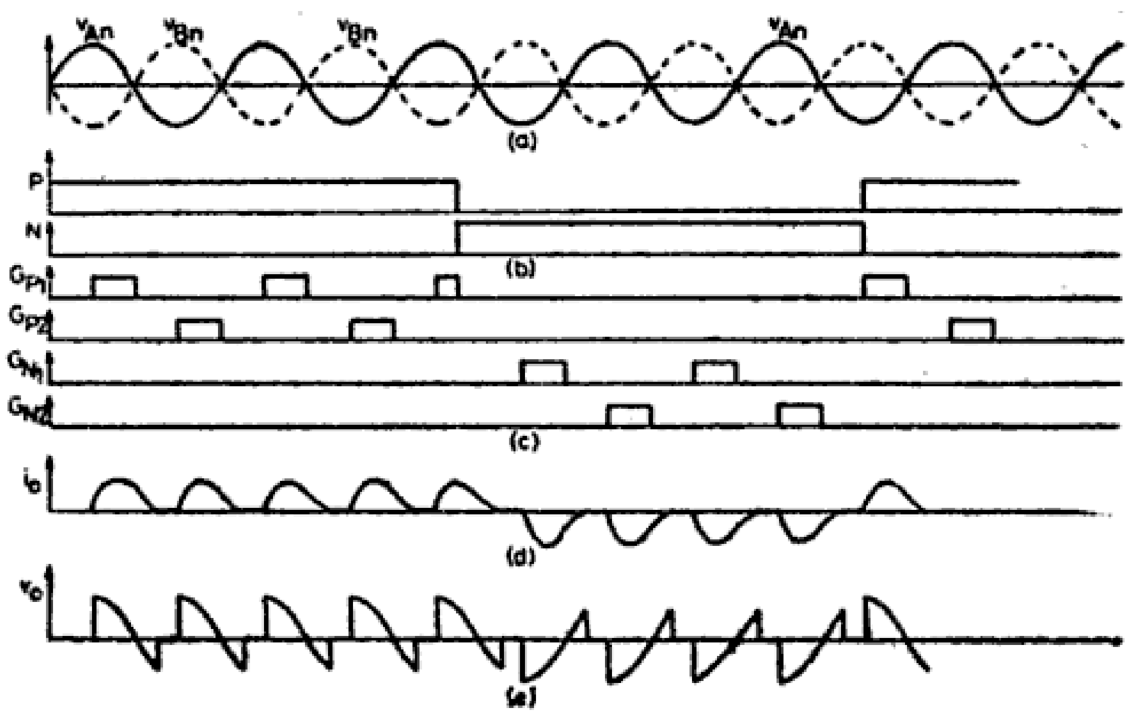
PROCEDURE:

1) Connect the circuit as shown in circuit diagram.
2) Connect 30V -0 – 30V tapping from the center tapped transformer.
3) Follow the precautions and switch ON the supply to the firing unit and kit.
4) Switch ON the MCBswitches ON the trigger outputs. Set the frequency division to 2 and vary the firing angles and observe the waveforms.
5) Compare the practical values of output voltage with theoretical values and tabulate them.
6) Plot the graphs for input voltage, output voltage, gate pulses and voltage across the thyristors for different values of firing angle.
7) Repeat the same procedure for RL load.
8) Follow the precautions and switch OFF the supply.

Model Waveforms:



Waveforms of 1-Φ cycloconverter with continuous load current; (a) Supply Voltage, (b) Blanking Signals, (c) Trigger pulses to thyristors, (d) Load Current, (e) Load Voltage.



Waveforms of 1-Φ cycloconverter with discontinuous load current; (a) Supply Voltage, (b) Blanking Signals, (c) Trigger pulses to thyristors, (d) Load Current, (e) Load Voltage.

Tabular Column:

S.No	V_{in} (Volts)	Frequency Division	Firing Angle	V_o volts	I_o Amps.
1					
2					
3					
4					

Calculations:

Result:

Viva Questions:

1.Explain working principle of cyclo-converter?\

2.What type of commutation is used in cyclo-converter?

3.What happens to the output if the frequency of operation is beyond suggested limit?

4. What is the major difference between an AC voltage controller and a cyclo- Converter?

5. What is the step up cycloconverter?

6.What is the step down cycloconverter?

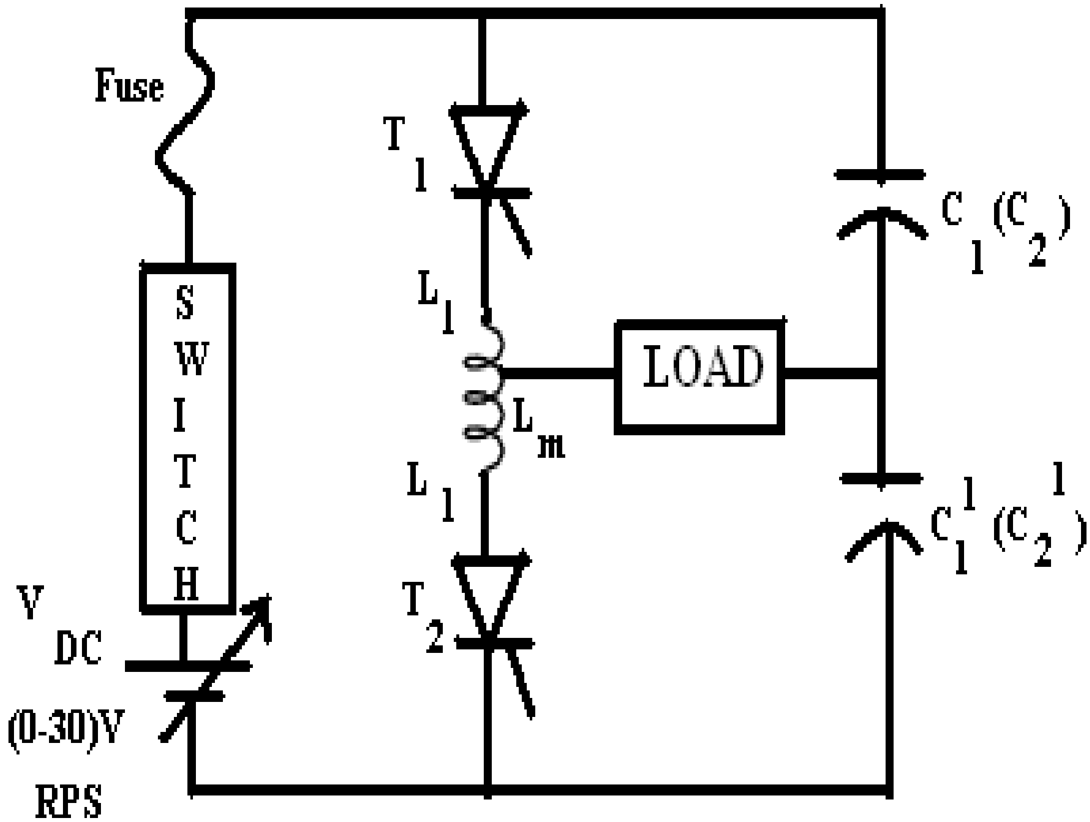
7. What is the effect on operation below one third frequency?

