JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY
SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING
• Constituent College of JSS Science and Technology University
• Approved by A.I.C.T.E
• Governed by the Grant-in-Aid Rules of Government of Karnataka
• Identified as lead institution for World Bank Assistance under TEQIP Scheme

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Laboratory Manual
Subject: Power Electronics
Subject Code: EC720

Lab location: CS 203

Prepared by:
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Assistant Professor
Dept. of ECE

Vision statement of the JSS Science and Technology University

1) Advancing JSS S&T University as a leader in education, research and technology on the international arena.
2) To provide the students a universal platform to launch their careers, vestingthe industry and research community with skilled and professional workforce.
3) Accomplishing JSS S&T University as an epicenter for innovation, centreof excellence for research with state-of-the-art lab facilities.
4) Fostering an erudite, professional forum for researchers and industrialist tocoexist and to work cohesively for the growth and development of scienceand technology for betterment of society.

Mission statement of the JSS Science and Technology University

1) Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio-economic conditions of the country.
2) Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which arestrongly supported with interdisciplinary research and academia.
3) JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.
4) JSS S&T University core mission is to create knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.

Vision statement of the department of E&CE

Be a leader in providing globally acceptable education in electronics and communication engineering with emphasis on fundamentals-to-applications, creative-thinking, research and career- building.

Mission statement of the department of E&CE

1. To provide best infrastructure and up-to-date curriculum with a conducive learning environment.

2. To enable students to keep pace with emerging trends in Electronics and Communication Engineering.

3. To establish strong industry participation and encourage student entrepreneurship.

4. To promote socially relevant eco-friendly technologies and inculcate inclusive innovation activities.

PROGRAM OUTCOMES (PO's)

1) **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2) **Problem Analysis:** Identify, formulate, 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 specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4) **Conduct investigations of complex problems:** Using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of 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 activities with an understanding of the limitations
6) **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7) **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of 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) **Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
12) **Project Management and Finance:** Demonstrate knowledge and understanding of 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.

PROGRAM SPECIFIC OUTCOMES (PSO's)

1. Analyze, design and provide engineering solutions in the areas of electronic circuits and systems.
2. Demonstrate the mathematical modeling techniques, nurture analytical and computational skills to provide engineering solutions in the areas ofelectronics and communication.
3. Ability to address multidisciplinary research challenges and nurture entrepreneurship

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

1. To enable the graduates to have strong Engineering fundamentals in Electronics & Communication, with adequate orientation to mathematics and basic sciences.
2. To empower graduates to properly formulate, critically analyse, efficientlydesign and thus be able to provide innovative solutions in Electronics & Communication, for real life problems taking into account environmental and societal needs
3. To ensure that graduates have adequate exposure to emerging technologiesand cutting-edge research areas in Engineering through industry interactionand to inculcate among students, professional and ethical values, effectivecommunication skills, team work and leadership qualities.
4. To nurture required skill sets to enable students to pursue successfulprofessional. Career in industry, higher education, research and entrepreneurship.

Evaluation Sheet

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY
SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING
MYSURU - 570 006
DEPARTMENT OF ELECTRONICS AND COMMUNICATION
RECORD OF CIE FOR PERFORMANCE IN THE LAB CLASSES

Section		Batch		Group Number	
Staff in Charge		Day		Timings	

Sl. No.	USN	Name of The Student	AC1: Preparedness (8M) AC2: Conduction (8M) AC3: Viva (8M) AC4: Report Writing (8M) AC5: Result Interpretation (8M) T: Total (40M)	SUBJECT: Power Electronics Lab (EC720L)
1.				
2.				
3.				

Sl. No.	Date	Experiment	Student-1						Student-2						Student-3						Remarks
			AC 1	AC 2	AC 3	AC 4	AC 5	T	AC 1	AC 2	AC 3	AC 4	AC 5	T	AC 1	AC 2	AC 3	AC 4	AC 5	T	
1.																					
2.																					
3.																					
4.																					
5.																					
6.																					
Event		Lab Event – I Simulation																			
CIE from Exp. 1 to 6(10M) + Simulation(10M) (20 Marks)																					

Sl. No.	Date	Experiment	Student-1						Student-2						Student-3						Remarks
			AC 1	AC 2	AC 3	AC 4	AC 5	T	AC 1	AC 2	AC 3	AC 4	AC 5	T	AC 1	AC 2	AC 3	AC 4	AC 5	T	
7.																					
8.																					
9.																					
10.																					
11.																					
Event		Lab Event-II Lab test																			
CIE from experiments 7 to 11(10M) + Lab test(10M) (20 Marks)																					

	Student-1	Student-2	Student-3
Attendance (Percentage)			
Event - II			
Event - IV			

Signature of the Staff in Charge:

1.

2.

Signature of the Lab in Charge:

LIST OF EXPERIMENTS

EC720: POWER ELECTRONICS

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 720	POWER ELECTRONICS	3	0	1	4	50	50	100

Course outcome: At the end of the course, the student will have the ability to

CO-1: Explain the various power devices and circuits.

CO-2: Analyze different power electronics circuits.

CO-3: Design power electronics circuits to meet the given specifications.

CO-4: Design and demonstrate the working of various power electronic circuits.

CO-5: Demonstrate the skill sets using modern tool for analysis and simulation of power electronics circuits.

COURSE ARTICULATION MATRIX

EAM	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	3	3	-	2
C05	-	-	-	-	3	-	-	-	3	3	-	2
Overall contribution to PO	3	3	2	-	3	-	-	-	3	3	-	2

Experiment-1

Analysis of static and dynamic characteristics of MOSFET

Aim: Analysis of static and dynamic characteristics of MOSFET.

Apparatus required: MOSFET-IRF640, power supply, wattage resistors, ammeter, voltmeter, etc.,

Circuit diagram:

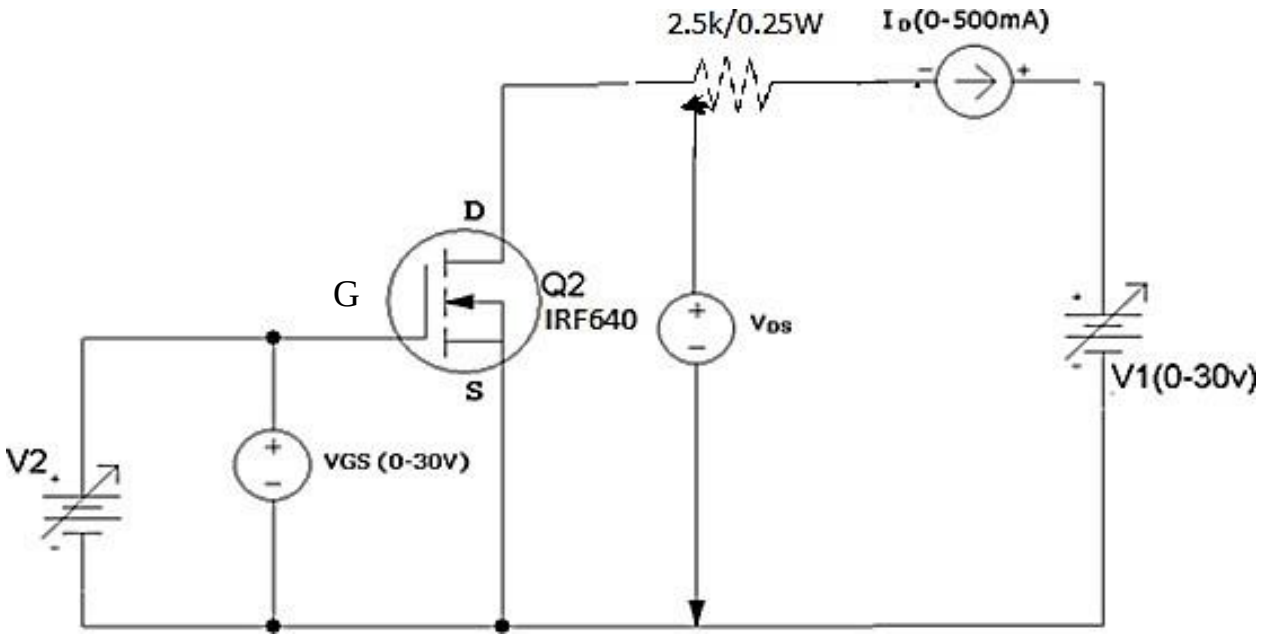


Figure 1.1: Circuit diagram

Procedure:

Drain characteristics

1. Connections are made as shown in the circuit diagram.
2. Adjust the value of V_{GS} slightly more than threshold voltage V_{th}.
3. By varying V1, note down I_D & V_{DS} and are tabulated in the tabular column.
4. Repeat the experiment for different values of V_{GS} and note down I_D v/s V_{DS}.
5. Draw the graph of I_D v/s V_{DS} for different values of V_{GS}.

Trans conductance characteristics

1. Connections are made as shown in the circuit diagram.
2. Initially keep V1 and V2 zero.
3. Set V_{DS}, slowly vary V2 (V_{GS}) with a step of 0.5 volts, note down corresponding I_D and V_{DS} readings for every 0.5v and are tabulated in the tabular column.
4. Repeat the experiment for different values of V_{DS} & draw the graph of I_D v/s V_{GS}.