8. What are the applications of cycloconverter?

9. What is the frequency range of operation of cycloconverter?

10. What is the variation of firing angle in cycloconverter operation?

Circuit Diagram:



SPECIFICATIONS:

$L_2 – L_1 – L_m – L_1 – L_2$: 10mH – 5mH – 0 – 5mH – 10mH / 2A.

C_1& C_1^1 : 6.8 µ F/ 100 V

C_2& C_2^1 : 10 µ F/ 100 V

EXPERIMENT N0:07 **DATE:**

SINGLE PHASE SERIES INVERTER WITH R & RL LOADS

AIM:

To study the operation of Single Phase Series Inverter using R Load.

APPARATUS:

S.NO.	APPARATUS	RANGE	QUANTITY
1	Single Phase Series Inverter Kit	---	1
2	Single Phase Series Inverter Firing Unit	---	1
3	R.P.S	0-30 V / 2A	1
4	Rheostat	50Ω/2A(WW)	1
5	CRO	(0-30)MHz	1
6	BNC Adaptors	---	1
7	Patch Cords	---	Required some

PRECAUTIONS:

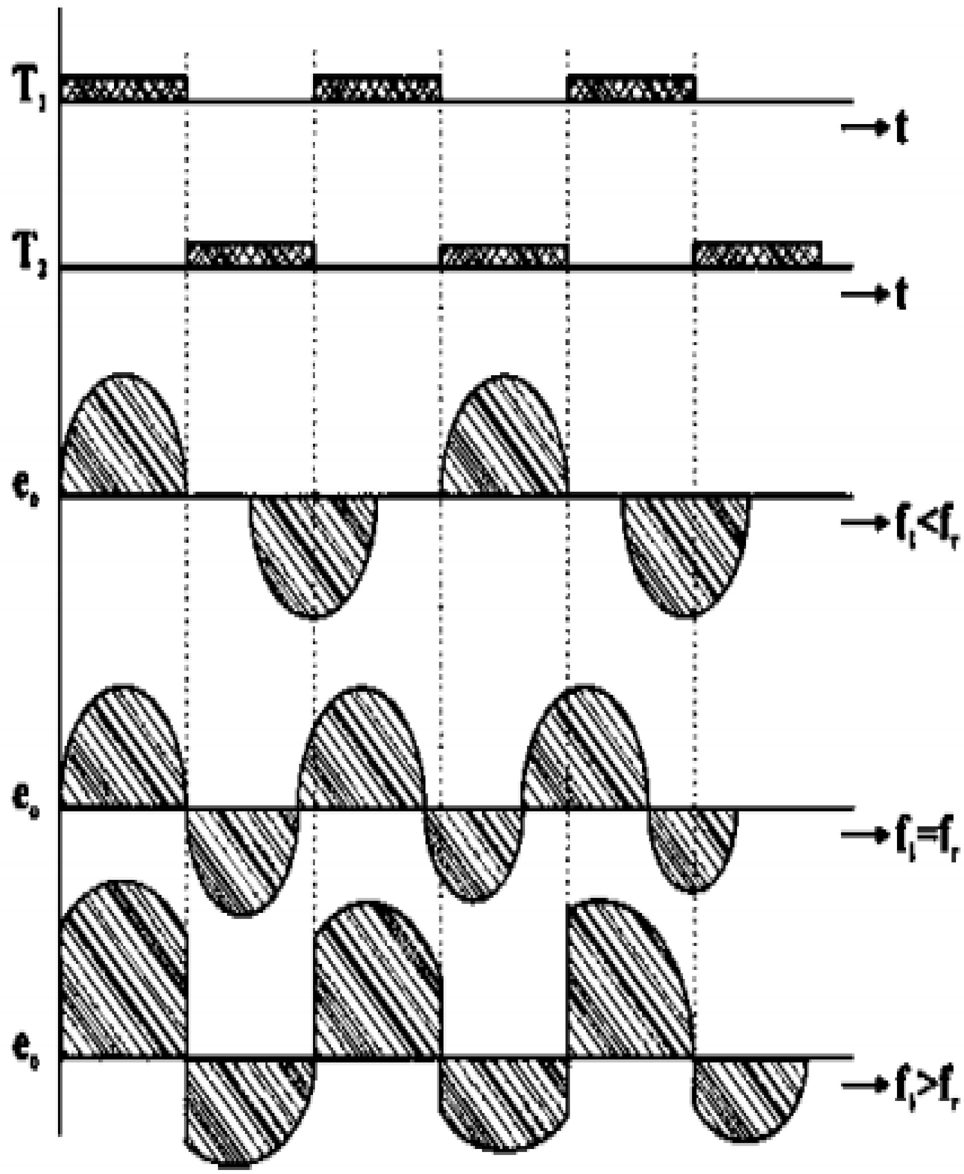
1) Connections should be right and tight.
2) To reset the kit switch OFF all the main supply switches.
3) To switch OFF the inverter, switch OFF supply first and then trigger pulses.

PROCEDURE:

1) Connect the circuit as shown in circuit diagram.
2) Switch ON the DC power supply And apply trigger pulses to the SCR's.
3) Vary the frequency and observe the waveforms.
4) If the inverter frequency is above the resonant frequency of the power circuit commutation will fail.
5) Repeat the same with different values of L, C and load.
6) Observe the waveforms with and without fly wheel diodes.
7) Follow the precautions and switch OFF the supply.

Calculations:

Model Graph:

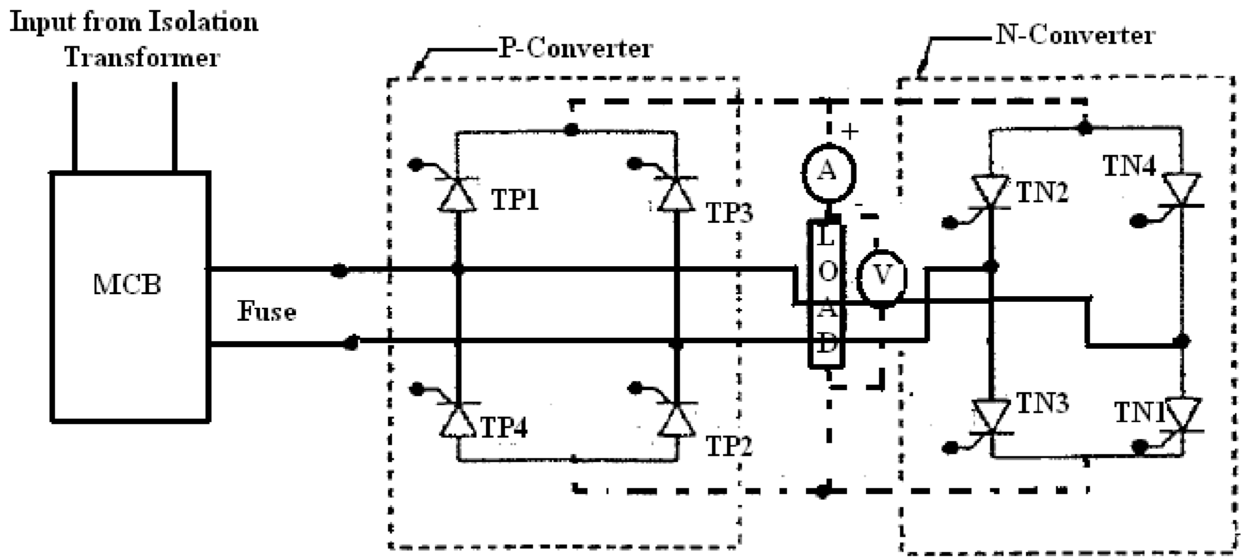


Result:

Viva Questions:

1. What is an inverter?
2. What is the basic principle of Series inverter?
3. What type of commutation is used in Series Inverter?
4. Why Inverter output is not pure sinusoidal?
5. Applications of series inverter are?
6. What type of switches can be used in the series inverter circuit?
7. Can a battery be connected in place of load in the series inverter circuit?
8. How the switches of series inverter must be operated?
9. What is/are inverter and rectifier?
10. Can this inverter be used as rectifier?

CIRCUIT DIAGRAM:



EXPERIMENT N0: 08 **DATE:**

SINGLE PHASE DUAL CONVERTER WITH R & RL LOADS

AIM:

To study Single Phase Dual Converter.

APPARATUS:

S.No.	Apparatus	Range	Quantity
1	Single Phase Dual Converter Firing Unit (Microcontroller Based)	---	1
2	Single Phase Dual Converter Kit	---	1
3	Single Phase Isolation Transformer	Primary: 230V, Secondary: (0-30-60-115-230)V	1
4	Rheostat	150Ω/5A(WW)	1
5	CRO	(0-30)MHz	1
6	BNC Adaptors	---	1
7	Patch Cords	---	Some

PRECAUTIONS:

1) Make fresh connections before you make a new experiment.
2) Preferably work at low voltages (20-30V) for every new connection after careful verification it can be raised to the maximum ratings. (This is to reduce damages due to wrong connections and high starting current problems)

PROCEDURE:

1) Switch ON the single phase dual converter firing converter circuit. Observe the test points.
2) Observe trigger outputs both in P and N-converter by varying firing angle in non-circulatory mode.
3) Make sure that all the pulses are proper before connecting to power circuit to conduct the experiment.
4) Check all the SCRs in the power circuit. This can be done by checking the resistance between gate and cathode and also between anode and cathode using a multi meter putting it in the diode range.
5) If the SCRs are good, it shows some resistance value of the order of 20Ω to 200Ω between gate and cathode. And very high resistance value of the few mega ohms between anode and cathode. If the resistance between gate / cathode is zero or very high means the device is faulty. If the resistance between anode / cathode is zero means the device is faulty.
6) Make sure that all the SCRs are good before connecting the firing pulses from the firing circuit.
7) Make the connections in the power circuit as shown in the circuit diagram for non circulatory current mode.
8) Connect firing pulses from the firing circuit to the respective SCR's gate / cathode terminals in the power circuit.

9) Connect input AC supply to the power circuit through an isolation transformer for safety for measurement. Initially adjust the input voltage for 30V.
10) Connect a rheostat of suitable value (150Ω/5A) between output terminals. Connect the ammeter and voltmeter as shown.
11) Switch ON the firing circuit. Select NCC mode. Switch ON the MCB.
12) Vary the firing angle by dec key and press ON / OFF key to ON and observe the voltage waveforms across load and the devices.
13) Note down the voltmeter and ammeter readings for different values of firing angle. Note down the reading in the tabular column.

TABULAR COLUMNS:

S. No.	Input Voltage V_{in}	Firing Angle	Output Voltage V_o	Output Current I_o
1				
2				
3				
4				

CALCULATIONS:

RESULT:

Viva Questions:

1. What is Dual converter?
2. Explain the difference between the circulating and non-circulating modes of operations?
3. What are the disadvantages of non-circulating modes of operation?
4. What is the disadvantage of circulating modes of operation?
5. How the dual converter is operated in four quadrants?
6. Can we interchange the role of the P & N type converters?
7. What is the application of dual converter?
8. How the firing angles of converters must vary in non circulating mode operation?
9. Can be a single full converter used to get four quadrant operation?
10. Can we use two semi converters to get similar operation as that of dual converter?