Ideal Graph:

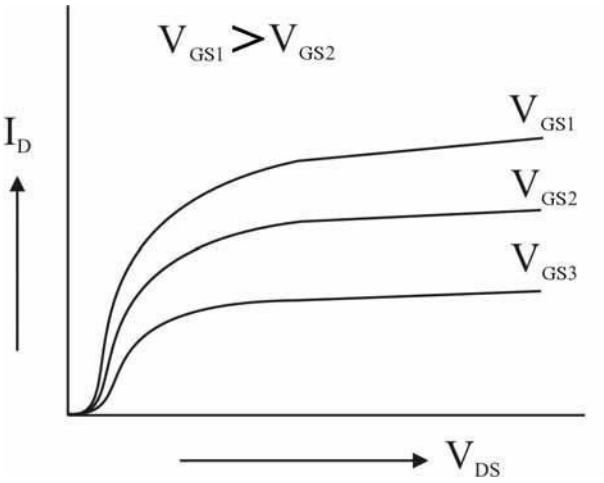


Figure 1.2: Drain Characteristics

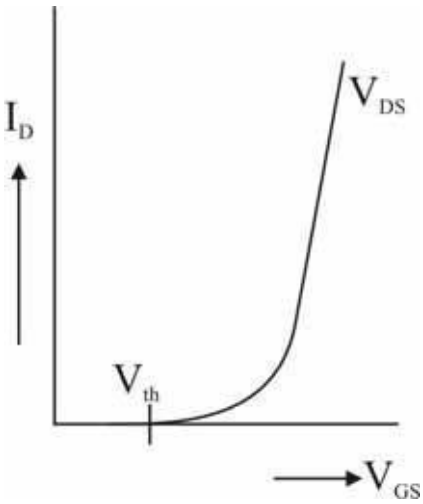


Figure 1.3: Trans conductance Characteristics

Tabular column:

V_{GS} =	
V_{DS} (V)	I_D (mA)

V_{DS} =	
V_{GS} (V)	I_D (mA)

Result:

Conclusion:

Experiment-2

Analysis of static and dynamic characteristics of IGBT

Aim: To study the static and dynamic characteristics of IGBT.

Apparatus required: IGBT-H20R1203, power supply, wattage resistors, ammeter, voltmeter, etc.,

Circuit Diagram:

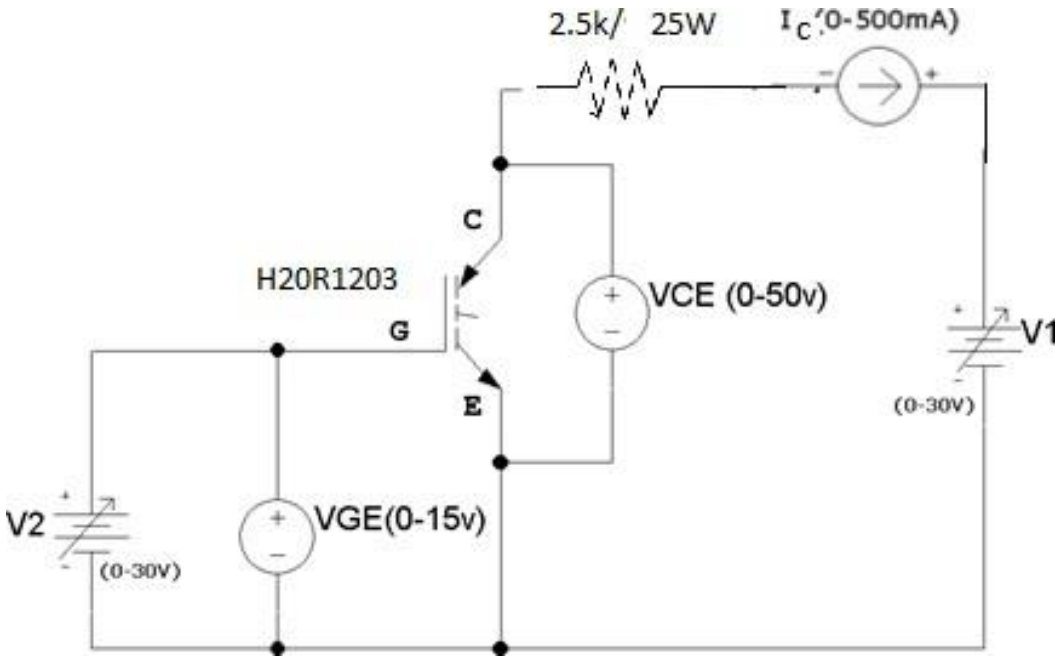


Figure 2.1: Circuit diagram

Procedure:

Collector Characteristics

1. Connections are made as shown in the circuit diagram.
2. Initially set V2 = 5v (slightly more than threshold voltage)
3. Slowly vary V1 and note down I_C and V_{CE}
4. For particular value of V_{GE} there is pinch off voltage (V_P) between collector and emitter.
5. Repeat the experiment for different values of V_{GE} and note down I_C v/s V_{CE}
6. Draw the graph of I_C v/s V_{CE} for different values of V_{GE}.

Trans conductance Characteristics

1. Connections are made as shown in the circuit diagram.
2. Initially keep V1 and V2 zero.
3. Set V_{CE}, slowly vary V2 (V_{GE}) with a step of 0.5 volts, note down corresponding I_D and V_{CE} readings for every 0.5v and are tabulated in the tabular column.
4. Repeat the experiment for different values of V_{CE} & draw the graph of I_E v/s V_{GE}.

Ideal Graph:

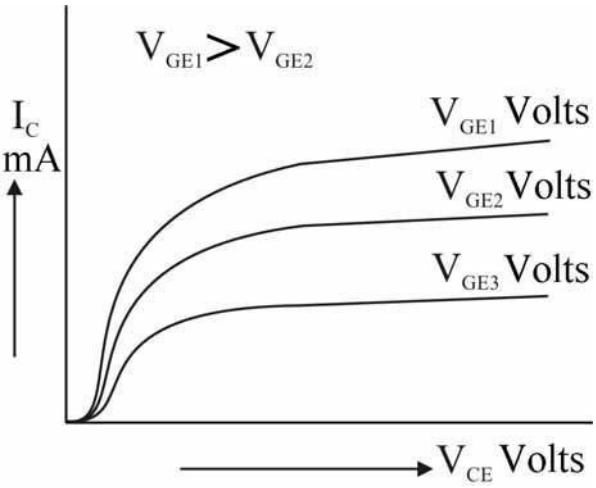


Figure 2.2: Collector Characteristics

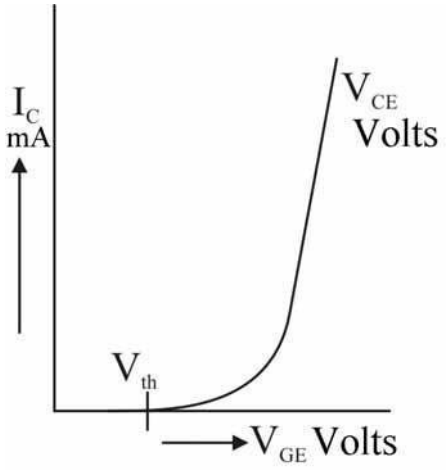


Figure 2.3: Trans conductance Characteristics

Tabular column:

V_{GE} =	
V_{CE} (V)	I_C (mA)

V_{CE} =	
V_{GE} (V)	I_E (mA)

Result:

Conclusion:

Experiment-3

Analysis of static and dynamic characteristics of SCR

Aim: To study the V-I characteristics of SCR and determine the break over voltage, on state resistance holding current & latching current.

Apparatus required: SCR – TYN612, power supply, wattage resistors, ammeter, voltmeter, etc.,

Circuit Diagram:

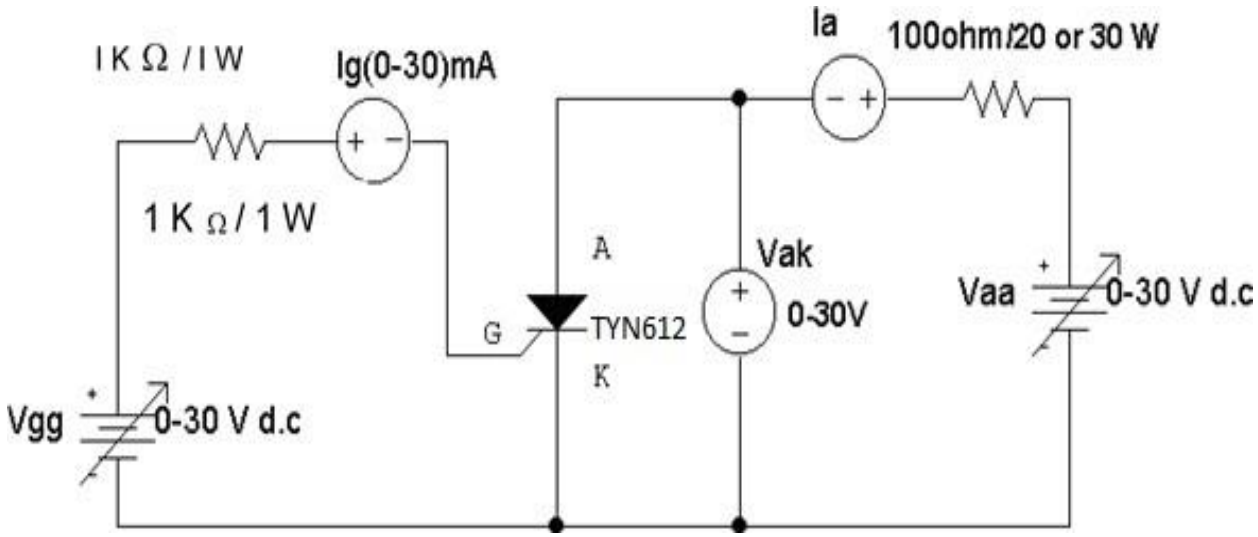


Figure 3.1: Circuit diagram

Procedure:

1. Connections are made as shown in the circuit diagram.
2. The value of gate current I_G, is set to convenient value by adjusting V_{GG}.
3. By varying the anode- cathode supply voltage V_{AA} gradually in step-by- step, note down the corresponding values of V_{AK} & I_A.
4. The point at which SCR fires, gives the value of break over voltage V_{BO}.
5. A graph of V_{AK} v/s I_A is to be plotted.
6. The gate supply voltage V_{GG} is to be switched off
7. Observe the ammeter reading by reducing the anode-cathode supply voltage V_{AA}. The point at which the ammeter reading suddenly goes to zero gives the value of Holding Current I_H.

Ideal Graph:

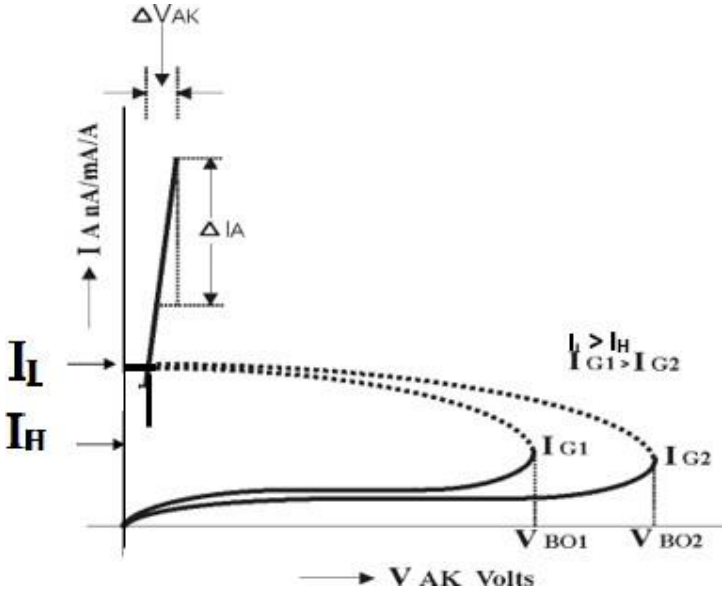


Figure 3.2: Ideal Graph

Tabular column:

V_{gmin} =_____V

I_{gmin} =_____mA

V_{AK} Volts	I_A mA

Result:

Conclusion:

Experiment-4

Performance analysis of controlled HWR and FWR using RC firing circuit

Aim: To study the performance & waveforms of HWR & FWR by using RC triggering circuit.

Apparatus required: Transformer, SCR – TY604, Diode – BY127, resistor, capacitor, ammeter, voltmeter.

Half wave rectifier

Circuit diagram:

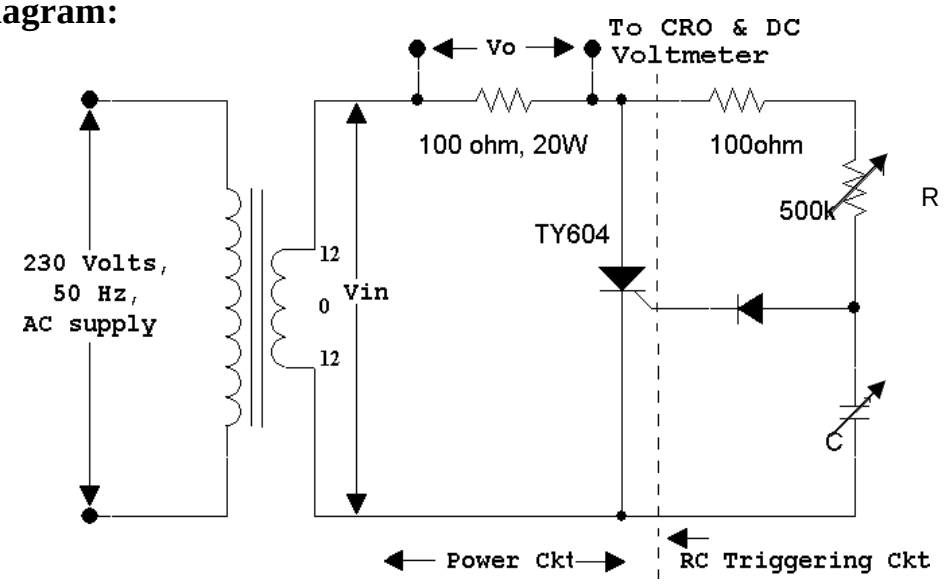


Figure 4.1: Circuit diagram of Half Wave Rectifier

Waveforms:

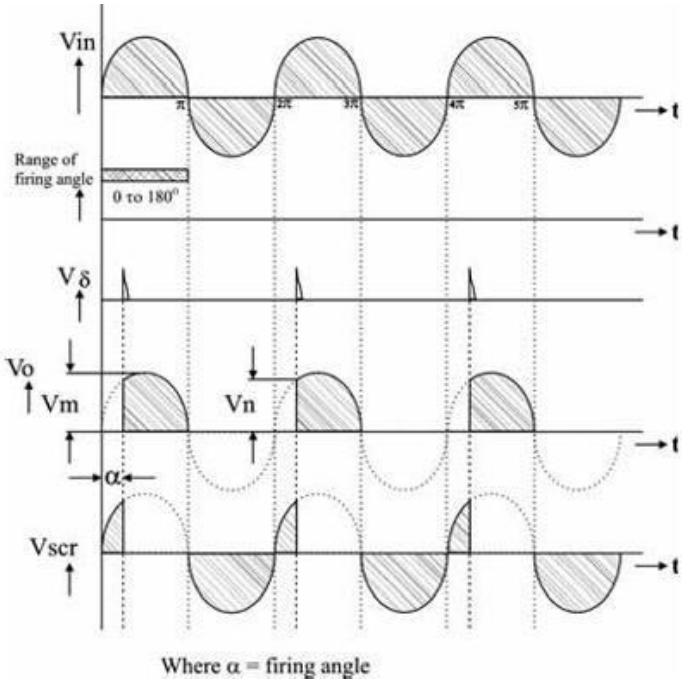


Figure 4.2: Expected Waveforms of Half Wave Rectifier

Graph:

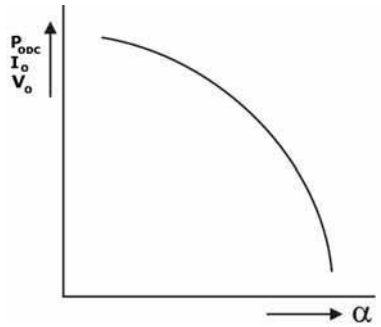


Figure 4.3: Ideal graph of Half Wave Rectifier

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Procedure:

1. Connections are made as shown in the circuit diagram.
2. By varying firing angle α note down the corresponding values of V_o from CRO. The readings are tabulated in the tabular column.
3. A graph of firing angle v/s load voltage is plotted.
4. Compare practical output voltage with theoretical output voltage.

Full Wave Rectifier

Circuit diagram:

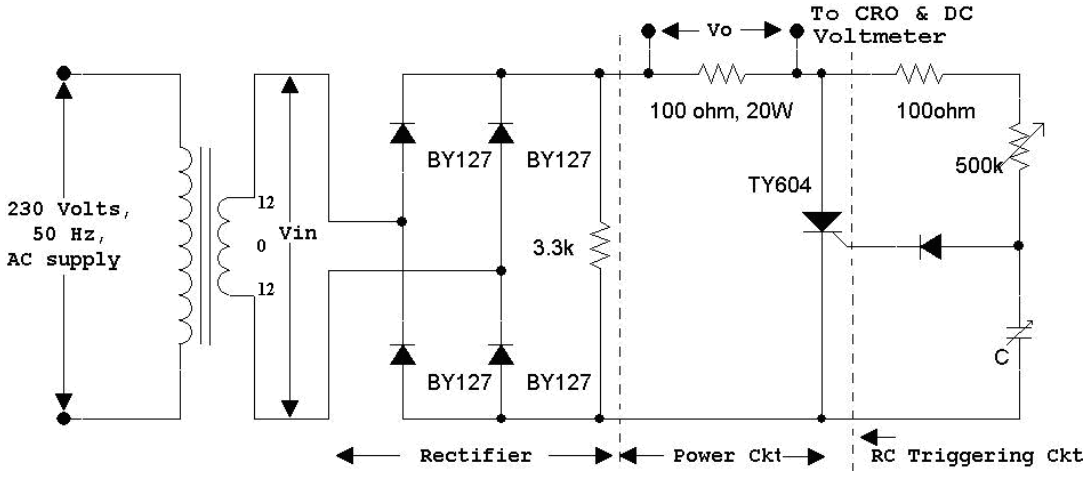


Figure 4.4: Circuit diagram of Full Wave Rectifier

Waveforms:

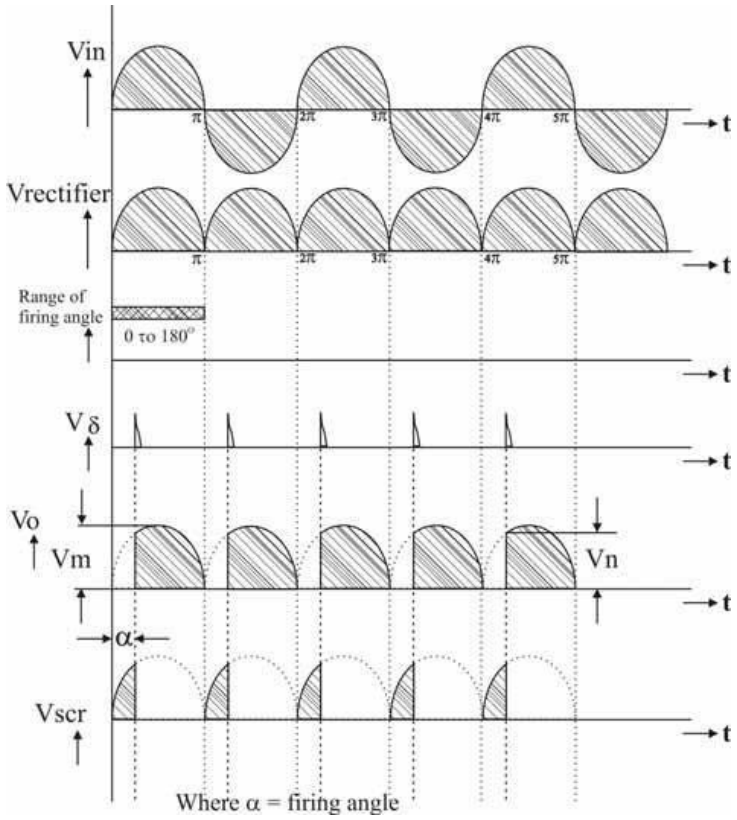


Figure 4.5: Expected Waveforms of Full Wave Rectifier

Procedure:

1. Connections are made as shown in the circuit diagram.
2. By varying firing angle α note down the corresponding values of V_o from CRO. The readings are tabulated in the tabular column.
3. A graph of firing angle v/s load voltage is plotted.
4. Compare practical output voltage with theoretical output voltage.

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Result:

Conclusion:

Experiment-5

Performance analysis of controlled HWR and FWR using UJT firing circuit

Aim: To study the performance & waveforms of U.J.T triggering of S.C.R.

Apparatus required: SCR-2N3669, power supply, wattage resistors, ammeter, voltmeter, UJT-2N2646, pulse transformer, etc.,

Circuit diagram:

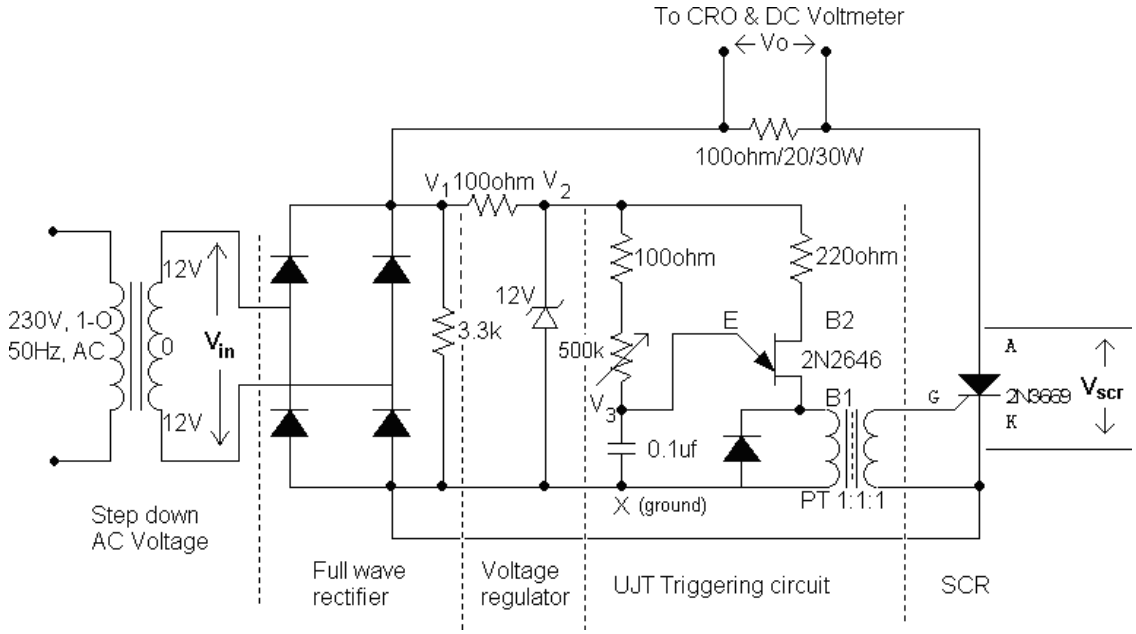


Figure 5.1: Circuit diagram

Waveforms:

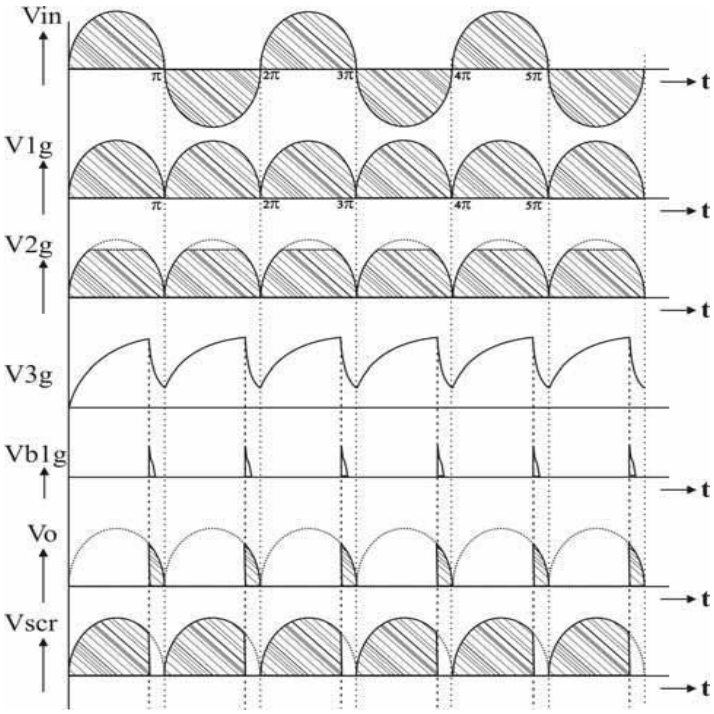


Figure 5.2: Expected Waveforms

Procedure:

1. Connections are made as shown in the circuit diagram.
2. By varying firing angle α note down the corresponding values of V_o from CRO. The readings are tabulated in the tabular column.
3. A graph of firing angle v/s load voltage is plotted.
4. Compare practical output voltage with theoretical output voltage.

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Result:

Conclusion:

Experiment-6

Performance analysis of AC voltage controller using TRIAC- DIAC combination

Aim: To study the AC voltage control by using TRIAC-DIAC combination.

Apparatus required: TRIAC, DIAC, supply voltage, wattage resistors, ammeter, voltmeter, etc.,

Circuit diagram:

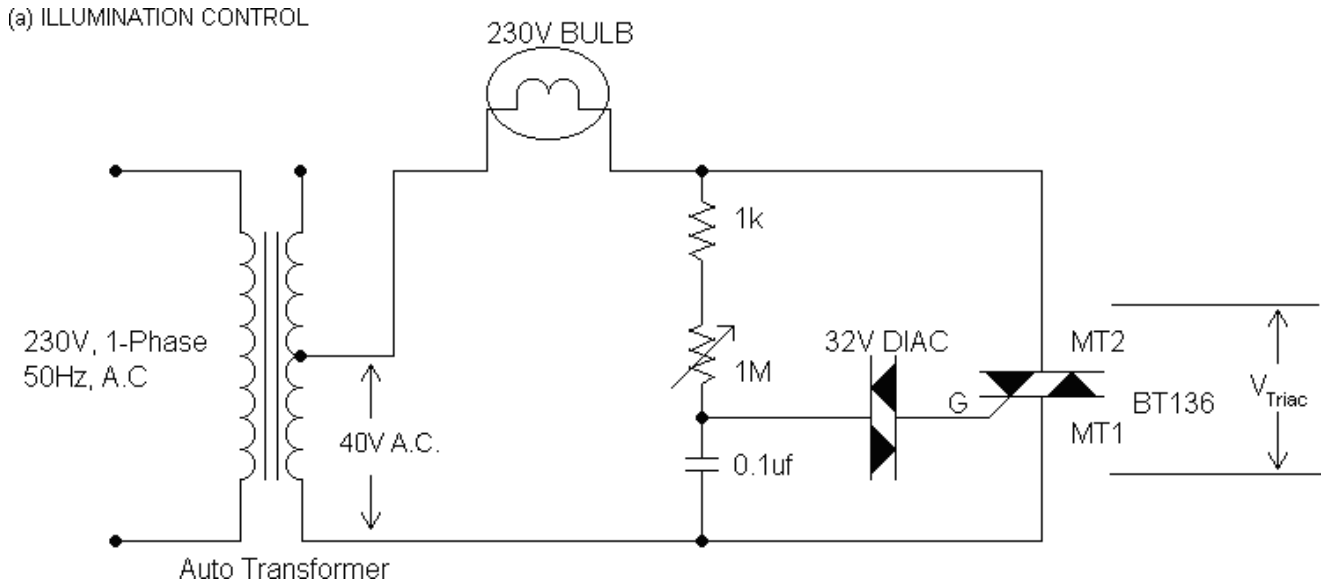


Figure 6.1: Circuit diagram of Resistive Load

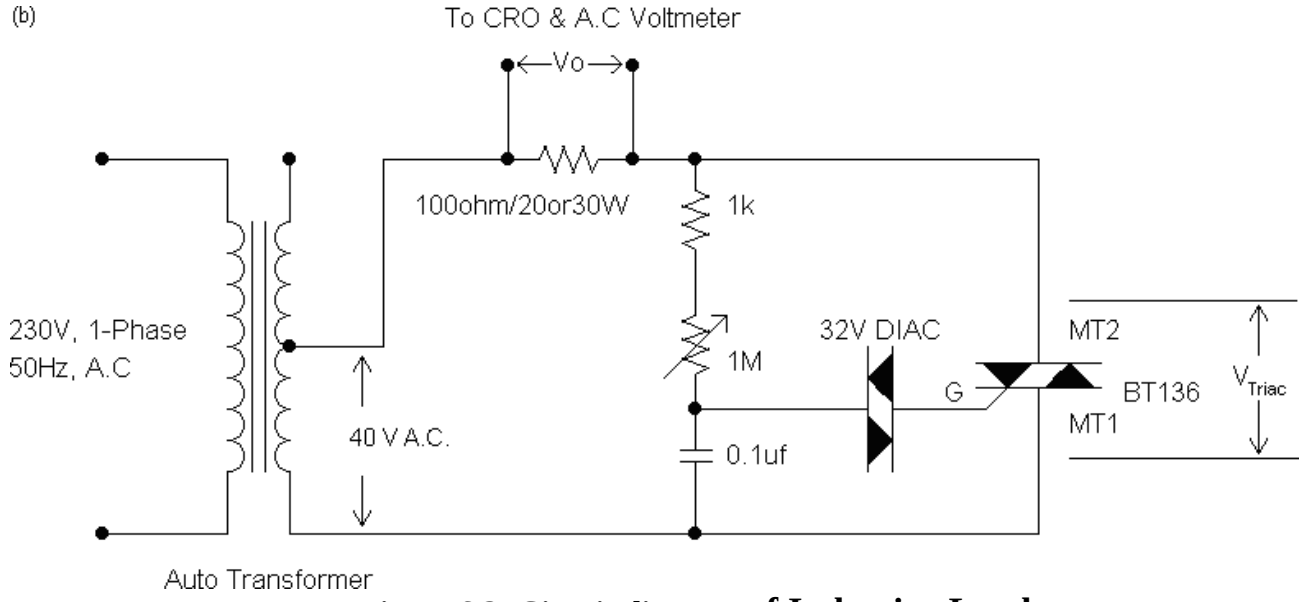


Figure 6.2: Circuit diagram of Inductive Load

Procedure:

A. Resistive load

1. Connections are made as shown in the circuit diagram (a)
2. By varying the variable resistance R_1 in step by step, observe the variation of intensity of light.

B. Inductive load

1. Connections are made as shown in the circuit diagram.
2. By varying firing angle α note down the corresponding values of V_o from CRO. The readings are tabulated in the tabular column.
3. A graph of firing angle v/s load voltage is plotted.
4. Compare practical output voltage with theoretical output voltage

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Result:

Conclusion:

Experiment-7

Performance analysis of two quadrant choppers

Aim: To study the performance of voltage commutated chopper and analysis of chopper parameters with different loads using suitable control circuits.

Apparatus required: Module, SCRs, diodes, inductor, capacitors, etc.,

Circuit Diagram:

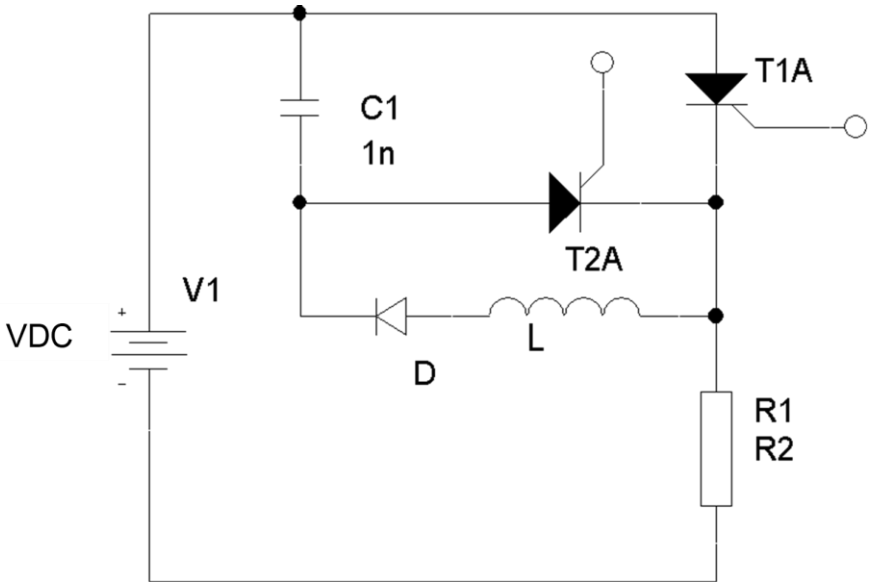


Figure 7.1: Circuit diagram

Expected Waveforms:

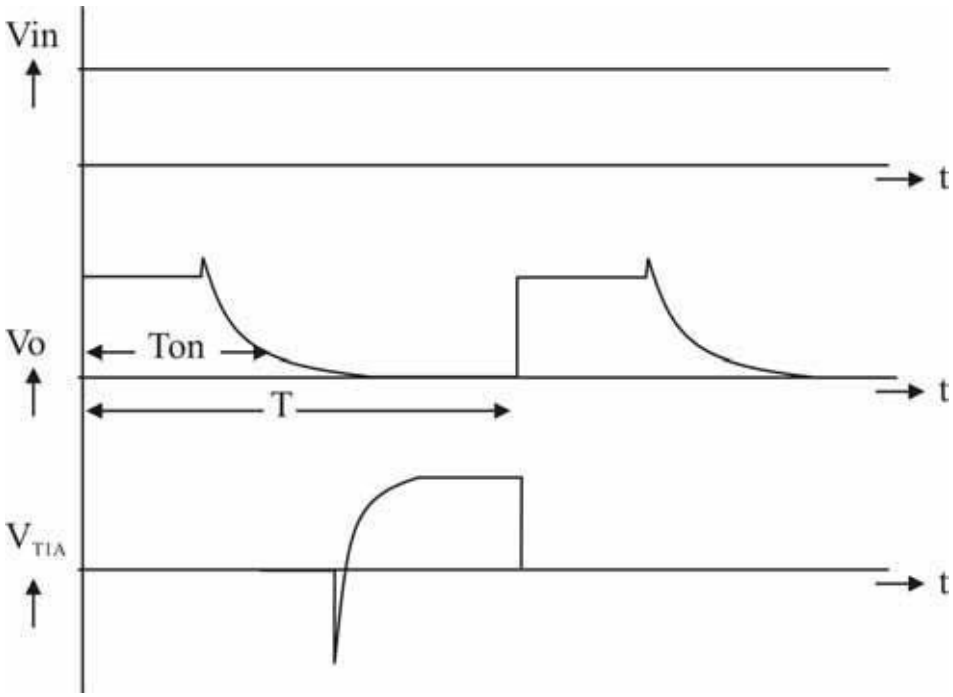


Figure 7.2: Expected Waveforms

Expected Graph:

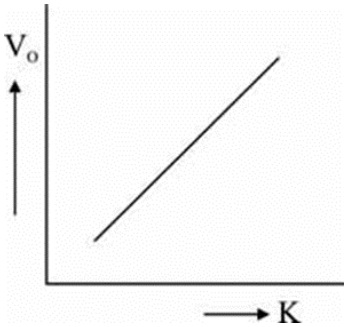


Figure 7.3: Expected Graph

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Input DC voltage is set to convenient value (10V to 25V).
3. By varying duty cycle knob of triggering circuit module step by step gradually note down corresponding Ton and T from the CRO and V_O from DC voltmeter and tabulate.
4. Initially frequency is to be kept constant. Vary the duty cycle and note down corresponding changes in load voltage.
5. Now keep duty cycle constant and vary frequency in steps and note down corresponding changes in load voltage.
6. A graph of frequency v/s load voltage and duty cycle v/s load voltage is to be plotted.