EXPERIMENTT N0 **DATE:**

1-PHASE FULLY CONTROLLED BRIDGE CONVERTER

AIM:

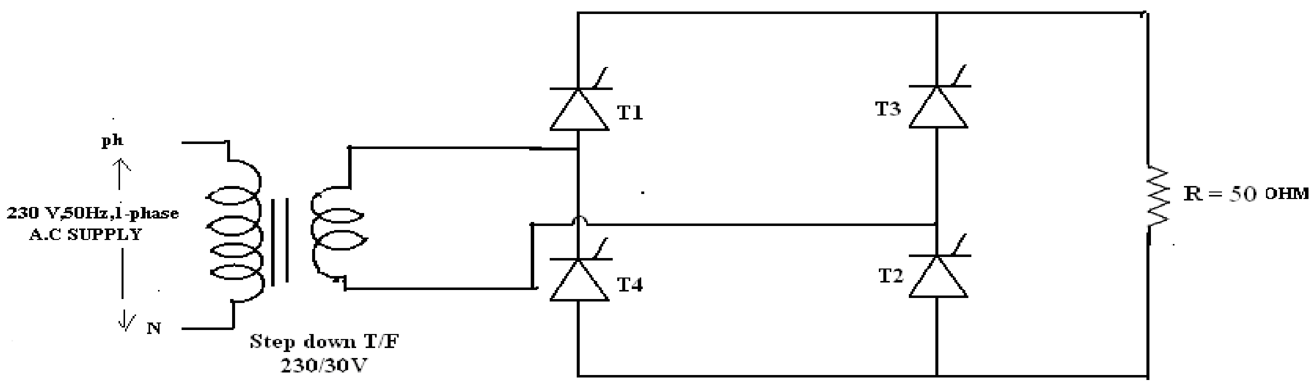
To Study the performance of a Single phase fully controlled bridge converter

APPARATUS:

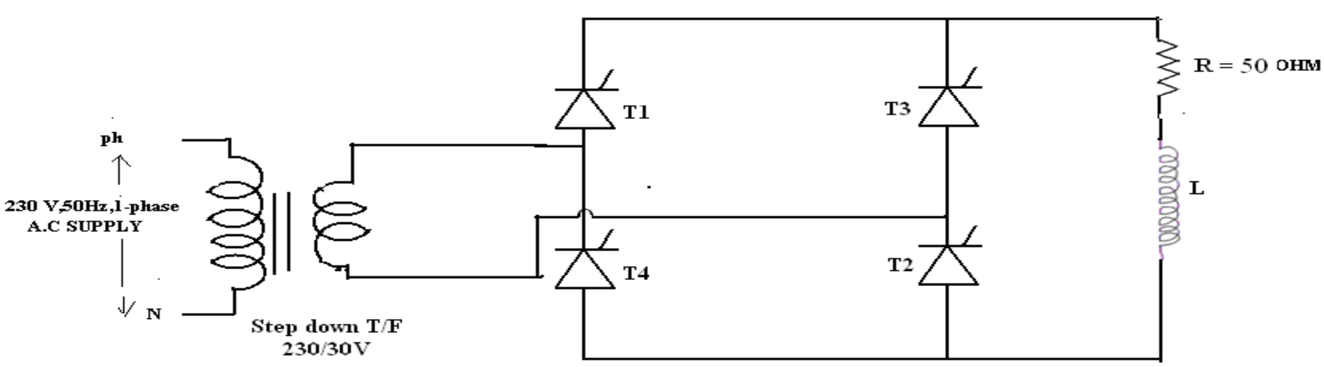
1. Thyristors-TYN612-4 no
2. Single phase fully controlled bridge firing kit
3. Rheostat-50 ohms
4. Loading inductor 10mH, 25mH&50mH
5. CRO
6. Connecting wires

CIRCUIT DIAGRAM:

SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER WITH R-LOAD

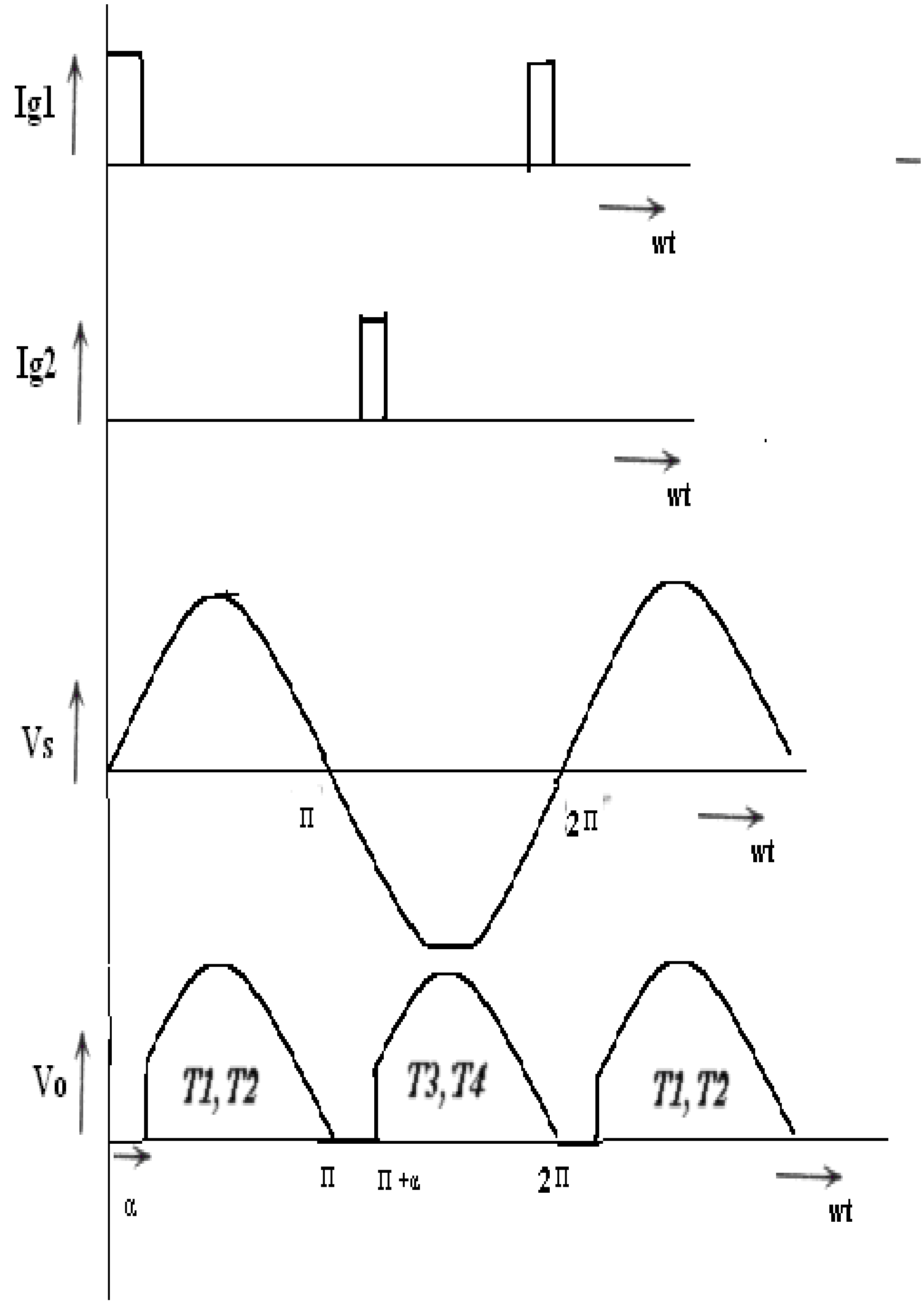


SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER WITH RL-LOAD

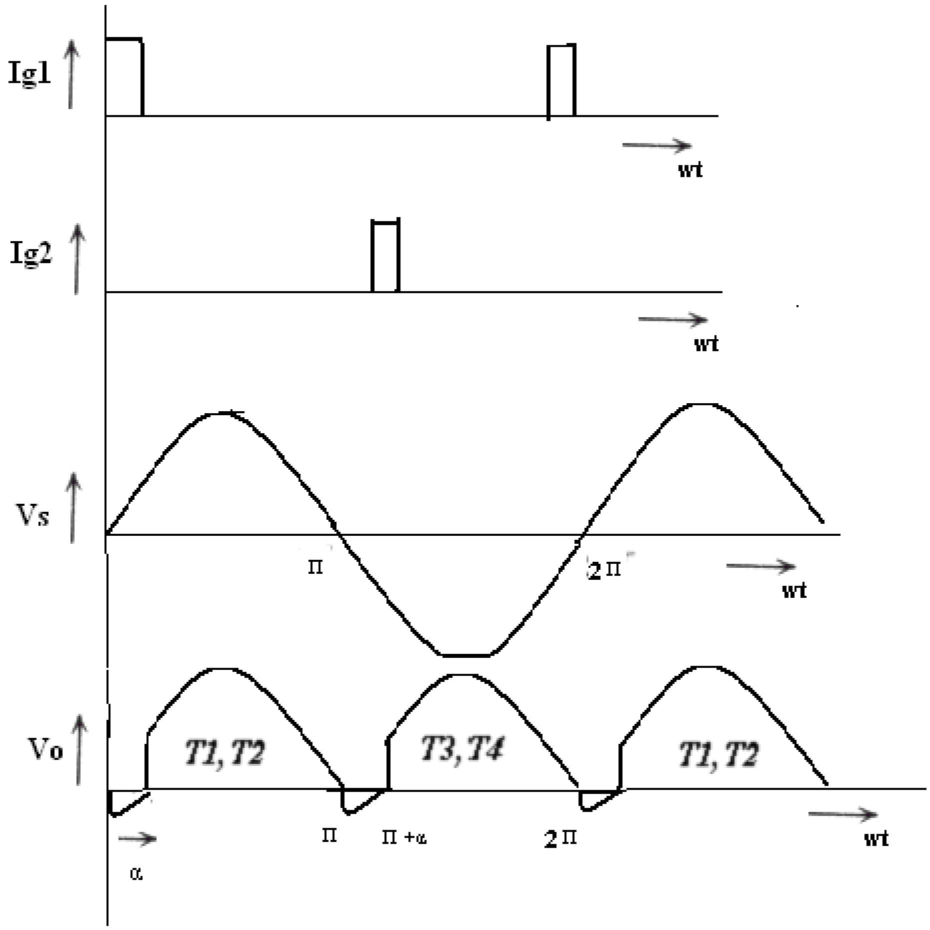


WAVE FORMS:

SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER WITH R-LOAD



SINGLE PHASE FULLY CONTROLLED BRIDGE CONVERTER WITH RL-LOAD



TABULAR COLUMN :

V_m = _______

S.NO	FIRING ANGLE (Π)	V_{avg} (Practical)	V_{avg} (Theoreticall)
1	**0**		
2	**30**		
3	**60**		
4	**90**		
5	**150**		

THEORETICAL CALCULATIONS:

$$V_{d.c} = V_{avg} = \frac{1}{T}\int_{\alpha}^{\pi} V_m Sin\,\omega t.d\omega t \quad \text{for R-Load}$$

$$= \frac{V_m}{\pi}(1 + Cos\alpha)$$

$$V_{d.c} = V_{avg} = \frac{1}{T}\int_{\alpha}^{\pi+\alpha} V_m Sin\,\omega t.d\omega t \quad \text{for RL-Load}$$

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

PRECAUTIONS:

1. Check the working condition of all the SCR's before connecting them in the circuit.
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 :

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. Wave forms across the load are observed in CRO values are noted down and tabulated for different firing angles.
5. The output wave forms are plotted on the graph sheet.
6. Similarly RL-load steps of the above are repeated.
7. Wave forms are observed in CRO

RESULT :

QUESTIONS FOR VIVA-VOCE :

1. How many quadrants does a Full controlled rectifier works?
2. What is meant by Line commutation?
3. How the thyristors get commutated?
4. When a full controlled rectifier work as inverter?
5. What is the change observed in wave forms for R-load & RL-load?

EXPERIMENT:10 **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 module			
3	Patch chords and probes			
4	Three phase transformer			
5	Rheostat			
6	DC Voltmeter			
7	DC Ammeter			

CIRCUIT DIAGRAM:

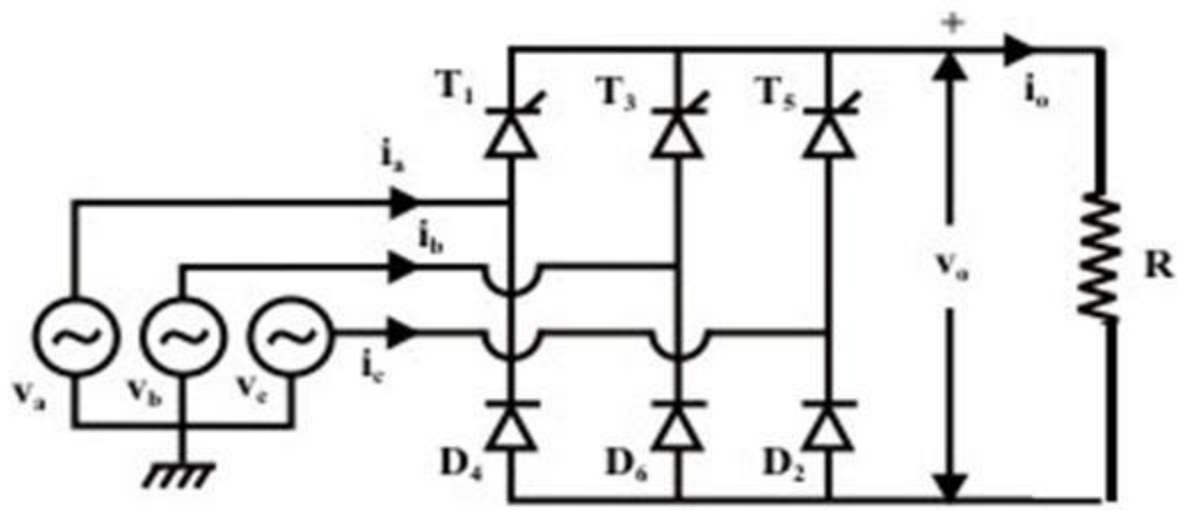


Fig - Half Controlled bridge converter with R load

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 and IRS switch and trigger output ON switch.
5. Connect CRO probes and observe waveforms in CRO across load and device in three 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 DC voltmeter & Ammeter.

8. Tabulate all readings for various firing angles.
9. Calculate the output voltage and current by theoretically and compare with it practically obtained values.

TABULAR COLUMN:

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

MODEL CALCULATIONS:

$V_o = 3\ V_{ml}*(1+\cos\alpha)/2\pi$
$I_o = 3\ V_{ml}*(1+\cos\alpha)/2\pi R$
α= firing angle
V_{ml} = line to line voltage

MODEL GRAPHS:

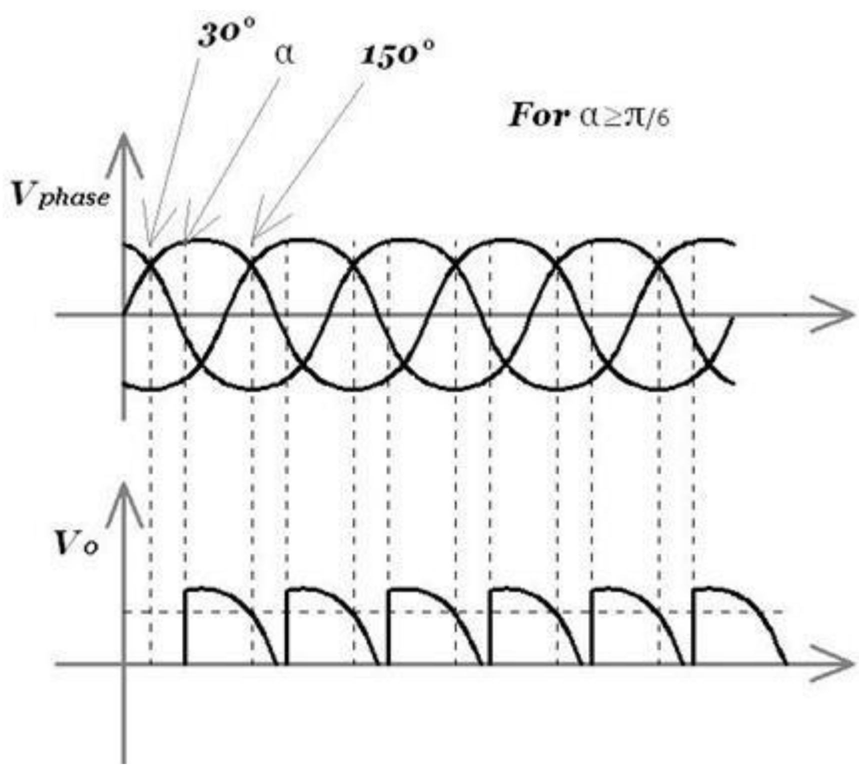


Fig – Input and output wave forms of a three phase half controlled bridge converter

RESULT:

LAB VIVA QUESTIONS

1. A converter which can operate in both 3 pulse and six pulse modes is?
2. What is the interval for SCRs triggering in three phase semi converter?
3. What is the interval for SCRs triggering in three phase full converter?
4. What is the function of freewheeling diode in three phase converters?
5. What are the advantages of three phase half controlled converters?
6. Which quadrant operation is possible with three phase half controlled converter?

EXPERIMENT - 11 **DATE:**

OPERATION OF MOSFET BASED CHOPPER

AIM:

To study the operation of chopper with MOSFET

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	MOSFET based chopper power circuit and firing circuit			
2	CRO with deferential module			
3	Patch chords and probes			
4	Regulated Power Supply			
5	Variable Rheostat			
7	DC Voltmeter			
8	DC Ammeter			

CIRCUIT DIAGRAM:

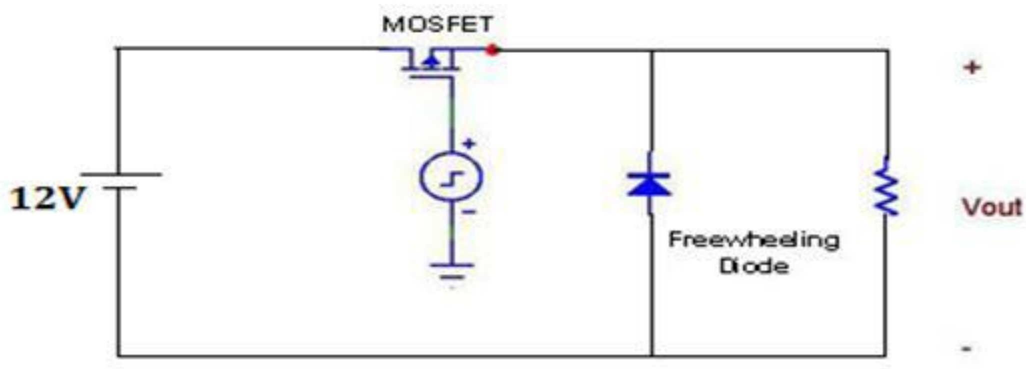


Fig – MOSFET based chopper

PROCEDURE:

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 VRPS output to 10v and connect to DC chopper module.
3. Switch on DC toggle switch of chopper module.
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 to maximum and record the output voltage readings.

7. Keep the frequency at mid position, vary duty cycle from minimum to maximum and output voltage readings.
8. 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)
1		
2		
3		
4		
5		
6		
7		
8		

Constant Frequency, Frequency control

S. No	TON(sec)	T_{OFF}(sec)	Duty Cycle (%)	VO(Volts)
1				
2				
3				
4				
5				
6				
7				
8				
9				

MODEL GRAPH:

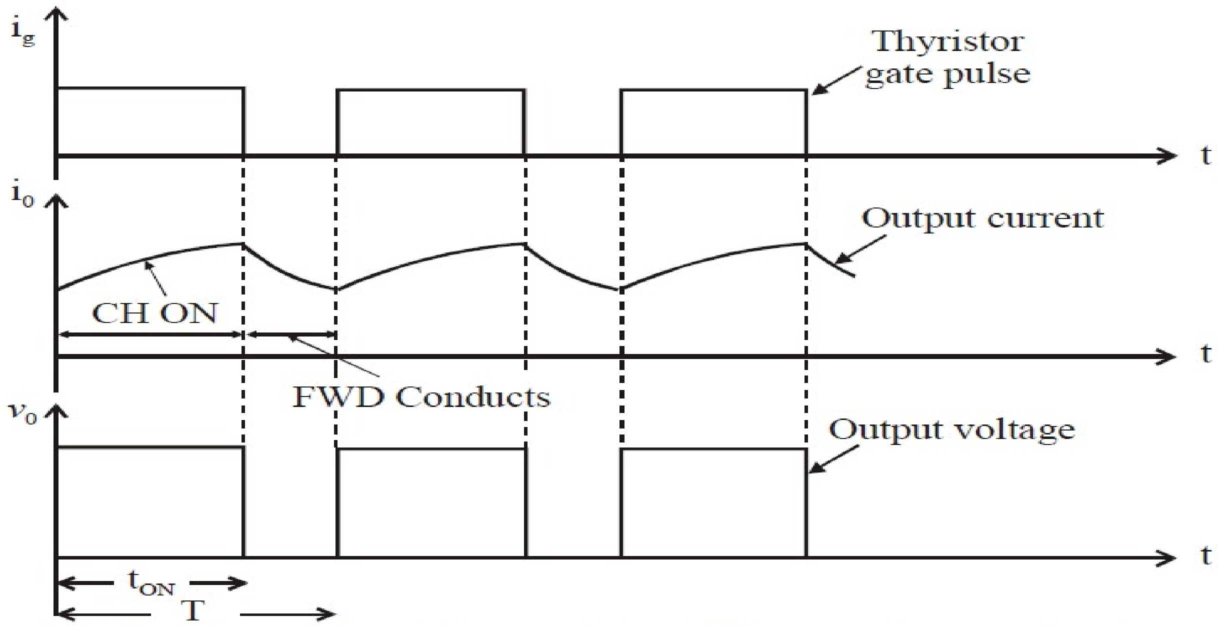


Fig – Chopper output waveforms

RESULT:

PRE LAB VIVA QUESTIONS:

1. What are the different control strategies found in choppers?
2. Explain the principle of operation of a chopper?
3. What is the function of chopper?
4. What are the advantages of DC choppers?
5. How can ripple current be controlled?
6. What is step up chopper?
7. On what does the commutating capacitor value depend on?
8. What are the disadvantages of choppers?

EXPERIMENT - 11 **DATE:**

1-ø BRIDGE INVERTER USING SPWM

AIM :

To study the performance of 1-ø Bridge Inverter using SPWM.

APPARATUS :

1.1-ø Bridge Inverter kit

2. Rheostat-0-350 ohm/1.2 A

3. Inductor

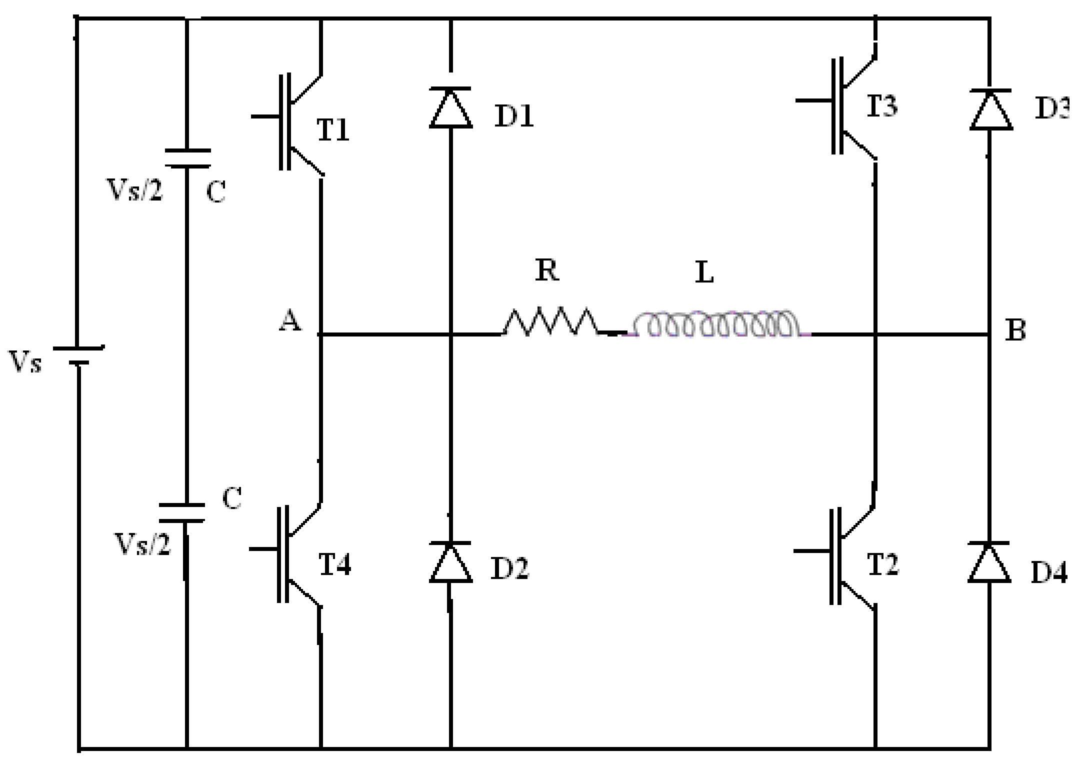
4. Isolation Transformer

5. Voltmeter 0-400 V

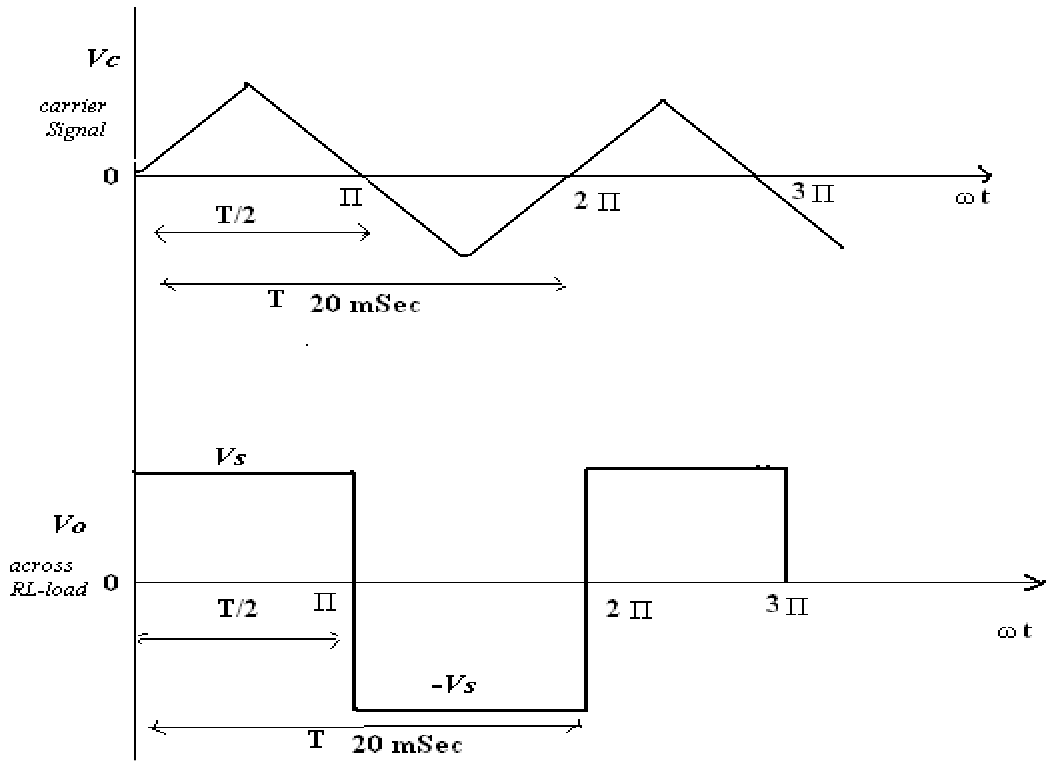
6. Ammeter 0-5 A

7. Connecting wires

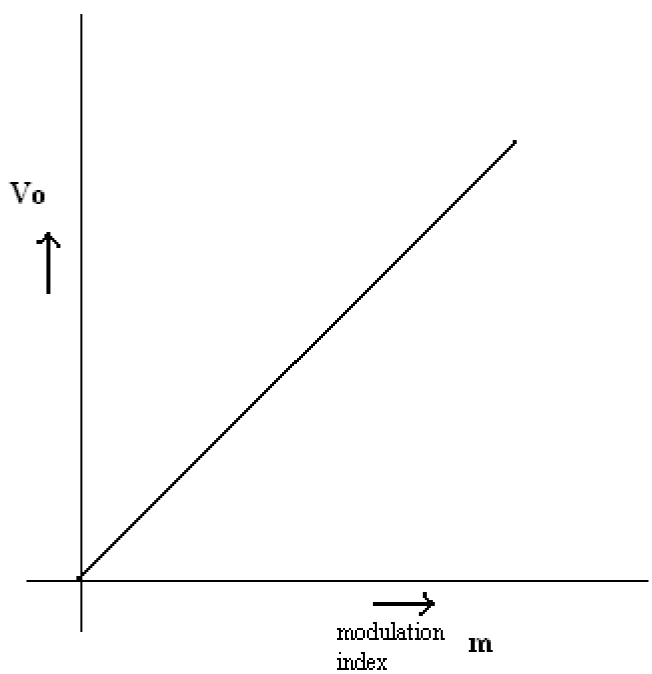
CIRCUIT DIAGRAM:



WAVEFORMS:



EXPECTED GRAPH:



PRECAUTIONS :

1.Ensure that the C.B & pulse release ON/OFF switch are in OFF position before starting the experiment.
2. Show the connections to lab faculty before you start the experiment.

PROCEDURE :

1. Connections are made as per the circuit diagram.
2. Connect the ammeter & voltmeter to measure load current & load voltage..
3. Connect AC i/p terminals L & N provided in the front anel.
4. With the C.B & pulse release ON/OFF switch are in OFF position give power to the Inverter module. This will ensure the control power supply to all the control circuitry.
5. Set the amplitude of the reference sin wave to the min. position
6. Keeping the pulse release switch in OFF position ,switch ON the power supply to the bridge rectifier
7. Release the gating signals to the inverter by switching ON the pulse release ON/Off switch.
8. Observe the triangular carrier & ref. sin wave in the CRO .Measure the amplitude of carrier wave & ref. wave and note it down in the tabular column.
9. Observe the wave forms across the RL-load in the CRO. & note down the readings.
10. Repeat the steps 8-9 by increasing the ref.wave amplitude in steps.
11. Calculate the modulation index value at each step
12. Plot the load & carrier wave s in the graph sheet, also draw the characteristics as mentioned.

TABULAR COLUMN:

S.NO	Vc (carrier signal)	Vsin (ref.signal)	ma (modulation index)	Vo (across load)	Time (Sec)

THEORETICAL CALICULATIONS :

$$m_a = \frac{V\sin}{Vcar} = \frac{Amplitude.of\,theref.\sin signal}{Amplitude.of\,the.carrier.signal}$$

$$Vo = m\frac{V}{\sqrt{2}}$$

$$rms.value.of.output.voltage. = Vo = \left[\frac{2}{T}\int_0^{T/2} V_s^2 dt\right]^{1/2} = Vs$$

RESULT :

VIVA_VOCE :

1. What is PWM ?
2. What are the various methods of PWM ?
3. What is the difference between SPWM and other PWM techniques ?
4. What is the differences between six step inverter & PWM inverter ?