Tabular column:

Effect of duty cycle on load voltage

Frequency=_____Hz

Duty cycle (%)	Load voltage in volts

Effect of frequency on load voltage

Duty cycle =_____%

Frequency (Hz)	Load voltage in volts

Result:

Conclusion:

Experiment-8

Performance analysis of series and parallel inverters

Aim: Experimental study of single-phase series and parallel inverter and analysis of performance parameters with different loads using suitable control circuit.

Apparatus required: Module, SCRs, diodes, inductor, capacitors, etc.,

Series inverter

Circuit diagram:

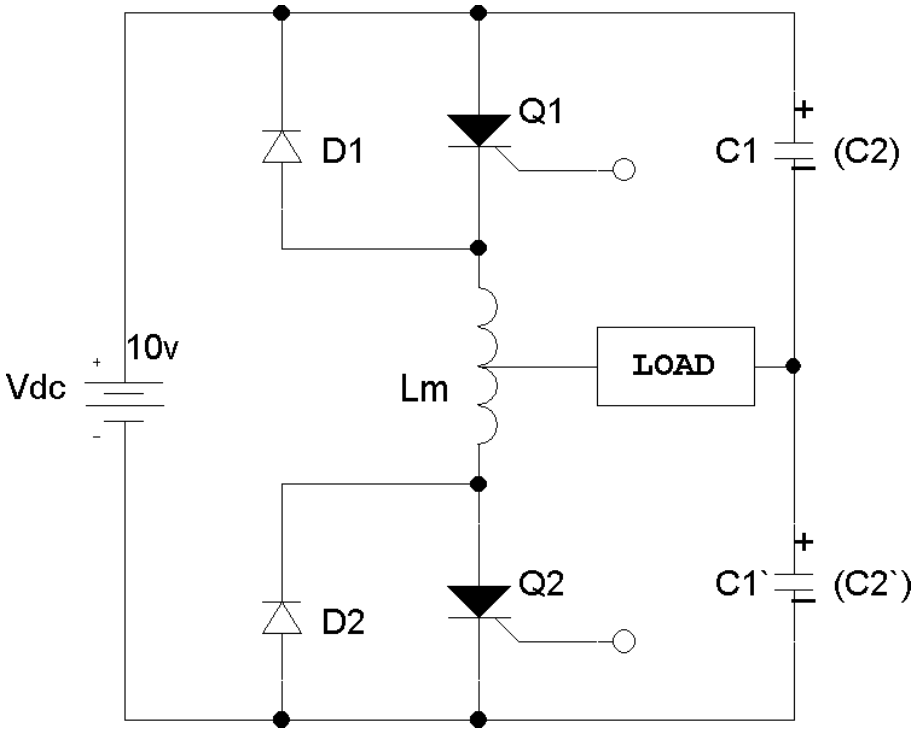


Figure 8.1: Circuit diagram of Series Inverter

Procedure:

1. To begin with switch on the power supply to the firing circuit check the trigger pulses by varying the frequency.
2. Connections are made as shown in the circuit diagram.
3. Now connect trigger outputs from the firing circuits to gate and cathode of SCR T1 & T2.
4. Connect DC input from a 30v/2A regulated power supply and switch on the input DC supply.
5. Now apply trigger pulses to SCR and observe voltage waveform across the load.
6. Measure V_{orms} & frequency of o/p voltage waveform.

Waveforms:

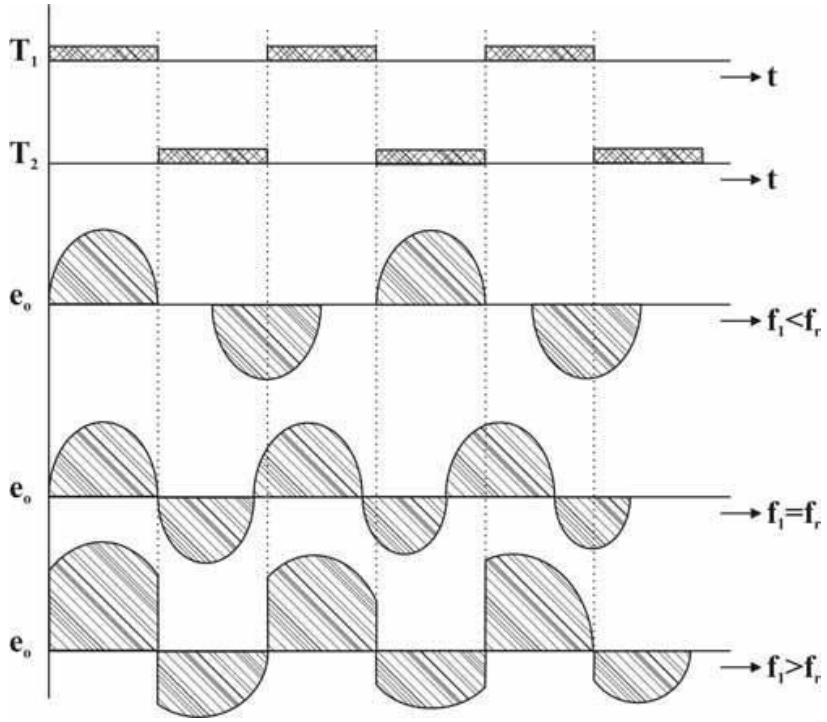


Figure 8.2: Expected Waveforms of Series Inverter

Tabular column:

Frequency in Hz	Load voltage in volts

Parallel inverter

Circuit Diagram:

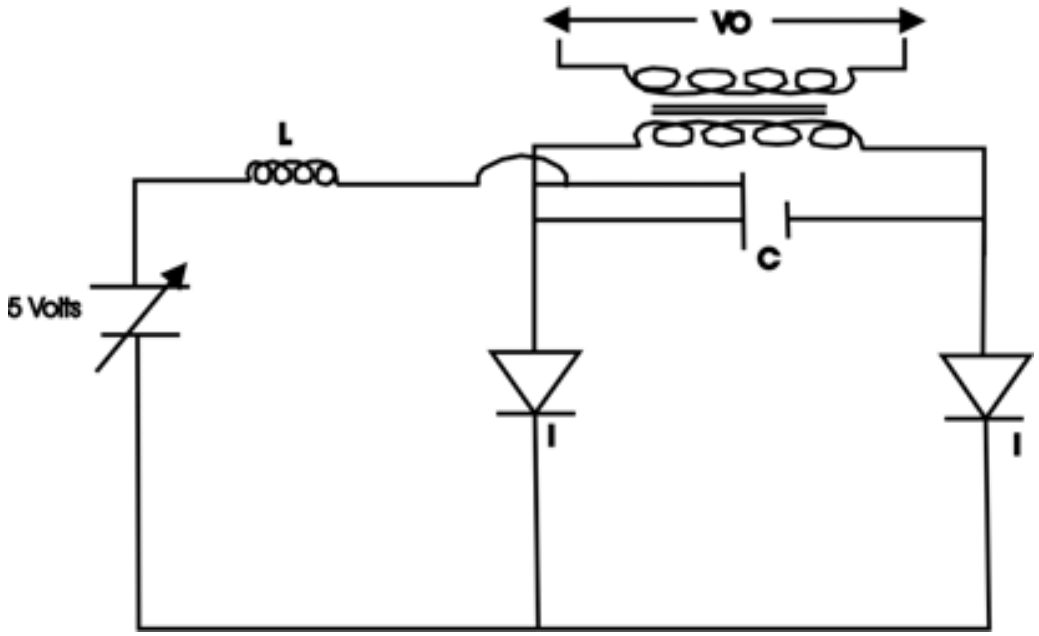


Figure 8.3: Circuit diagram of Parallel Inverter

Expected Waveform

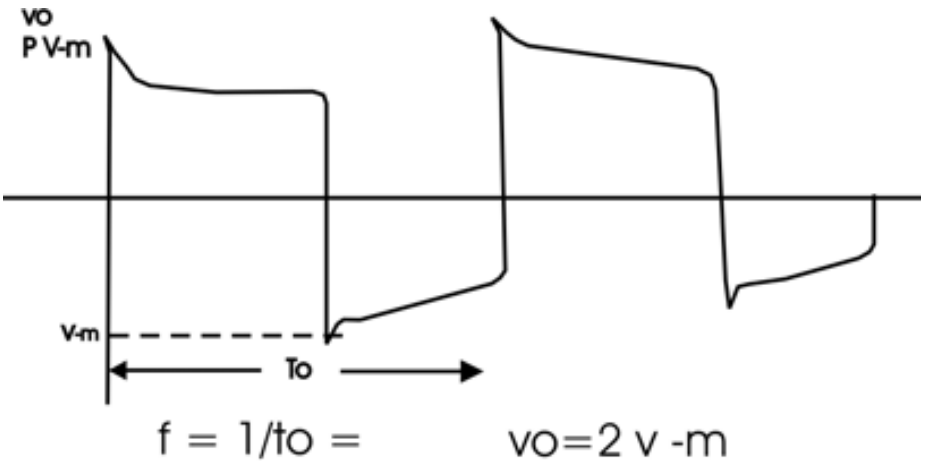


Figure 8.4: Expected Waveforms of Parallel Inverter

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Select values of C = , L =
3. Set input voltage to 5 volts
4. Apply trigger voltage; observe corresponding output voltage at load terminal.
5. Note down the voltage & frequency of output waveform.
6. The o/p ac voltage is almost equal to the two times of the DC input voltage.

Tabular column:

Frequency in Hz	Load voltage in volts

Result:

Conclusion:

Experiment-9

Study of generation of firing signals for converters / inverters using digital circuits / microprocessors.

Aim: To study the performance parameters of ZCD/digital firing circuits with AC voltage controller and controlled rectifier with different loads.

Apparatus required: Digital firing module, SCR-TYN604, resistor, etc.,

Circuit Diagram:

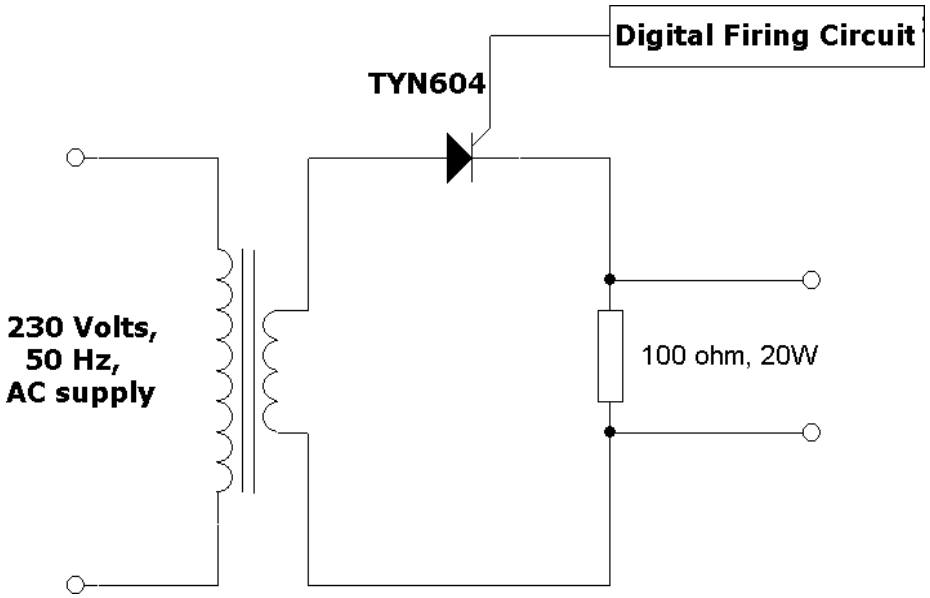


Figure 9.1: Circuit diagram

Waveforms:

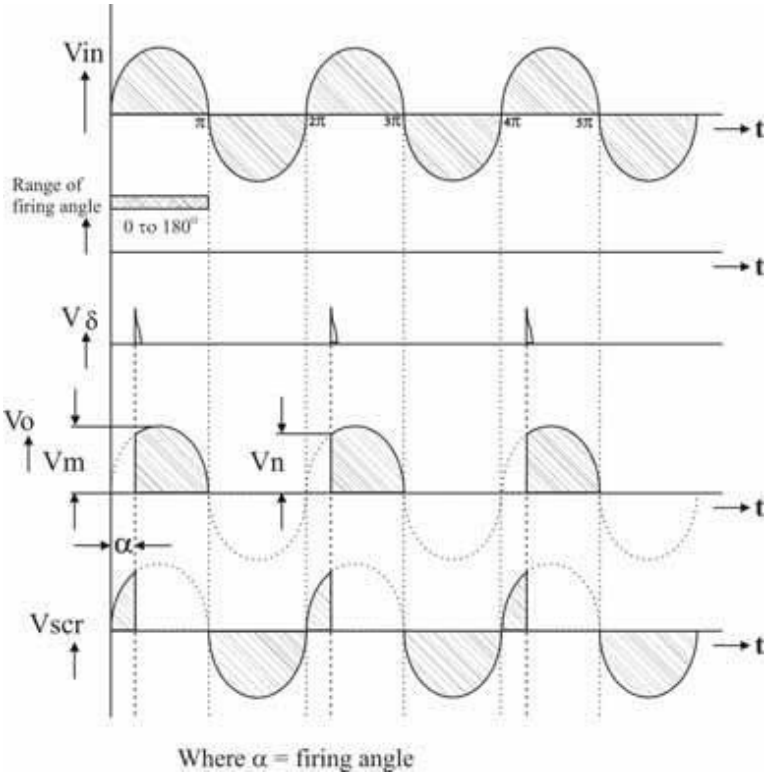


Figure 9.2: Expected Waveforms

Tabular column:

Firing angle (α)	Load voltage in volts

Procedure:

1. Connections are made as shown in the circuit diagram.
2. Firing angle is varied in steps gradually, note down corresponding values of load voltage and tabulate.
3. A graph of firing angle v/s load voltage is plotted.

Result:

Conclusion:

Experiment-10

Performance of single phase fully controlled and semi controlled converters for R and RL loads for continuous current mode

Aim: Performance evaluation of single phase fully controlled and semi controlled converters for R and RL Loads.

Apparatus required: Converter module, CRO with probes, resistor, inductor.

Semi-converter

Circuit diagram:

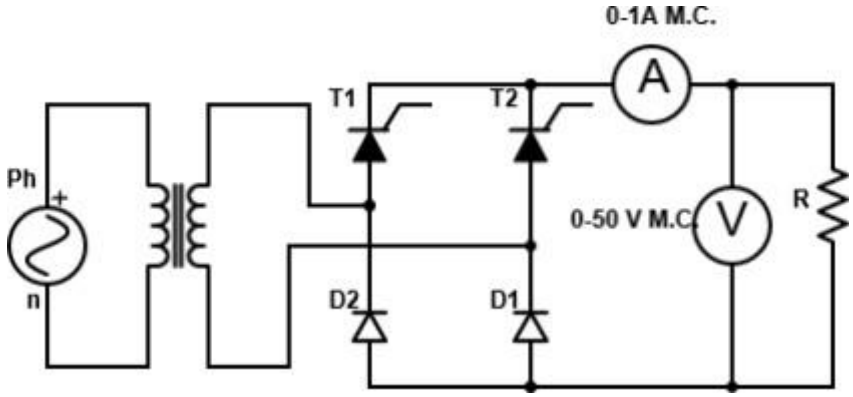
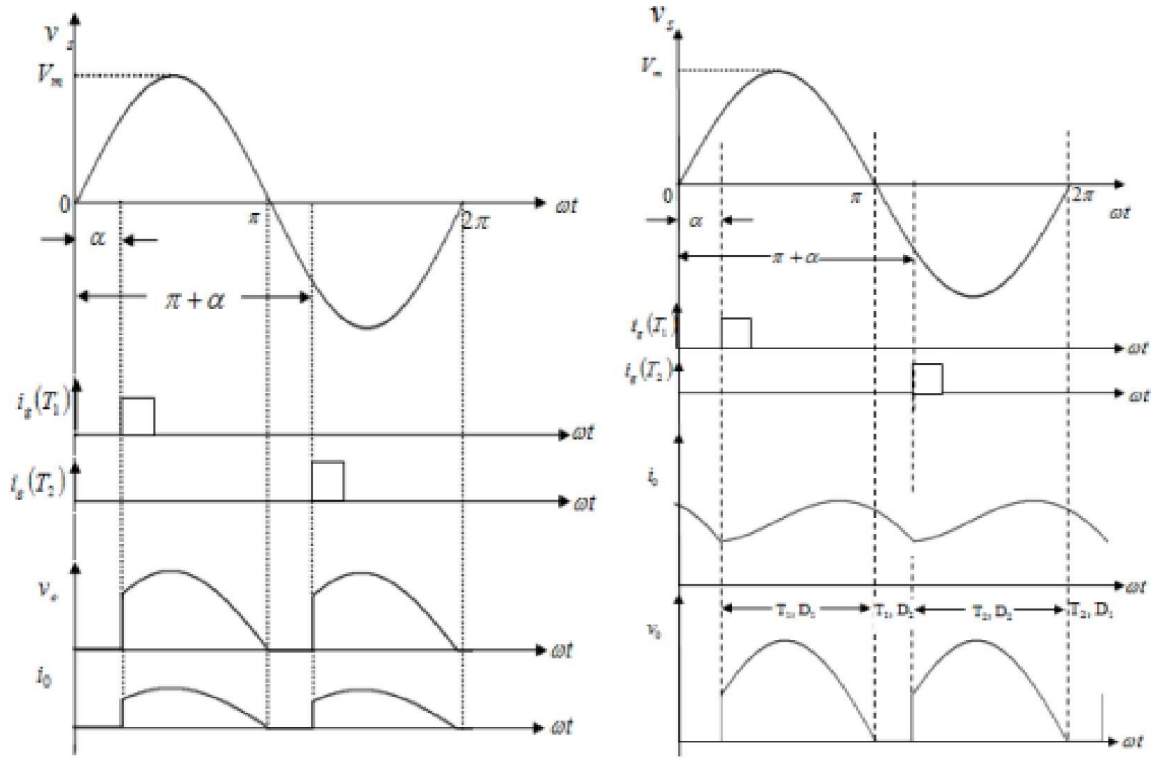


Figure 10.1: Circuit diagram of Semi Converter

Expected Waveforms



Waveforms of semiconverter with (a) R-load and (b) RL load.

Figure 10.2: Expected Waveforms of Semi Converter

Procedure:

1. Connect the circuit with R-load as shown in the circuit diagram.
2. Switch on the main supply.
3. Vary the firing angle, observe the load voltage waveform on CRO and note down the firing angle and sketch the output voltage.

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Full converter

Circuit diagram:

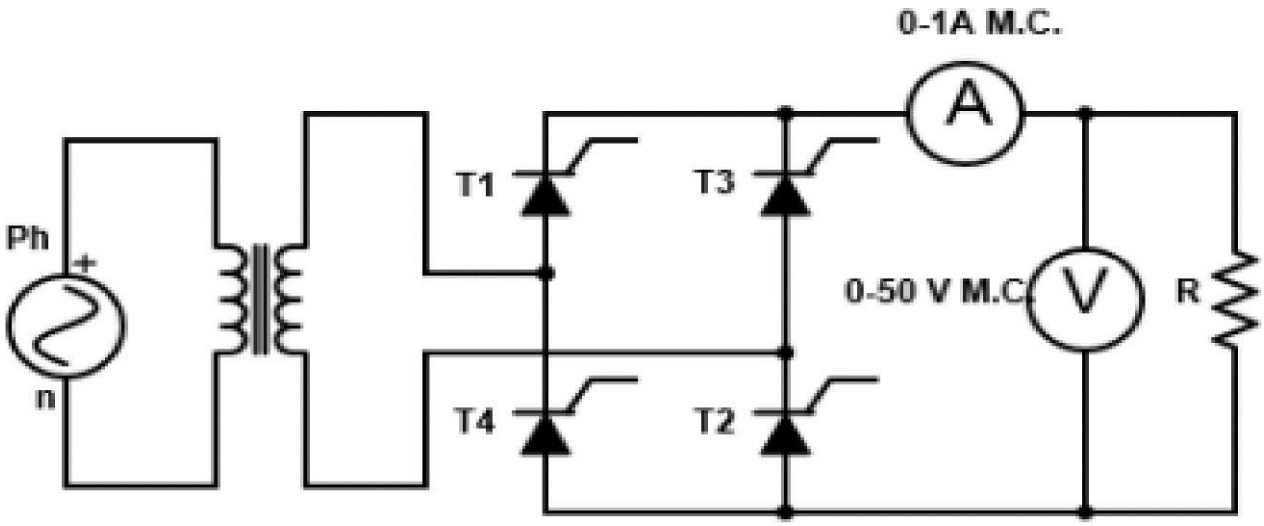


Figure 10.3: Circuit diagram of Full Converter

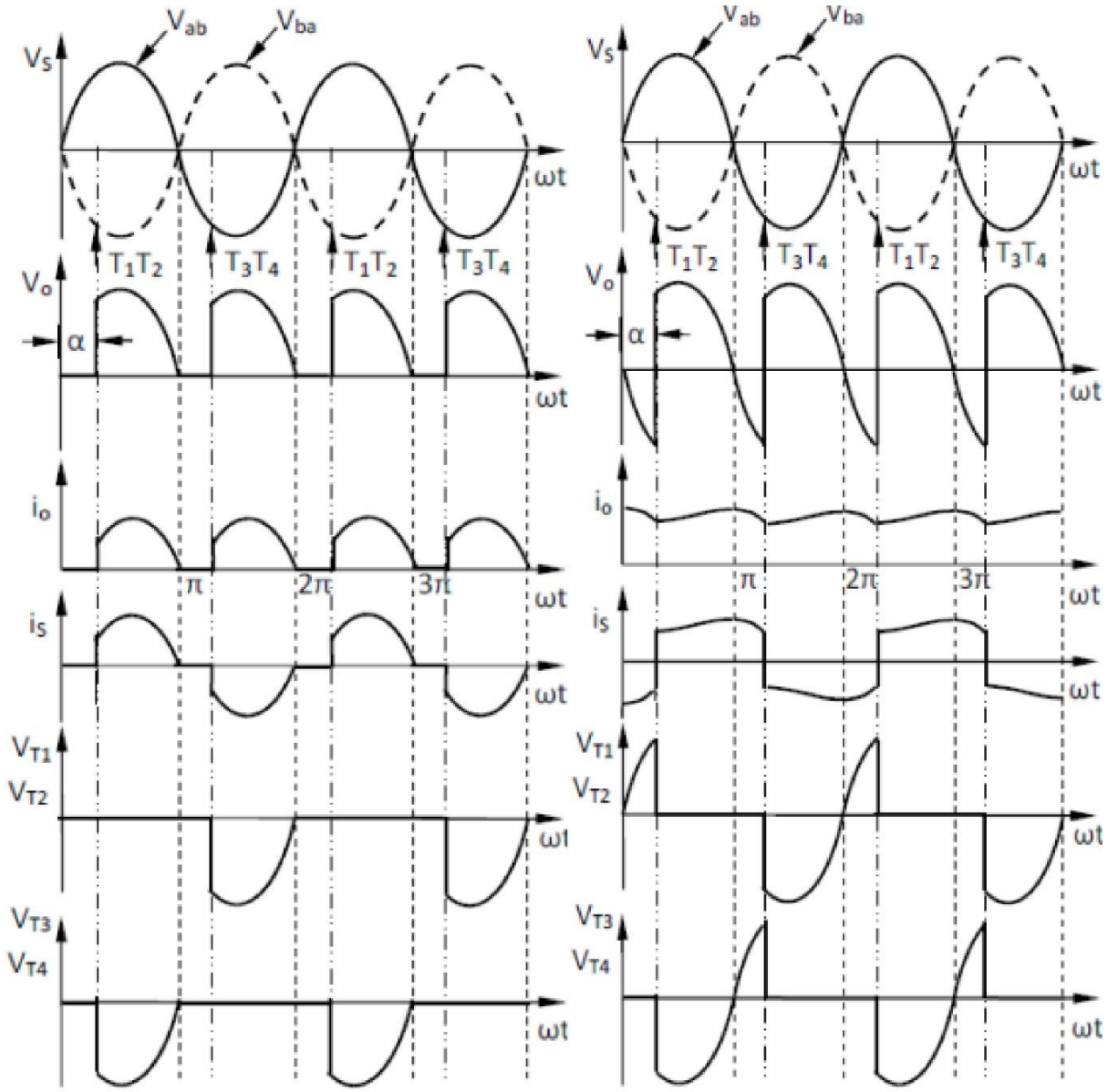
Procedure:

1. Connect the circuit with R-load as shown in the circuit diagram.
2. Switch on the main supply.
3. Vary the firing angle, observe the load voltage waveform on CRO and note down the firing angle and sketch the output voltage.

Tabular column:

Firing Angle (α)	Load Voltage (Theoretical)	Load Voltage (Practical)

Waveforms:



Output and SCR voltage wave forms of full bridge converter for (a) R and (b) RL loads.

Figure 10.4: Expected Waveforms of Full Converter

Result:

Conclusion:

Experiment-11

Performance analysis of single-phase semi-controlled converter fed separately excited DC motor for continuous current mode

Aim: Analysis of performance parameters of single phase semi-controlled converter using separately excited DC motor.

Apparatus required: DC motor, power supply, SCR, diode etc.,

Circuit diagram:

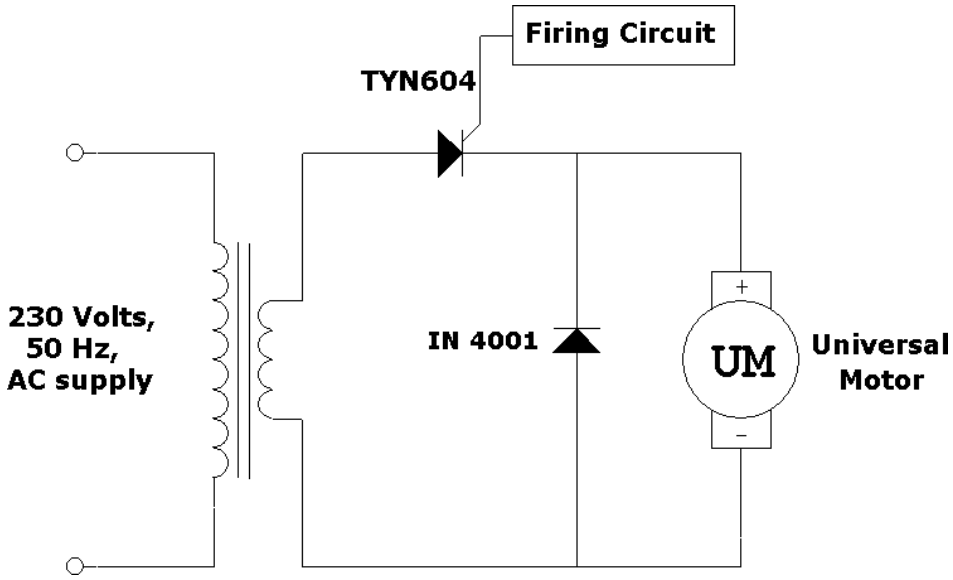


Figure 11.1: Circuit diagram

Procedure:

1. Connect the circuit with motor load as shown in the circuit diagram.
2. Switch on the main supply.
3. Vary the firing angle, observe the load voltage waveform on CRO and note down the firing angle and sketch the output voltage.
4. Measure the speed of the motor using tachometer.
5. Plot a graph of firing angle V/s load voltage.

Tabular column:

Firing angle (α)	Θ (degree)	Back emf (volts)	Load voltage (volts)	Speed (rpm)

Result:

Conclusion: