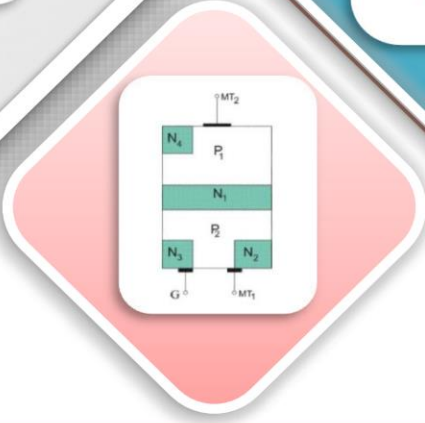
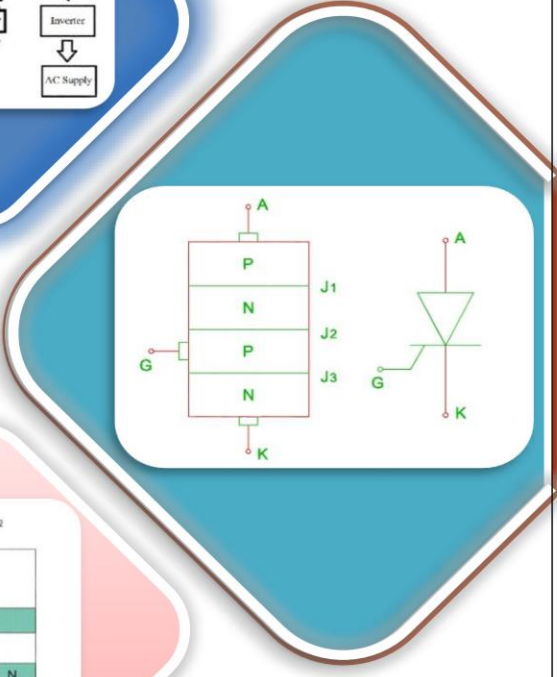
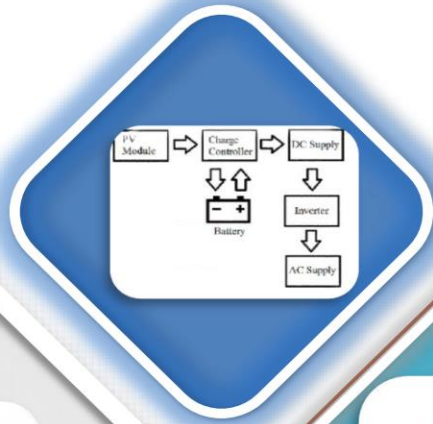


SCHEME : K

Name : _____
Roll No. : _____ Year : 20__ 20__
Exam Seat No. : _____

LABORATORY MANUAL FOR FUNDAMENTALS OF POWER ELECTRONICS (313335)



ELECTRICAL ENGINEERING GROUP



**MAHARASHTRA STATE BOARD OF
TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)**

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the following:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

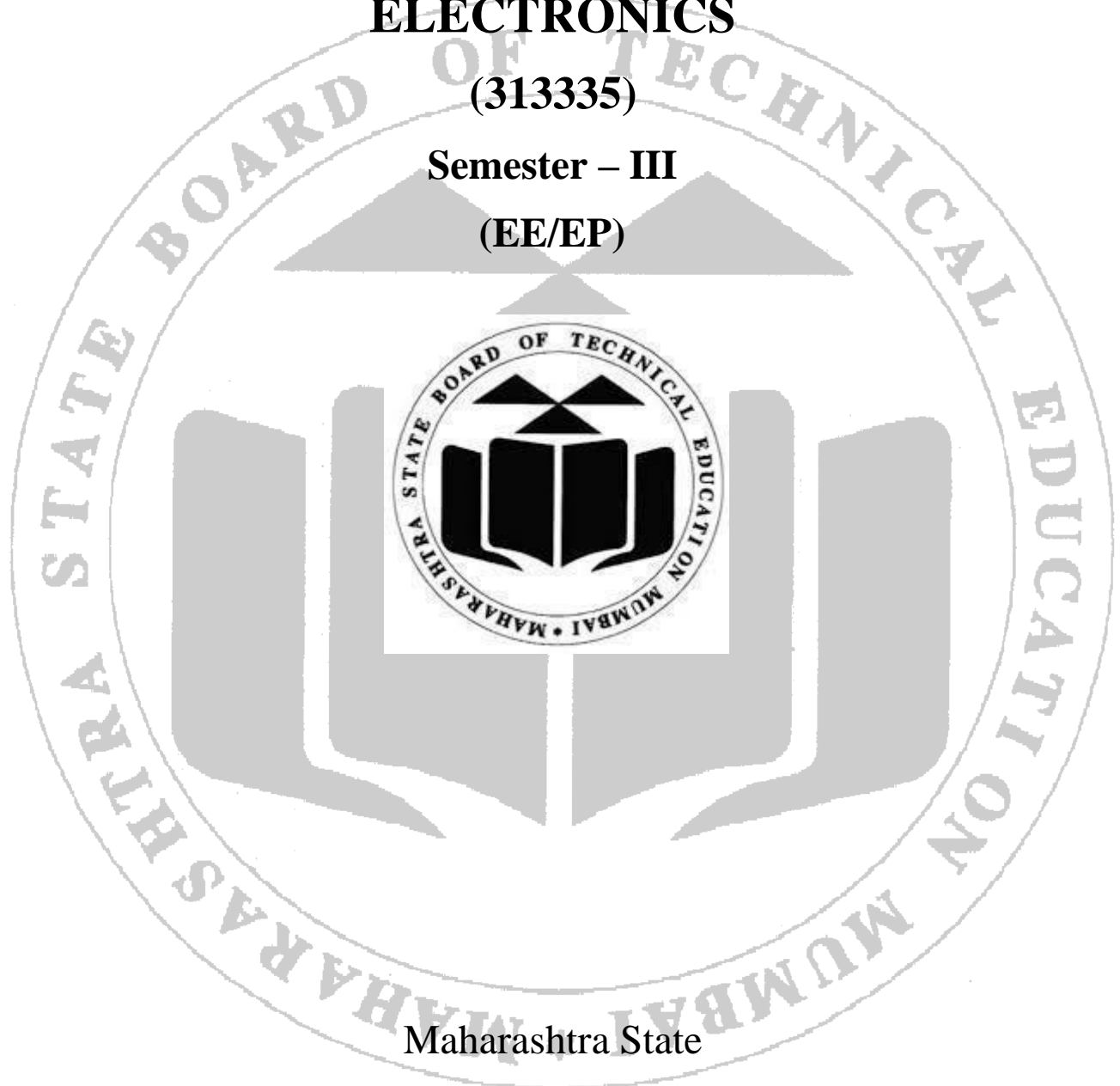
A Laboratory Manual For

**FUNDAMENTALS OF POWER
ELECTRONICS**

(313335)

Semester – III

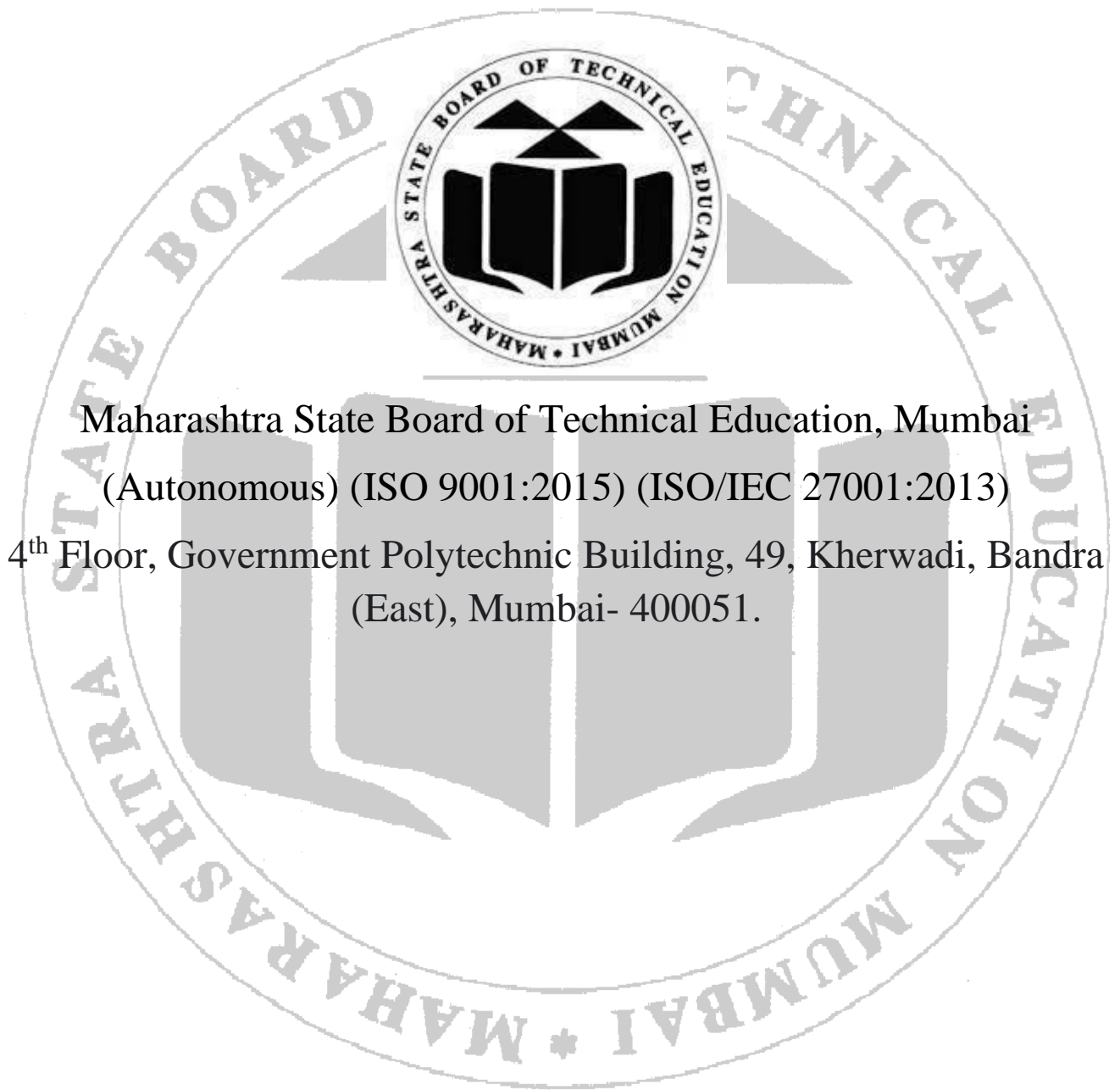
(EE/EP)



Maharashtra State

Board of Technical Education, Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)



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4th Floor, Government Polytechnic Building, 49, Kherwadi, Bandra
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**MAHARASHTRA STATE
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Certificate**

This is to certify that Mr. /Ms.....

Roll No.of Third Semester of Diploma in

.....of Institute

(Code :) has completed the term work satisfactorily in course
FUNDAMENTALS OF POWER ELECTRONICS (313335) for the
academic year 20.....to 20..... as prescribed in the curriculum.

Place:

Enrollment No:

Date:

Exam Seat No:

Subject Teacher

Head of department

Principal

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programs with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher, instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a '*vehicle*' to develop this industry identified competency in every student. The practical skills are difficult to develop through "chalk and duster" activity in the classroom situation. Accordingly, the "K" scheme laboratory manual development team designed the practical to focus on the outcomes, rather than the traditional age old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected. from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the Practical Significance, industry relevant skills, course level Learning outcomes and Relevant Affective Domains which serve key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The basic aim of this course is developing skills to apply principle of single phase and three phase AC circuits and network theorems to analyze and solve simple electric circuit related problems.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

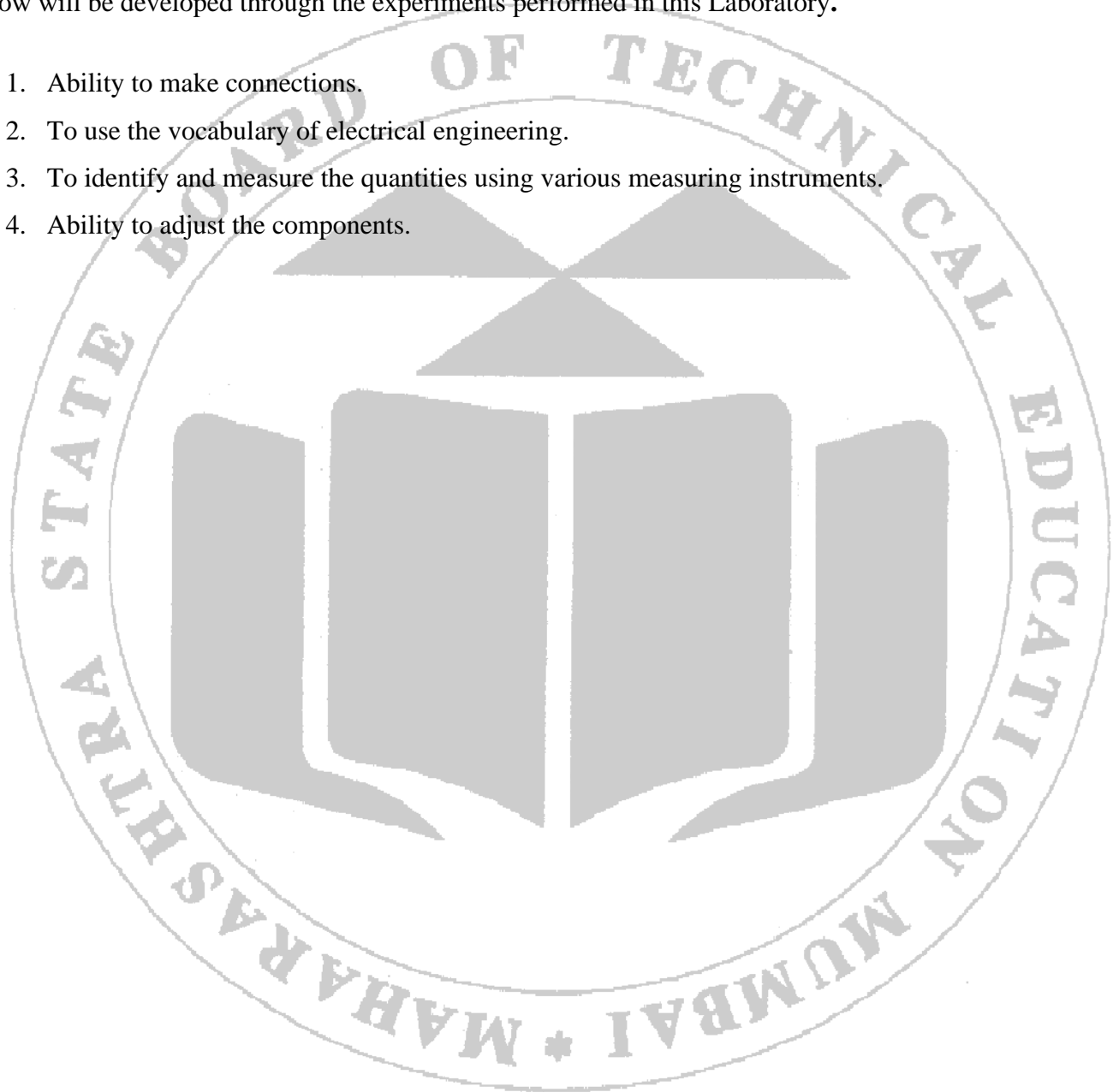
Program Outcomes (POs) to be achieved through this course learning

- **PO 1. Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.
- **PO 2. Problem analysis:** Identify and analyze well-defined engineering problems using codified standard methods.
- **PO 3. Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of system components or processes to meet specified needs.
- **PO 4. Engineering tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
- **PO 5. Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
- **PO 6. Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
- **PO 7. Life-long learning:** Ability to analyze individual needs and engage in updating in the context of technological changes.

List of Relevant expected psychomotor domain Skills

This Lab manual intends to develop expected psychomotor domain skills of students. The skills mentioned below will be developed through the experiments performed in this Laboratory.

1. Ability to make connections.
2. To use the vocabulary of electrical engineering.
3. To identify and measure the quantities using various measuring instruments.
4. Ability to adjust the components.



Practical-Course outcome matrix

COURSE LEVEL LEARNING OUTCOMES (COS)						
<ol style="list-style-type: none"> 1. CO1 – Test the functionality of a given power electronic device. 2. CO2 - Test the switching performance of a thyristor. 3. CO3 - Test the performance of given controlled converter. 4. CO4 – Test the performance of given chopper. 5. CO5 - Use suitable power electronic circuit for given application. 						
Sr. No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
1	*Power Electronic Devices	✓	-	-	-	-
2	*V-I Characteristics of SCR.	✓	-	-	-	-
3	*Testing of power MOSFET.	✓	-	-	-	-
4	*Testing of IGBT.	✓	-	-	-	-
5	Testing of TRIAC.	✓	-	-	-	-
6	*Performance of Snubber circuit.	-	✓	-	-	-
7	*Resistance triggering circuit of SCR.	-	✓	-	-	-
8	RC triggering circuit of SCR.	-	✓	-	-	-
9	Triggering of SCR using Pulse transformer	-	✓	-	-	-
10	*Class A (Load Commutation) commutation circuit.	-	✓	-	-	-
11	Class F (Line Commutation) commutation circuit	-	✓	-	-	-
12	*Operation of single phase half wave controlled rectifier with resistive load.	-	✓	✓	-	-
13	Operation of single phase half wave controlled rectifier with RL load without freewheeling diode.	-	✓	✓	-	-
14	*Operation of single phase half wave controlled rectifier with RL load with freewheeling diode.	-	✓	✓	-	-

15	Operation of single phase full wave controlled rectifier with R load.	-	✓	✓	-	-
16	*Operation of single phase full wave controlled rectifier with RL load.	-	✓	✓	-	-
17	Operation of three phase full wave controlled rectifier with R load.	-	✓	✓	-	-
18	*Voltage control using controlled rectifier.	-	✓	✓	-	-
19	*Operation of single phase half wave bridge inverter with resistive load.	-	✓	✓	-	-
20	Operation of single phase full wave bridge inverter with resistive load.	-	✓	✓	-	-
21	Operation of single phase half wave bridge inverter with RL load.	-	✓	✓	-	-
22	Operation of single phase full wave bridge inverter with RL load.	-	✓	✓	-	-
23	Operation of step-up chopper.	-	✓	-	✓	-
24	*Operation of step-down chopper.	-	✓	-	✓	-
25	Charge controller in PV system	-	-	-	✓	✓
26	*Demonstration of AC to AC converter (with DC link) used in wind power plant.	-	-	✓	✓	✓
27	*Speed control of fan using TRIAC.	-	-	✓	-	✓

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each experiment
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry. Circuit diagrams provided in manual include major components only with connections based on general concept. Teachers shall provide inputs to students for connections of additional components if required or any specific connection.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
9. Practical No 26 is a demonstration expected to conduct using one of suitable tools like experimentation kit, simulation software, animation videos, nearest site visit etc. Respective faculty shall decide appropriate method to conduct this practical as per available resource.

Instructions for Students

1. Listen carefully the lecture given by teacher about subject, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record all programs.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines.
7. Student should develop habit to submit the practical's on date and time.
8. Student should well prepare while submitting write-up of exercise.
9. Attach/paste separate papers wherever necessary.
10. Circuit diagrams provided in manual include major components only with connections based on general concept. Students shall seek inputs from teachers for connections of additional components if required or any specific connection.
11. Practical No 26 is a demonstration expected to conduct using one of suitable tools like experimentation kit, simulation software, animation videos, nearest site visit etc. Students shall follow the instruction of respective faculty for the performance of this practical and prepare a report accordingly.

Content Page

List of Practical's and Progressive Assessment Sheet

Sr. No.	Title of the Practical	Page no.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated sign. of Teacher	Remarks (If any)
1	*Power Electronic Devices	16					
2	*V-I Characteristics of SCR.	23					
3	*Testing of power MOSFET.	29					
4	*Testing of IGBT.	37					
5	Testing of TRIAC.	44					
6	*Performance of Snubber circuit.	52					
7	*Resistance triggering circuit of SCR.	58					
8	RC triggering circuit of SCR.	65					

9	Triggering of SCR using Pulse transformer	69					
10	*Class A (Load Commutation) commutation circuit.	74					
11	Class F (Line Commutation) commutation circuit	81					
12	*Operation of single phase half wave controlled rectifier with resistive load.	85					
13	Operation of single phase half wave controlled rectifier with RL load without freewheeling diode.	89					
14	*Operation of single phase half wave controlled rectifier with RL load with freewheeling diode.	96					
15	Operation of single phase full wave controlled rectifier with R load.	103					
16	*Operation of single phase full wave controlled rectifier with RL load.	109					

17	Operation of three phase full wave controlled rectifier with R load.	115					
18	*Voltage control using controlled rectifier.	121					
19	*Operation of single phase half wave bridge inverter with resistive load.	128					
20	Operation of single phase full wave bridge inverter with resistive load.	134					
21	Operation of single phase half wave bridge inverter with RL load.	140					
22	Operation of single phase full wave bridge inverter with RL load.	147					
23	Operation of step-up chopper.	154					
24	*Operation of step-down chopper.	160					

25	Charge controller in PV system	166					
26	*Demonstration of AC to AC converter (with DC link) used in wind power plant.	##					
27	*Speed control of fan using TRIAC.	171					

Note :

Out of above suggestive LLOs -

- * Marked Practical's (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs is to be performed to achieve desired outcomes.
- ##Read the guideline (9) and instruction (11) given on page number 10.

Practical No. 1: Identify given power electronic device. (SCR, IGBT, power MOSFET or TRIAC)

I Practical Significance:

Power electronic devices play a crucial role in modern electrical and electronic systems, enabling the efficient control and conversion of electrical power. Their practical significance can be highlighted in various applications and industries like renewable energy, electric vehicle, FACTS, HVDC, etc.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the functionality of a given power electronic device.

IV Laboratory Learning Outcome(s)

LLO 1. Identify given power electronic device.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

1. SCR (Silicon-Controlled Rectifier): It is a unidirectional device with anode (A), cathode (K), and gate (G) terminals. SCR conducts current when a gate pulse is applied. It requires commutation arrangement to turn off. It usually has three terminals (A, K, G) and a heat sink. It is generally used for rectifiers and motor control.

2. IGBT (Insulated-Gate Bipolar Transistor): It combines the characteristics of a MOSFET and a bipolar transistor, with terminals for collector (C), emitter (E), and gate (G). It is a voltage-controlled device with high input impedance and low on-state voltage drop. It generally has three terminals (C, E, G) and a heat sink. Applications of IGBT are in inverters, motor drives, switching power supplies.

3. Power MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor): Power MOSFET is similar to a standard MOSFET but designed for high power applications, with drain (D), source (S), and gate (G) terminals. It is a voltage-controlled device with high switching speed. It typically has three terminals (D, S, G), often with a heat sink. Applications: High-frequency applications, DC-DC converters, SMPS.

4. TRIAC (Triode for Alternating Current): It is a bidirectional device with terminals MT1, MT2 (Main Terminals), and gate (G). It conducts current in both directions when triggered by a gate pulse. It generally has three terminals (MT1, MT2, G), often with a heat sink. Applications: Light dimmers, motor speed control, phase control.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

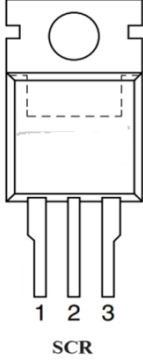


Fig. No. 1.1 Diagram for SCR



Fig. No. 1.2 Diagram for IGBT



Fig. No. 1.3 Diagram for power MOSFET

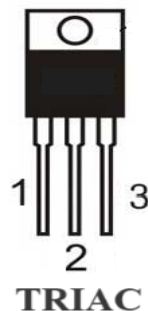


Fig. No. 1.4 Diagram for TRIAC

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Power MOSFET	V_{ds} -400V, I_d -10A-6.3A PD-125W	2
2	SCR	$I_{rms} = 16A$, $I_H = 100mA$, $I_L = 200mA$, $I_{GT} = 90$ to 35 mA, $V_{GT} = 3$ to 1 V, $V_{rms} = 1600V$	2
3	IGBT	$V_{ces} = 1200V$, $V_{GE} = 20V$, $I_C = 139$ to $93A$, PD = 650 to 300W	1
4	TRIAC	$I_t = 4A$, $I_{GT} = 10mA$, $V_t = 600V$	1

IX Precautions to be followed:

Ensure proper handling of devices to avoid damage due to static electricity.

X Procedure**a) Visual Inspection:**

1. Observe the physical structure of the given device. Look for the number of terminals, size, and presence of a heat sink.
2. Refer to the datasheet for identifying the three pins of devices.

b) Electrical Testing:

1. For SCR and TRIAC, identify the gate terminal by checking the resistance between different terminals.
2. For IGBT and Power MOSFET, identify the gate, drain/collector, and source/emitter terminals by measuring the resistance.

XI Observations and calculations

A) Visual Inspection:

SCR	
Pin No.	Name of given pin (anode, cathode, or gate)
1	
2	
3	

IGBT	
Pin No.	Name of given pin (collector, emitter, or gate)
1	
2	
3	

Power MOSFET	
Pin No.	Name of given pin (drain, source, or gate)
1	
2	
3	

SCR	
Pin No.	Name of given pin (MT1, MT2, or gate)
1	
2	
3	

B) Electrical Testing:

SCR	
Pin No.	Measures resistance between terminal
1-2	
2-3	
3-1	

IGBT	
Pin No.	Measures resistance between terminal
1-2	
2-3	
3-1	

Power MOSFET	
Pin No.	Measures resistance between terminal
1-2	
2-3	
3-1	

SCR	
Pin No.	Measures resistance between terminal
1-2	
2-3	
3-1	

XII Results:

1. Off state resistance of SCR is
2. Off state resistance of IGBT is
3. Off state resistance of power MOSFET is
4. Off state resistance of TRIAC is

XIII Interpretation of results:

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.....

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Identify theoretical values of given component from datasheets	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 2: Performance of SCR (Silicon Controlled Rectifier)

I Practical Significance:

The SCRs are capable to control the power given to the load by controlling its firing angle. SCRs are typically used at the highest energy levels in power conditioning circuits because they are designed to handle the largest currents and voltages of any device technology (systems with voltages approximately greater than 1 kV or currents higher than 100 A). SCRs are used for industrial applications such as motor speed control, battery charging and HVDC.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the functionality of a given power electronic device.

IV Laboratory Learning Outcome(s)

LLO 1. Test the performance of SCR.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Silicon Controlled Rectifier (SCR) is a unidirectional semiconductor device made of silicon. SCR is a three terminal, four-layer as p-n-p-n and three junction device.

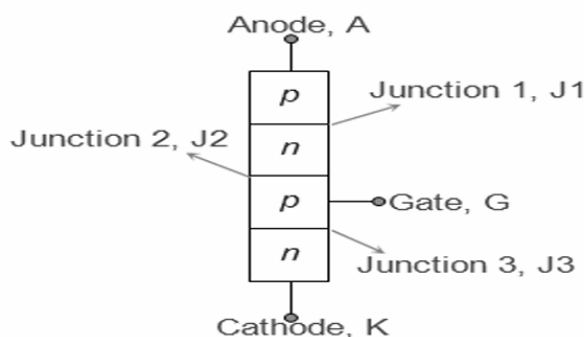


Fig. 2.1 Layered structure of SCR

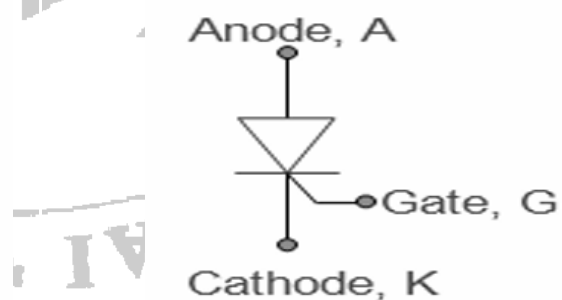


Fig. 2.2 Symbol of SCR

VII Actual Circuit diagram used in laboratory with equipment Specifications:

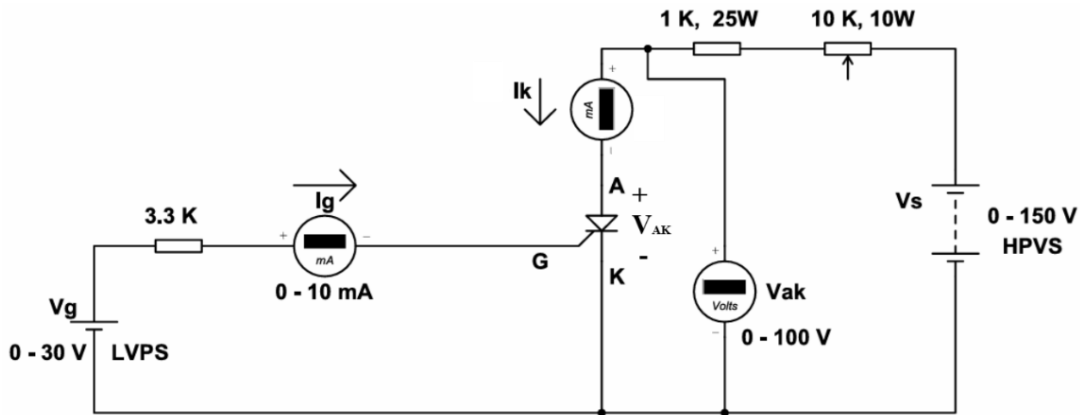


Fig. 2.3 Circuit diagram for forward characteristics of SCR

Note: Students should trace the circuit from the available KIT / kit manual. Also, go through the data sheet for the SCR and then, use relevant SCR, power supplies, voltmeter, ammeters.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-150 V DC, 0-30 V DC	2
2	Digital Voltmeter	0-150V DC	1
3	Digital Ammeter	0-30 mA, 0-150 mA	2
4	SCR	TYN604 /TYN612 or any other available	1
5	Resistors	$R_L = 10\text{ K}\Omega$, 10 watt $R_G = 3.3\text{ K}\Omega$, 0.25 watt	1 each

Note: Also, go through the data sheet of the SCR available on the Kit and then, use relevant power supplies, voltmeter, ammeters and resistors.

IX Precautions to be followed:

1. Ensure that all the knobs of the power supplies are at zero value before switching them on.
2. Do not increase the voltage, current more than its rated value.
3. Reading should be noted without parallax error.

X Procedure

a) For forward characteristics :

1. Make the circuit connection as per the circuit diagram.
2. Keep knobs of DC supplies to zero

3. Switch on power supply.
4. Set $I_G = 0$ mA.
5. Increase V_{AK} power supply gradually and when I_A flows, then this V_{AK} is called as V_{BO} .
6. Set $I_{G1} = 2$ mA, increase V_{AK} power supply gradually till SCR turns ON and record the readings of V_{AK} and I_A .
7. Set I_{G2}, I_{G3} ($I_{G3} > I_{G2} > I_{G1}$) and repeat step 6.
8. Record I_A for I_{G1}, I_{G2}, I_{G3} respectively.
9. Plot I_A versus V_{AK} curves for various values of I_G on graph paper.

b) To determine latching current:

1. Set V_{AK} to any suitable value given by the teacher.
2. Apply sufficient gate current and turn ON the SCR.
3. After the SCR has turned ON, remove gate current.
4. If SCR remains ON, then switch off V_{AK} .
5. Increase the value of resistor (R_L) and turn ON the SCR at lower I_A .
6. As the value of R_L is increased, I_A will go on decreasing, record lowest value of I_A at which SCR remains ON even after gate current is removed.
7. The lowest value of I_A is the latching current.

c) To determine holding current:

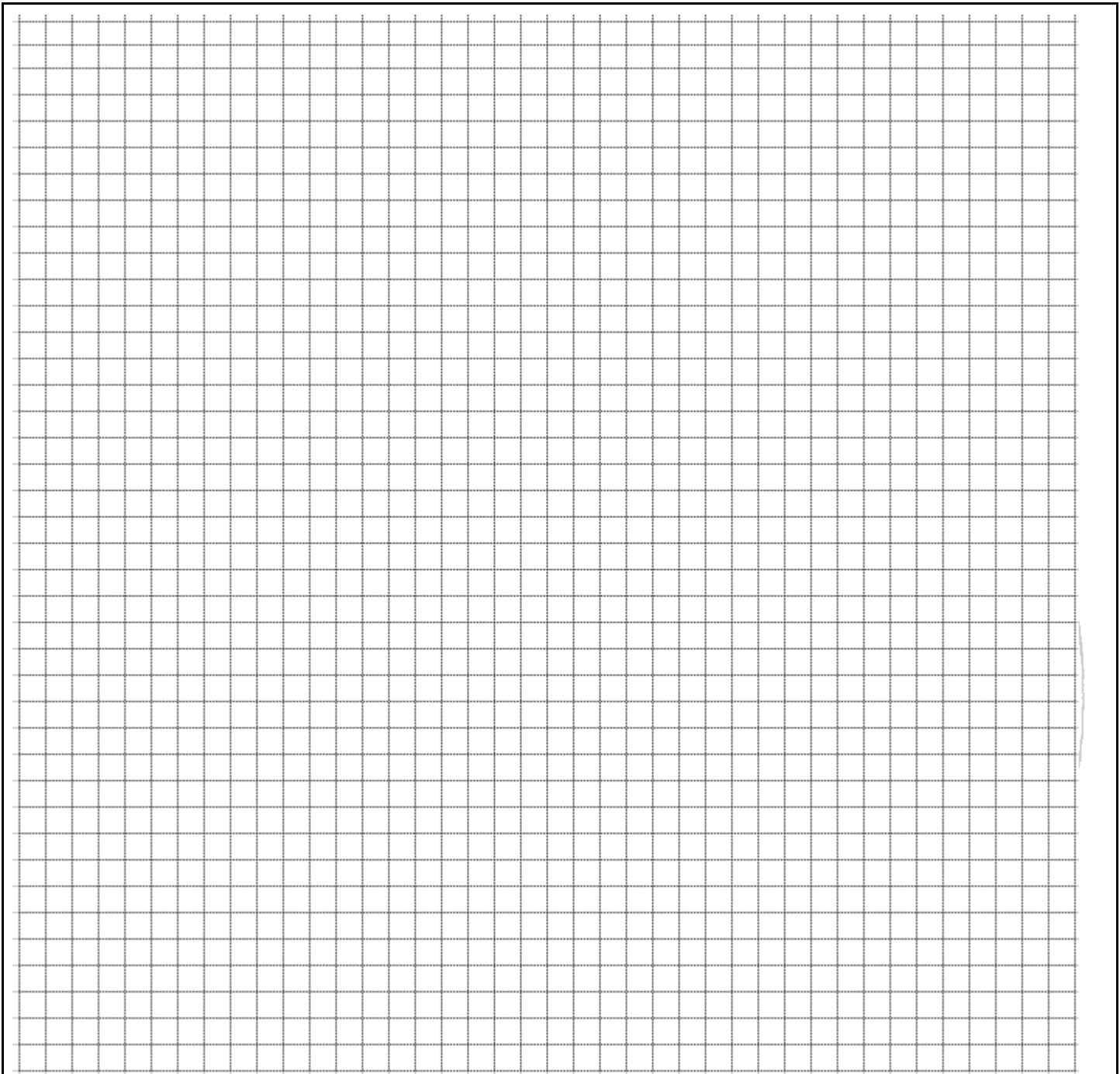
1. Set V_{AK} to suitable value and increase gate current gradually to turn the SCR on and absolutely small I_A flows through it.
2. Now remove gate current if the SCR turns off, then as per step no. 1 for minimum I_g if a Min I_A flows through the SCR, then it is called I_H note it down.
3. Gradually increase R which will decrease I_A .
4. Record the lowest value of I_A at which SCR turns OFF. This is the holding current.

XI Observations and calculations

Sr. No.	$I_{G1} =$ mA		$I_{G2} =$ mA		$I_{G3} =$ mA	
	V_{AK}	I_A	V_{AK}	I_A	V_{AK}	I_A
1						
2						
3						
4						
5						
6						

XII Results:

1. $V_{BO} =$
2. Holding Current, $I_H =$
3. Latching current, $I_L =$



Title of Graph:

XIII Interpretation of results:

.....
.....
.....

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 3: Performance of Power MOSFET

I Practical Significance:

Power MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) play a crucial role in electrical engineering due to their high efficiency and fast switching capabilities, making them ideal for power conversion and management in various applications. They are widely used in power supplies, inverters, and motor drives because they can handle high voltages and currents with minimal losses. Their low on-resistance reduces power dissipation, improving the overall efficiency of systems like DC-DC converters. Power MOSFETs are also essential in renewable energy systems, such as solar inverters and electric vehicle (EV) charging stations, where efficient power handling is critical. They offer excellent thermal stability and can operate at high frequencies, which allows for compact and lightweight power electronics designs.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the functionality of a given power electronic device.

IV Laboratory Learning Outcome(s)

LLO 1. Test the proper functioning of power MOSFET.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A power MOSFET has three terminals called drain, source and gate in place of the corresponding three terminals collector, emitter and base for BJT. The circuit symbol of power MOSFET is as shown in Fig. 3.1. Here the arrow indicates the direction of electron flow. A BJT is a current controlled device whereas a power MOSFET is a voltage-controlled device. As its operation depends upon the flow of majority carriers only, MOSFET is a unipolar device. The control signal, or base current in BJT is much larger than the control signal (or gate current) required in a MOSFET. This is because of the fact that gate circuit impedance in MOSFET is extremely high, of the order of 10^9 ohm. This large impedance permits the MOSFET gate to be driven directly from microelectronic circuits. BJT suffers from second breakdown voltage whereas MOSFET is free from this problem. Power MOSFETs are now finding increasing applications in low-power high frequency converters.

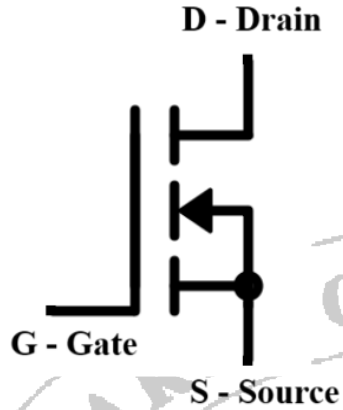


Fig. 3.1: Symbol of Power MOSFET

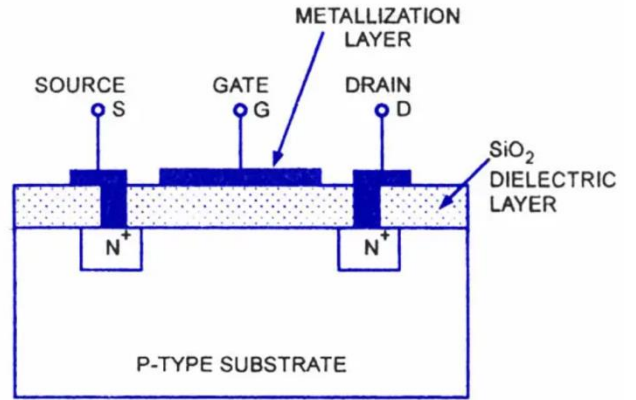


Fig. 3.2: Basic Structure of Power MOSFET

VII Actual Circuit diagram used in laboratory with equipment Specifications:

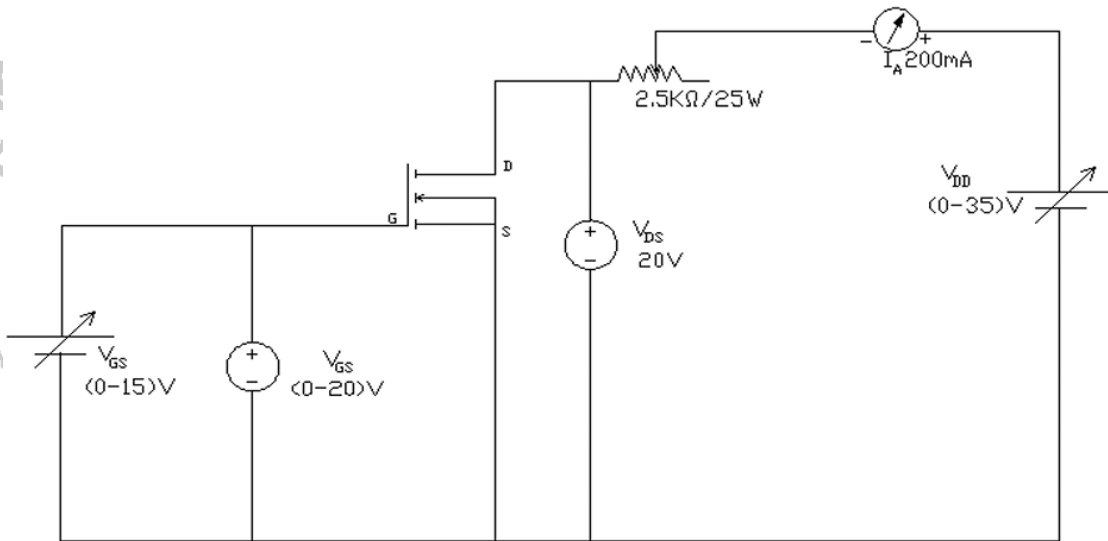


Fig. 3.3: Circuit Diagram for Obtaining Characteristics of Power MOSFET

Note: Students should trace the circuit from the available KIT / kit manual. Also, go through the relevant data sheets and then, use relevant SCR, power supplies, voltmeter, ammeters.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-50 V DC	1
2	Digital Voltmeter	0-50V DC	1
3	Digital Voltmeter	0-15V DC	1
4	Regulated power supply	0-20 V DC	1
5	Digital Ammeter	0-500 mA	1
6	Power MOSFET	V _{ds} -400V, I _D -10A-6.3A P _d -125W	1
7	Resistors	2.5kohm / 25W	1

IX Precautions to be followed:

1. Ensure that all the knobs of the power supplies are at zero value before switching them on.
2. Identify Gate, Source, and Drain terminals of the given power MOSFET and make the connections as shown in the circuit diagram.
3. Ensure that the voltage and current applied during testing do not exceed the MOSFET's rated limits, as this can lead to permanent damage.
4. Use the appropriate heat sink if required.
5. Reading should be noted without parallax error.

X Procedure

a) Transfer Characteristic :

1. Make the circuit connection as per the circuit diagram.
2. Switch on the equipment. Keep V_{DS} say 10V, vary V_{GS} in steps.
3. Note down the corresponding drain current I_D.
4. Tabulate the readings in the table.
5. Plot a graph of I_D against V_{GS}.

b) Output Characteristics:

1. Keep V_{GS} constant, (V_{GS} must be within the range determined by transfer characteristics).
2. Vary V_{DS} in steps, note down corresponding I_D.
3. Repeat step 2 for different values of V_{GS}.
4. Tabulate the readings in the table.
5. Plot a graph of I_D against V_{DS} for different V_{GS}.

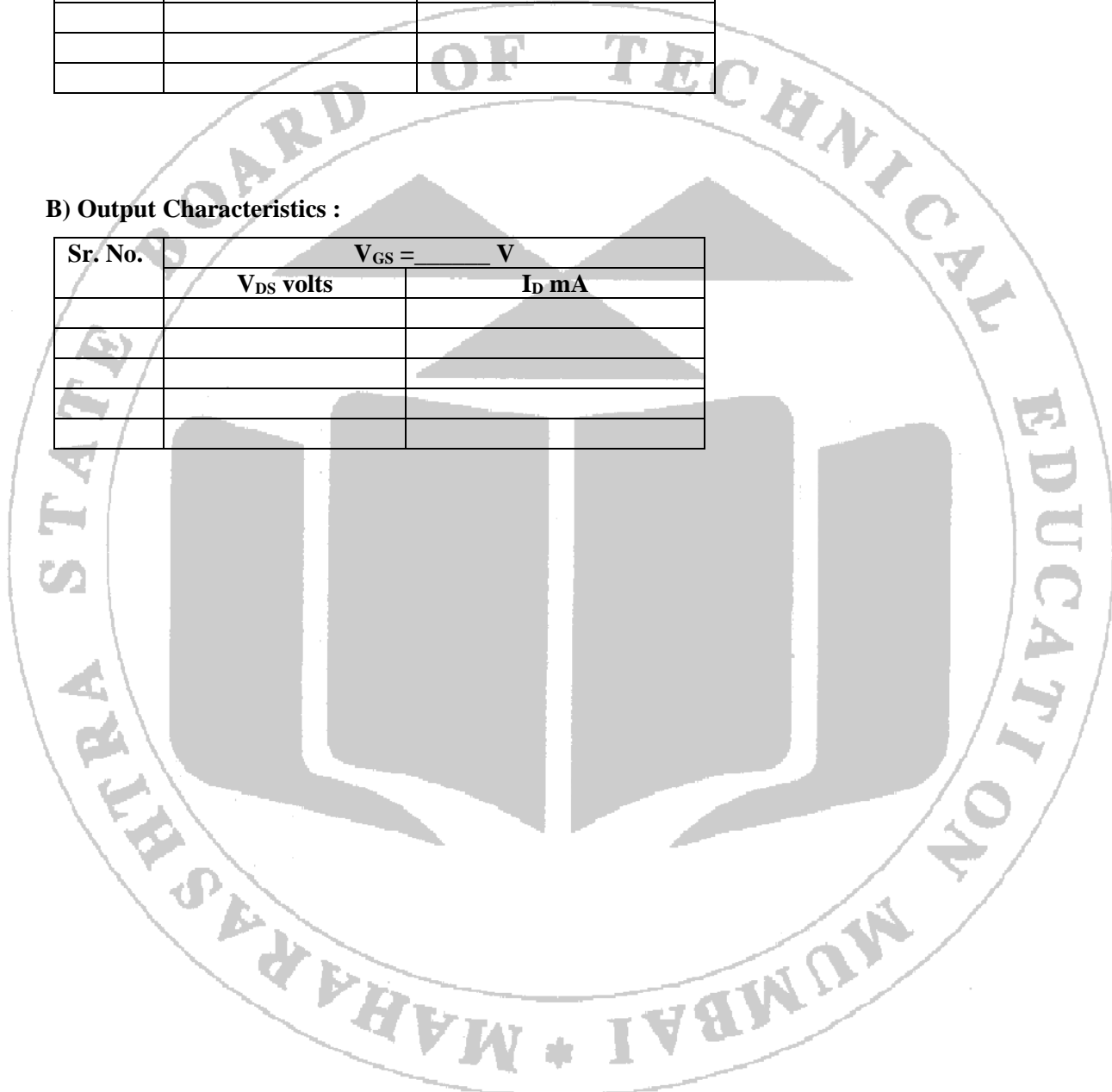
XI Observations and calculations

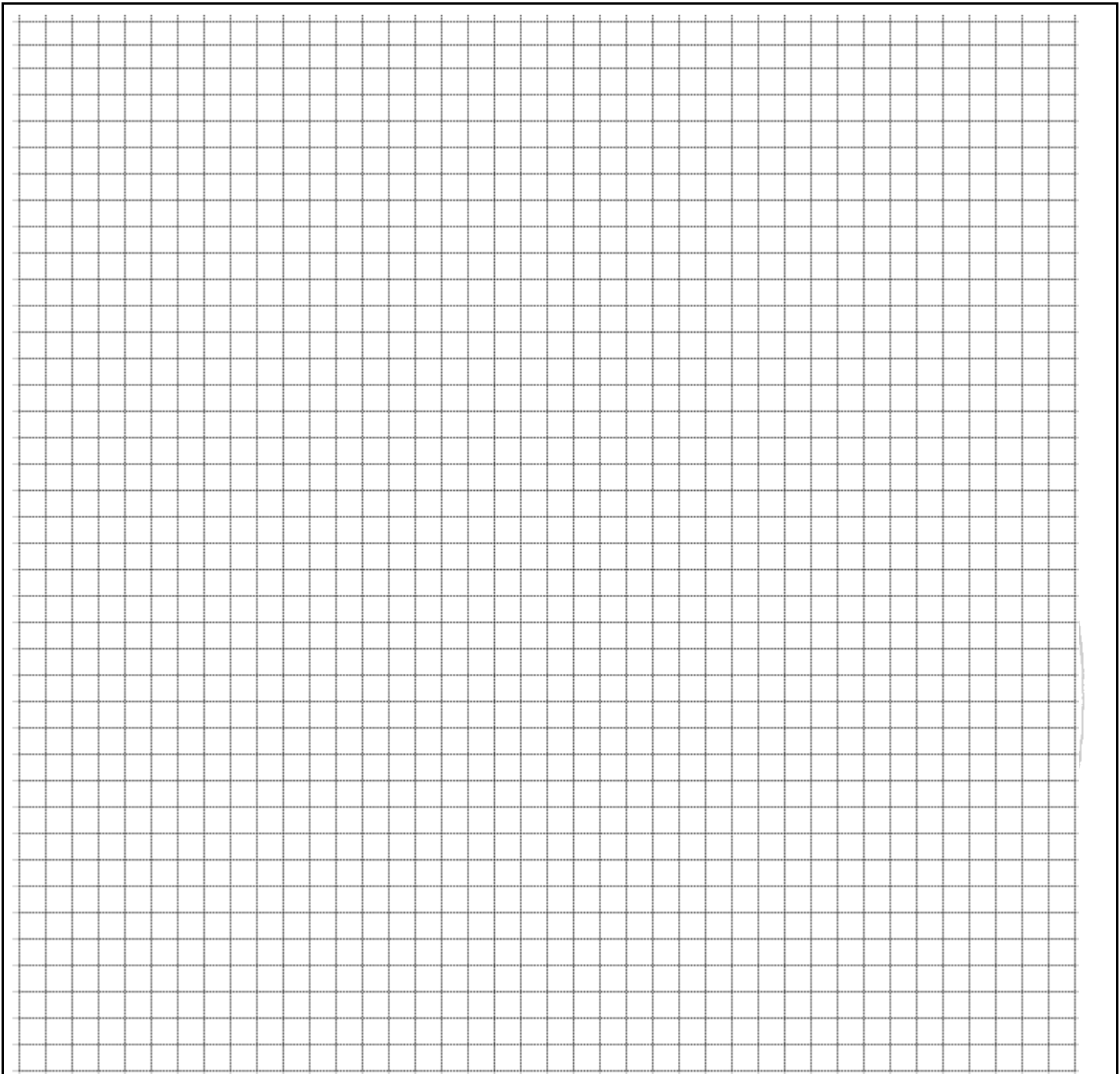
A) Transfer Characteristics :

Sr. No.	$V_{DS} = \underline{\hspace{2cm}} \text{ V}$	
	V_{GS} volts	I_D mA

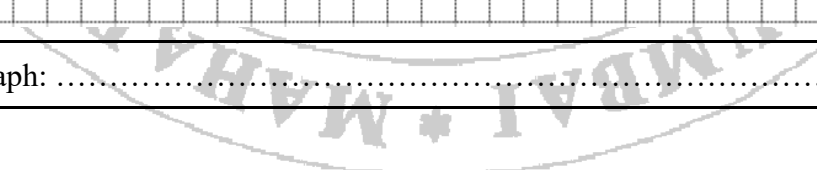
B) Output Characteristics :

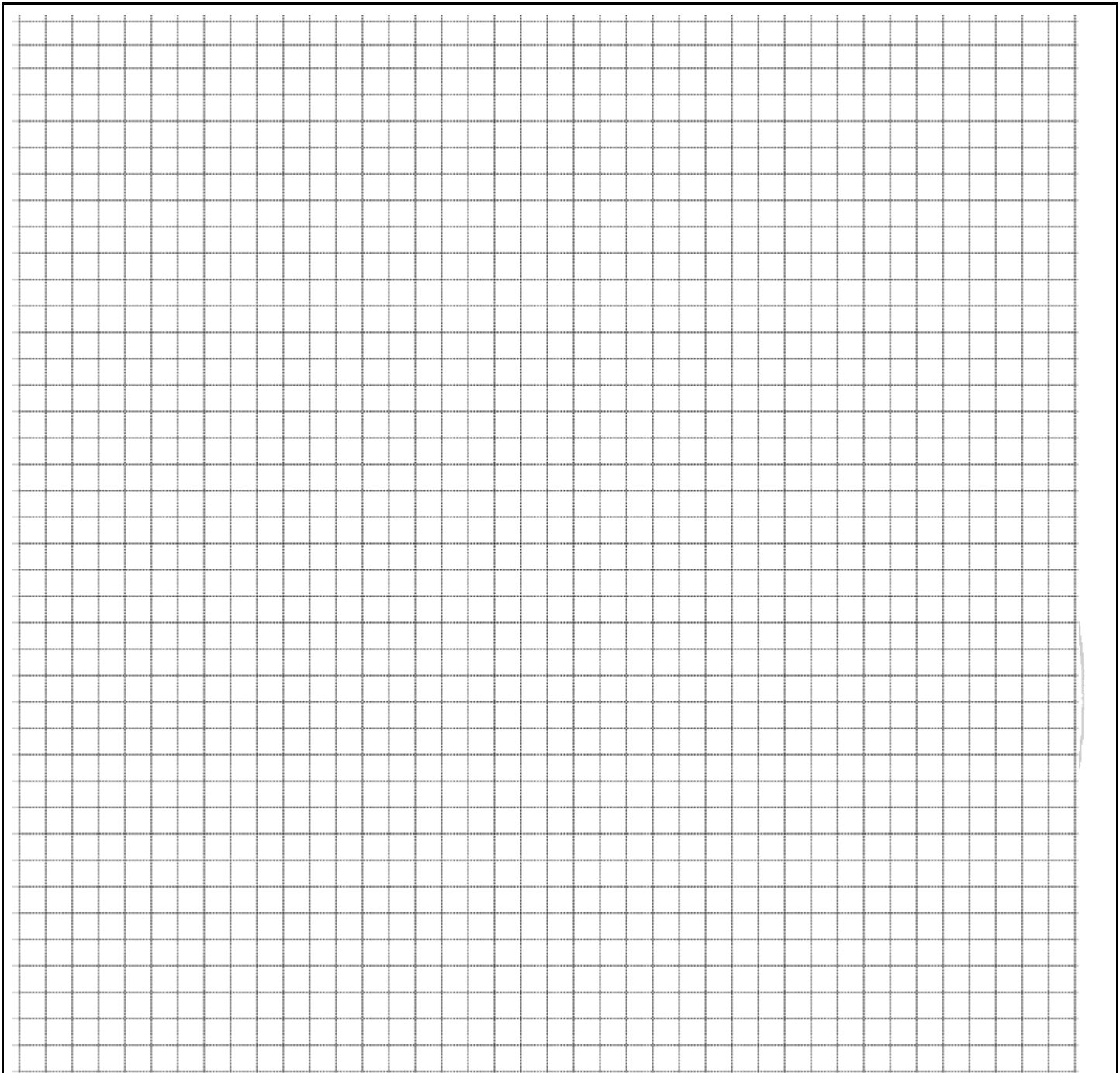
Sr. No.	$V_{GS} = \underline{\hspace{2cm}} \text{ V}$	
	V_{DS} volts	I_D mA





Title of Graph:





Title of Graph:

XII Results:

1. Threshold voltage of the given power MOSFET $V_{GST} = \dots\dots\dots V$

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 4: Performance of IGBT (Insulated Gate Bipolar Transistor)

I Practical Significance:

This device is designed to make use of the benefits of both BJT and MOSFET devices. IGBTs are widely used in medium power applications such as dc and ac motor drives, UPS systems, power supplies and drives for solenoids, relays and contactors. It increases the efficiency, dynamic performance and reduces the level of the audible noise (typically operated at high frequency more than 20 KHz).

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the functionality of a given power electronic device.

IV Laboratory Learning Outcome(s)

LLO 1. Test the proper functioning of IGBT

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

IGBT is a hybrid MOS gated turn-on/turn-off bipolar transistor that combines the attributes of MOSFET, BJT and thyristor. It has the input characteristics of a MOSFET and an output characteristics of a bipolar transistor. That means it has high input impedance and low on state conduction loss. But it has no second breakdown problem like BJT. It has simple drive circuit, wide safe operating area, peak current capability, ruggedness and bipolar voltage blocking capability like a thyristor. It has three terminals, Collector (C), Emitter (E), source(S),and gate(G),according to a MOSFET model or emitter(E),collector(C),and gate(G), according to a BJT model.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

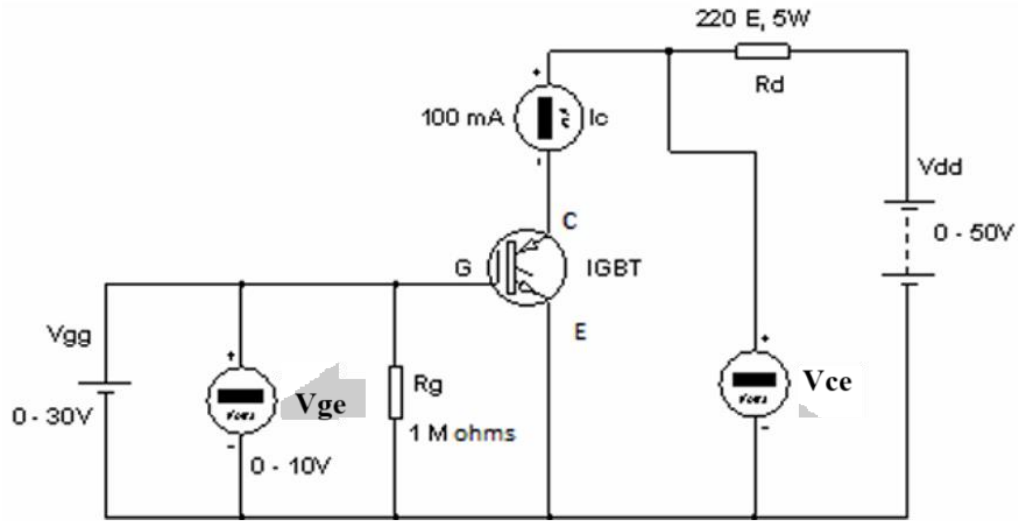


Fig. No. 4.1 Circuit Diagram for VI Characteristics of IGBT

Note: Students should trace the circuit from the available KIT / kit manual. Also, go through the relevant data sheets and then, use relevant SCR, power supplies, voltmeter, ammeters.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-50 V DC	2
2	Digital Voltmeter	0-50V DC	2
3	Digital Ammeter	0-500 mA	1
4	IGBT	IRG4BC20U	1
5	Resistors	Rg = 1 MO Rd = 220 2	2

IX Precautions to be followed:

1. Ensure that all the knobs of the power supplies are at zero value before switching them on.
2. Identify Gate, Collector, and Emitter terminals of the given IGBT and make the connections as shown in the circuit diagram.
3. The applied voltage, current should not exceed the maximum rating of the given IGBT.
4. If the IGBT is getting heated, either use an appropriate heat sink or limit the collector current.
5. Reading should be noted without parallax error .

X Procedure

a) Transfer Characteristic :

1. Make the circuit connection as per the circuit diagram.
2. Keep knobs of DC supplies to zero
3. Switch on power supply.
4. Set $V_{CE} = 10V$ and gradually vary power supply V_{gg} in steps of 1V and note down I_c and V_{ge} .
5. The minimum gate voltage V_{ge} required for conduction of IGBT is called the threshold voltage $V_{ge(TH)}$.
6. Plot the transfer characteristics (I_c versus V_{ge}) on graph paper.

b) Output Characteristics:

1. Switch on the power supply V_{gg} and set $V_{ge} \geq V_{ge(TH)}$.
2. Now increase power supply V_{dd} gradually in steps of 2V from zero and record V_{ce} and I_c .
3. Repeat step 2 for two more values of V_{ge} .
4. Plot the output characteristics (I_c versus V_{ce}) on graph paper.

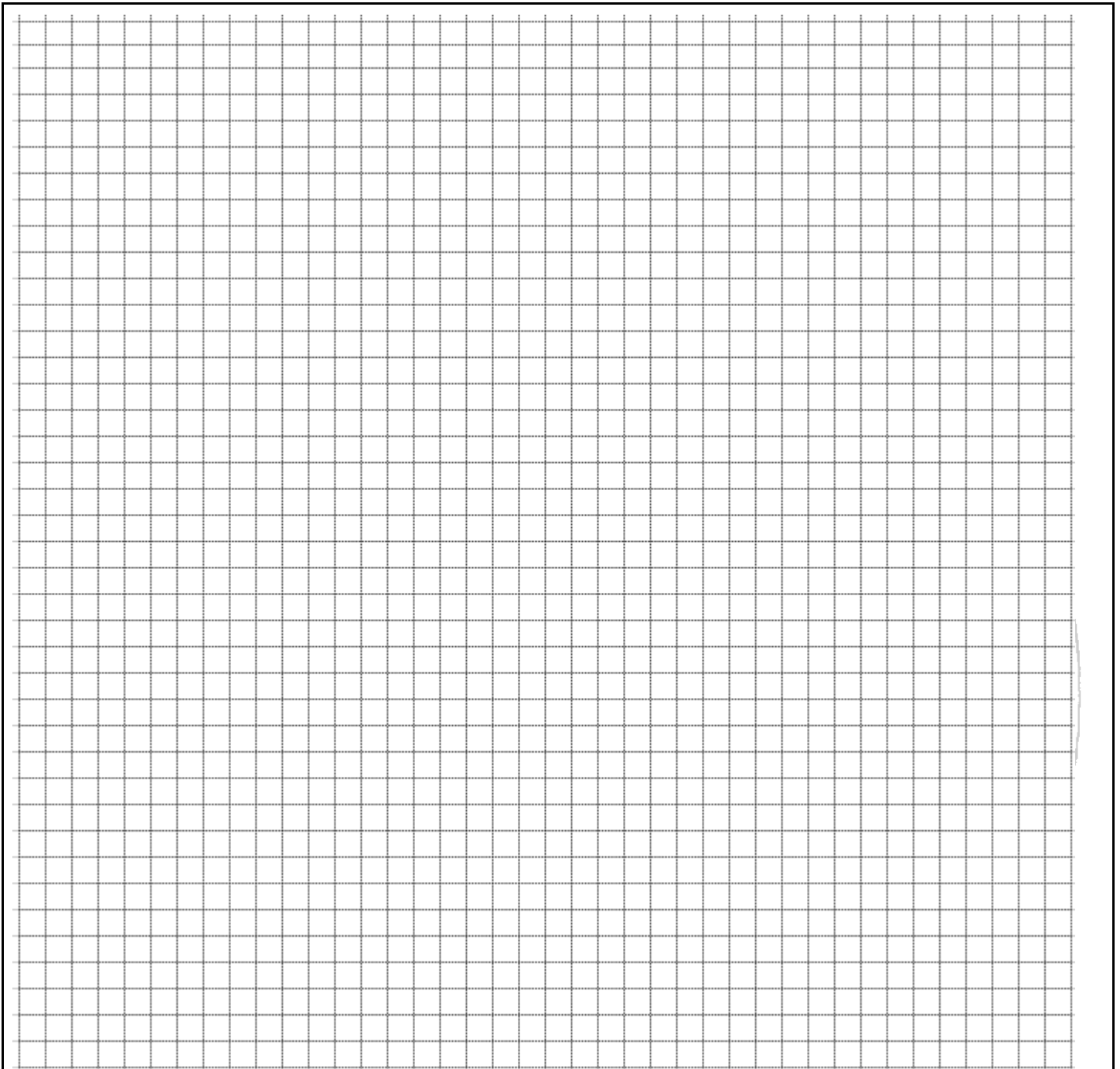
XI Observations and calculations

A) Transfer Characteristics :

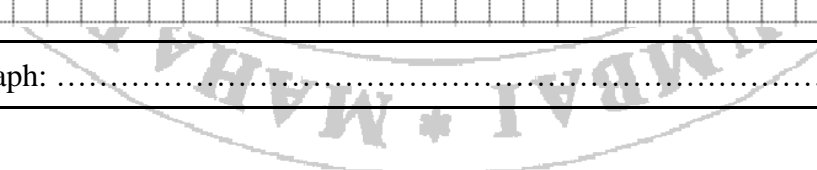
Sr. No.	$V_{ce} = 10 V$	
	V_{ge} volts	I_c mA

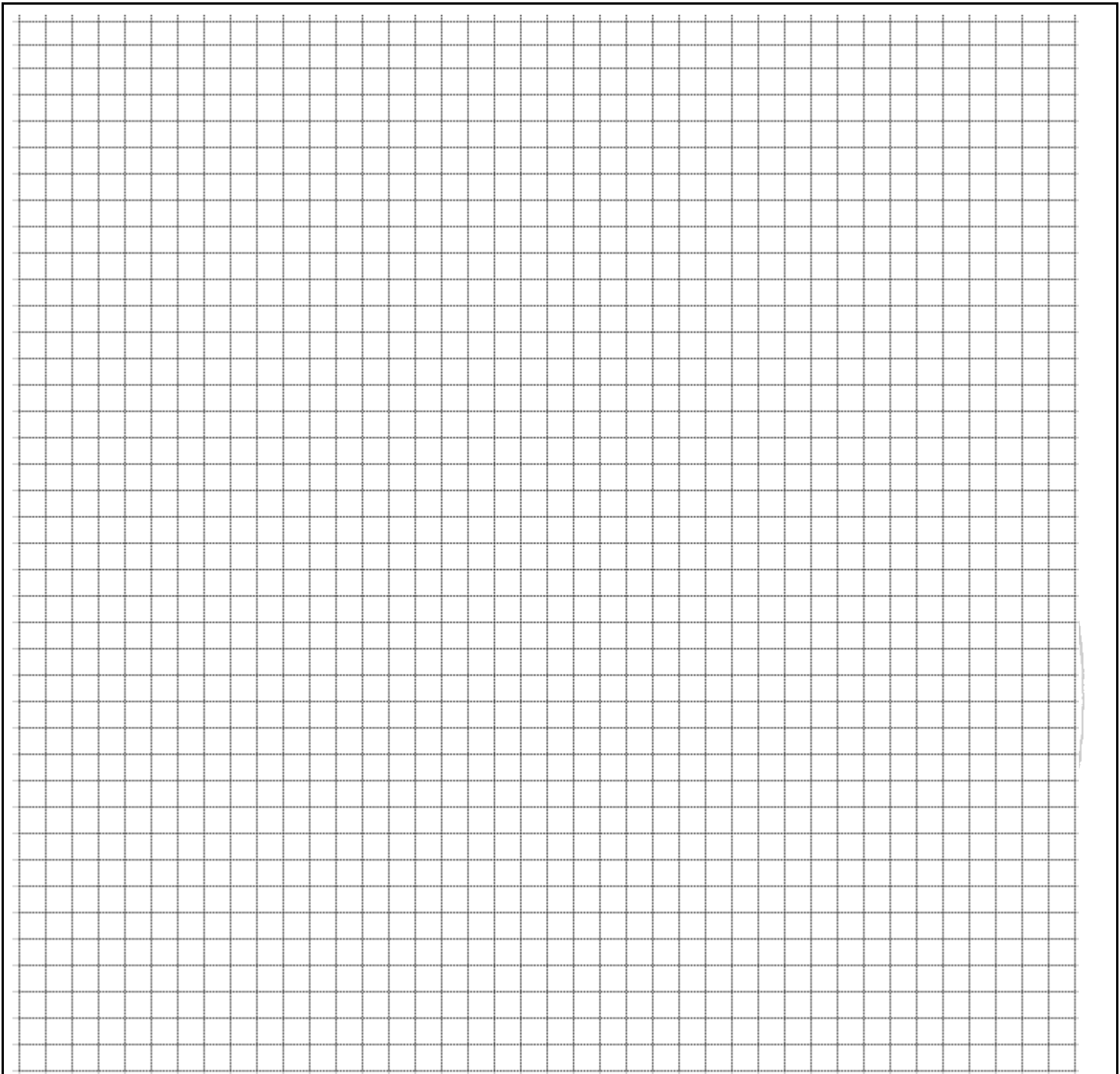
B) Output Characteristics :

Sr. No.	$V_{ge1} = V$		$V_{ge2} = V$	
	V_{ce} volts	I_c mA	V_{ce} volts	I_c mA



Title of Graph:





Title of Graph:

XII Results:

1. Threshold voltage of the given IGBT $V_{ge(TH)} = \dots\dots\dots V$
2. When $V_{ge} < V_{ge(TH)}$, $I_c = \dots\dots\dots mA$, $V_{ce} = \dots\dots\dots V$ and the IGBT switch is.....(ON/OFF)

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. Transistor database user guide,2016.

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 5: Testing of TRIAC

I Practical Significance:

A TRIAC is a semiconductor device used for controlling AC power, making it essential in various applications like light dimmers, motor speed controllers, and heating control systems. It allows for bidirectional current flow, meaning it can control the power in both halves of an AC cycle, which is ideal for AC applications. TRIACs enable precise control over the amount of power delivered to a load, allowing for smooth adjustments in lighting or motor speed. They are used in household appliances, such as fans and washing machines, to provide variable control over operation modes. TRIACs help in reducing power consumption by adjusting power delivery based on demand. They are also compact and cost-effective, making them a popular choice in consumer electronics.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the functionality of a given power electronic device.

IV Laboratory Learning Outcome(s)

LLO 1. Test the proper functioning of the TRIAC.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A TRIAC can conduct in both directions. A TRIAC is a bidirectional thyristor with three terminals. It is used extensively for control of power in AC circuits. When in operation, a TRIAC is equivalent to two SCRs connected in antiparallel. As the TRIAC can conduct in both directions, the terms anode and cathode are not applicable to TRIAC. Its three terminals are usually designated as MT1 (main terminal 1), MT2 (main terminal 2) and gate. With no signal in the gate, TRIAC will block both half cycles of applied voltage in case the peak value of the voltage is less than the break over voltage of the TRIAC. The TRIAC can however be turned ON in each half cycle of the applied voltage by applying a positive or negative voltage to MT2 with respect to MT1.

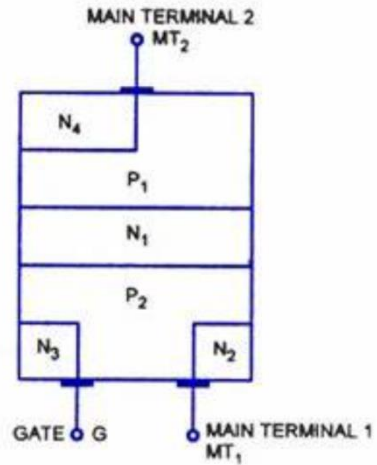


Fig. 5.1: Basic Structure of TRIAC

VII Actual Circuit diagram used in laboratory with equipment Specifications:

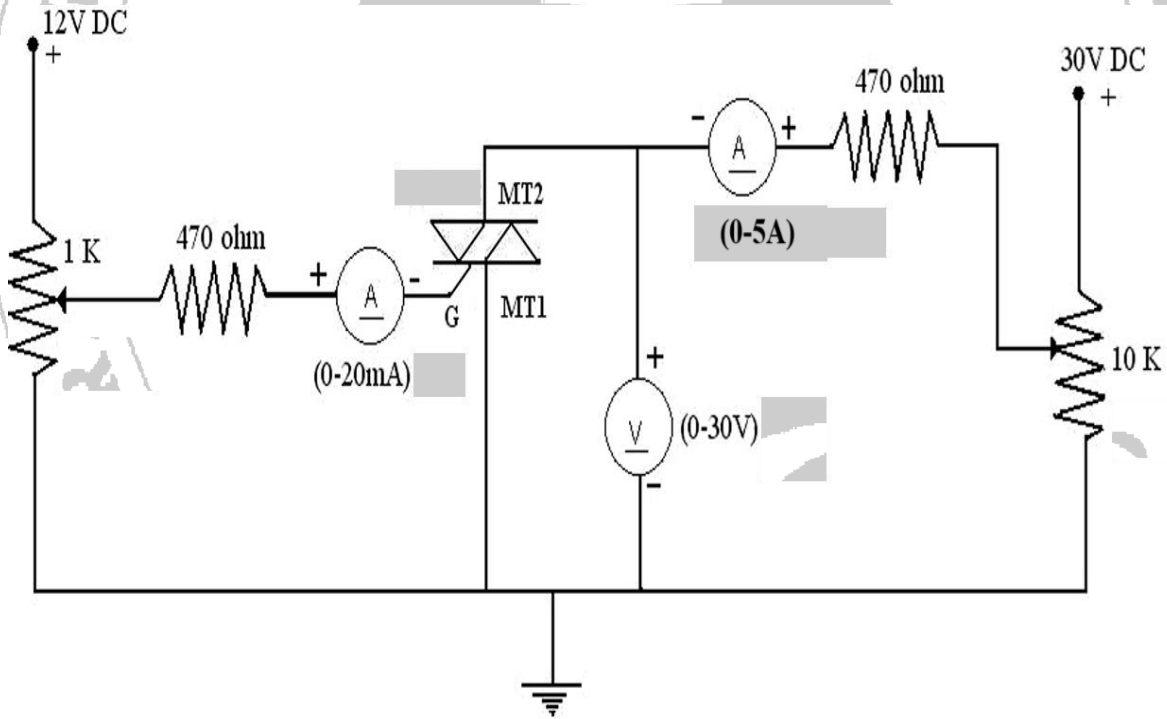


Fig. 5.2: Circuit Diagram for Testing of TRIAC

Note: Students should trace the circuit from the available KIT / kit manual. Also, go through the relevant data sheets and then, use relevant SCR, power supplies, voltmeter, ammeters.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-30 V DC	2
2	Voltmeter	0-30 V DC	1
3	Ammeter	0-20 mA DC	1
5	Ammeter	0-5 A DC	1
6	Resistor	470 Ω	2
7	Variable resistor	1K Ω	1
8	Variable resistor	10K Ω	1
9	TRIAC	$I_t = 4A, I_{GT} = 10mA, V_t = 600V$	4

IX Precautions to be followed:

1. Ensure that the connections are correct and tight to avoid any loose contacts.
2. Handle the TRIAC and other components carefully to avoid damage due to overheating.

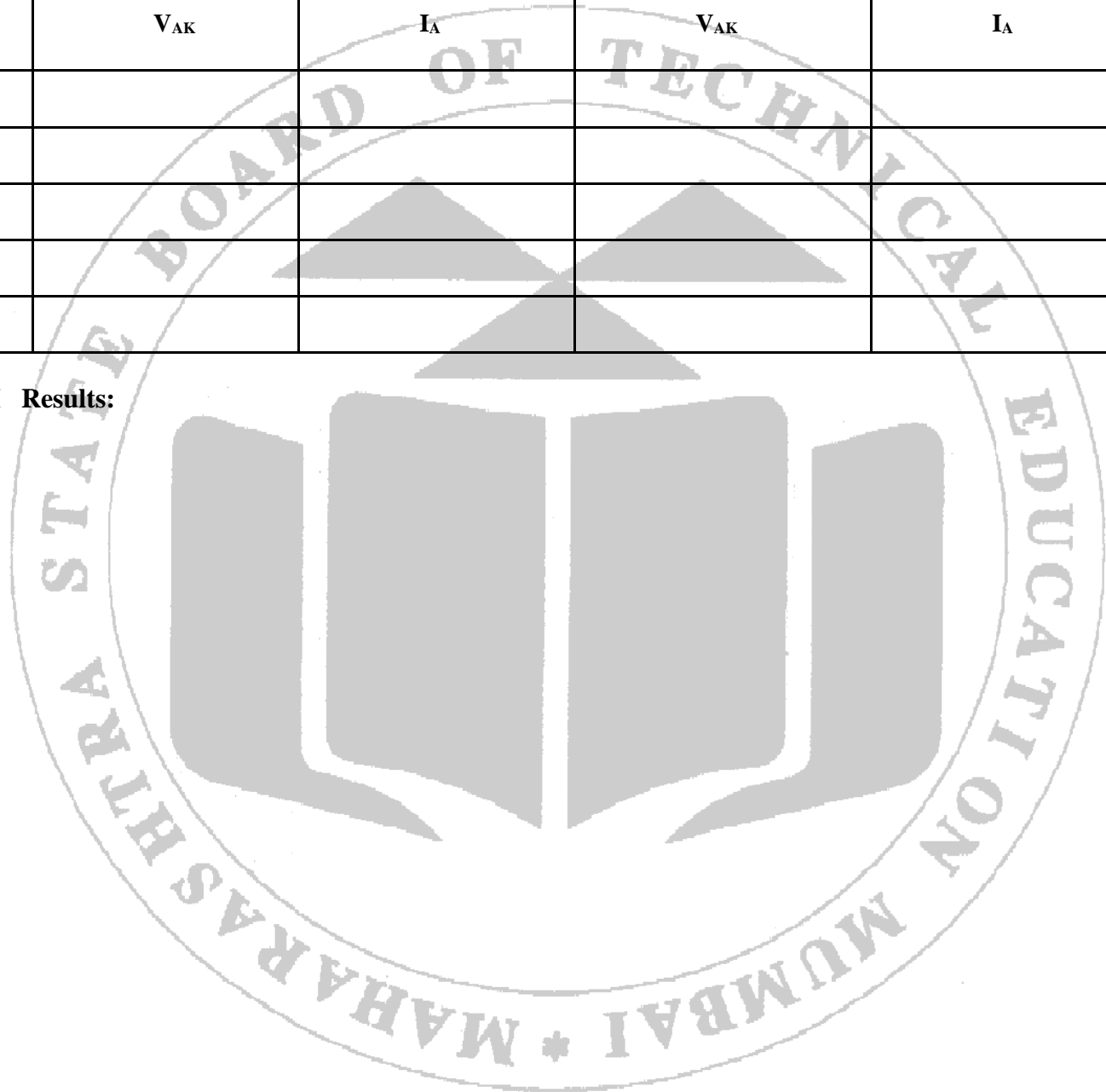
X Procedure

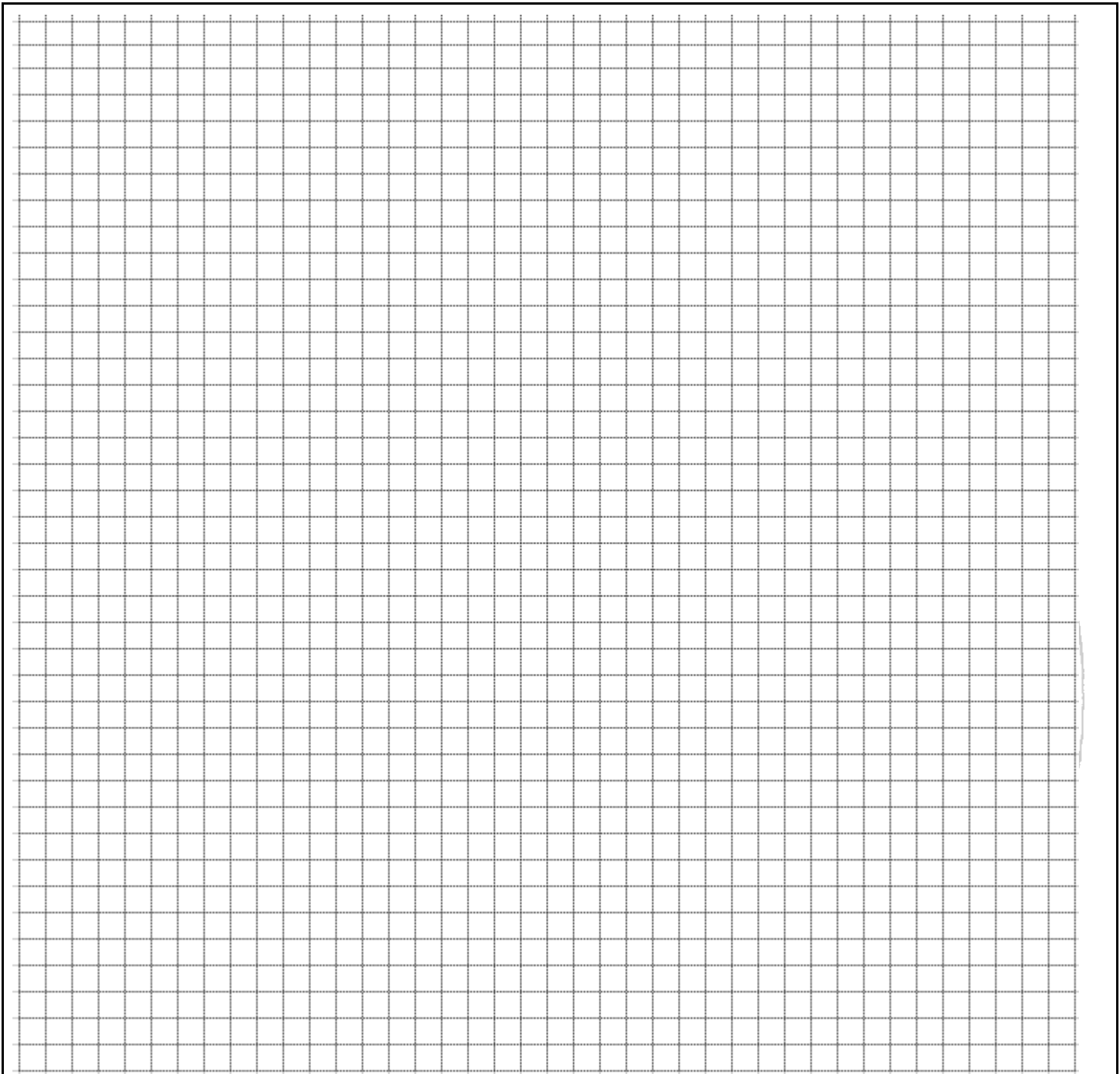
1. Assemble the circuit as per the circuit diagram.
2. Switch on the main supply.
3. Vary the pot3 and set the gate current as per rating of TRIAC.
4. Switch on the power supply without turning on the SCR
5. Slowly increase V_{AK} by varying pot4 till the TRIAC gets turned ON. Note down the ammeter (I_A) and voltmeter (V_{AK}) readings.
6. Now note down the forward breakdown voltage.
7. Further increase V_{AK} and note the anode current.
8. Now tabulate the readings.
9. Plot the graph V_{AK} versus I_A .
10. Connect MT2 terminal of the TRIAC to negative with respect to MT1 with positive gate current.
11. Repeat the procedure from step 3 to 9.

XI Observations and calculations

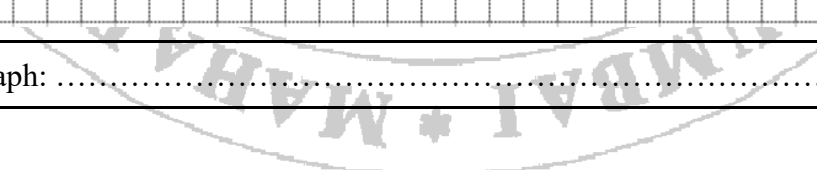
Sr. No.	When MT2 terminal connected to positive with respect to MT1		When MT1 terminal connected to positive with respect to MT2	
	V_{AK}	I_A	V_{AK}	I_A
1				
2				
3				
4				
5				

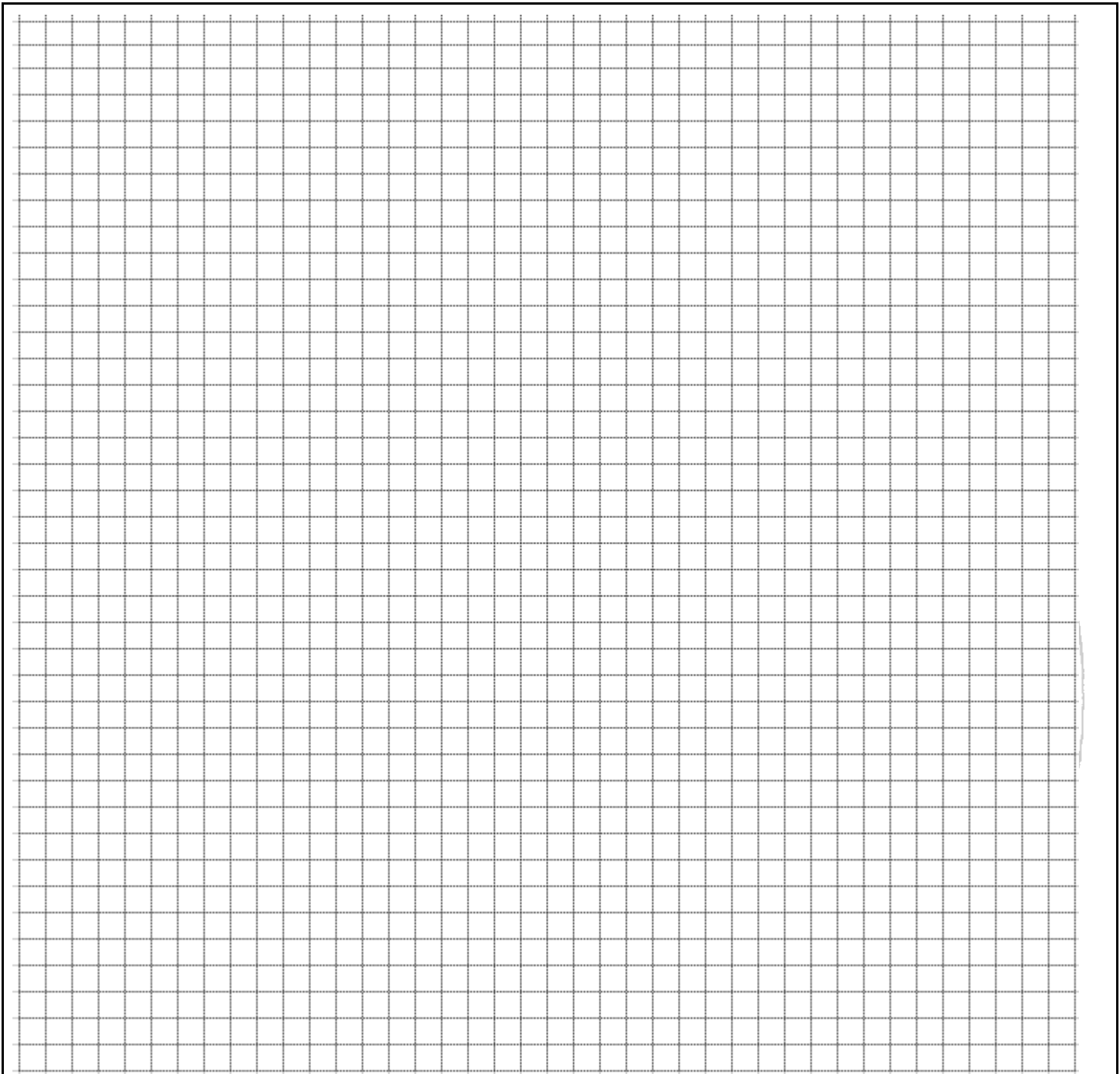
XII Results:





Title of Graph:





Title of Graph:

XIII Interpretation of results:

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 6. Performance of Snubber Circuit

I Practical Significance:

A Snubber circuit is crucial in protecting power electronics, particularly in devices like switches, from voltage spikes and transients. These circuits help absorb or limit sudden changes in voltage or current, thereby preventing damage to components such as transistors or thyristors. By reducing electrical noise, snubber circuits improve the reliability and longevity of electronic systems. They also minimize electromagnetic interference (EMI), which can cause malfunction in nearby electronic devices.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Test the performance of snubber circuit

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A snubber circuit is used to protect the SCR from high voltage transients and to control the rate of rise of voltage (dv/dt) across the SCR during turn-off. It typically consists of a series combination of a resistor (R) and a capacitor (C) connected across the SCR.

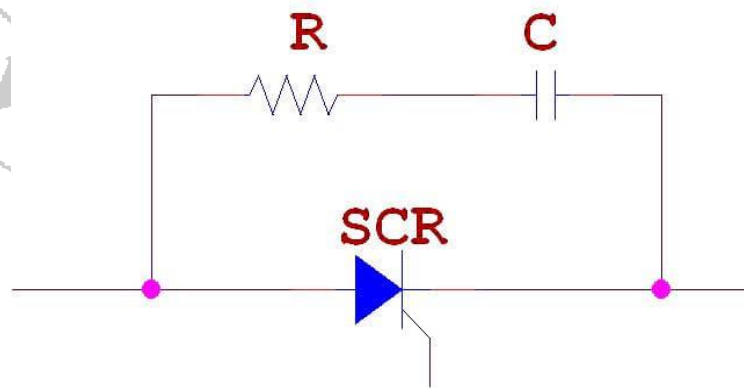


Fig. 6.1: Snubber Circuit of SCR in Simplest Form

VII Actual Circuit diagram used in laboratory with equipment Specifications:

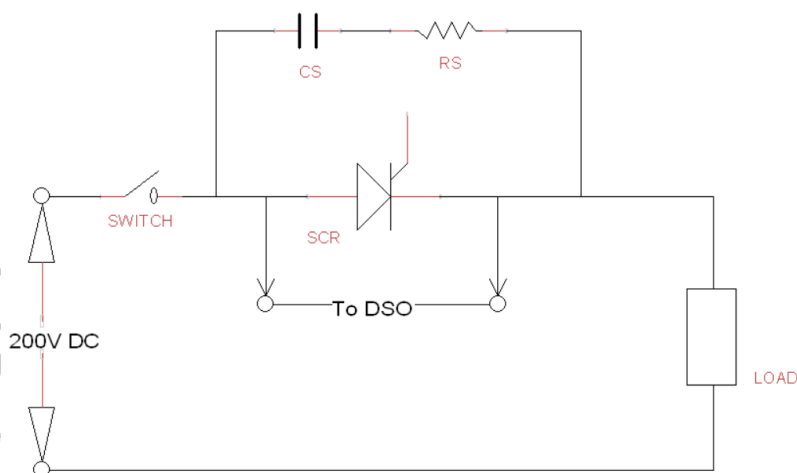


Fig. 6.2: Circuit Diagram for Testing Snubber Circuit of SCR

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-200 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	On-Off Switch	250V, 32A, Single Phase	1
5	Resistor	10 Ohm	1
6	Capacitor	0.5 microfarad	1
7	Load (Resistive)	100 Ohm; 250V	1

IX Precautions to be followed:

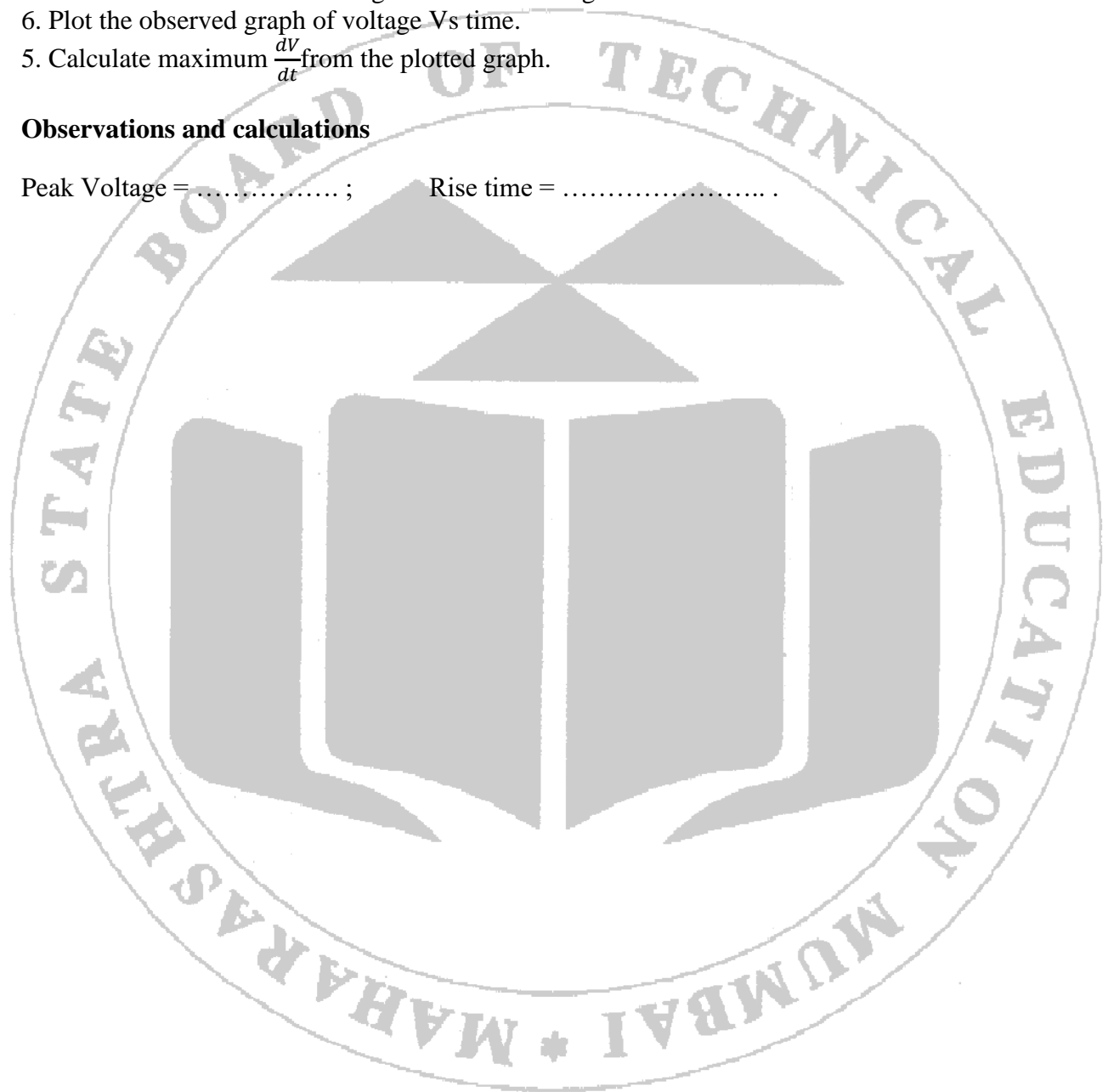
1. Ensure that the connections are correct and tight to avoid any loose contacts.
2. Make sure the oscilloscope probes are correctly placed and grounded.
3. Handle the SCR and other components carefully to avoid damage due to overheating.

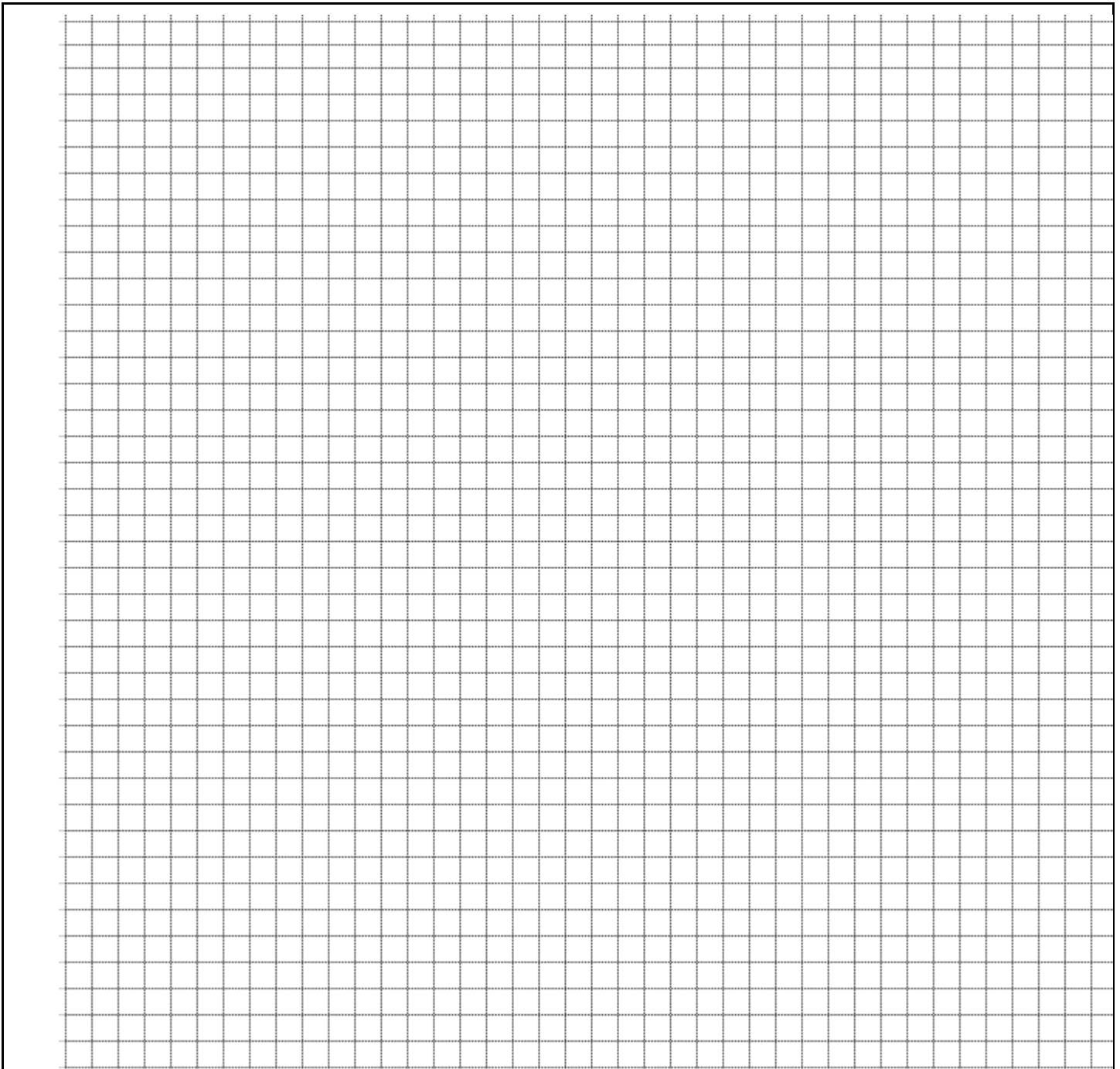
X Procedure

1. Assemble the circuit as per the circuit diagram.
2. Connect the snubber circuit (R-C network) across the SCR.
3. Connect the DC power supply, DSO, and load as shown in the circuit diagram.
4. Switch on the power supply without turning on the SCR
5. Observe the variation in voltage across SCR using DSO
6. Plot the observed graph of voltage Vs time.
5. Calculate maximum $\frac{dv}{dt}$ from the plotted graph.

XI Observations and calculations

Peak Voltage = ; Rise time =





Title of Graph:

XII Results:

1. Maximum $\frac{dV}{dt}$ across the SCR =

XIII Interpretation of results:

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.....

XIV Conclusion and recommendation

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.....
.....

XV Practical related questions (Provide space for answers)

- 1. State the types of protections required for SCR.
- 2. Illustrate the change in current and voltage across the snubber circuit during the turning on process of SCR with the help of diagram. (Assume the capacitor is charged before turning on the SCR.)

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XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 7: Resistance Triggering Circuit of SCR

I Practical Significance:

It is the simplest and economical type of triggering but limited for few applications. In the R triggering circuit firing angle is limited to 90° only and the RC triggering circuit provides the firing angle control from 0 to 180° . These are the most commonly used methods of triggering.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Test the effect of variation of resistance in R triggering circuit on the firing angle of SCR.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

SCR can be turned on by gate signal at any phase angle with respect to applied ac voltage. Firing angle is the phase angle of ac voltage at which SCR is turned ON. A positive signal is applied between the gate and cathode terminal of SCR. With the gate triggering SCR can be triggered much before the breakover voltage V_{BO} . Three types of signals can be used for this purpose i) DC signal ii) AC signal iii) Pulse signal.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

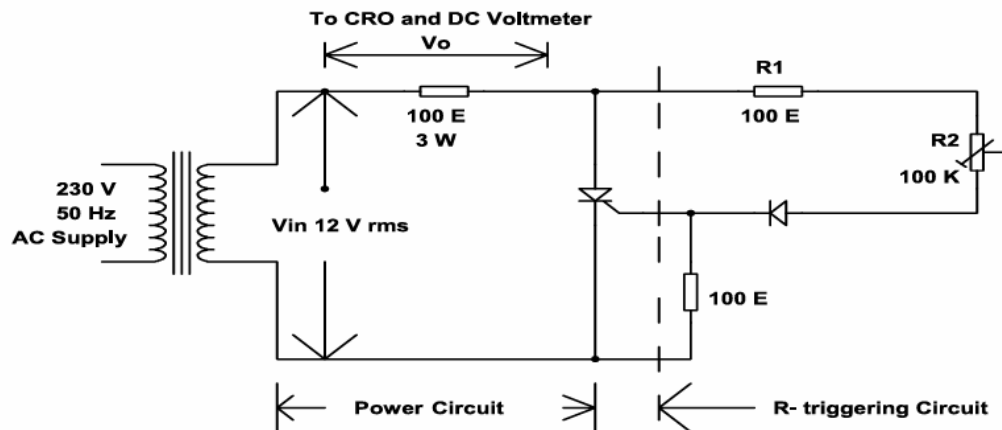


Fig. 7.1: Circuit Diagram for R Triggering of SCR

Note: Students should trace the circuit from the available kit/kit manual. Also refer the data sheet for SCR and then use relevant SCR, Power supplies, voltmeter, CRO.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-230 V AC	1
2	Transformer	12V; 500mA	1
3	SCR	TYN 612 or any other available	1
4	Voltmeter	0-300 V DC	1
5	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
6	Capacitor (variable)	0.22 microfarad	1
7	Diode	D1	1
8	Resistors	R1=100 Ohm, R2, potentiometer = 100KOhm, RG=100 Ohm RL= 100 Ohm, 3 watts	1 each

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant voltmeter.

IX Precautions to be followed:

1. Ensure that the pulse transformer is correctly connected to avoid damaging the SCR.
2. Check all connections carefully before powering the circuit.
3. Use appropriate load values to prevent excessive current flow through the SCR.
4. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

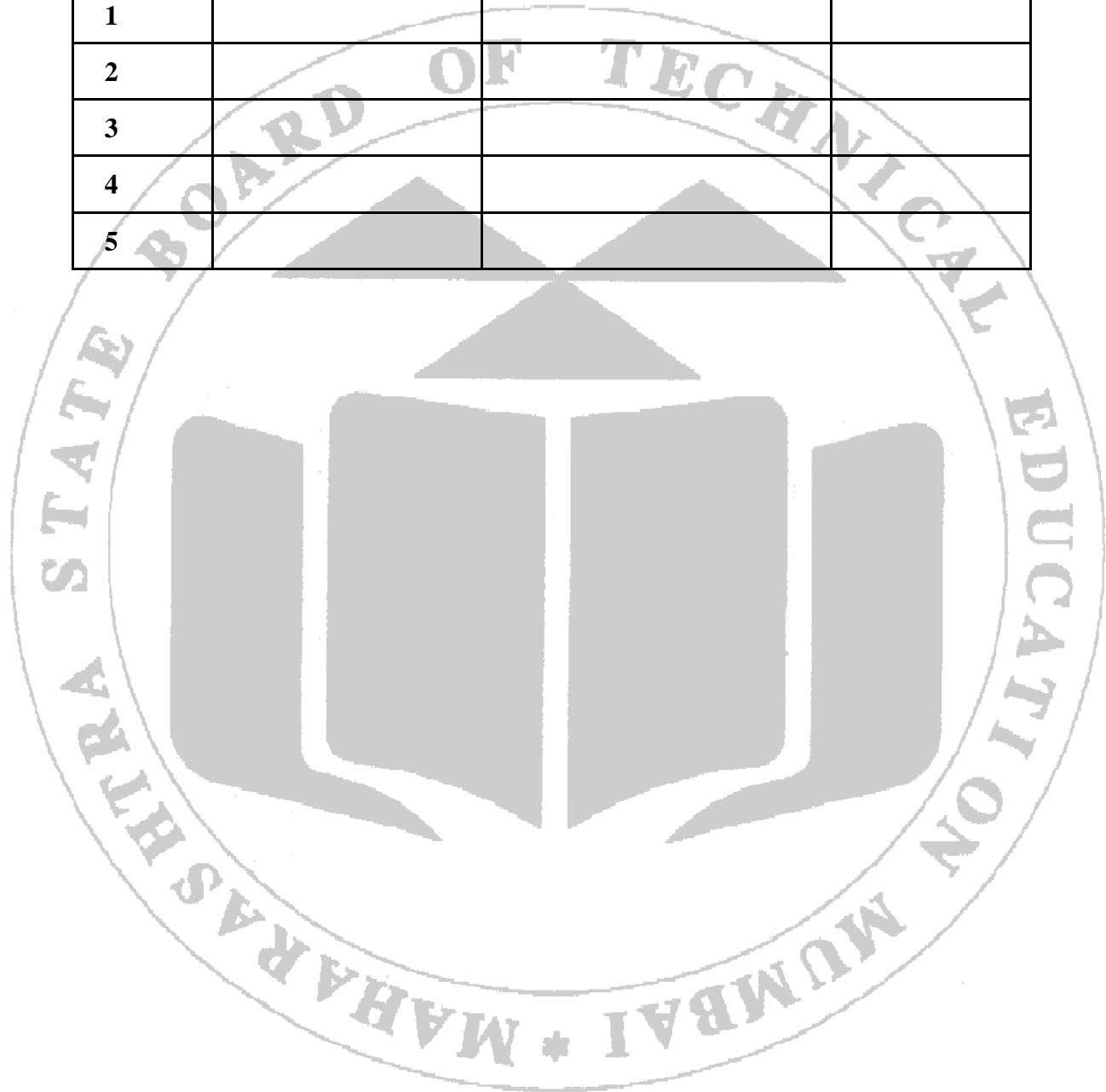
X Procedure

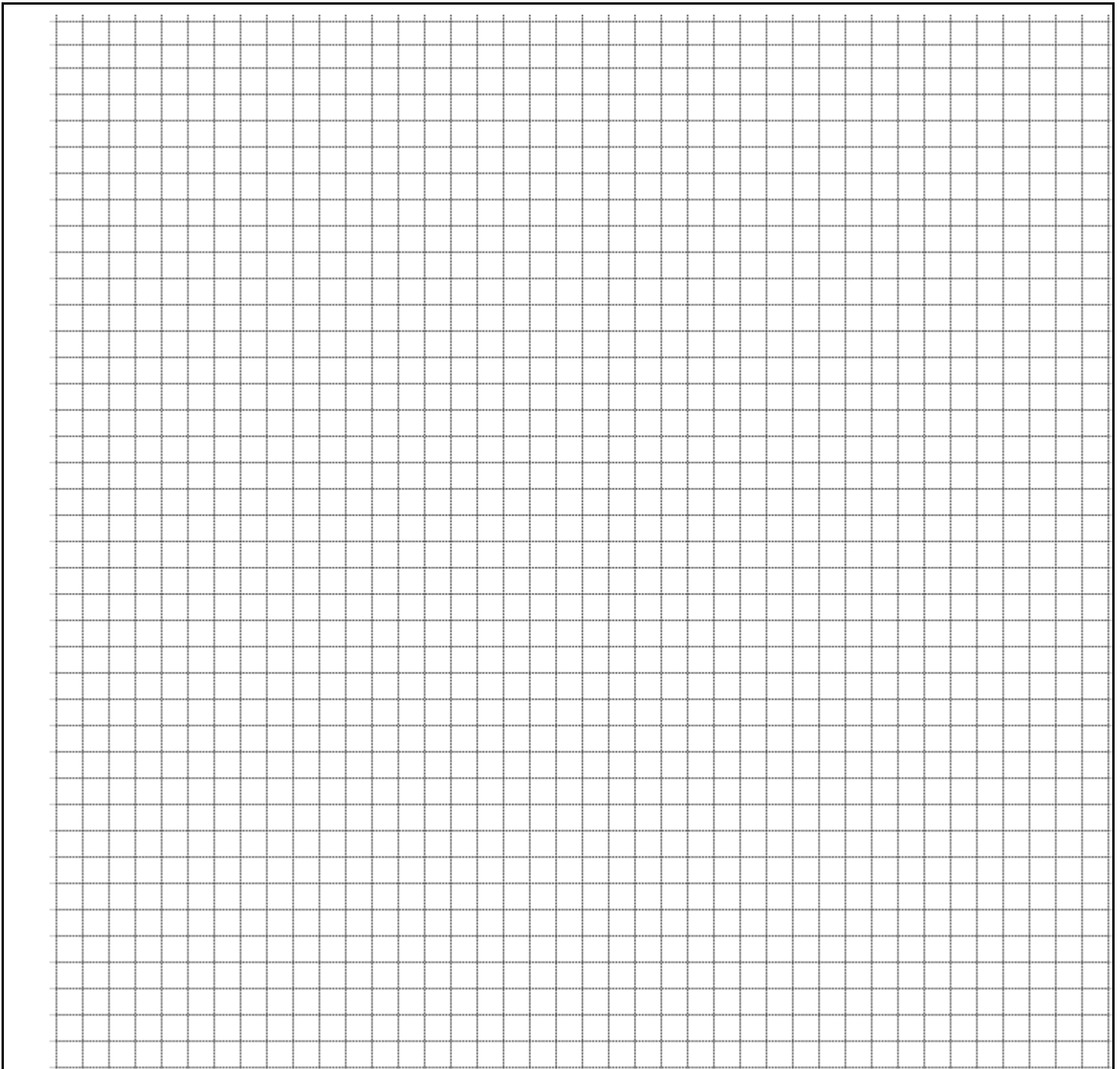
1. Make the circuit connection as per the circuit diagram.
2. Keep Potentiometer R2 at maximum value.
3. Switch on Mains supply.
4. Decrease the resistance R2 of the Potentiometer in steps, note down the corresponding values of output voltage.
5. Also measure / record the corresponding firing angle on CRO.
6. Draw the corresponding waveform on Graph Paper for any two firing angles.

XI Observations and calculations

$V_{in} = \dots\dots\dots$

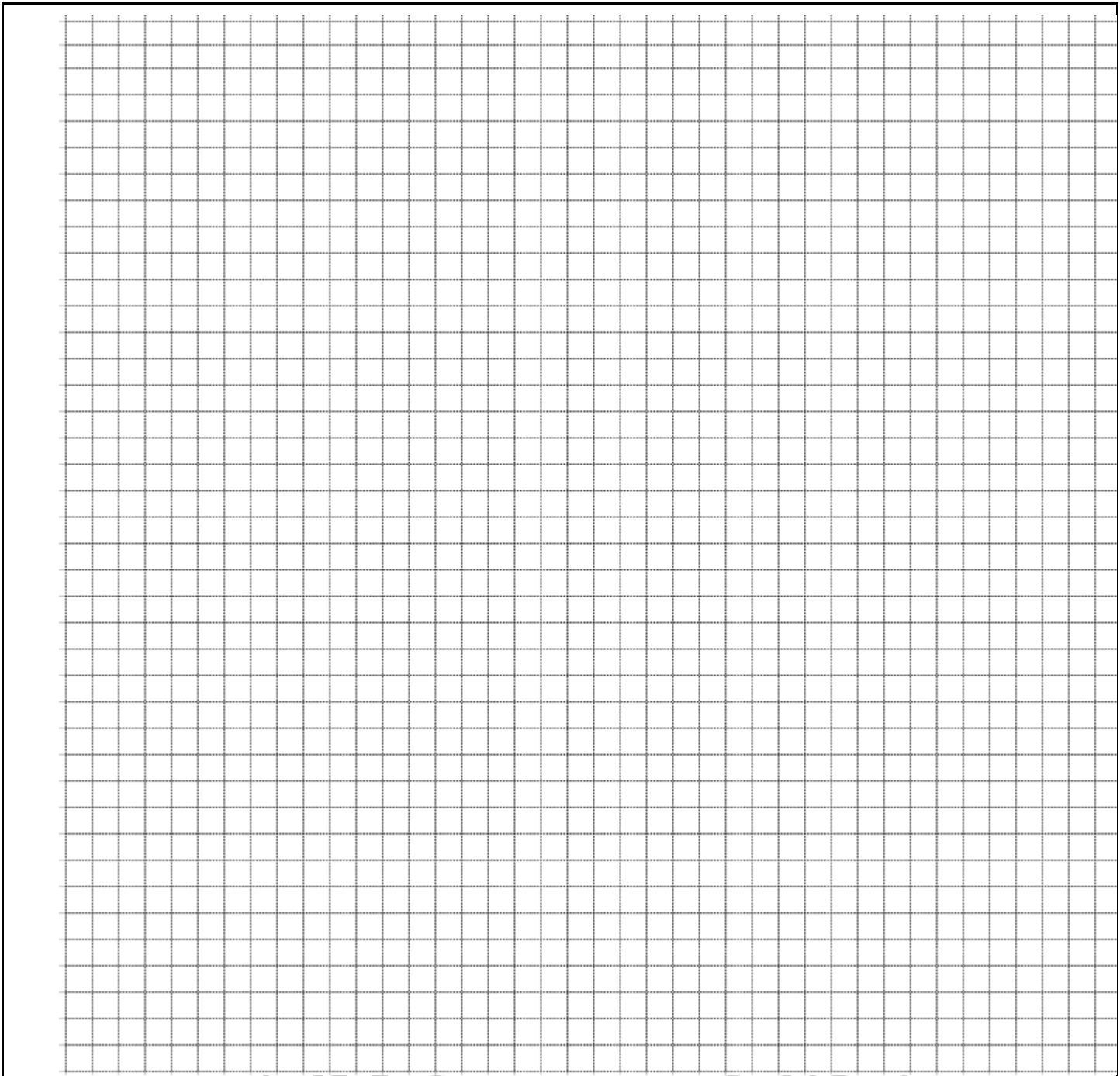
Sr. No.	Resistance value	Average output Voltage	Firing Angle
1			
2			
3			
4			
5			





Title of Graph:





Title of Graph:

XII Results:

1. Maximum firing angle = ; Corresponding resistance value =
2. Minimum firing angle = ; Corresponding resistance value =

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 8: RC Triggering Circuit of SCR

I Practical Significance:

It is the simplest and economical type of triggering but limited for few applications. In the R triggering circuit firing angle is limited to 90° only and the RC triggering circuit provides the firing angle control from 0 to 180° . These are the most commonly used methods of triggering.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Test the effect of variation of resistance and capacitance in RC triggering circuit on the firing angle of SCR.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

SCR can be turned on by gate signal at any phase angle with respect to applied ac voltage. Firing angle is the phase angle of ac voltage at which SCR is turned ON. A positive signal is applied between the gate and cathode terminal of SCR. With the gate triggering SCR can be triggered much before the breakover voltage V_{BO} . Three types of signals can be used for this purpose i) DC signal ii) AC signal iii) Pulse signal.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

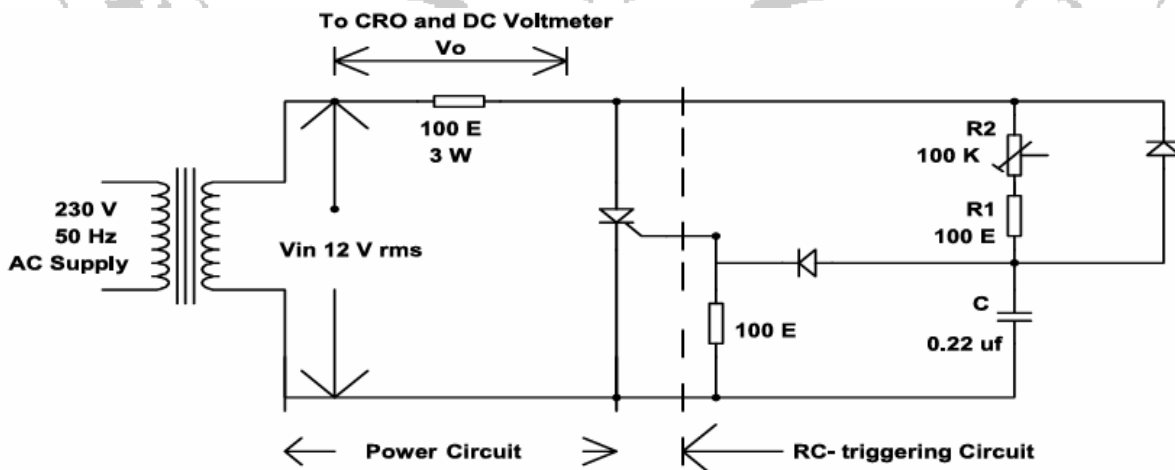


Fig. 8.1: Circuit Diagram for RC Triggering of SCR

Note: Students should trace the circuit from the available kit/kit manual. Also refer the data sheet for SCR and then use relevant SCR, Power supplies, voltmeter ,CRO.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-230 V AC	1
2	Transformer	12V; 500mA	1
3	SCR	TYN 612 or any other available	1
4	Voltmeter	0-300 V DC	1
5	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
6	Capacitor (variable)	0.22 microfarad	1
7	Diode	D1 and D2	1
8	Resistors	R ₁ =100 Ohm, R ₂ , potentiometer = 100 kΩ, R _G =100 Ohm R _L = 100 Ohm, 3 W	1 each

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant voltmeter.

IX Precautions to be followed:

1. Ensure that the pulse transformer is correctly connected to avoid damaging the SCR.
2. Check all connections carefully before powering the circuit.
3. Use appropriate load values to prevent excessive current flow through the SCR.
4. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Keep Potentiometer R₂ at maximum value.
3. Switch on Mains supply.
4. Decrease the resistance R₂ of Potentiometer in steps , note down the corresponding values of output voltage.
5. Also measure / record the corresponding firing angle on CRO.
6. Draw the corresponding wave form on Graph Paper for any two firing angles.

XI Observations and calculations

$V_{in} = \dots\dots\dots$

Sr. No.	Firing Angle	Average output Voltage
1		
2		
3		
4		
5		

XII Results:

1. For high resistance $R = \dots\dots\dots$; firing angle = $\dots\dots\dots$
2. For low resistance $R = \dots\dots\dots$; firing angle = $\dots\dots\dots$

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

1. If diode is open circuited, state the effect on Voltage across Load.
2. If R_1 and R_2 are short circuited, state the effect on load voltage.
3. State the range of firing angle with RC triggering circuit.

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XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 9: Triggering of SCR Using Pulse Transformer

I Practical Significance:

The pulse transformer plays a critical role in isolating the low-voltage control circuit from the high-voltage power circuit when triggering an SCR. It ensures safe operation by protecting sensitive control electronics from voltage spikes or noise in the power side. Additionally, the pulse transformer allows precise and efficient transmission of trigger pulses to the SCR gate without direct electrical connection. Its ability to provide sharp, high-current pulses improves the reliability of SCR triggering. This isolation and pulse shaping enhance the overall stability and safety of power control systems.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Perform the triggering of SCR using pulse transformer

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

An SCR is a unidirectional semiconductor device that is used for switching and power control applications. It has three terminals: Anode, Cathode, and Gate. The SCR can be turned on by applying a short pulse of current to the gate terminal. This current can be applied using various methods, one of which is via a pulse transformer.

A pulse transformer isolates the control circuit from the SCR power circuit and provides the necessary pulse to the gate of the SCR. The pulse helps trigger the SCR into conduction mode (turns it "ON").

VII Actual Circuit diagram used in laboratory with equipment Specifications:

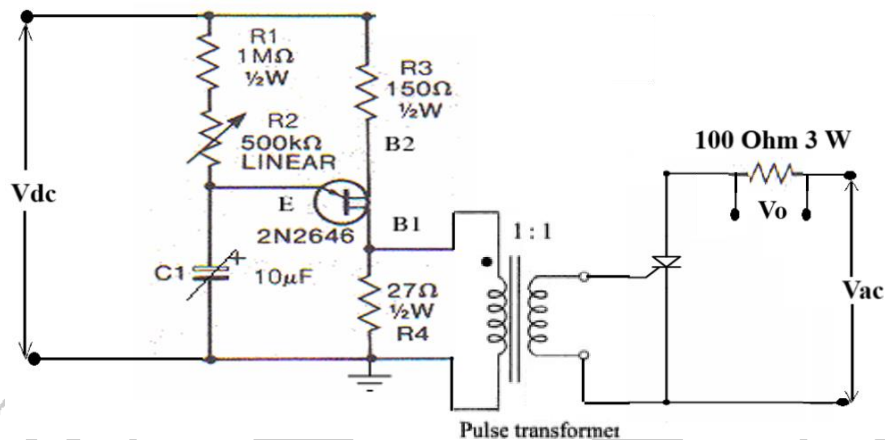


Fig. 9.1: Circuit Diagram for Triggering of SCR

Note: Students should trace the circuit from the available kit/kit manual, then draw the circuit diagram. Also refer the data sheet for SCR and then use relevant SCR, Power supplies, voltmeter ,CRO.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-230 V AC	1
2	Regulated power supply	0-30 V DC	1
3	SCR	TYN 612 or any other available	1
4	Resistors	100 Ohm, 3W	1
5	Voltmeter	0-30 V DC	1
6	Voltmeter	0-300 V DC	1
7	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
8	UJT	2N2646 or any other	1
9	Capacitor (variable)	C1 = 100 μF or any other available	1
10	Resistors	R1 = 10K, 1/4 watt R2 (pot) = 500 K R3 = 150,0.25 watt R4 = 27 , 0.25 watt	1 each
11	Pulse transformer	1:1 turns ratio	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant voltmeter.

IX Precautions to be followed:

1. Ensure that the pulse transformer is correctly connected to avoid damaging the SCR.
2. Check all connections carefully before powering the circuit.
3. Use appropriate load values to prevent excessive current flow through the SCR.
4. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

X Procedure

1. Assemble the circuit as per the circuit diagram.
2. Switch on the power supply and adjust the values of R2 and C1 to trigger the SCR.
3. The gate pulse should cause the SCR to conduct, turning on the load.
4. Measure the average voltage at the load resistance.
5. Vary the firing angle by varying the R2 and C1 and repeat step 4.

XI Observations and calculations

Sr. No.	R2	C1	Average output Voltage (Vo)
1			
2			
3			
4			
5			

XII Results:

1. Range of output voltage of SCR =

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 10: Class A Commutation (Load Commutation) Circuit

I Practical Significance:

Continuous conduction causes problems in choppers, inverters and cycloconverters. By the commutation process the thyristor operating mode is changed from forward conducting to forward blocking mode. In class A commutation, thyristor can be turned OFF by reducing the anode current below the holding current with the help of active and passive components.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Perform the operation of Class A commutation circuit.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Thyristor current can be reduced to a value below the value of holding current. Since, the thyristor is turned off forcibly it is termed as a forced commutation process. Class A commutation is also known as load commutation. In this commutation, the source of commutation voltage is in series with SCR. The load must be an under damped R-L-C supplied with a DC supply so that natural zero current is obtained at the ringing frequency.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

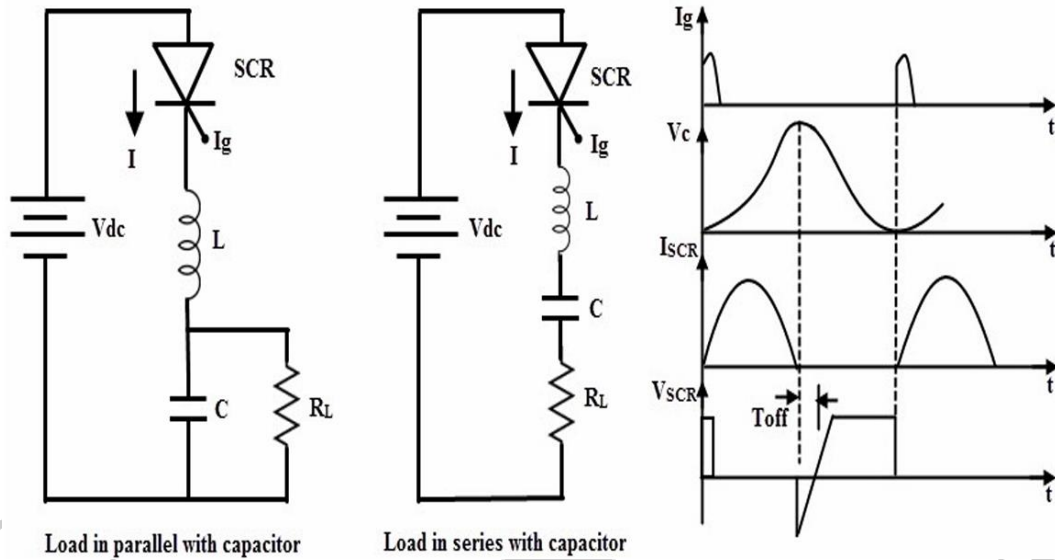


Fig. 10.1: Class A Commutation

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-300/32 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	SCR	TYN 612 or any other available	1
4	Resistors	1KOhm	1
5	Inductor	5mH	1
6	Capacitor	1 microfarad	1
7	UJT triggering circuit	-	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

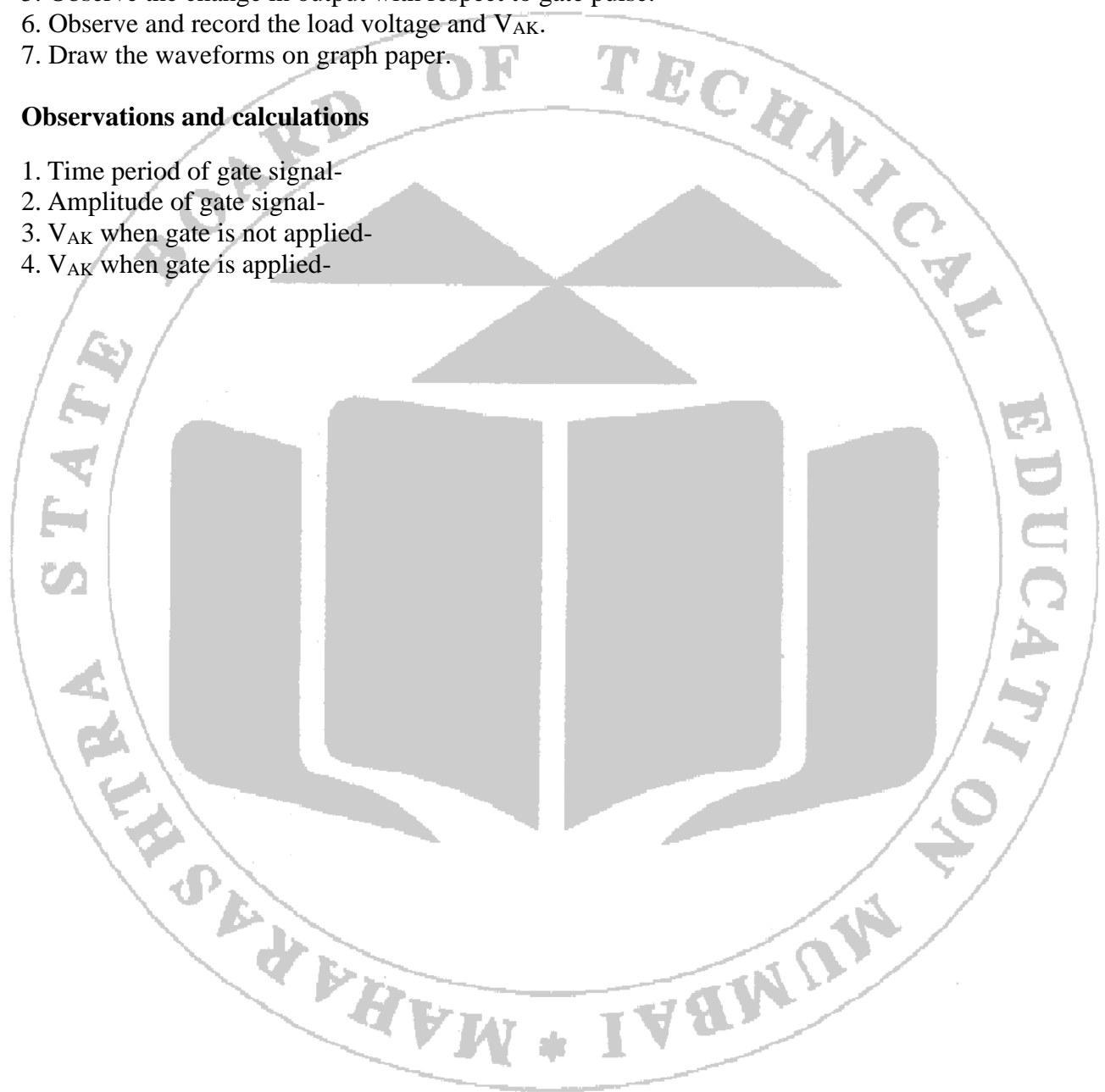
1. Ensure that the pulse transformer is correctly connected to avoid damaging the SCR.
2. Check all connections carefully before powering the circuit.
3. Use appropriate load values to prevent excessive current flow through the SCR.
4. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

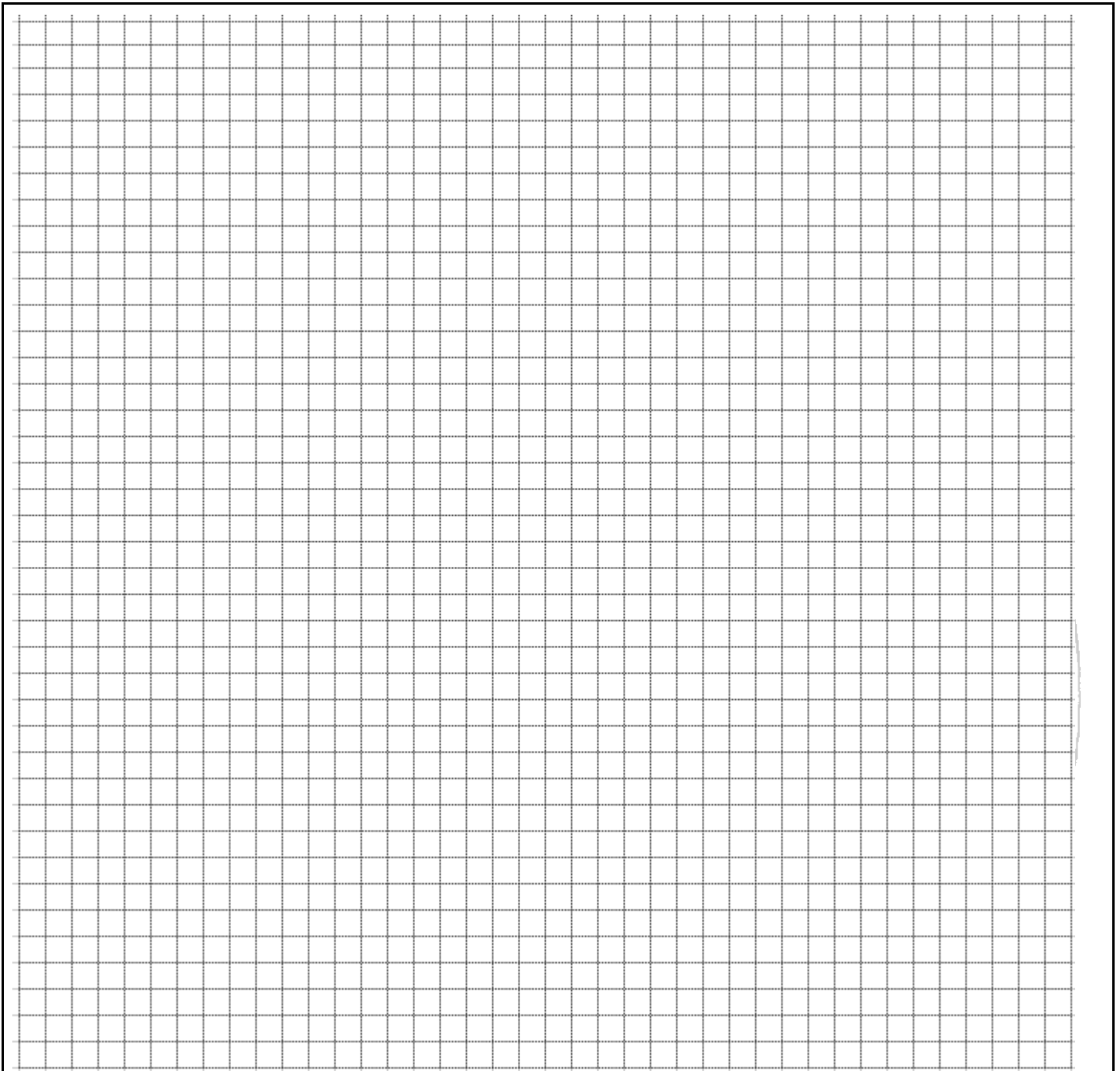
X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on the power supply.
3. Observe and note output V_{AK} if gate voltage is not applied.
4. Now apply gate signal to the SCR .
5. Observe the change in output with respect to gate pulse.
6. Observe and record the load voltage and V_{AK} .
7. Draw the waveforms on graph paper.

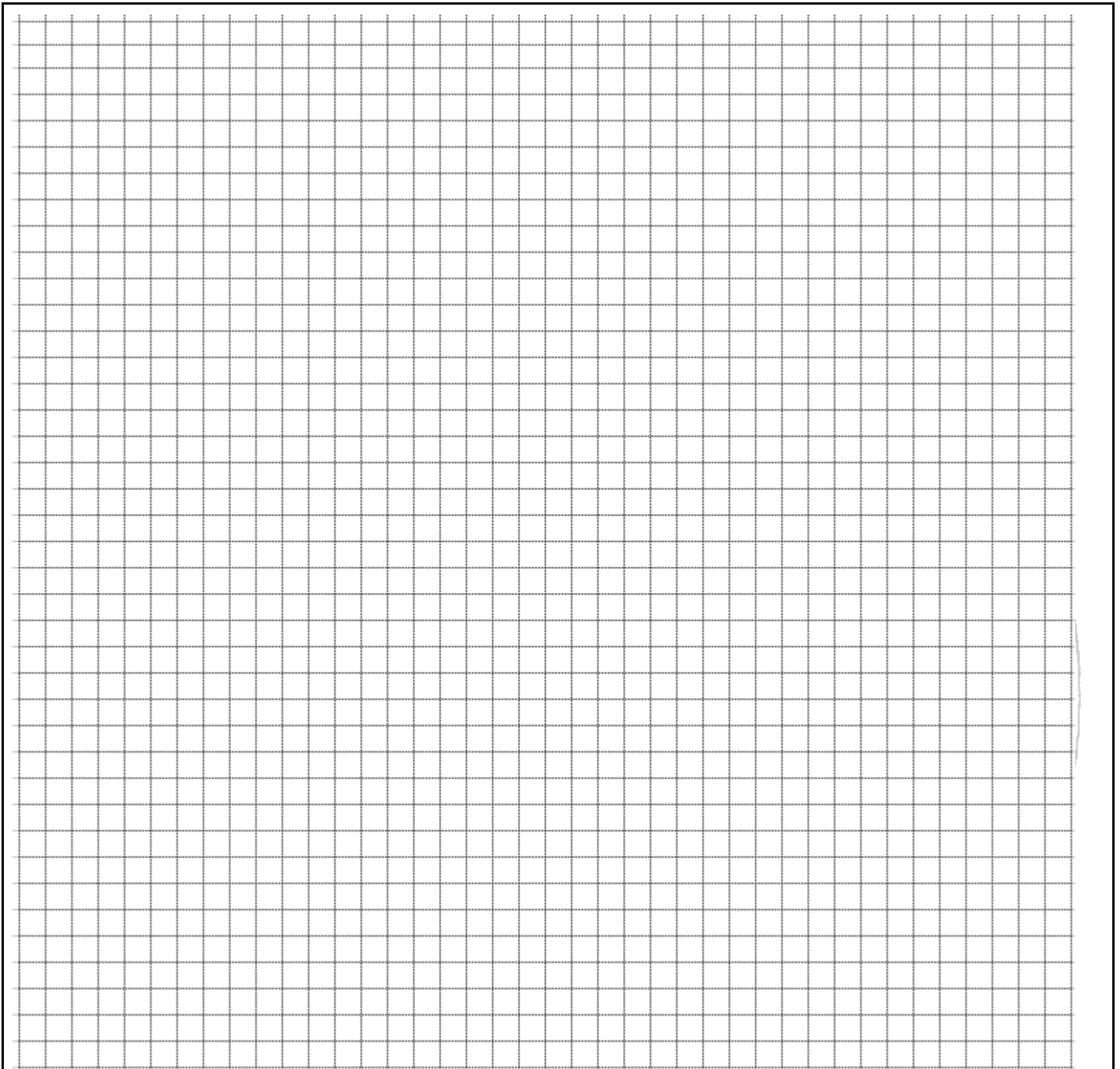
XI Observations and calculations

1. Time period of gate signal-
2. Amplitude of gate signal-
3. V_{AK} when gate is not applied-
4. V_{AK} when gate is applied-





Title of Graph:



Title of Graph:

XII Results:

1. Voltage across SCR when it is in ON condition =

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 11: Class F Commutation (Line Commutation) Circuit

I Practical Significance:

Continuous conduction causes problems in choppers, inverters and cycloconverters. By the commutation process the thyristor operating mode is changed from forward conducting to forward blocking mode. In class F commutation, thyristor is turned off due to the negative half cycle of applied ac voltage.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

IV Laboratory Learning Outcome(s)

LLO 1. Perform the operation of Class F commutation circuit.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Thyristor current can be reduced to a value below the value of holding current. Since, the thyristor is turned off forcibly it is termed as a forced commutation process. No separate commutation components are required in class F commutation. Due to the negative half cycle of ac input, thyristors are turned off. Hence such controlled rectifiers are also called line commutated converters.

AC input is given to the controlled rectifier circuits. In single phase half wave controlled rectifier SCR conducts in positive half cycle and turned off naturally due to reverse voltage in negative half cycle. Turn off time of converter grade SCRs is in the range of 200 to 300 μ sec and duration of negative half cycle for 50 Hz frequency is 10 msec. As turn off time of SCR is very less and duration of negative half cycle is too large with compared to turn off time, SCR is turned off during each negative half cycle. Hence controlled rectifiers are also called as line commutated converters. This type of commutation is called as class F or natural commutation.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

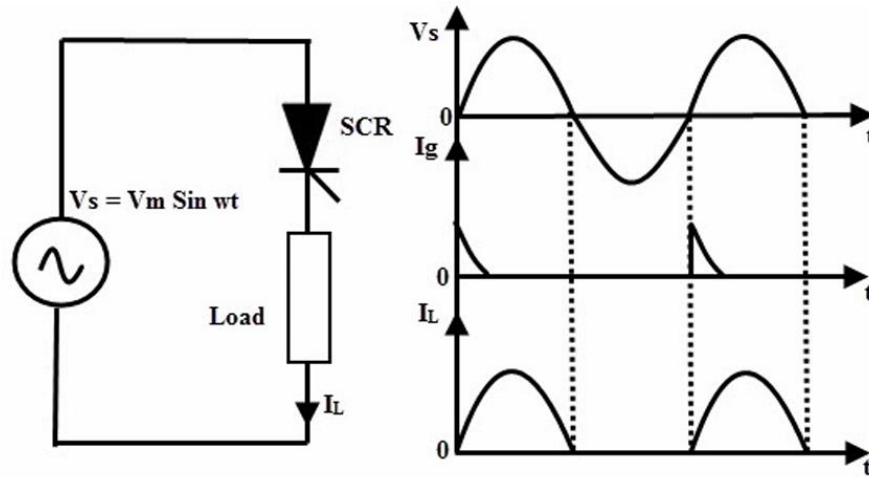


Fig. 10.1: Class F Commutation

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	SCR	TYN 612 or any other available	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Ensure that the pulse transformer is correctly connected to avoid damaging the SCR.
2. Check all connections carefully before powering the circuit.
3. Use appropriate load values to prevent excessive current flow through the SCR.
4. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

I Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on the power supply.
3. Observe and note output V_{AK} if gate voltage is not applied.
4. Now apply gate signal to the SCR .
5. Observe the change in output with respect to gate pulse.
6. Observe and record the load voltage and V_{AK} .
7. Draw the waveforms on graph paper.

X Observations and calculations

1. AC input voltage-
2. Average load voltage-
3. V_{AK} when gate is not applied-
4. V_{AK} when gate is applied-

XI Results:

1. Voltage across SCR when it is in ON condition =

XII Interpretation of results:

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XIII Conclusion and recommendation

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XIV Practical related questions (Provide space for answers)

1. State the advantages of class F commutation circuit.

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XV References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVI Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 12: Operation of single phase half wave controlled rectifier with resistive load.

I Practical Significance:

A single-phase half-wave controlled rectifier with a resistive load allows for variable DC output by adjusting the firing angle of the thyristor, making it ideal for applications like light dimmers and heating control.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Controlled rectifier is a circuit which converts constant AC input voltage into controlled DC output voltage using controlled device like SCR by varying firing angle i.e. phase angle can be controlled. In half wave controlled rectifier, output voltage can be controlled in only one half cycle of the input AC voltage. It gives unidirectional output.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

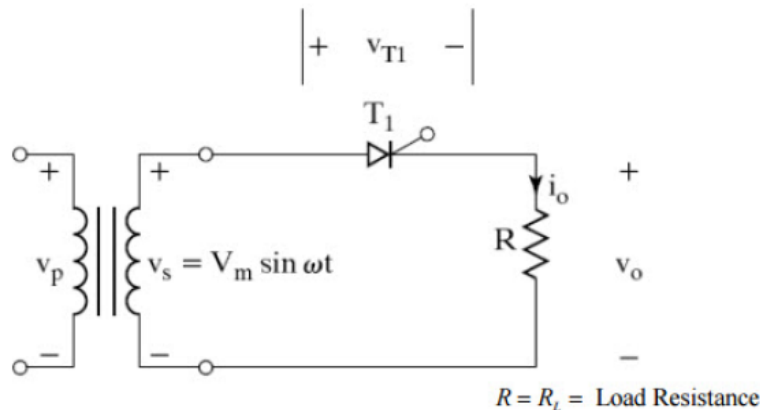


Fig. 11.1: Single phase half wave controlled rectifier with resistive load

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	SCR	TYN 612 or any other available	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by the meter at secondary of transformer.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper.

XI Observations and calculations

Sr. No.	Firing Angle	Measure Output Voltage	Calculated Output Voltage
1			
2			
3			
4			

XII Results:

1. For firing angle $\alpha = 60^\circ$, Output Voltage =.....
2. For firing angle $\alpha = 90^\circ$, Output Voltage =.....

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

1. State the effect on output if there is no gate pulse is applied.
2. State the effect on output if gate pulse is applied at 180° .

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XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K. ; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 13. Operation of single phase half wave controlled rectifier with RL load without freewheeling diode.

I Practical Significance:

A single phase half wave controlled rectifier with RL load without freewheeling diode allows control of the power delivered to the load by adjusting the firing angle of the thyristor (or SCR). This is useful in applications to control the speed of motors, the brightness of lights, or the heating element in ovens.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

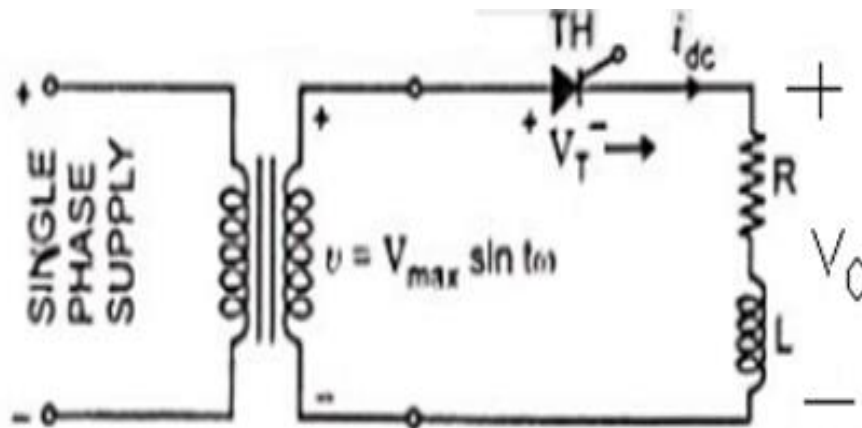
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Controlled rectifier is a circuit which converts constant AC input voltage into controlled DC output voltage using controlled device like SCR by varying firing angle. When the thyristor conducts, the output voltage to the load is a portion of input sinusoidal waveform starting from the firing angle α . The current through an RL load does not follow the voltage waveform directly due to the inductive reactance. The current waveform lags the voltage waveform and is affected by the inductor's stored energy. Without a freewheeling diode, when the thyristor turns off, the inductor tries to maintain current flow, potentially causing a high voltage spike.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Half wave rectifier kit	Trainer kit of half wave controlled rectifier with connecting facility for i) RL load	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Variable inductive load	0-100mH	1
6	Voltmeter	0-300 V AC	1
7	Voltmeter	0-300V DC	1
8	Ammeter	0-1 A DC	

IX Precautions to be followed:

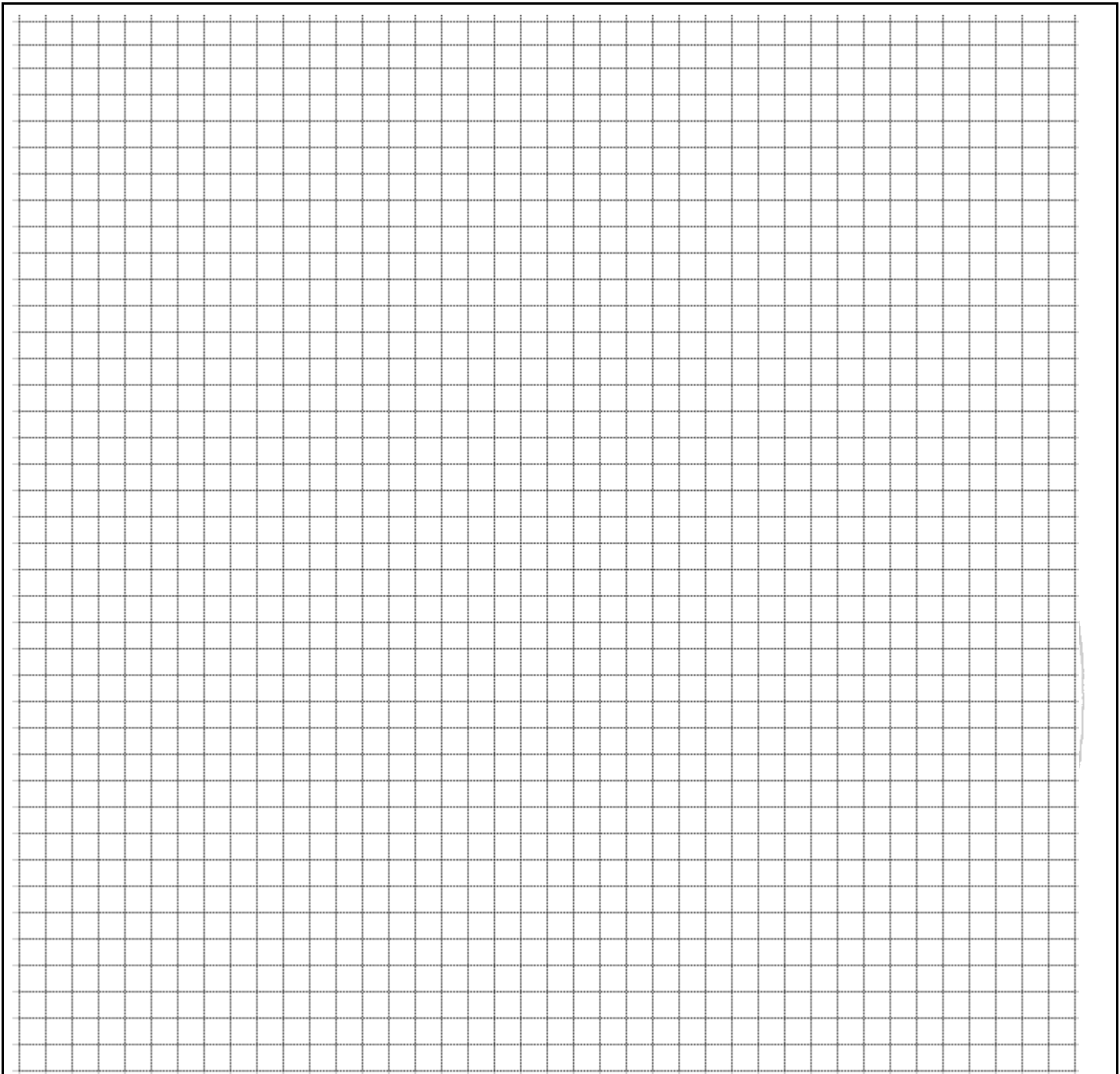
1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.

X Procedure

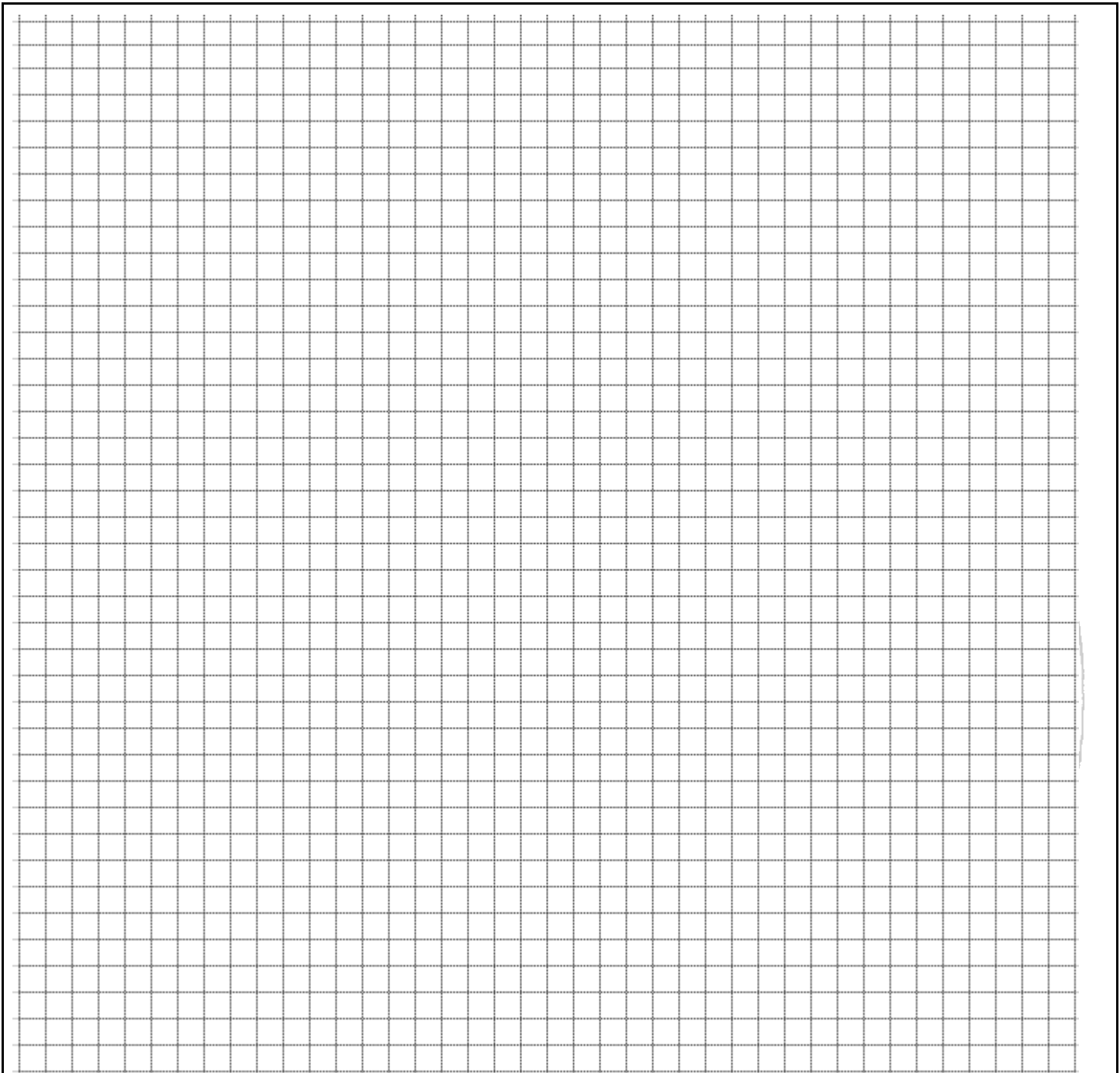
1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for $\alpha = 60^\circ$ and for $\alpha = 90^\circ$

XI Observations and calculations





Input and Output Voltage Waveform for $\alpha = 60^\circ$



Input and Output Voltage Waveform for $\alpha = 90^\circ$

XII Results:

1. For firing angle $\alpha = 60^\circ$, Output Voltage =.....
2. For firing angle $\alpha = 90^\circ$, Output Voltage =.....

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

1. State the effect on output if there is no gate pulse applied.
2. State advantages and disadvantages of using a single-phase half-wave controlled rectifier without freewheeling diode

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XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 14. Operation of single phase half wave controlled rectifier with RL load with freewheeling diode.

I. Practical Significance:

A single phase half wave controlled rectifier with RL load with freewheeling diode allows control of the power delivered to the load by adjusting the firing angle of the thyristor (or SCR). With a freewheeling diode in place, the load (especially inductive loads) operates more smoothly. This is crucial for applications like motor drives and other devices where stable and continuous operation is necessary.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of single phase half wave controlled rectifiers by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

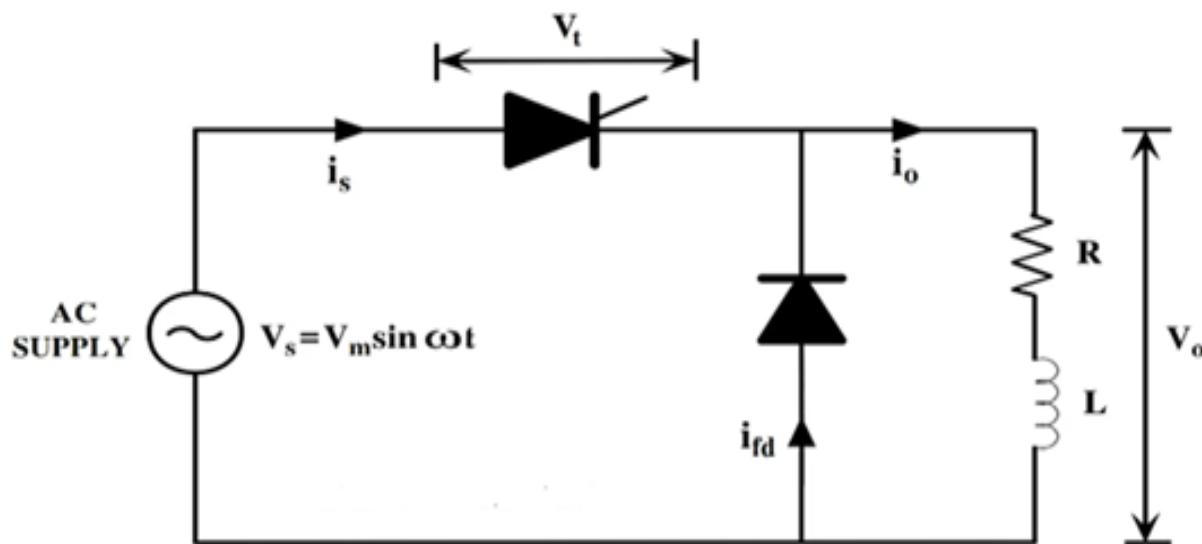
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Half Wave Controlled rectifier is a circuit which converts constant AC input voltage into controlled DC output voltage using controlled device like SCR by varying firing angle. When the thyristor conducts, the output voltage to the load is a portion of input sinusoidal waveform starting from the firing angle α . Freewheeling Diode Provides a path for the current when the thyristor is off, allowing continuous current flow through the inductor and preventing high voltage spikes. When the thyristor turns off, the diode becomes forward-biased and allows the inductor's stored energy to flow through it, maintaining a steady current, reducing ripple and preventing voltage spikes and protecting the circuit.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Half wave rectifier kit	Trainer kit of half wave controlled rectifier with connecting facility for i) RL load ii) Freewheeling diode	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Variable inductive load	0-100mH	1
6	Voltmeter	0-300 V AC	1
7	Voltmeter	0-300V DC	1
8	Ammeter	0-1 A DC	

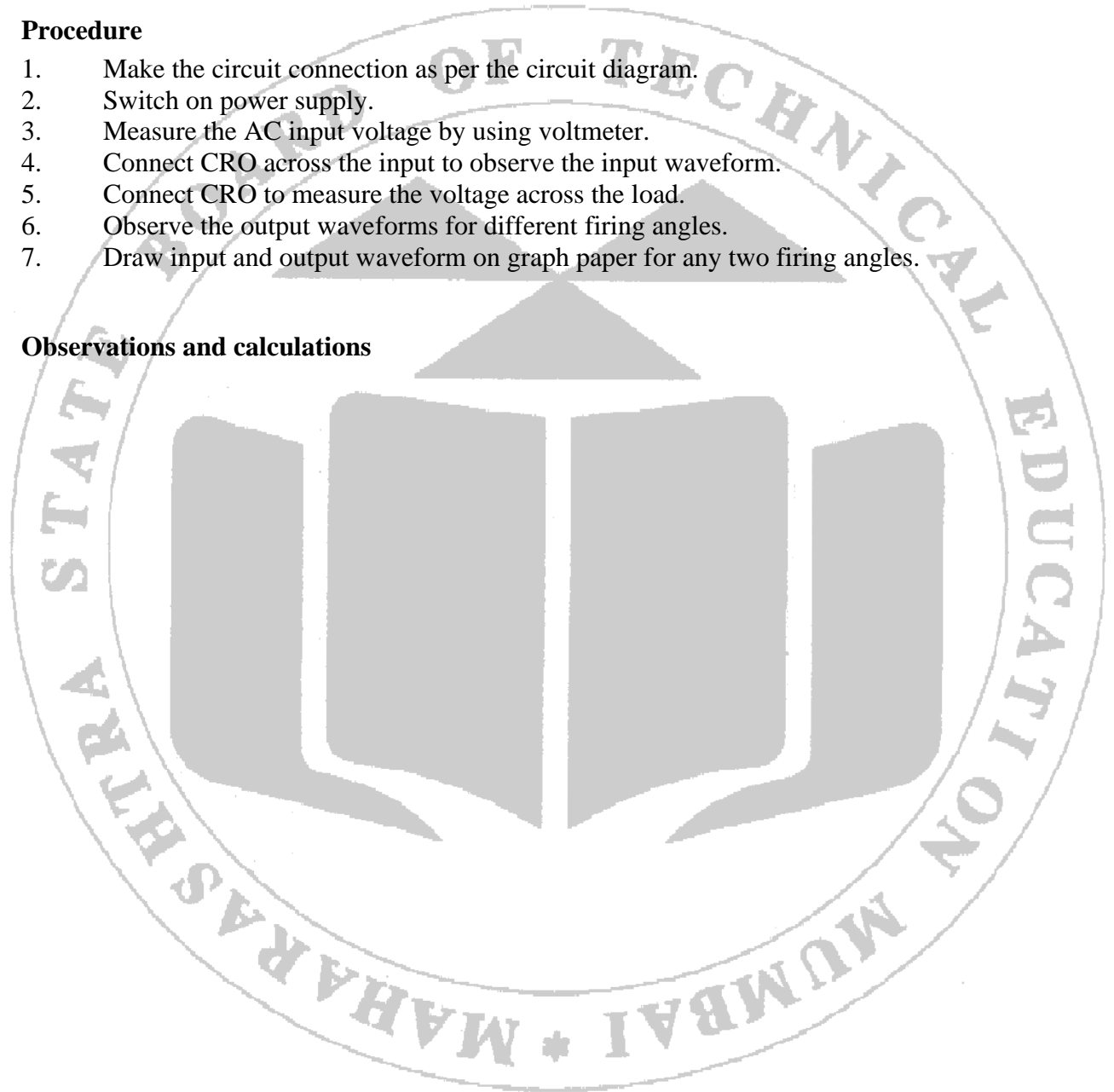
IX Precautions to be followed:

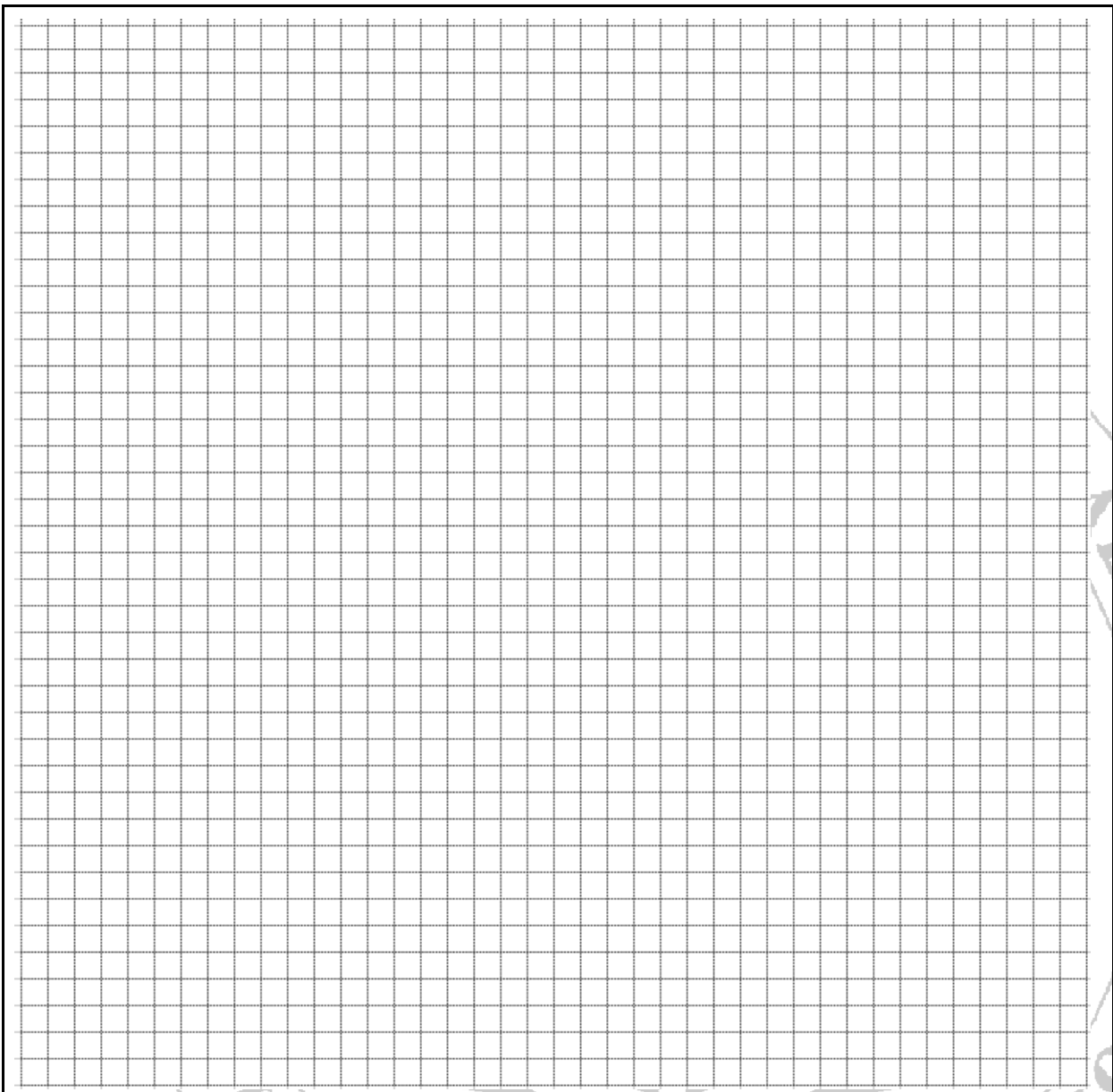
1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. Reading should be noted without parallax error

X Procedure

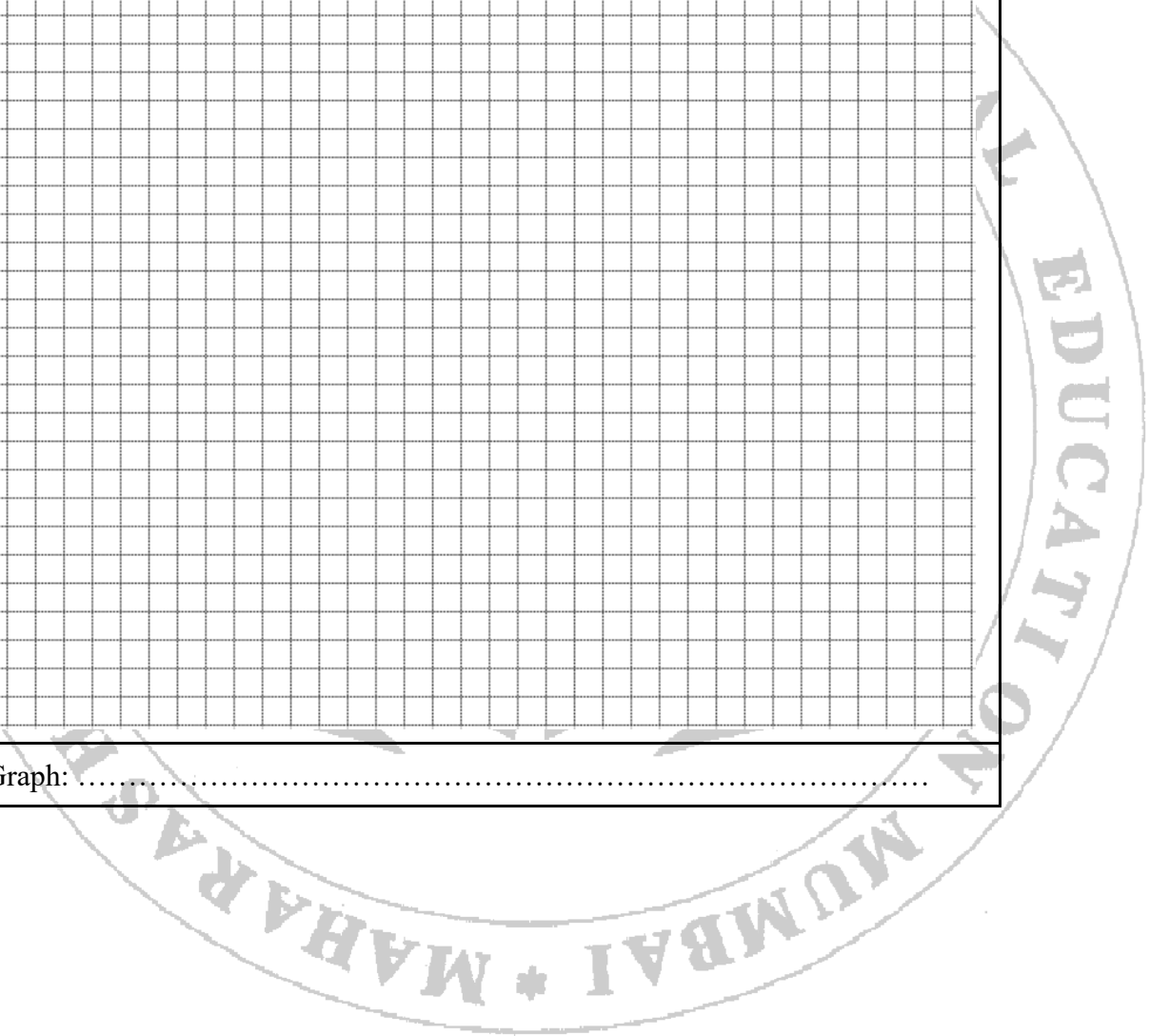
1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for any two firing angles.

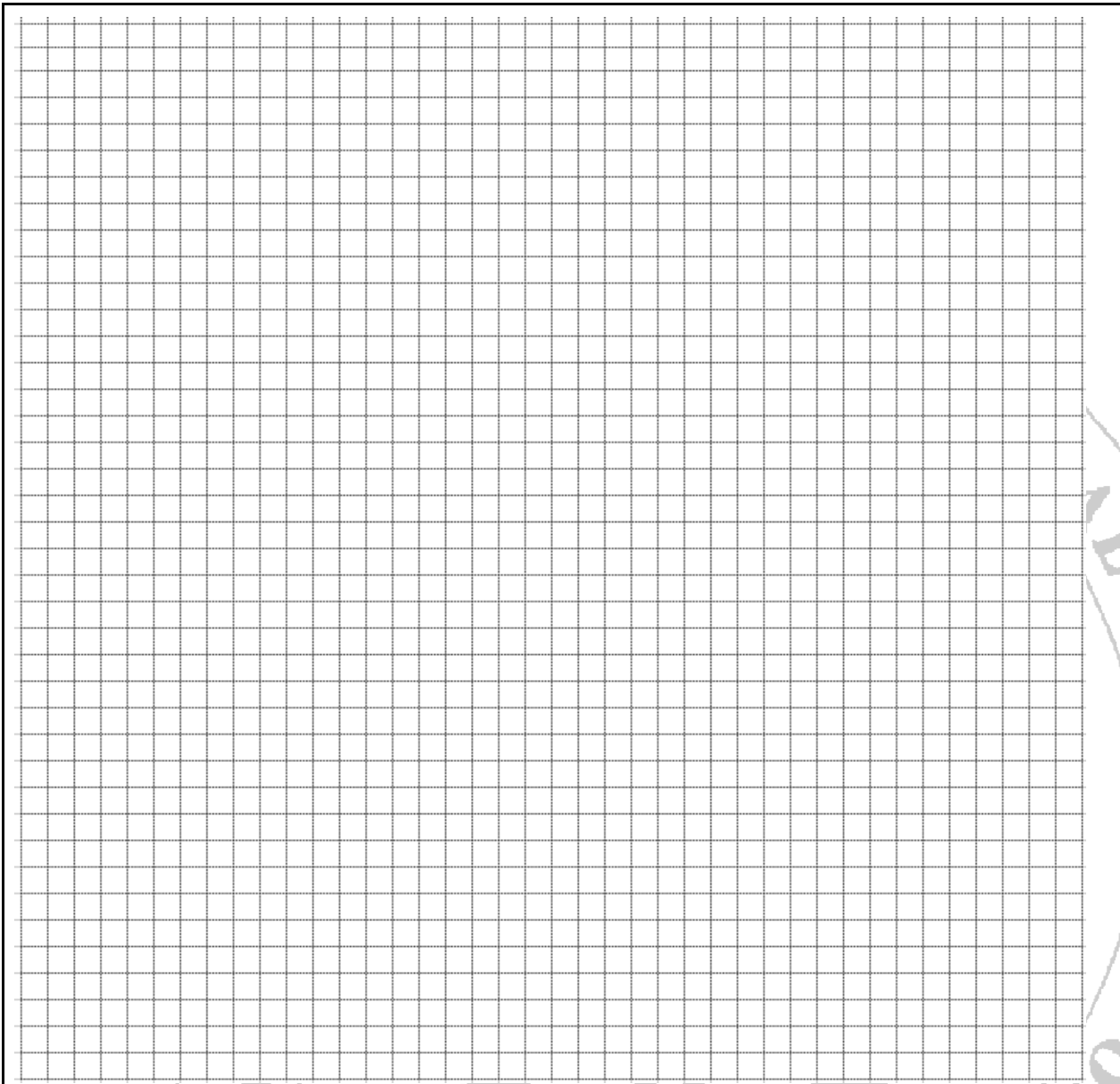
XI Observations and calculations





Title of Graph:





Title of Graph:

XII Results:

1. For firing angle $\alpha = 60^\circ$, Output Voltage =.....
2. For firing angle $\alpha = 90^\circ$, Output Voltage =.....

XIII Interpretation of results:

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 15. Operation of single phase full wave controlled rectifier with R load.

I Practical Significance:

To run the DC motor on high DC power single phase full wave controlled rectifier circuit is used. Controlled rectifier circuit plays an important role for converting AC power to DC power. Average output voltage is controlled by controlling the SCR firing angle in both the half cycles of ac input voltage. It is also used in Battery charger circuit, high voltage DC transmission.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of single phase full wave controlled rectifiers by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

V Relevant Affective Domain related outcome(s)

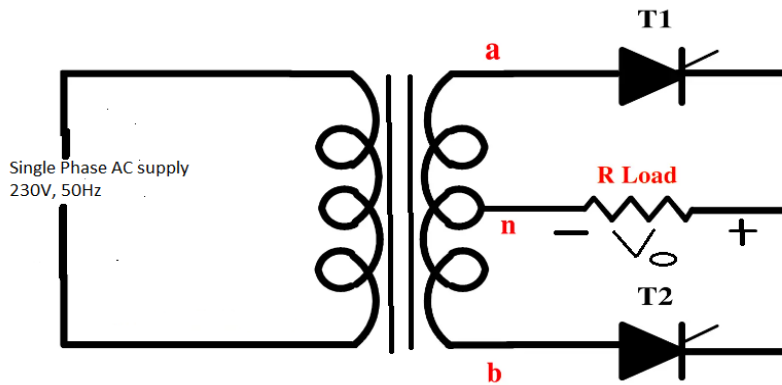
Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

For full-wave rectification , two SCRs are connected across the centre tapped secondary of the transformer , as shown in below figure The gates of both SCRs are supplied from two gate control circuits. One SCR conducts during the positive half cycle and the other during the negative half cycle and thus unidirectional current flows in the load circuit. The main advantage of this circuit over ordinary full-wave rectifier circuits is that the output voltage can be controlled by varying the firing angle. Now, if the supply voltage $V = V_m \sin \omega t$ and the firing angle is α , then average voltage output will be given by the expression.

$$V_{av} = (V_m / \pi) (1 + \cos \alpha)$$

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Full wave rectifier kit	Trainer kit of full wave controlled rectifier with centre tap transformer (12V-0-12V) with connecting facility for R load	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300V DC	1
7	Ammeter	0-1 A DC	1

IX Precautions to be followed:

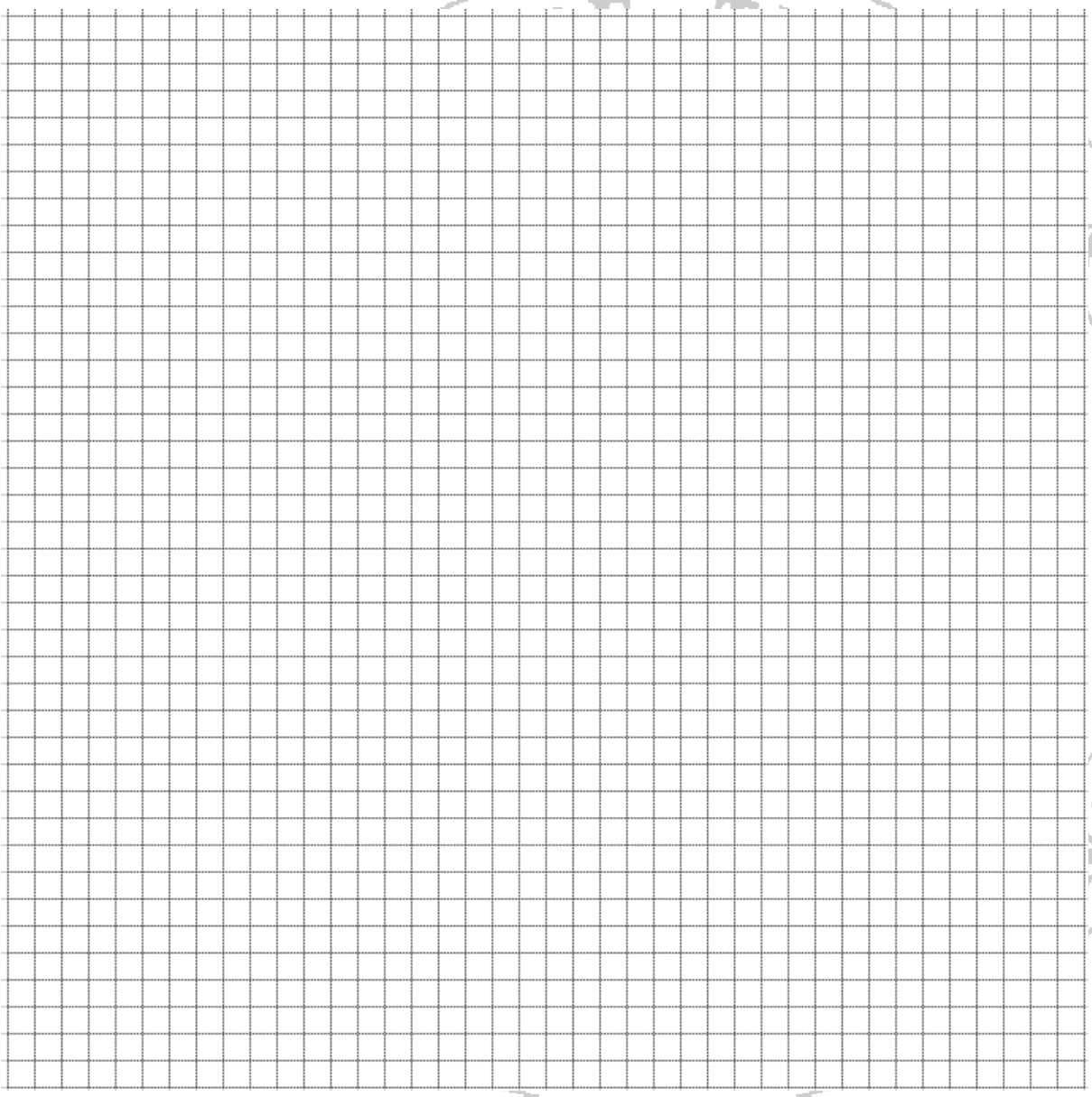
1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. Reading should be notes without parallax error.

X Procedure

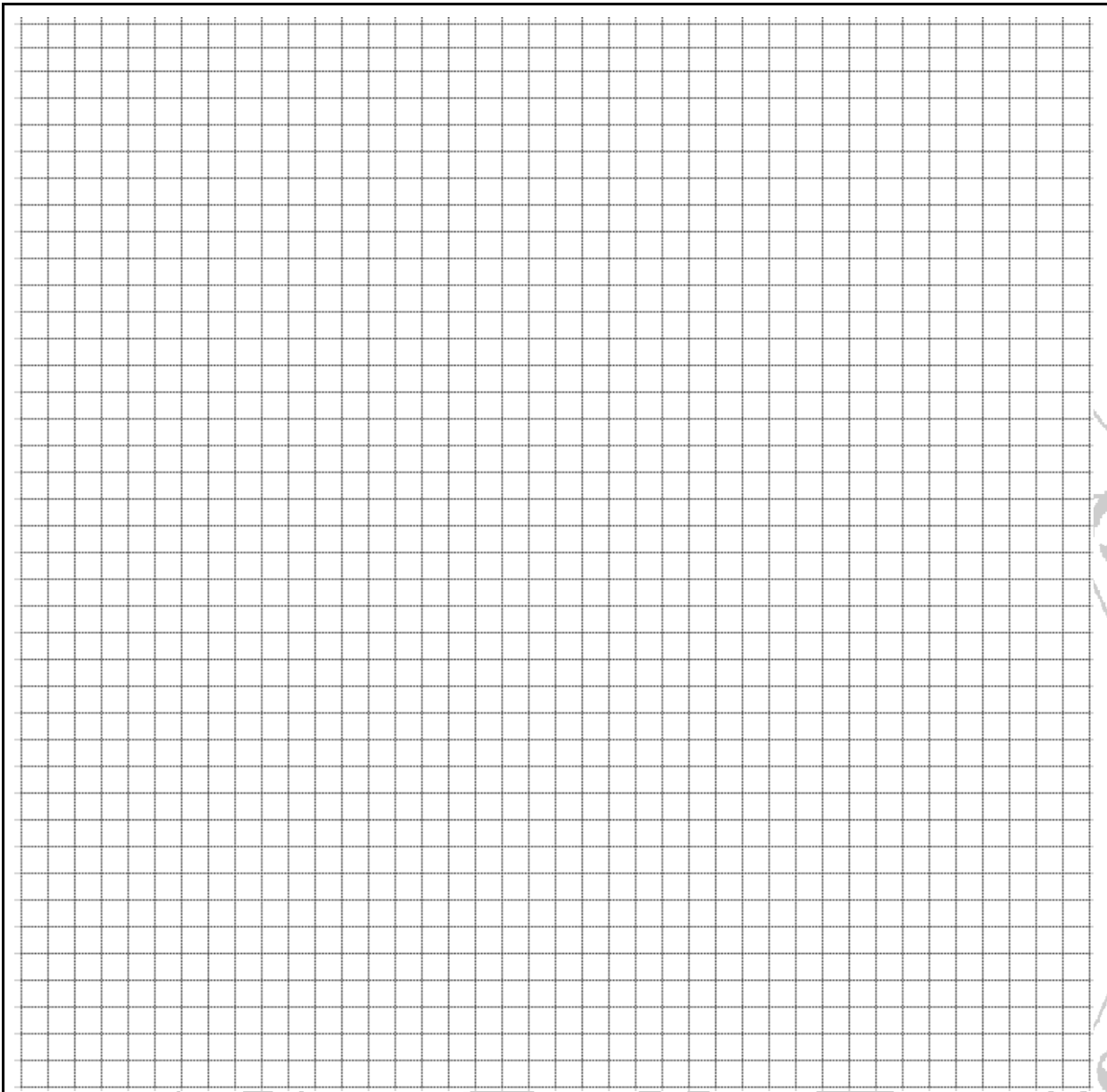
1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.

5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for any two firing angles.

XI Observations and calculations



Title of Graph:



Title of Graph:

XII Results:

1. For firing angle $\alpha = 60^\circ$, Output Voltage =.....
2. For firing angle $\alpha = 90^\circ$, Output Voltage =.....

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

- 1. How do you select the appropriate thyristors for the given circuit
- 2. State the effect on output voltage and current if gate pulse is applied .

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XVI References/Suggestions for further reading:

- 1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
- 2. <https://www.alldatasheet.com/>
- 3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 16. Operation of single phase full wave controlled rectifier with RL load.

I Practical Significance:

To run the DC motor on high DC power single phase full wave controlled rectifier circuit is used. Controlled rectifier circuit plays an important role for converting AC power to DC power. Average output voltage is controlled by controlling the SCR firing angle in both the half cycles of ac input voltage. It is also used in Battery charger circuit, high voltage DC transmission. In this practical student will be able to convert ac input power to pulsating dc output power,

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of single phase full wave controlled rectifiers by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

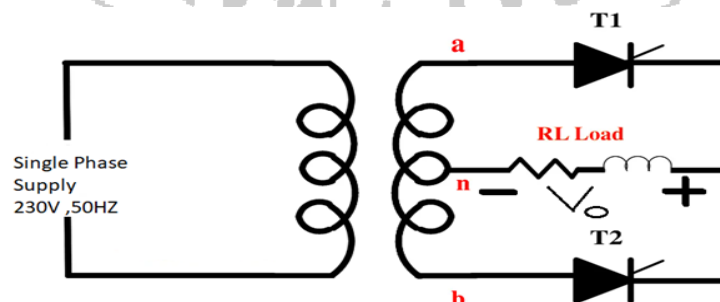
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

For full-wave rectification, two SCRs are connected across the centre tapped secondary of the transformer, as shown in below figure. The gates of both SCRs are supplied from two gate control circuits. One SCR conducts during the positive half cycle and the other during the negative half cycle and thus unidirectional current flows in the load circuit. The main advantage of this circuit over ordinary full-wave rectifier circuits is that the output voltage can be controlled by varying the firing angle. Now, if the supply voltage $V = V_m \sin \omega t$ and the firing angle is α , then average voltage output will be given by the expression $V_{av} = (2V_m / \pi) * (\cos \alpha)$

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-230 V AC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Full wave rectifier kit	Trainer kit of full wave controlled rectifier with centre tap transformer (12V-0-12V) with connecting facility for RL load	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Inductive load	0-100mH	1
6	Voltmeter	0-300 V AC	1
7	Voltmeter	0-300V DC	1
8	Ammeter	0-1 A DC	1

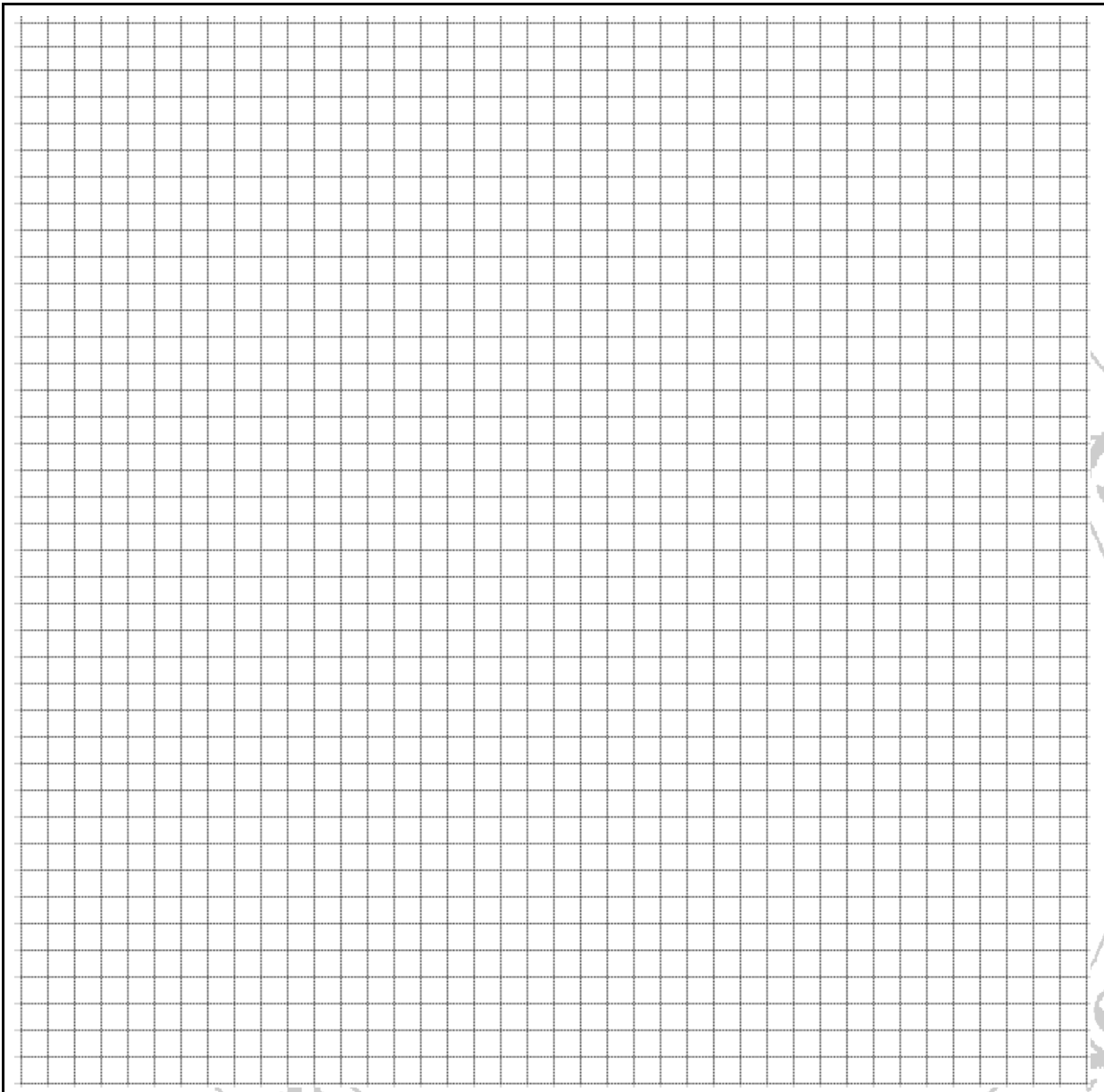
IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. Reading should be notes without parallax error.

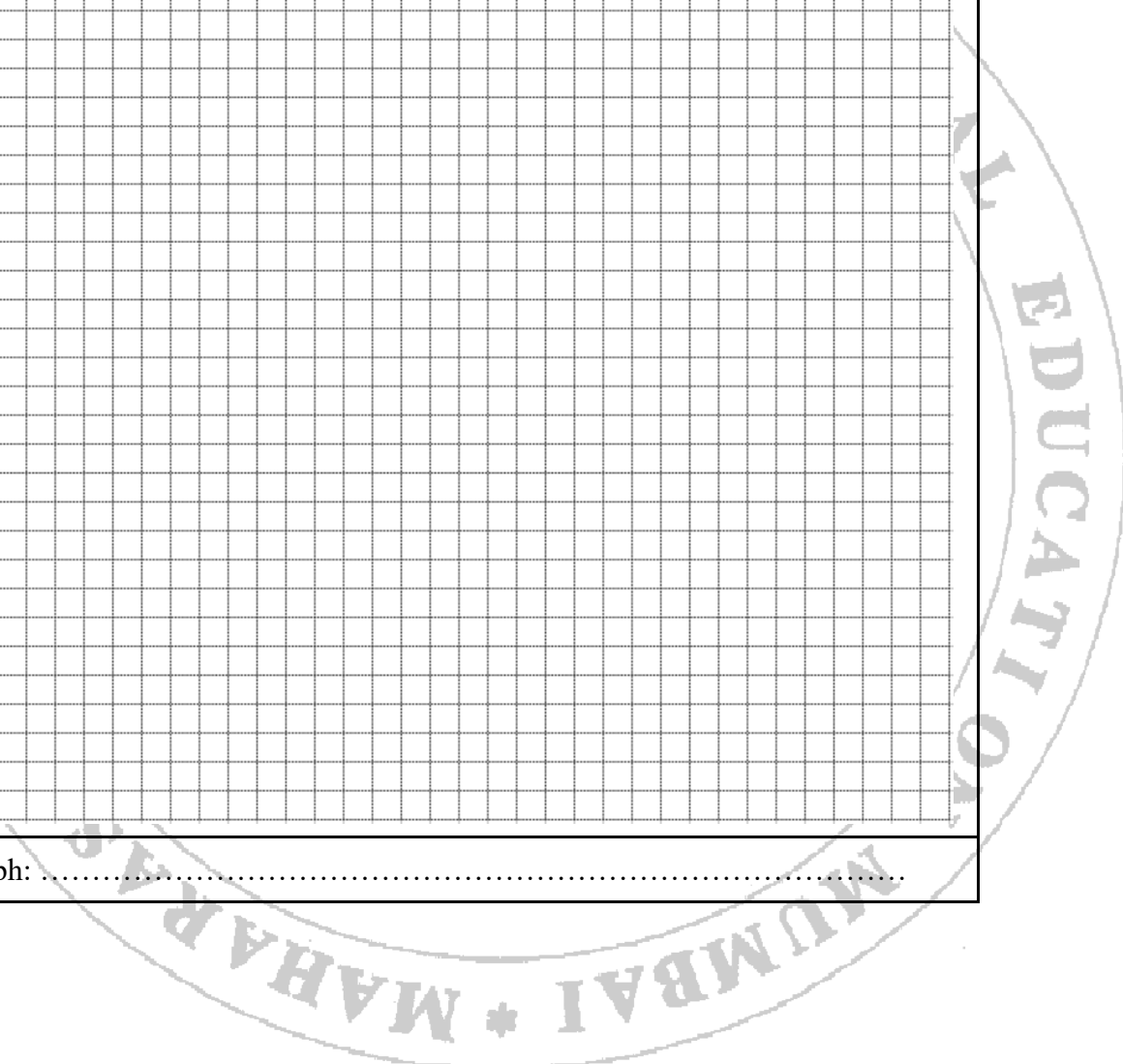
X Procedure

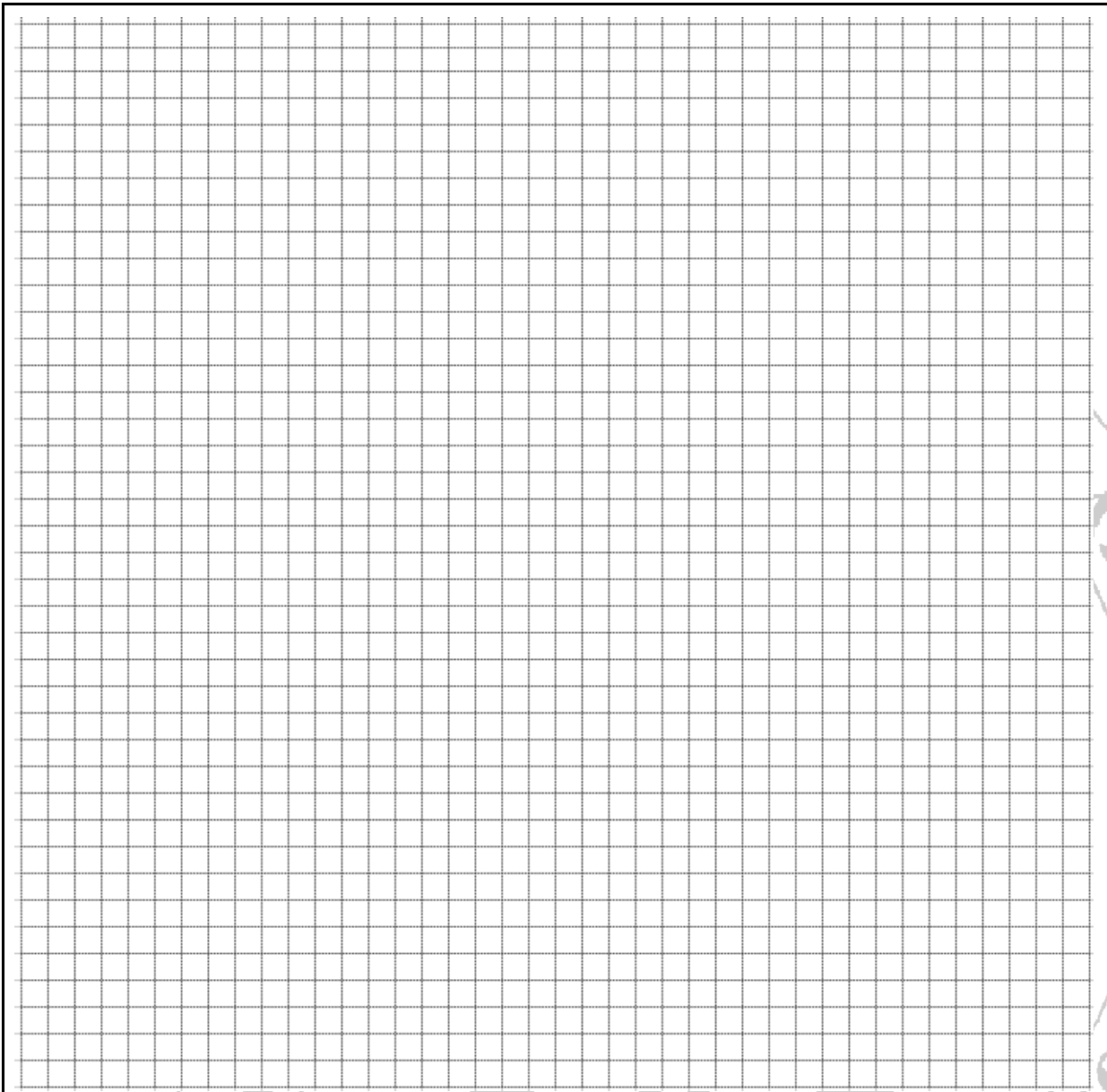
1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for any two firing angle.

XI Observations and calculations



Title of Graph:





Title of Graph:

XII Results:

1. For firing angle $\alpha = 60^\circ$, Output Voltage =
2. For firing angle $\alpha = 90^\circ$, Output Voltage =

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 17. Operation of three phase full wave controlled rectifier with R load.

I Practical Significance:

Three phase full wave controlled rectifier is used to convert three-phase AC power to DC power. The three-phase full-wave controlled rectifier with an R load is significant in industrial applications due to its efficiency, precise control capabilities, reliability, and capability to handle higher power levels with reduced ripple. Its ability to provide stable and adjustable DC output makes it a valuable component in various power electronics and industrial control systems applications.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1. Measure output voltage of three phase full wave controlled rectifiers by using CRO/DSO.

LLO 2. Use the various controls of the CRO/DSO.

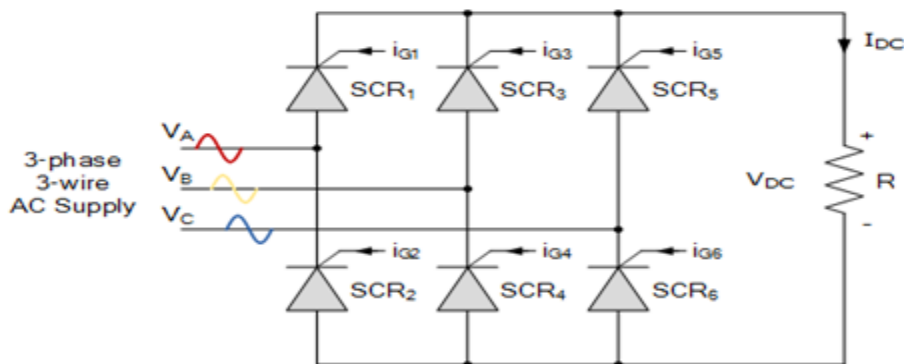
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A three-phase system consists of three sinusoidal voltages of equal magnitude, 120 degrees out of phase with each other. This results in a more continuous power supply compared to single-phase systems. Three phase full-wave rectification converts the three phase AC input into a unidirectional DC output. In a three-phase system, this is achieved using bridge configuration. The three-phase full-wave rectifier typically uses a bridge circuit of six thyristors. The thyristors are triggered in pairs to conduct during each 60-degree segment of the three-phase AC cycle. The output DC voltage is controlled by adjusting the firing angle (α) of the thyristors. For a three-phase full-wave rectifier with resistive load, the average DC output voltage is derived from integrating the output voltage over one cycle and accounting for the firing angle. The three-phase rectifier reduces harmonic distortion compared to single-phase rectifiers. However, harmonics are still present, and filtering may be required to improve power quality.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Three phase transformer	0-440V AC , 50Hz	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Three phase full wave rectifier kit	Trainer kit of three phase full wave controlled rectifier with connecting facility for R load	1
4	Variable resistive load	Single phase, 0-3kW	1
6	Voltmeter	0-600V AC	1
7	Voltmeter	0-300V DC	1
8	Ammeter	0-5A DC	1

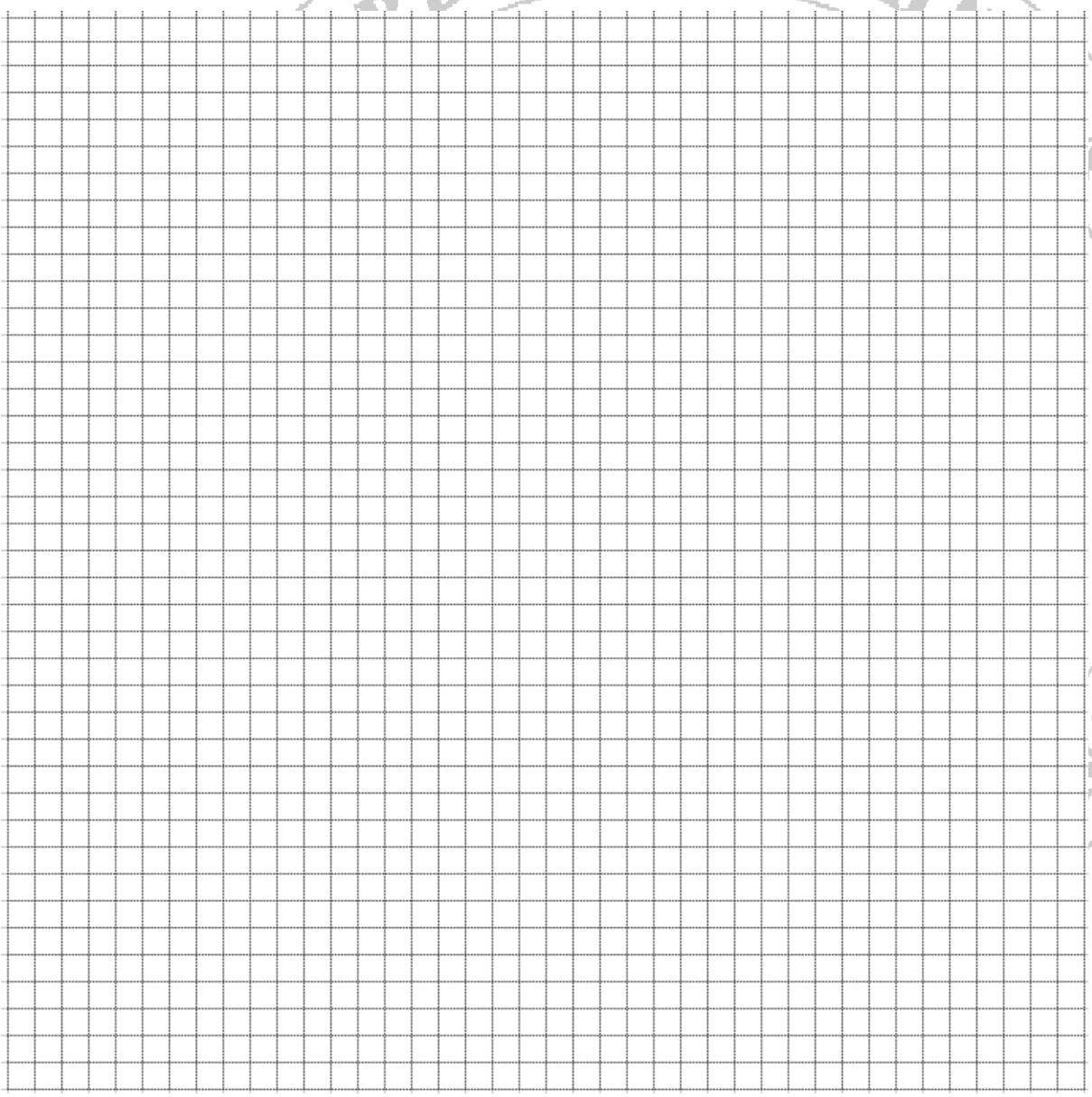
IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. The thyristors must be turned off at the end of each conduction period to prevent continuous current flow.
3. The gating circuit must ensure that only two thyristors are conducting at any given time.
4. The load current must be within the rated current of the thyristors
5. Reading should be notes without parallax error.

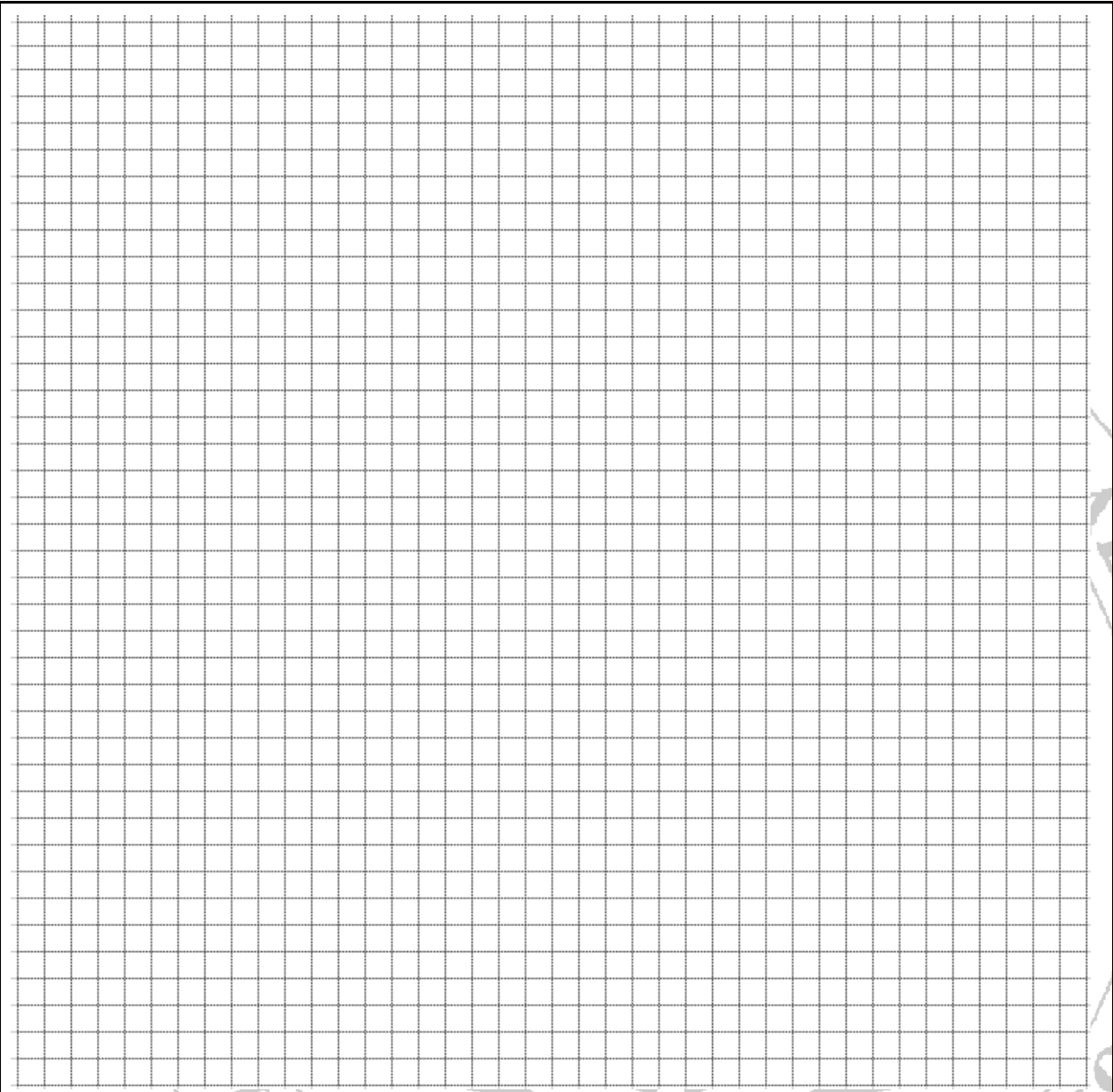
X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for any two firing angles.

XI Observations and calculations



Title of Graph:



Title of Graph:

XII Results:

- 1. For firing angle $\alpha = 60^\circ$, Output Voltage =
- 2. For firing angle $\alpha = 90^\circ$, Output Voltage =

XIII Interpretation of results:

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 18: Voltage Control using Controlled Rectifier

I Practical Significance:

Three phase full wave controlled rectifier is used to convert three-phase AC power to DC power. The three-phase full-wave controlled rectifier with an R load is significant in industrial applications due to its efficiency, precise control capabilities, reliability, and capability to handle higher power levels with reduced ripple. Its ability to provide stable and adjustable DC output makes it a valuable component in various power electronics and industrial control systems applications.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 18.1 Measure the output voltage with different firing angles of the controlled rectifier available in your laboratory

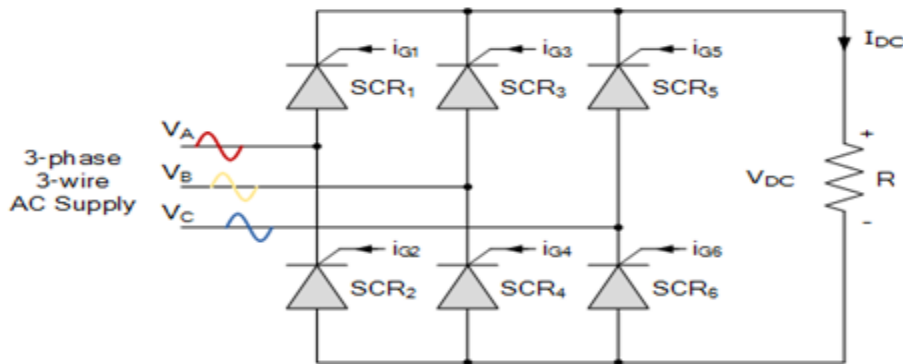
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A three-phase system consists of three sinusoidal voltages of equal magnitude, 120 degrees out of phase with each other. This results in a more continuous power supply compared to single-phase systems. Three phase full-wave rectification converts the three phase AC input into a unidirectional DC output. In a three-phase system, this is achieved using bridge configuration. The three-phase full-wave rectifier typically uses a bridge circuit of six thyristors. The thyristors are triggered in pairs to conduct during each 60-degree segment of the three-phase AC cycle. The output DC voltage is controlled by adjusting the firing angle (α) of the thyristors. For a three-phase full-wave rectifier with resistive load, the average DC output voltage is derived from integrating the output voltage over one cycle and accounting for the firing angle. The three-phase rectifier reduces harmonic distortion compared to single-phase rectifiers. However, harmonics are still present, and filtering may be required to improve power quality.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Three phase transformer	0-440V AC , 50Hz	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Three phase full wave rectifier kit	Trainer kit of three phase full wave controlled rectifier with connecting facility for R load	1
4	Variable resistive load	Single phase, 0-3kW	1
6	Voltmeter	0-600V AC	1
7	Voltmeter	0-300V DC	1
8	Ammeter	0-5A DC	1

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. The thyristors must be turned off at the end of each conduction period to prevent continuous current flow.
3. The gating circuit must ensure that only two thyristors are conducting at any given time.
4. The load current must be within the rated current of the thyristors
5. Reading should be notes without parallax error.

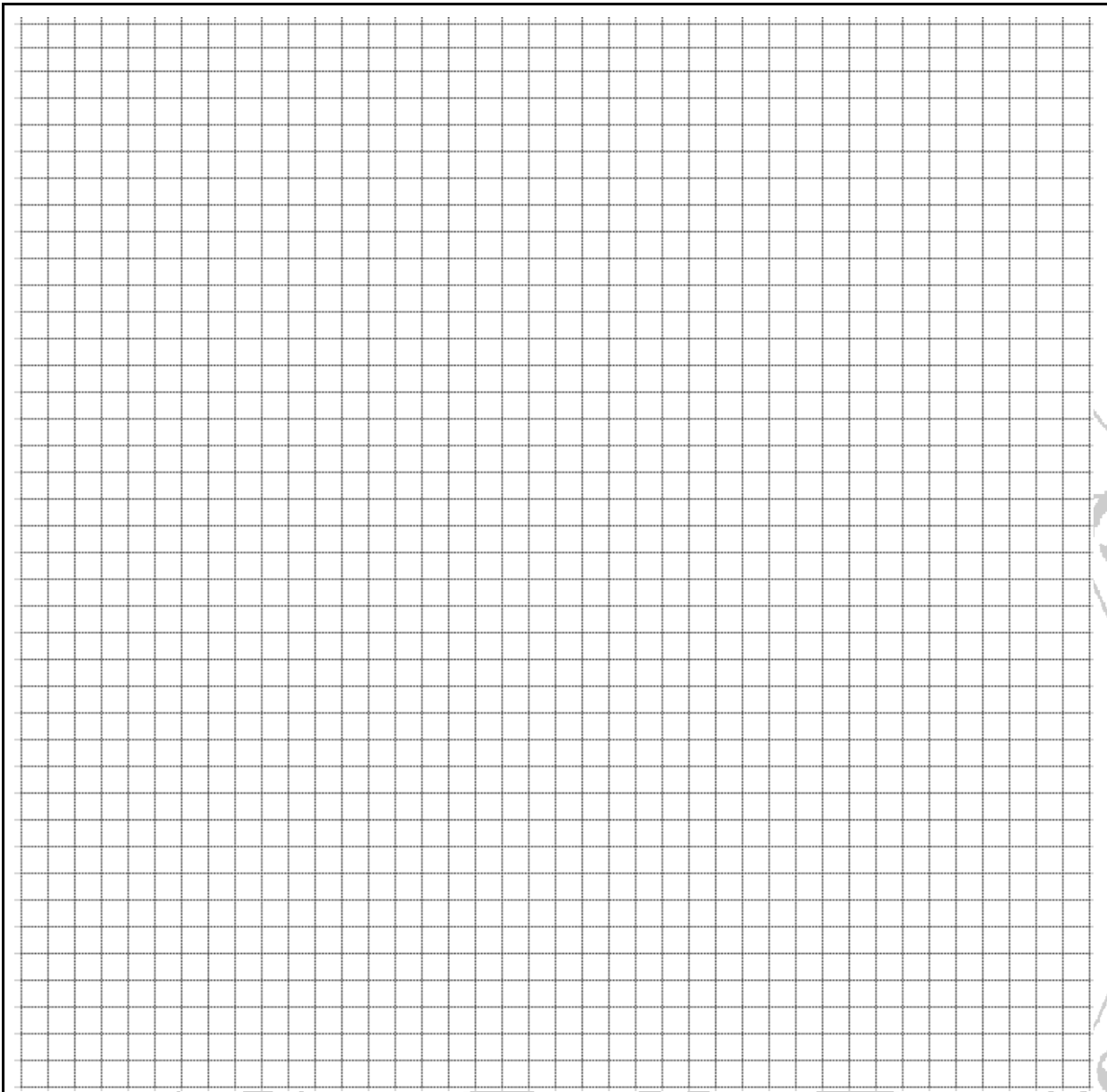
X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Measure the AC input voltage by using voltmeter.
4. Connect CRO across the input to observe the input waveform.
5. Connect CRO to measure the voltage across the load.
6. Observe the output waveforms for different firing angles.
7. Draw input and output waveform on graph paper for any two firing angles.

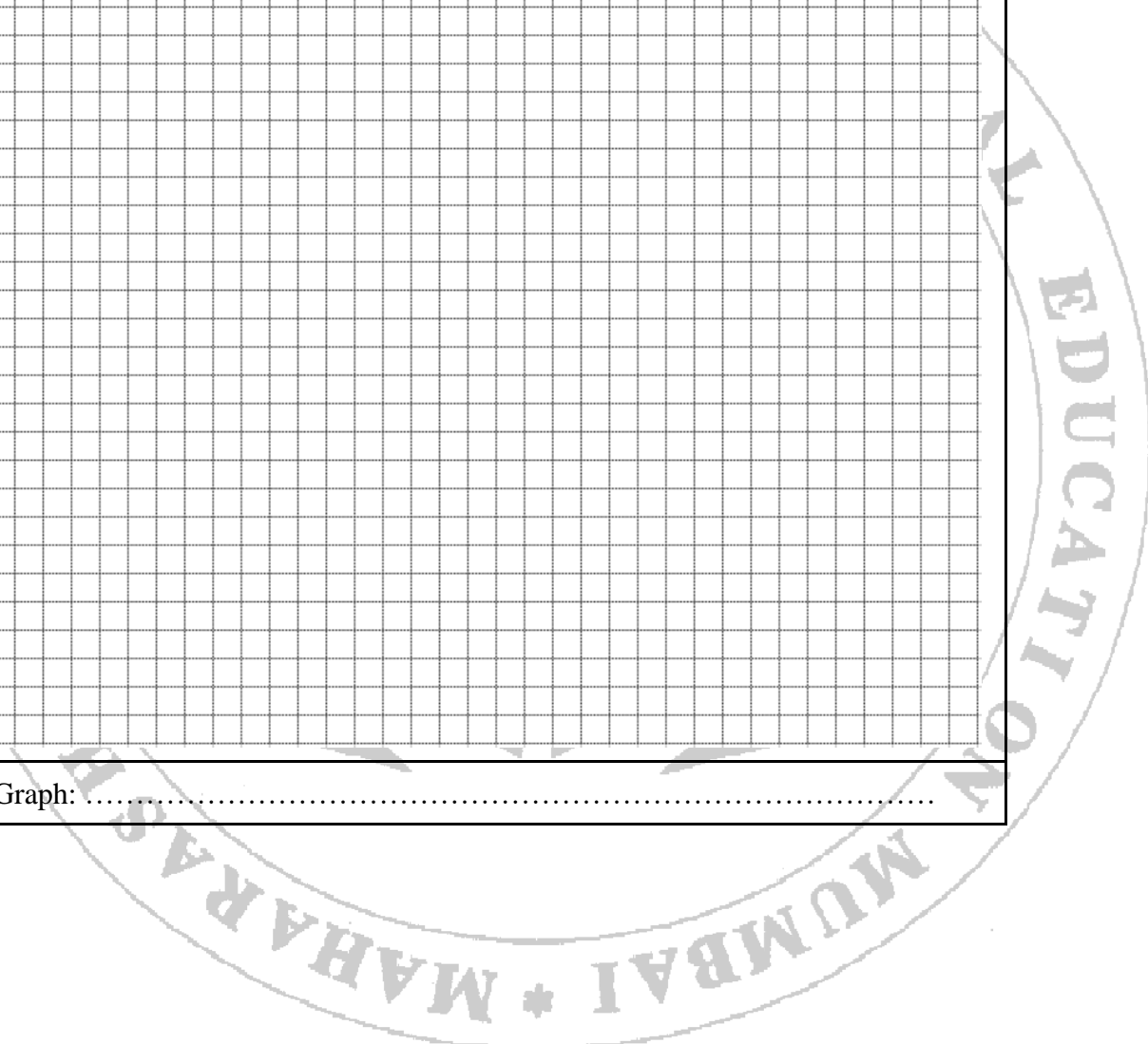
XI Observations and calculations

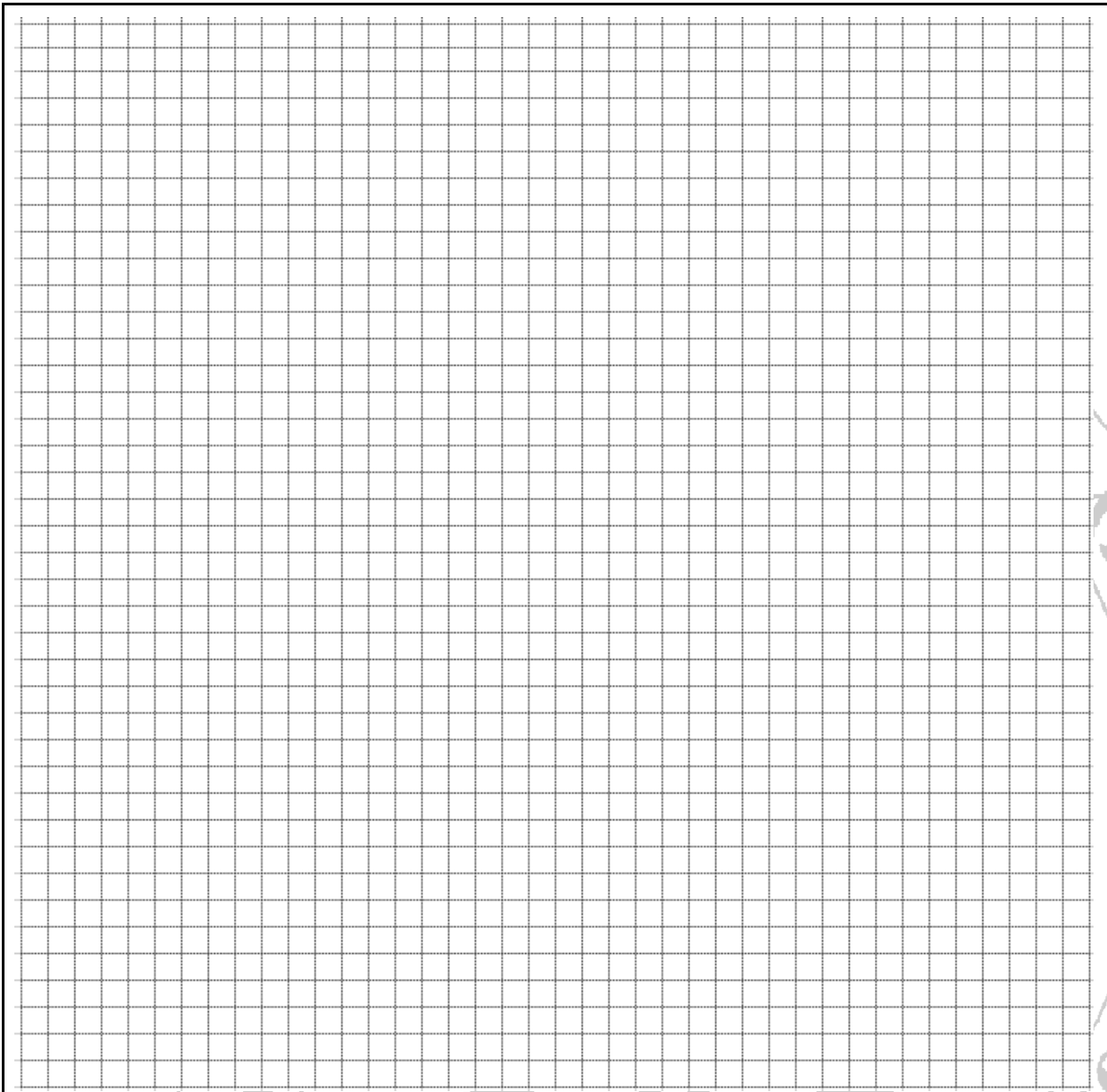
Sr. No.	Firing Angle	Average Output

XII Results:



Title of Graph:





Title of Graph:

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 19 Operation of single phase half wave bridge inverter with resistive load.

I Practical Significance:

The practical significance of a single-phase half-wave bridge inverter with a resistive load lies in its ability to convert DC voltage into AC voltage. This is essential for various applications such as power supplies for electronic devices, motor drives, and lighting systems. The inverter's simplicity and low cost make it a popular choice for many applications, especially in situations where high efficiency and low harmonic distortion are not critical requirements.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO.

LLO 2 Use various controls of the CRO/DSO

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A single-phase half-wave bridge inverter is a power electronic circuit that converts DC voltage into AC voltage. It consists of a two switches (usually a transistor or thyristor) and a diode. Here's how it operates:

Positive Half-Cycle: When the switch T1 is turned on, the DC voltage is applied across the resistive load. This causes current to flow through the load in one direction.

Negative Half-Cycle: When the switch T2 is turned on, the diode conducts, allowing the current to flow through the load in the opposite direction. This creates a negative half-cycle.

Output Waveform: The output voltage waveform is a pulsating DC waveform with a frequency equal to the switching frequency of the inverter. It consists of positive half-cycles and negative half-cycles.

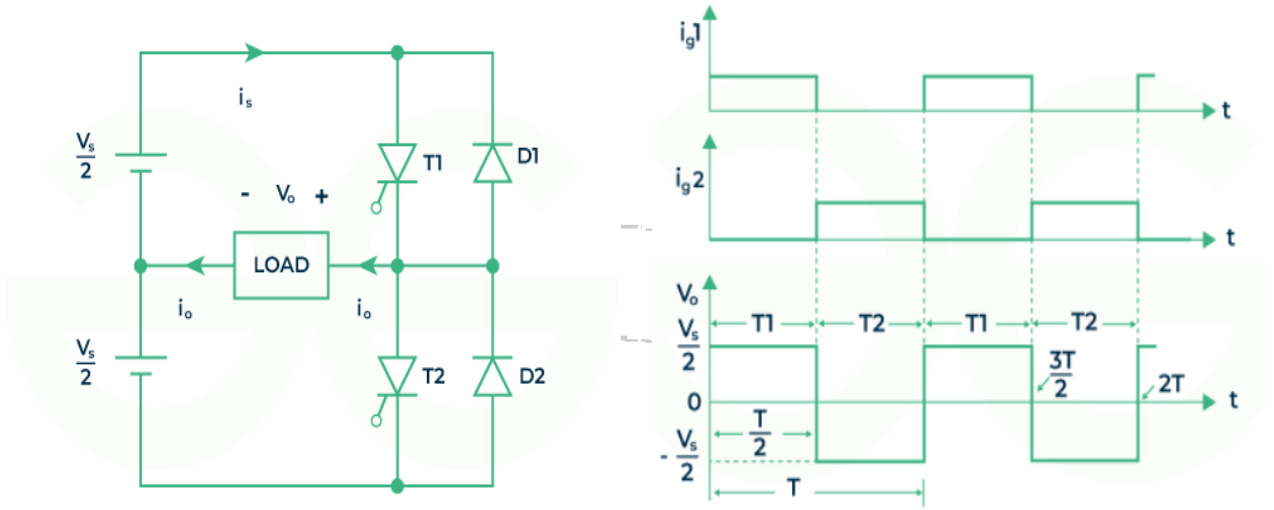


Fig. 19.1.a : single phase half wave bridge inverter with resistive load

Fig. 19.1.b : waveform for single phase half wave bridge inverter with resistive load

VII Actual Circuit diagram used in laboratory with equipment Specifications:

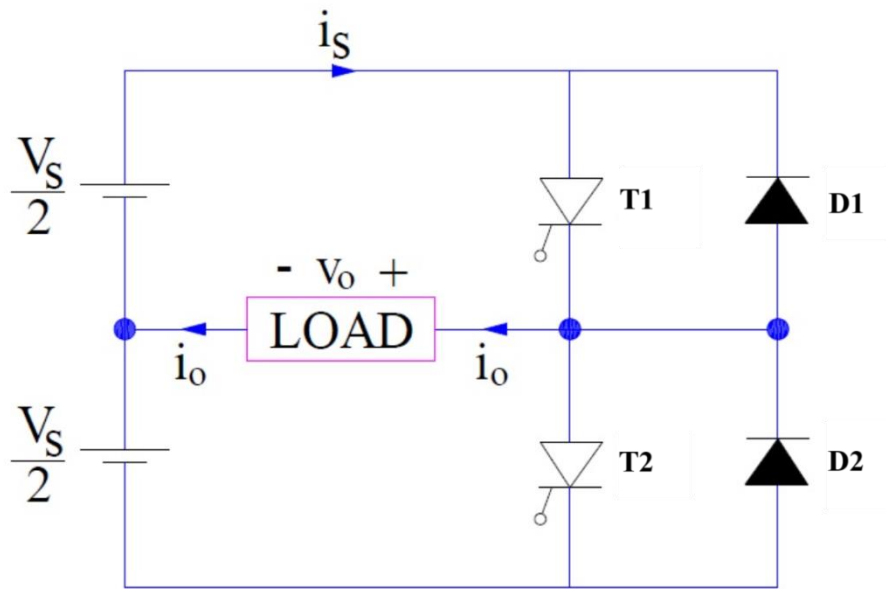


Fig. 19.2 : single phase half wave bridge inverter with resistive load

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-120 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Variable resistive load	Single phase, 0-3kW	1
4	Single-phase half-wave bridge inverter module	-	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1

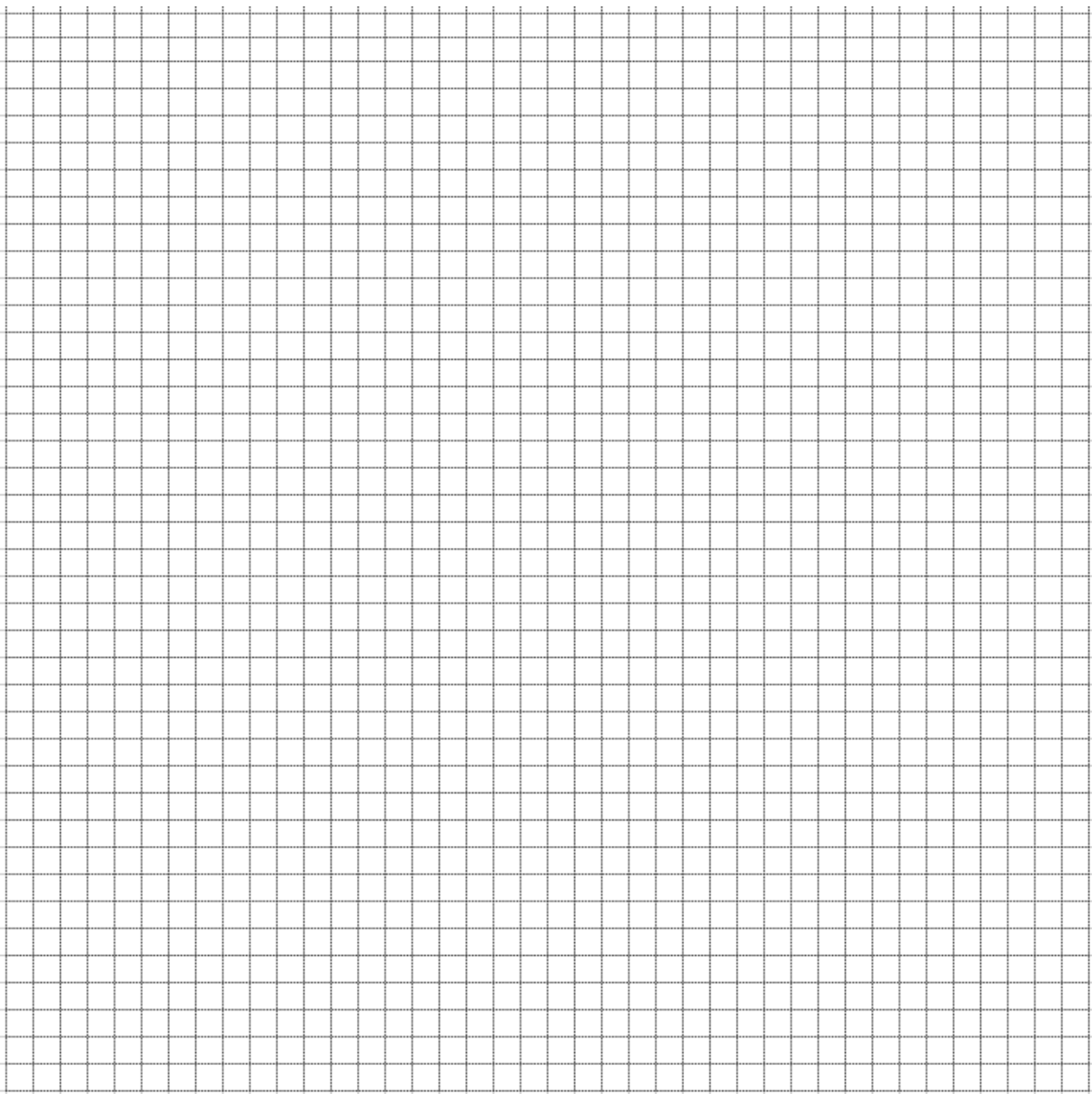
Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. High Voltage: Always exercise caution when working with high-voltage AC circuits.
5. Heat Dissipation: Ensure adequate heat dissipation for the thyristor to prevent overheating.
6. Component Ratings: Never exceed the maximum ratings for the thyristor or load components.

X Procedure

1. Connect the DC power supply to the input terminals of the inverter module.
2. Connect the resistor to the output terminals of the inverter module.
3. Connect the oscilloscope to measure the output voltage across the resistor.
4. Connect the multimeter to measure the DC input voltage and the average output voltage.
5. Turn on the power supply and adjust the output voltage to a desired level.
6. Measure and record the DC input voltage using the multimeter.
7. Set the oscilloscope to a suitable time base and voltage scale.
8. Observe the output voltage waveform on the oscilloscope screen.
9. Note the shape of the waveform (pulsating DC) and its frequency.
10. Measure the output current at various resistive loads.



Title of Graph:

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 20: Operation of single phase full wave bridge inverter with resistive load

I Practical Significance:

A single-phase full-bridge inverter is significant for converting DC power into AC power, commonly used in applications like uninterruptible power supplies (UPS), renewable energy systems, and motor drives. It offers the flexibility to control the output voltage and frequency, making it useful in adjustable-speed drives and other systems requiring variable AC output. The full-bridge configuration ensures efficient utilization of the DC input and allows for higher power output compared to half-bridge inverters. Its bidirectional nature also makes it suitable for regenerative braking systems in electric vehicles. The compact design and reliability make it ideal for residential and industrial use.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO.

LLO 2 Use various controls of the CRO/DSO

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A single-phase full-wave bridge inverter converts DC power to AC by using four switching devices arranged in an H-bridge configuration. In each half cycle, two diagonally opposite switches conduct, reversing the current direction through the load, thus producing an alternating voltage. The switches are controlled in pairs, with one pair operating for the positive half cycle and the other for the negative half. The output is a square wave AC voltage, which can be filtered to approximate a sinusoidal waveform.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

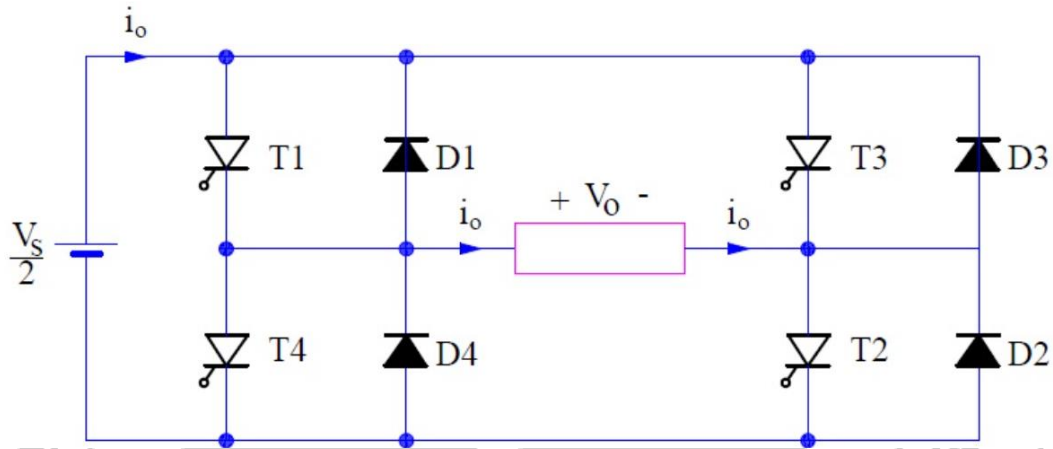


Fig.20.1: Single Phase Full Wave Bridge Inverter

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-120 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Variable resistive load	Single phase, 0-3kW	1
4	Single-phase full-wave bridge inverter module	-	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. High Voltage: Always exercise caution when working with high-voltage AC circuits.
5. Heat Dissipation: Ensure adequate heat dissipation for the thyristor to prevent overheating.
6. Component Ratings: Never exceed the maximum ratings for the thyristor or load components.

X Procedure

1. Connect the DC power supply to the input terminals of the inverter module.
2. Connect the resistor to the output terminals of the inverter module.
3. Connect the oscilloscope to measure the output voltage across the resistor.
4. Connect the multimeter to measure the DC input voltage and the average output voltage.
5. Turn on the power supply and adjust the output voltage to a desired level.
6. Measure and record the DC input voltage using the multimeter.
7. Set the oscilloscope to a suitable time base and voltage scale.
8. Observe the output voltage waveform on the oscilloscope screen.
9. Note the shape of the waveform (pulsating DC) and its frequency.
10. Measure the output current at various resistive loads.

XI Observations and calculations

Sr. No.	Resistance Value	Measure Output Current	Calculated Output Current
1			
2			
3			
4			

XII Results:

1. Output Voltage =
2. Frequency =

XIII Interpretation of results:

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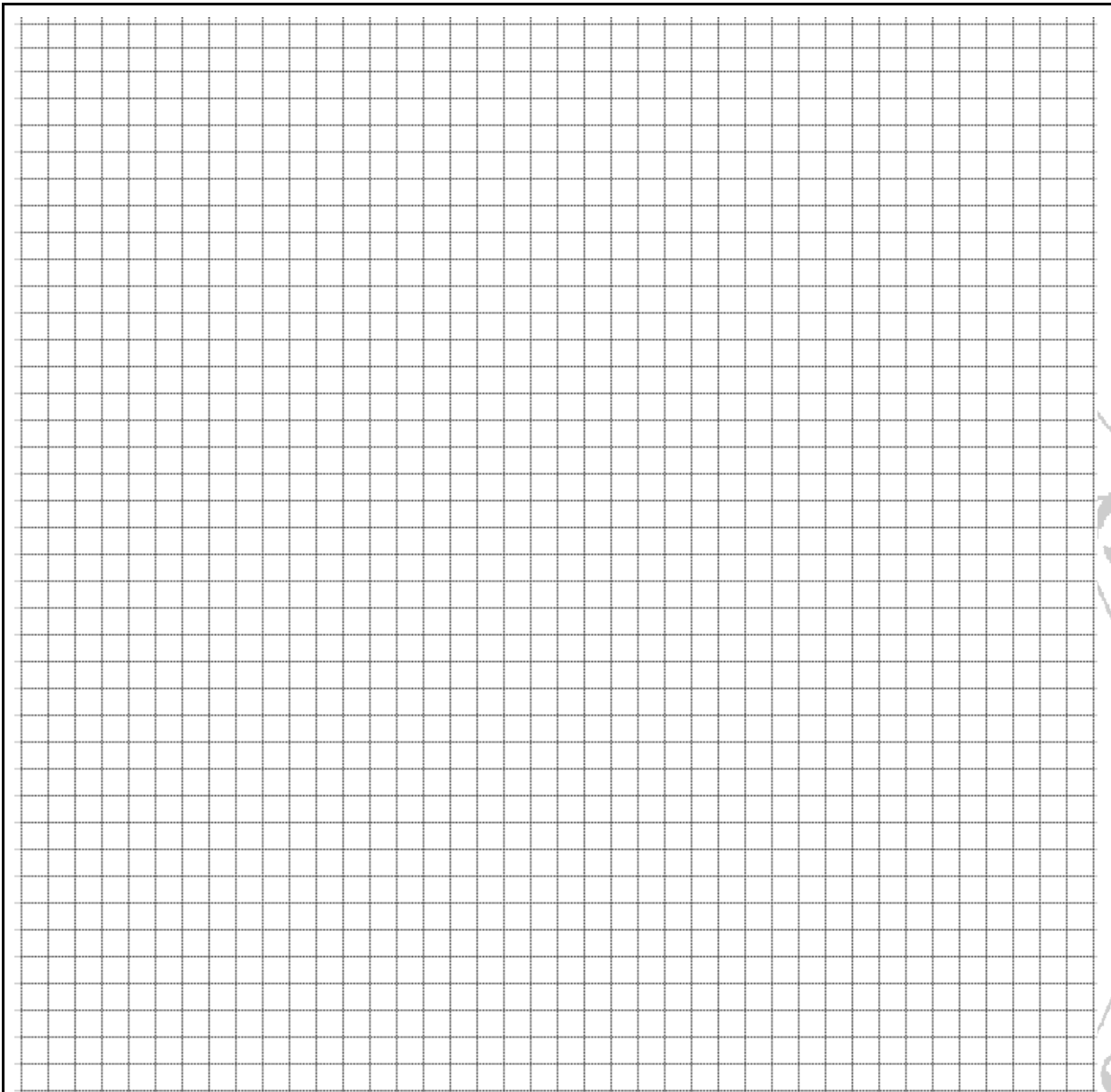
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XIV Conclusion and recommendation

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Title of Graph:

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K. ; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 21 Operation of single phase half wave bridge inverter with RL load

I Practical Significance:

The practical significance of a single-phase half-wave bridge inverter with a resistive load lies in its ability to convert DC voltage into AC voltage. This is essential for various applications such as power supplies for electronic devices, motor drives, and lighting systems. The inverter's simplicity and low cost make it a popular choice for many applications, especially in situations where high efficiency and low harmonic distortion are not critical requirements.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO.

LLO 2 Use various controls of the CRO/DSO

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A single-phase half-wave bridge inverter is a power electronic circuit that converts DC voltage into AC voltage. It consists of two switches (usually a transistor or thyristor) and a diode.

Here's how it operates:

Positive Half-Cycle: When the switch T1 is turned on, the DC voltage is applied across the resistive load. This causes current to flow through the load in one direction.

Negative Half-Cycle: When the switch T2 is turned on, the diode conducts, allowing the current to flow through the load in the opposite direction. This creates a negative half-cycle.

Output Waveform: The output voltage waveform is a pulsating DC waveform with a frequency equal to the switching frequency of the inverter. It consists of positive half-cycles and negative half-cycles.

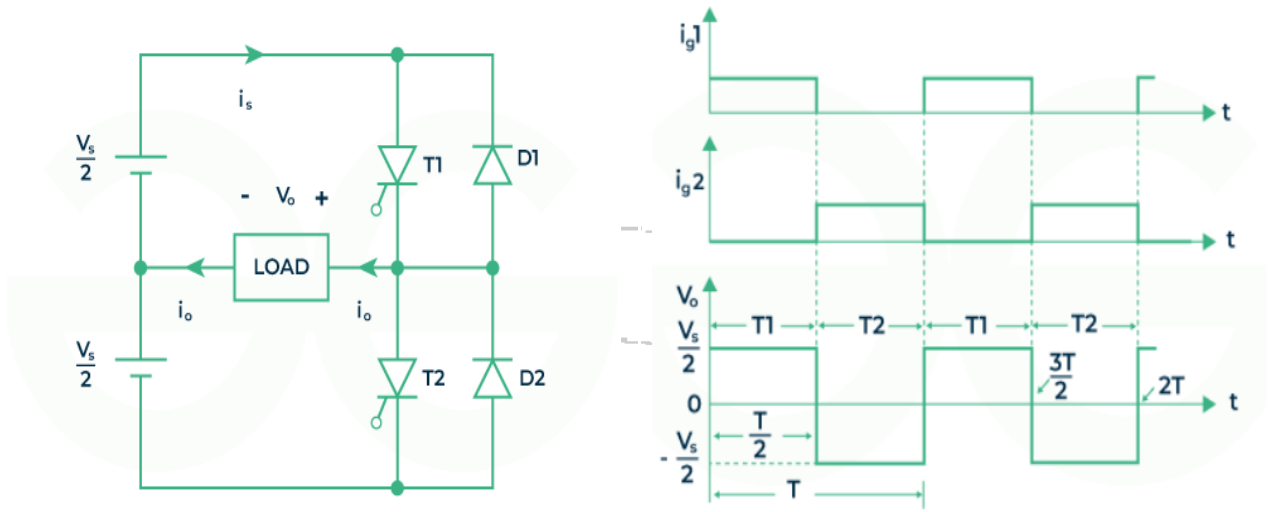


Fig. 21.1.a : single phase half wave bridge inverter with resistive load

Fig. 21.1.b : waveform for single phase half wave bridge inverter with resistive load

VII Actual Circuit diagram used in laboratory with equipment Specifications:

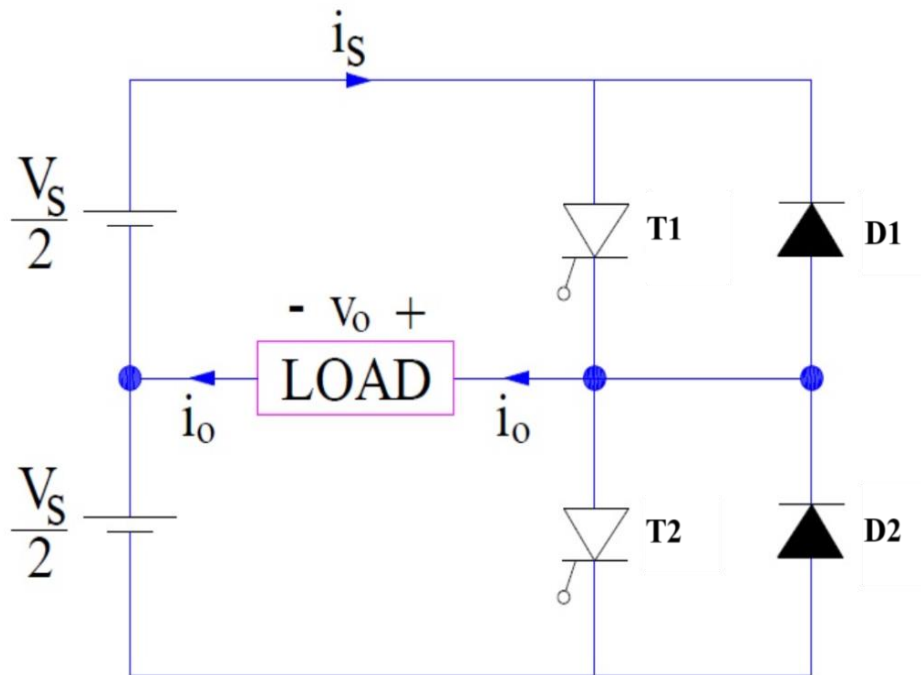


Fig. 21.2 : single phase half wave bridge inverter with resistive load

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-120 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Variable resistive load	Single phase, 0-3kW	1
4	Single-phase half-wave bridge inverter module	-	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1
7	Variable inductive load	Single phase, 0-1kVAR	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. High Voltage: Always exercise caution when working with high-voltage AC circuits.
5. Heat Dissipation: Ensure adequate heat dissipation for the thyristor to prevent overheating.
6. Component Ratings: Never exceed the maximum ratings for the thyristor or load components.

X Procedure

1. Connect the DC power supply to the input terminals of the inverter module.
2. Connect the resistor to the output terminals of the inverter module.
3. Connect the oscilloscope to measure the output voltage across the resistor.
4. Connect the multimeter to measure the DC input voltage and the average output voltage.
5. Turn on the power supply and adjust the output voltage to a desired level.
6. Measure and record the DC input voltage using the multimeter.
7. Set the oscilloscope to a suitable time base and voltage scale.
8. Observe the output voltage waveform on the oscilloscope screen.
9. Note the shape of the waveform (pulsating DC) and its frequency.
10. Measure the output current at various loads.

XI Observations and calculations

1. For L =

Sr. No.	Resistance Value	Measure Output Current	Calculated Output Current
1			
2			
3			
4			

2. For L =

Sr. No.	Resistance Value	Measure Output Current	Calculated Output Current
1			
2			
3			
4			

XII Results:

- Output Voltage =
- Frequency =

XIII Interpretation of results:

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XIV Conclusion and recommendation

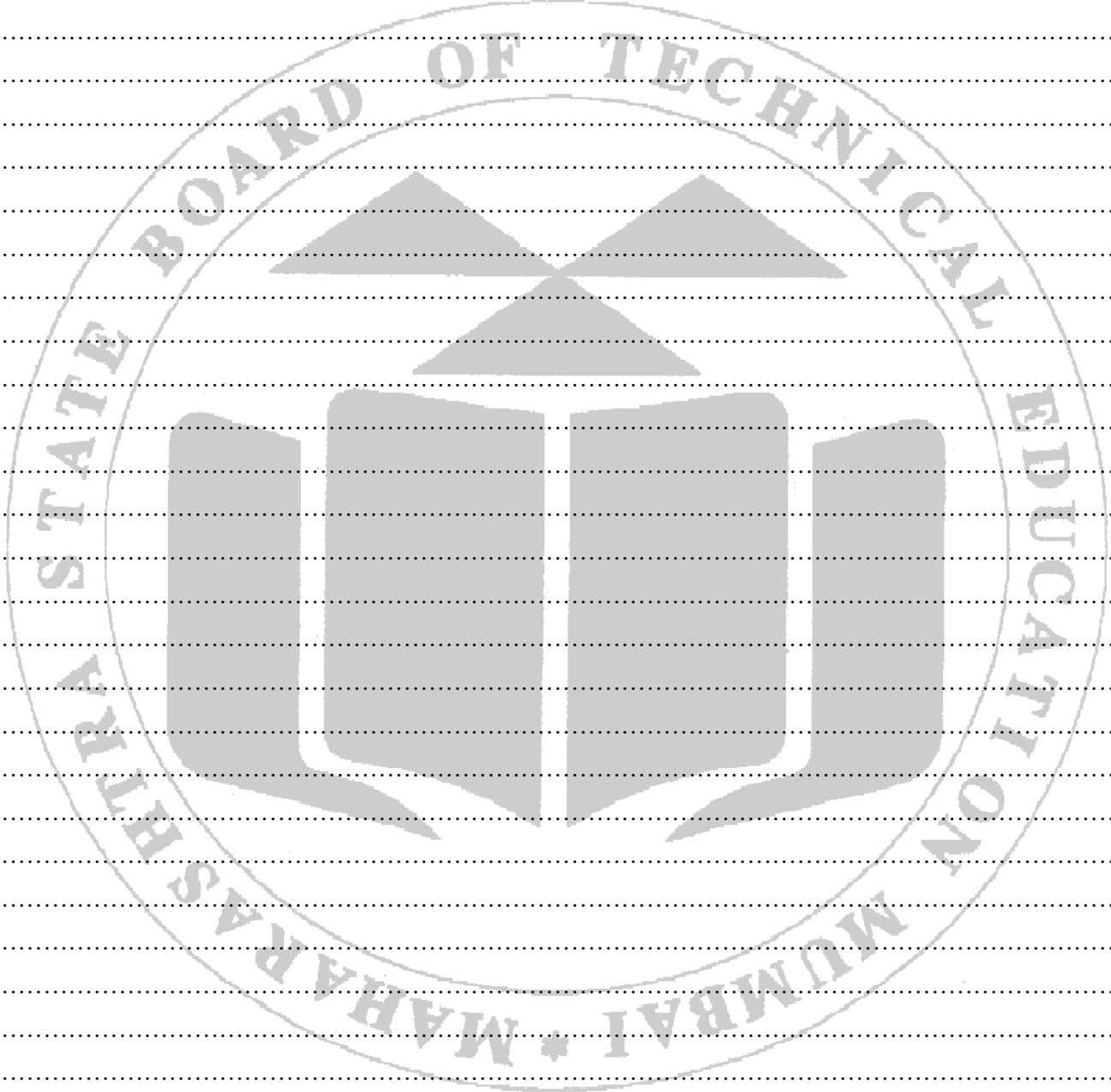
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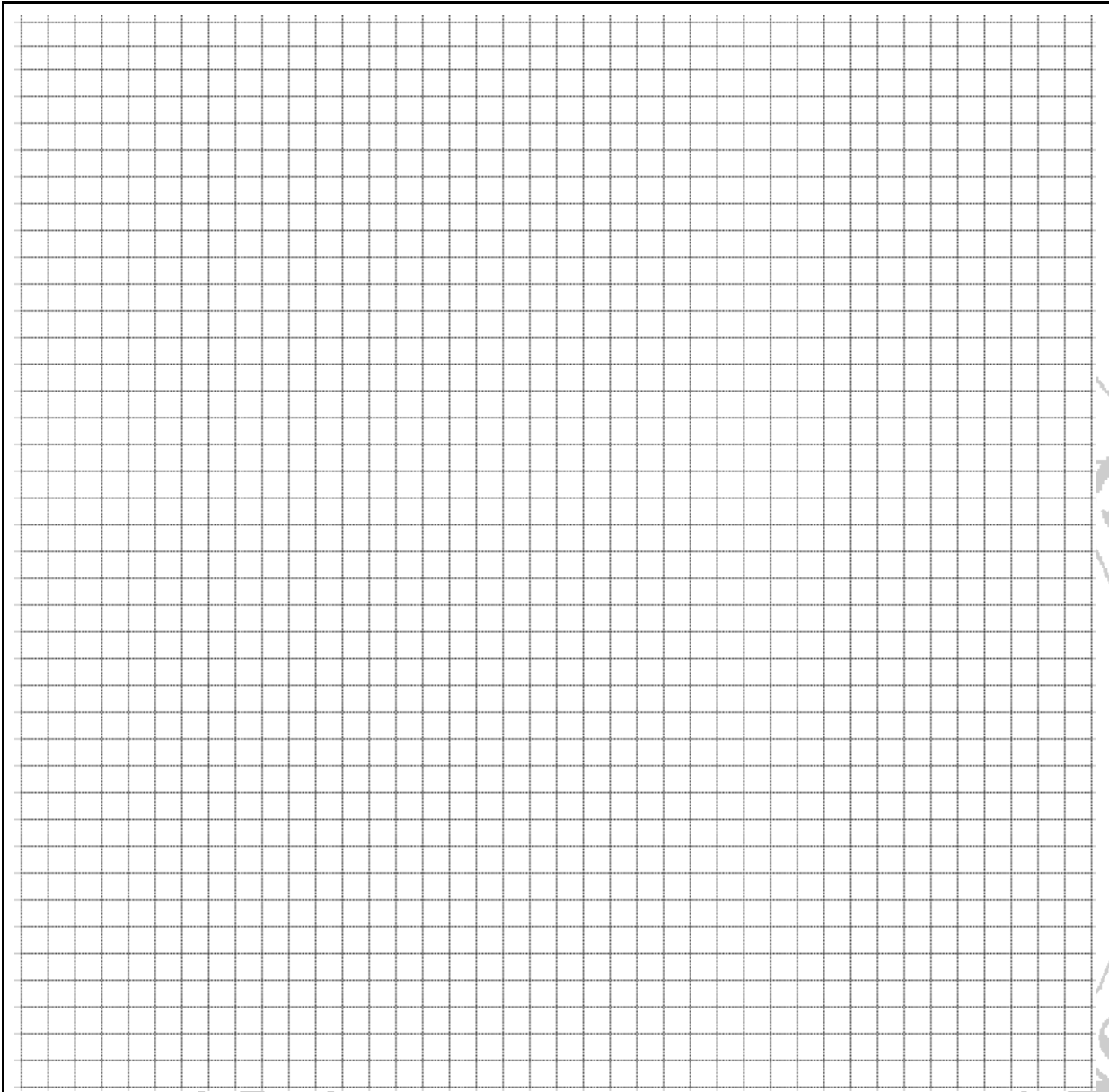
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XV Practical related questions (Provide space for answers)

- 1. Plot a graph of peak-to-peak output voltage versus time.
- 2. State the type of power electronic device suitable for inverter application.
- 3. Discuss the effect of switching frequency on the output voltage waveform.





Title of Graph:

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 22: Operation of single phase full wave bridge inverter with RL load

I Practical Significance:

A single-phase full-bridge inverter is significant for converting DC power into AC power, commonly used in applications like uninterruptible power supplies (UPS), renewable energy systems, and motor drives. It offers the flexibility to control the output voltage and frequency, making it useful in adjustable-speed drives and other systems requiring variable AC output. The full-bridge configuration ensures efficient utilization of the DC input and allows for higher power output compared to half-bridge inverters. Its bidirectional nature also makes it suitable for regenerative braking systems in electric vehicles. The compact design and reliability make it ideal for residential and industrial use.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given controlled converter

IV Laboratory Learning Outcome(s)

LLO 1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO.

LLO 2 Use various controls of the CRO/DSO

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A single-phase full-wave bridge inverter converts DC power to AC by using four switching devices arranged in an H-bridge configuration. In each half cycle, two diagonally opposite switches conduct, reversing the current direction through the load, thus producing an alternating voltage. The switches are controlled in pairs, with one pair operating for the positive half cycle and the other for the negative half. The output is a square wave AC voltage, which can be filtered to approximate a sinusoidal waveform.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

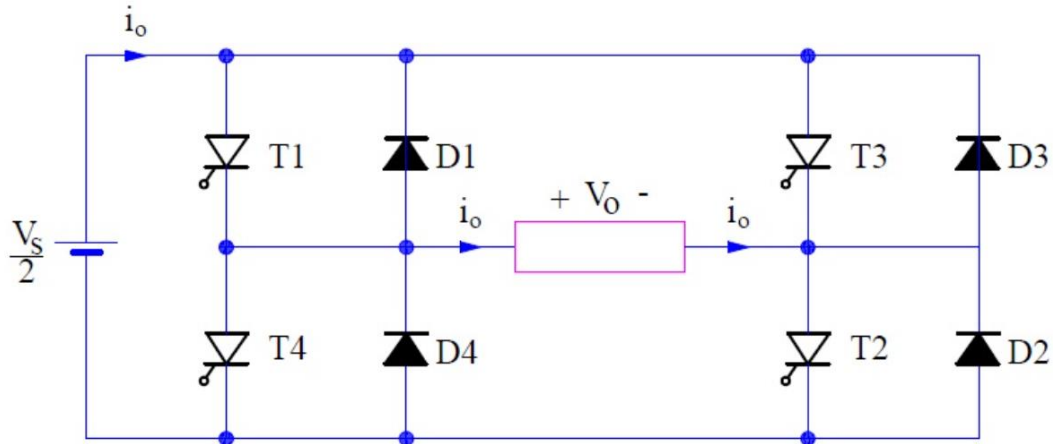


Fig.22.1: Single Phase Full Wave Bridge Inverter

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-120 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Variable resistive load	Single phase, 0-3kW	1
4	Single-phase full-wave bridge inverter module	-	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1
7	Variable inductive load	Single phase, 0-1kVAR	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR.
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. High Voltage: Always exercise caution when working with high-voltage AC circuits.
5. Heat Dissipation: Ensure adequate heat dissipation for the thyristor to prevent overheating.
6. Component Ratings: Never exceed the maximum ratings for the thyristor or load components.

X Procedure

1. Connect the DC power supply to the input terminals of the inverter module.
2. Connect the resistor to the output terminals of the inverter module.
3. Connect the oscilloscope to measure the output voltage across the resistor.
4. Connect the multimeter to measure the DC input voltage and the average output voltage.
5. Turn on the power supply and adjust the output voltage to a desired level.
6. Measure and record the DC input voltage using the multimeter.
7. Set the oscilloscope to a suitable time base and voltage scale.
8. Observe the output voltage waveform on the oscilloscope screen.
9. Note the shape of the waveform (pulsating DC) and its frequency.
10. Measure the output current at various resistive loads.

XI Observations and calculations

1. For $L = \dots\dots\dots$

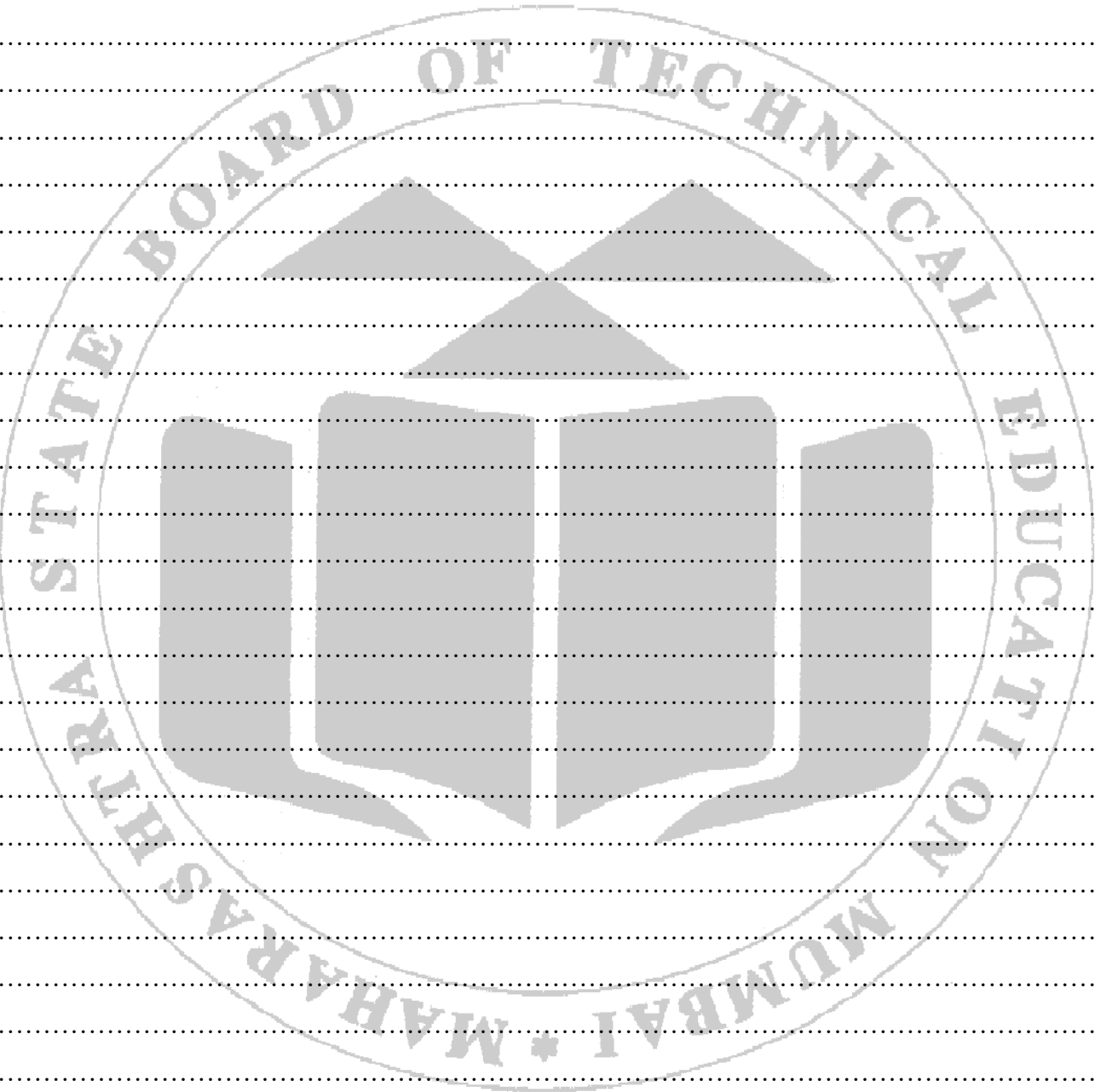
S. No.	Resistance Value	Measure Output Current	Calculated Output Current
1			
2			
3			
4			

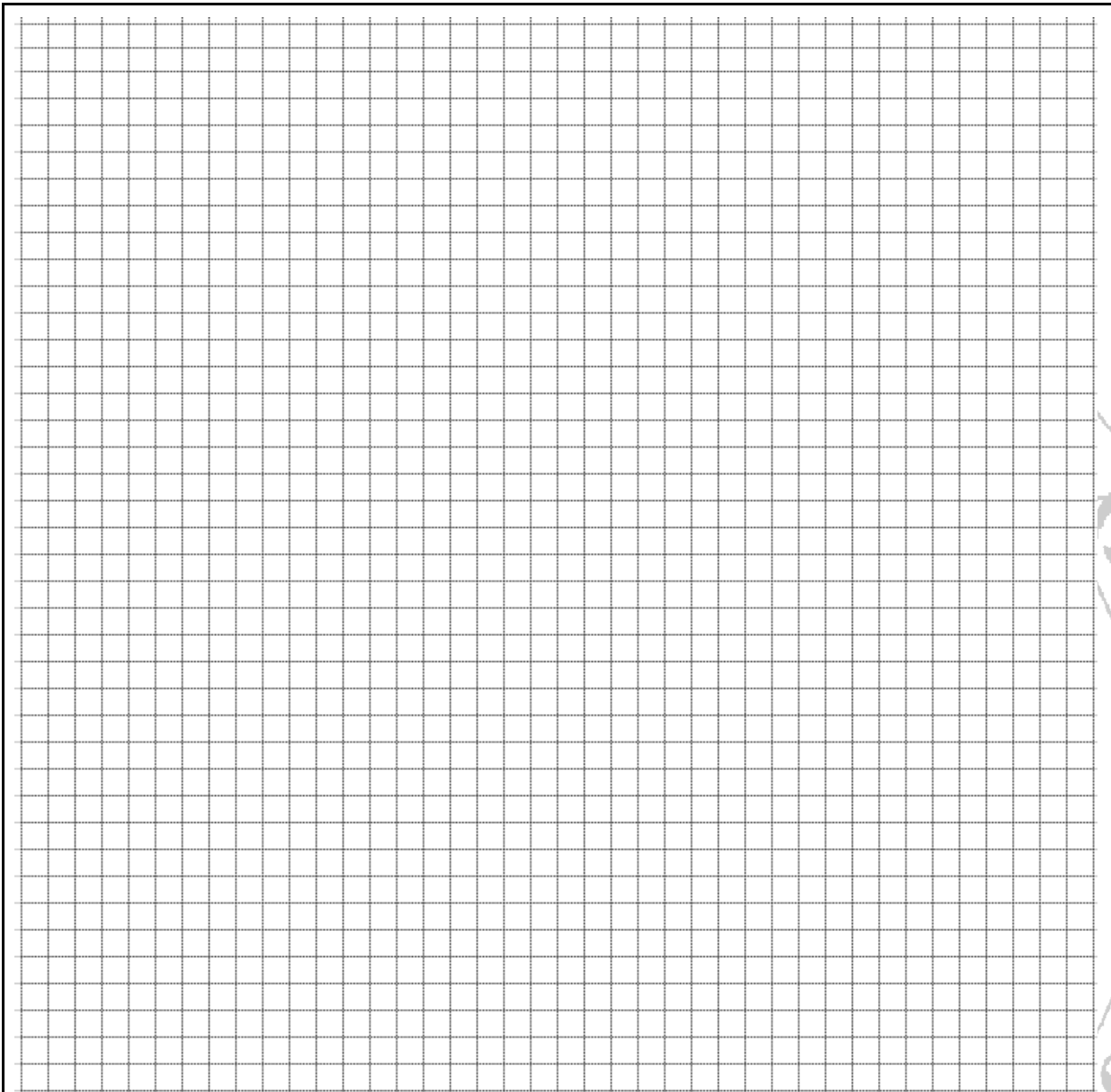
2. For $L = \dots\dots\dots$

S. No.	Resistance Value	Measure Output Current	Calculated Output Current
1			
2			
3			
4			

XII Results:

1. Output Voltage =
2. Frequency=





Title of Graph:

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 23. Operation of step-up chopper

I Practical Significance:

A step-up chopper, also known as a boost converter, is a vital component in power electronics that increases the input voltage to a higher output voltage. Its practical significance lies in its ability to efficiently supply power to power devices that require higher voltages than what is provided by the power source, such as in battery-powered systems. This makes it crucial for applications like portable electronics, where maintaining battery life and performance is essential.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

1. Test the switching performance of thyristor.
2. Test the performance of given chopper.

IV Laboratory Learning Outcome(s)

LLO 1. Measure the output voltage of chopper by varying duty cycle.

LLO 2. Use various controls of CRO/DSO

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Chopper known as DC Transformer is a static device that converts fixed de input voltage to variable DC output voltage directly. It is high speed ON-OFF switch. It connect source to load and disconnect the load from the source at very fast speed. In this chopper the large inductor used in series with source voltage. In a step up chopper output voltage is more than input chopper.

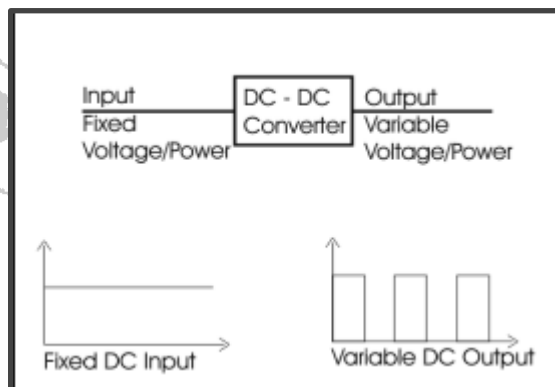


Fig. 23.1: Block Diagram of Chopper

VII Actual Circuit diagram used in laboratory with equipment Specifications:

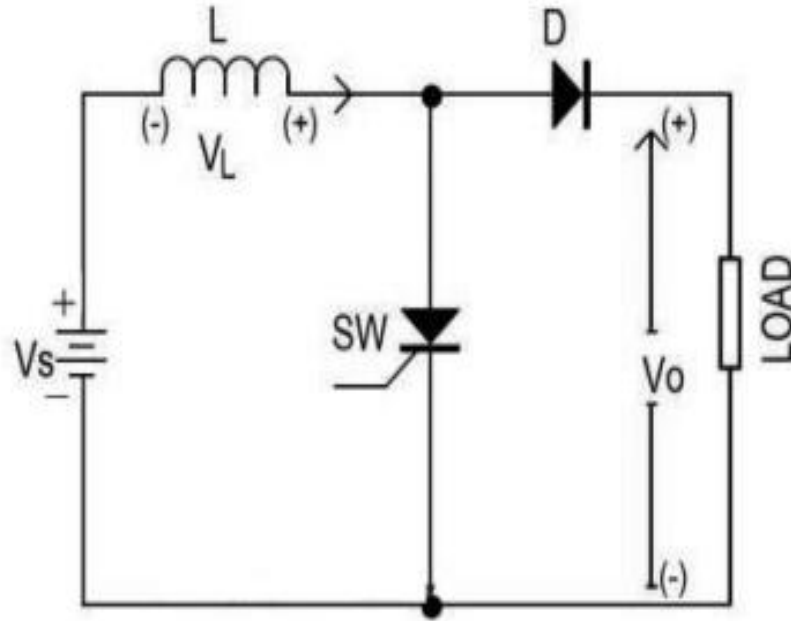


Fig. 23.2: Step-up chopper

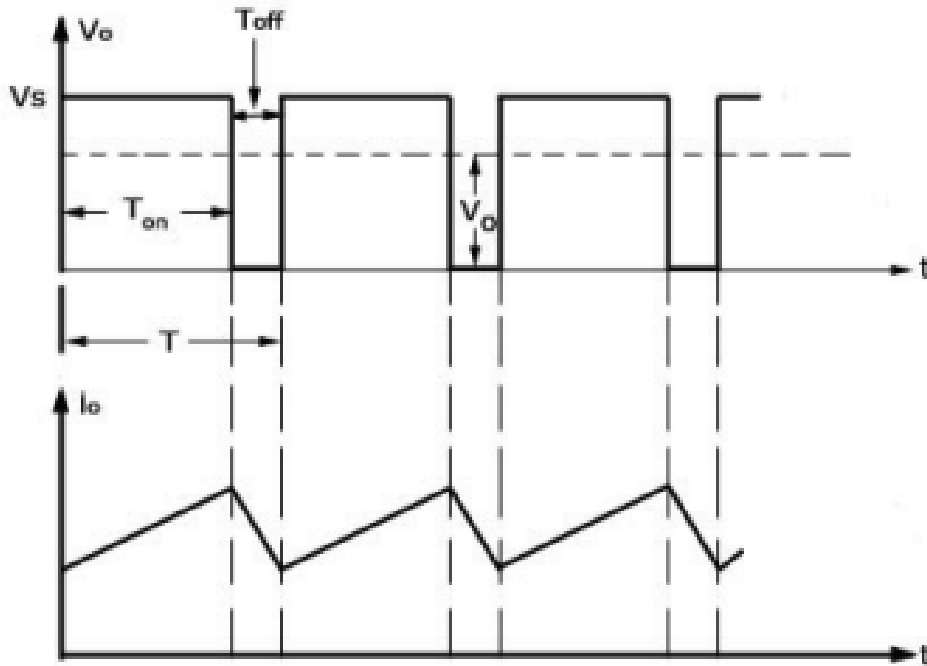


Fig. 23.3: Output voltage and current waveform

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	1 phase DC to DC converter practical kit (step up chopper)	Trainer kit of step up SCR based chopper with various test points	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	SCR	TYN 612 or any other available	1
4	Variable resistive load	Single phase, 0-3kW	1
5	Voltmeter	0-300 V AC	1
6	Voltmeter	0-300 V DC	1
7	Multimeter	0-230VDC, 0-230V AC	1

Note: Also refer to the data sheet for SCR available on the Kit and then use the relevant resources.

IX Precautions to be followed:

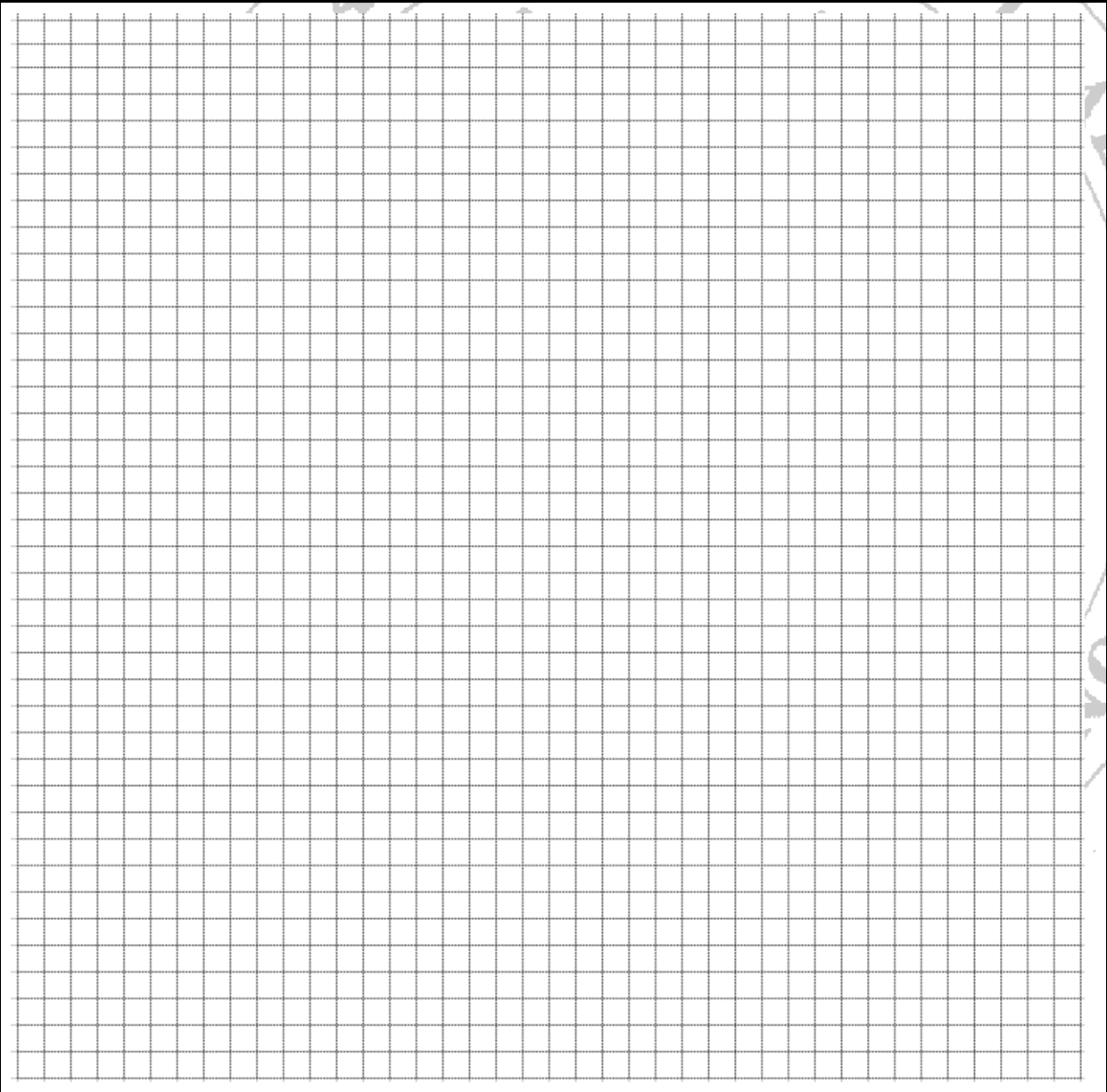
1. Check all the connection before switching on the connections.
2. Do not touch live wires.
3. The applied voltage, current should not exceed the maximum rating of the given SCR.
4. Reading should be noted without parallax error.

X Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 23.2
2. Switch on the power supply.
3. Set the duty cycle below 50% and observe the output waveform on the CRO.
4. Measure the RMS value of output with a multimeter.
5. Observe the output waveforms across the load.
6. Change the duty cycle above 50%.
7. Repeat the steps 4 and 5.
8. Draw the output waveform across load for different duty cycle.

XI Observations and calculations

Sr. No.	Input DC Voltage(V)	Output DC Voltage(V)	Time Period(ms)	
			T _{ON}	T _{OFF}
1				
2				
3				
4				
5				



Title of Graph:

XII Results:

1. Maximum Output Voltage =
2. Duty Cycle for Maximum Output Voltage =

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

1. Write the relation between duty cycle and output voltage.
2. Find whether the load voltage of a chopper can be controlled by varying the duty cycle or firing angle.
3. Write the specification of switching device used in practical kit..

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XVI References/Suggestions for further reading:

4. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K. ; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
5. <https://www.alldatasheet.com/>
6. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 24: Operation of Step Down Chopper.

I Practical Significance:

Choppers are very much useful as many industrial applications are dependent upon DC voltage source. The performance of this application will be improved if variable DC supply is used. It will help to improve controllability of equipment. Examples of such applications are subway cars, trolley buses, battery operated vehicles. In this practical student will be able to convert fixed input DC voltage to variable DC output voltage.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

Test the switching performance of thyristor.

Test the performance of given chopper.

IV Laboratory Learning Outcome(s)

LLO 1. Measure the output voltage of chopper by varying duty cycle.

LLO 2. Use the various controls of the CRO/DSO.

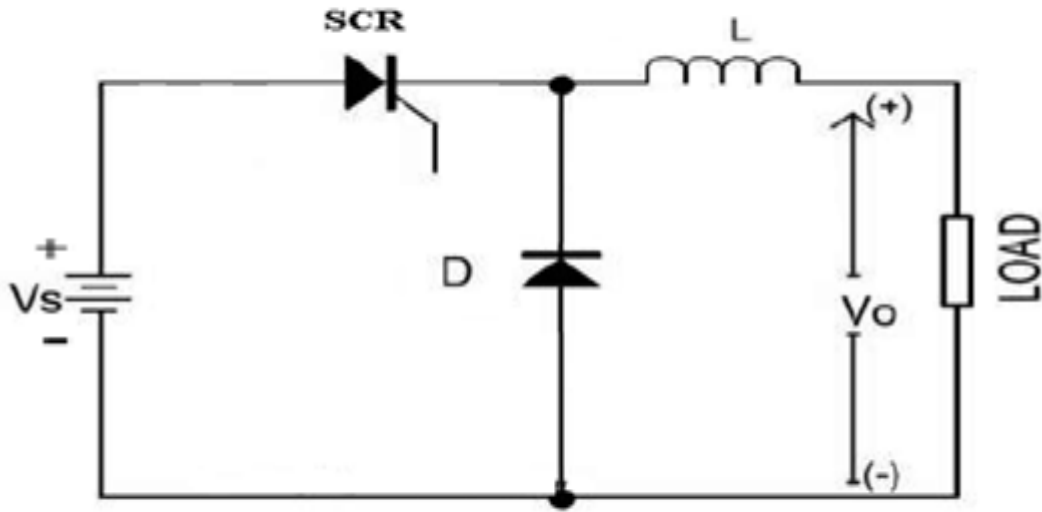
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A step-down chopper, or buck converter, is a type of DC-DC converter designed to lower the input voltage to a desired output voltage. It works by switching the input voltage on and off rapidly and using an inductor and capacitor to smooth out the resulting waveform. When the switch (typically a MOSFET or IGBT) is closed (on), current flows from the input through the inductor to the output. During this phase, the inductor stores energy. When the switch is open (off), the inductor continues to provide current to the load through the diode, which prevents current from flowing back into the switch. The energy stored in the inductor is released to the load, and the capacitor continues to filter the output voltage.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	Regulated power supply	0-100 V DC	1
2	CRO/Digital Oscilloscope	20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	1
3	Trainer kit of chopper	Trainer kit of chopper with connecting facility for R load	1
4	Variable resistive load	Single phase, 0-3kW	1
7	Voltmeter	0-300V DC	1
8	Set of Connecting wires.	As per kit requirement.	1

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Use appropriate load values to prevent excessive current flow through the SCR and diode
3. Avoid applying excessive gate current to the SCR, as it can damage the gate junction.
4. Reading should be noted without parallax error.

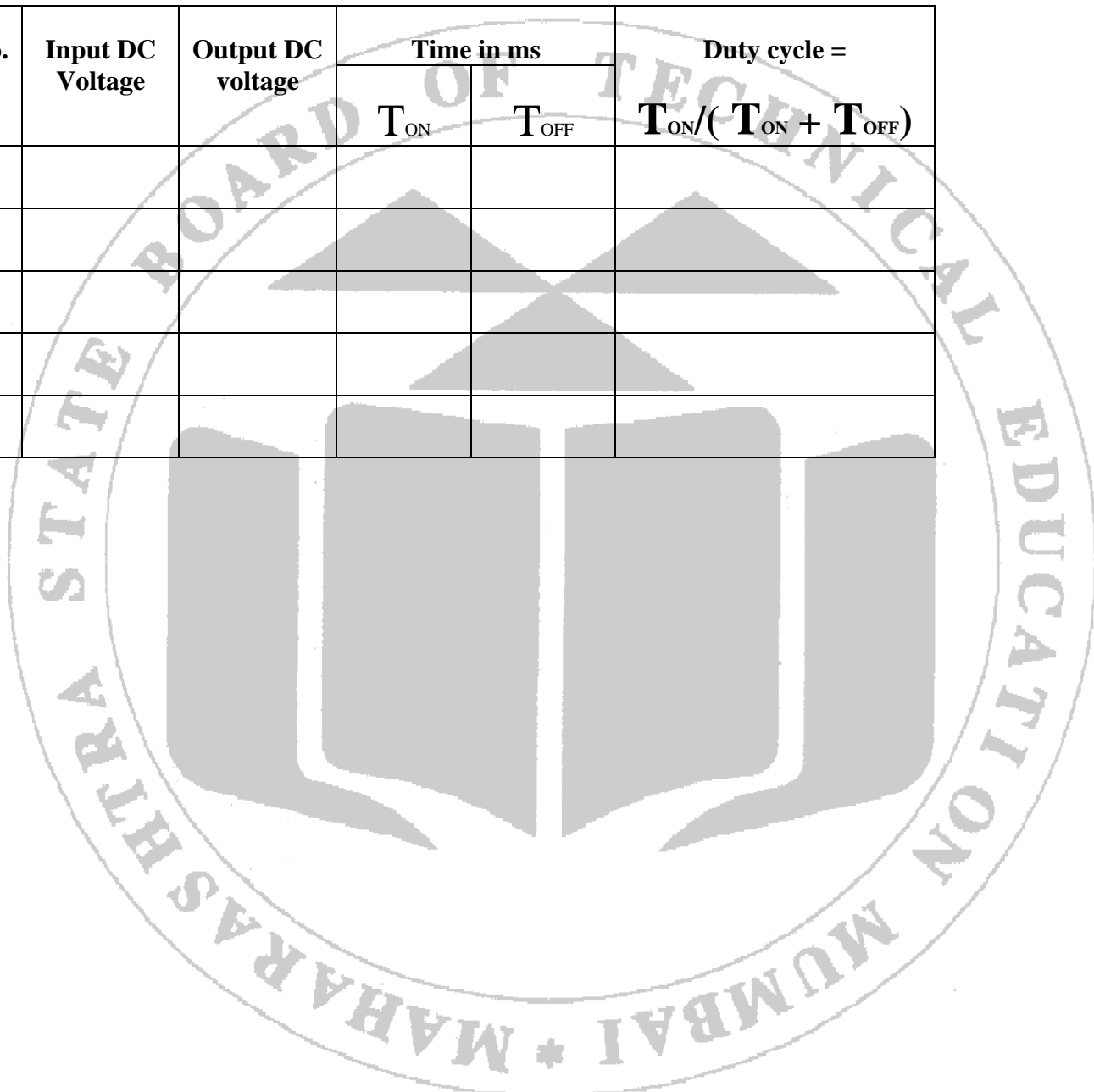
X Procedure

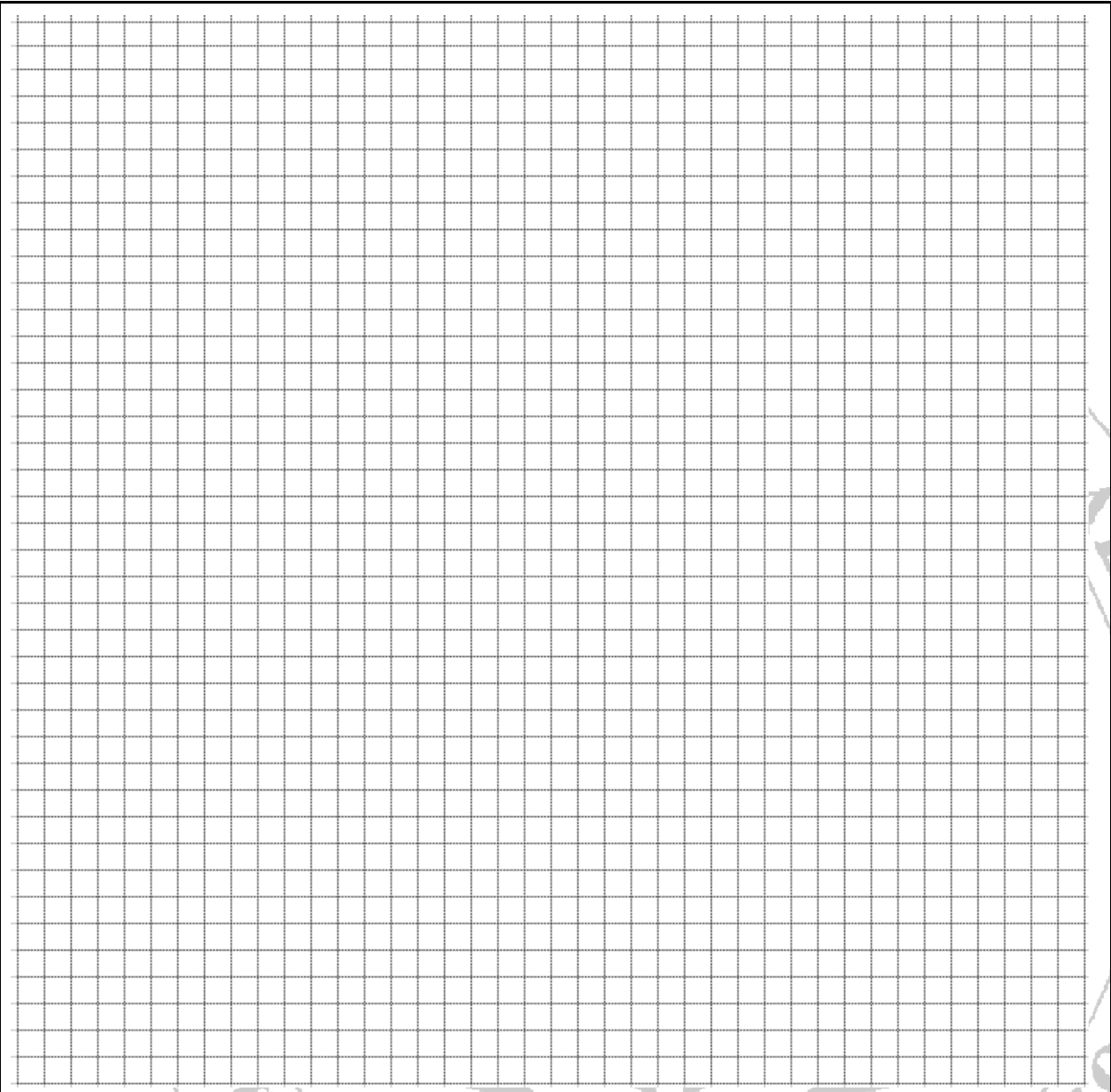
1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Set duty cycle below 50% and observe the output waveform on the CRO.
4. Measure output voltage by using voltmeter.

5. Observe the output waveform across load on CRO
6. Change the duty cycle above 50%.
7. Repeat the steps 4 and 5.
8. Draw the output waveform across load for different duty cycle

XI Observations and calculations

Sr. No.	Input DC Voltage	Output DC voltage	Time in ms		Duty cycle =
			T_{ON}	T_{OFF}	$T_{ON}/(T_{ON} + T_{OFF})$
1					
2					
3					
4					
5					





Title of Graph:

XII Results:

- 1. Maximum Output Voltage =.....
- 2. Minimum Output Voltage =.....

XIII Interpretation of results:

.....
.....
.....

XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 25. Charge Controller in PV System

I Practical Significance:

A charge controller is essential in renewable energy systems, particularly in solar and wind energy setups, for regulating the voltage and current going into batteries. It prevents overcharging, which can damage batteries and reduce their lifespan. By controlling the flow of energy, it also helps avoid excessive discharging, ensuring efficient battery usage. Some charge controllers also provide protection against power surges and short circuits. In advanced systems, they offer features like tracking maximum power points (MPPT) to optimize energy capture.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

CO4 - Test the performance of a given chopper.

CO5 - Use a suitable power electronic circuit for a given application.

IV Laboratory Learning Outcome(s)

LLO 1. Test the performance of charge controller in PV system.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A charge controller is a crucial component in PV systems, designed to regulate the voltage and current from the PV panels to the battery. It prevents overcharging and over-discharging of the battery, thereby extending its life. Charge controllers typically operate in two modes:

1. PWM (Pulse Width Modulation) Charge Controller: Regulates the voltage by gradually reducing the charging current as the battery reaches its full charge.

2. MPPT (Maximum Power Point Tracking) Charge Controller: Optimizes the PV panel output by adjusting the voltage to ensure the maximum power output.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

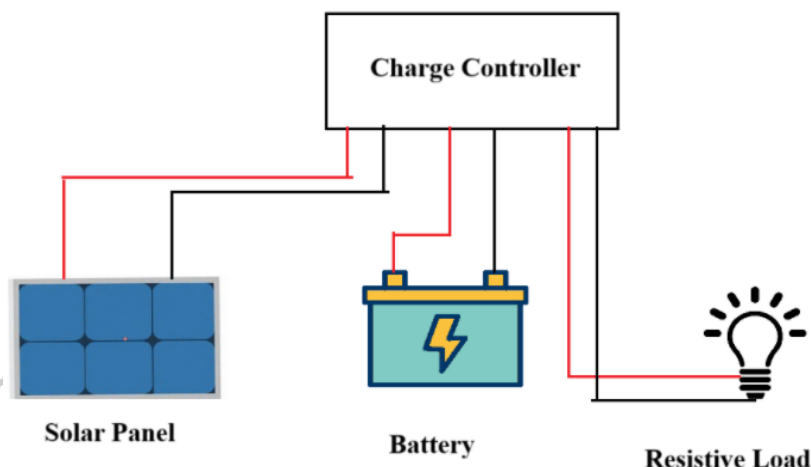


Fig. 25.1: Connection Diagram for Charge Controller

Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specifications	Quantity
1	PV Panel	50W or higher	1
2	Charge Controller	PWM or MPPT	1
3	Battery	12V or 24V, depending on the charge controller specification	1
4	Variable resistive load	30W to 100W	1
5	Voltmeter	0-30 V DC	1
6	Ammeter	0-10 A DC	1

Note: Also refer to the data sheet for charge controller available on the Kit and then use the relevant resources.

IX Precautions to be followed:

1. Ensure Correct Polarity: Always connect the PV panel, battery, and load to the charge controller with the correct polarity (positive to positive and negative to negative). Incorrect connections can damage the charge controller, battery, or other components.
2. Avoid Short Circuits: When connecting and disconnecting the PV panel, battery, and load, ensure that there are no short circuits. Use insulated tools and avoid touching exposed wires or terminals to prevent electrical hazards or damage to equipment.

X Procedure

Step 1: Circuit Setup

1. PV Connection: Connect the PV panel to the input terminals of the charge controller.
2. Battery Connection: Connect the battery to the charge controller's battery terminals. Ensure correct polarity (positive to positive and negative to negative).
3. Load Connection: Connect a resistive load or an inverter to the load terminals of the charge controller.
4. Measurement Setup: Connect meters at the input (PV panel), battery, and output (load) terminals to measure voltage and current.

Step 2: Test Under No-Load Condition

1. Ensure the load is disconnected.
2. Record the following parameters:
 - PV Voltage (V_{oc}): Open circuit voltage from the PV panel.
 - PV Current (I_{sc}): Short circuit current from the PV panel.
 - Battery and Current (V_{bat} , I_{bat}): Measure the voltage and current across the battery terminals.
3. Check if the charge controller properly charges the battery without the load.

Step 3: Test Under Load Condition

1. Connect a load (e.g., resistive load or inverter) to the output terminals.
2. Record the following parameters:
 - PV Voltage and Current (V_{pv} , I_{pv}): Measure the voltage and current at the input side from the PV panel.
 - Battery Voltage and Current (V_{bat} , I_{bat}): Measure the battery voltage and current to verify charging status.
 - Load Voltage and Current (V_{load} , I_{load}): Measure the output voltage and current delivered to the load.

XI Observations and calculations

1. No-Load Condition:
 - PV Open Circuit Voltage (V_{oc}) =
 - PV Short Circuit Current (I_{sc}) =
 - Battery Voltage (V_{bat}) =
 - Battery Current (I_{bat}) =
2. Under Load Condition:
 - PV Input Voltage (V_{pv}) =
 - PV Input Current (I_{pv}) =
 - Battery Voltage (V_{bat}) =
 - Battery Current (I_{bat}) =
 - Load Voltage (V_{load}) =
 - Load Current (I_{load}) =

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XVI References/Suggestions for further reading:

1. Laboratory Manual for introductory electronics experiments, Maheshwari, L.K .; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi, ISBN:9780852265543
2. <https://www.alldatasheet.com/>
3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

Performance indicators		Weightage
Process related (60%)		15 Marks
1	Handling of the components	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (40%)		10 Marks
5	Calculate theoretical values of given component	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 27: Speed control of the fan using TRIAC.

I Practical Significance:

Speed control of a fan using a TRIAC offers energy efficiency, cost-effectiveness, and smooth, continuous speed adjustment. It extends fan lifespan, reduces operational noise, and provides a compact and simple design. Additionally, it enhances user comfort, minimizes mechanical wear, and aids in thermal management in industrial applications.

II Industry/Employer Expected Outcome(s)

Test the Performance of Power Electronic Devices and Circuits.

III Course Level Learning Outcome(s)

CO3 - Test the performance of given controlled converter.

CO5 - Use suitable power electronic circuit for given application.

IV Laboratory Learning Outcome(s)

LLO Control speed of fan by using TRIAC

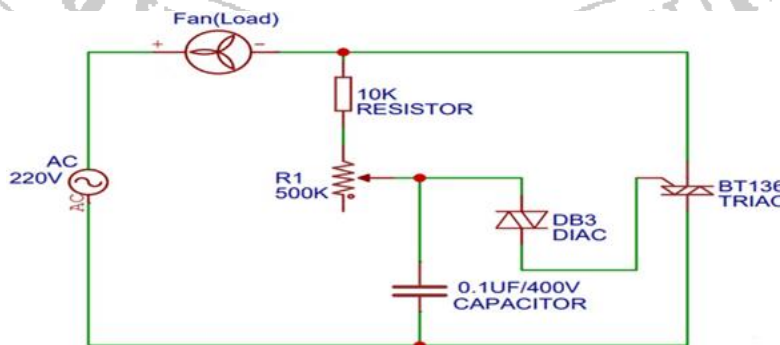
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

In this circuit a fan acts as load, a potentiometer (P) is used for varying the firing angle of the TRIAC and a fixed resistor (R) at which the potentiometer is at zero resistance value. The resistance value by the potentiometer decides the charging time constant which is required by the capacitor. If the resistance is low, the firing angle as well as the charging time of the capacitor is low and if the resistance is high, then it will take more time to charge. The speed of the fan will depend upon the value of resistance. If the resistance value decreases, the speed of the fan will increase and vice versa.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



Note: Students should trace the circuit from the available kit/kit manual.

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	TRIAC	BT136	1
2	DIAC	DB3	1
3	Fan	80W	1
4	Resistor	R1=10K ohm resistor, R2=500K ohm resistor(Potentiometer)	1
7	Capacitor	0.1micro-f/400v Capacitor	1
8	2 pin terminal block	As per requirement	1
9	Connecting wire	As per requirement	1
10	Multimeter	0-300V	1

IX Precautions to be followed:

1. Check all connections carefully before powering the circuit.
2. Do not touch live wires.
3. Reading should be noted without parallax error.

X Procedure

1. Make the circuit connection as per the circuit diagram.
2. Switch on power supply.
3. Vary the potentiometer R2 slowly and observe its effect on the load-fan.
4. Measure the voltage across the fan and TRIAC at different values of R2.

XI Observations and calculations

Sr. No.	Speed of fan	Resistance R2(Ohm)	Voltage across TRIAC(V)	Voltage across Load fan(V)
1	Low			
2	Moderate			
3	High			

XII Results:

At rated speed of fan

- 1. Voltage across load =.....
- 2. Resistance =.....

XIII Interpretation of results:

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

- 1. Measure and note down voltage across TRIAC and fan at rated speed.
- 2. Write down the specification of the triggering device used in this practical circuit.

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XVI References/Suggestions for further reading:

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3. Power Electronics by P. S. Bimbhra; ISBN: 978-8174092793

XVII Assessment Scheme:

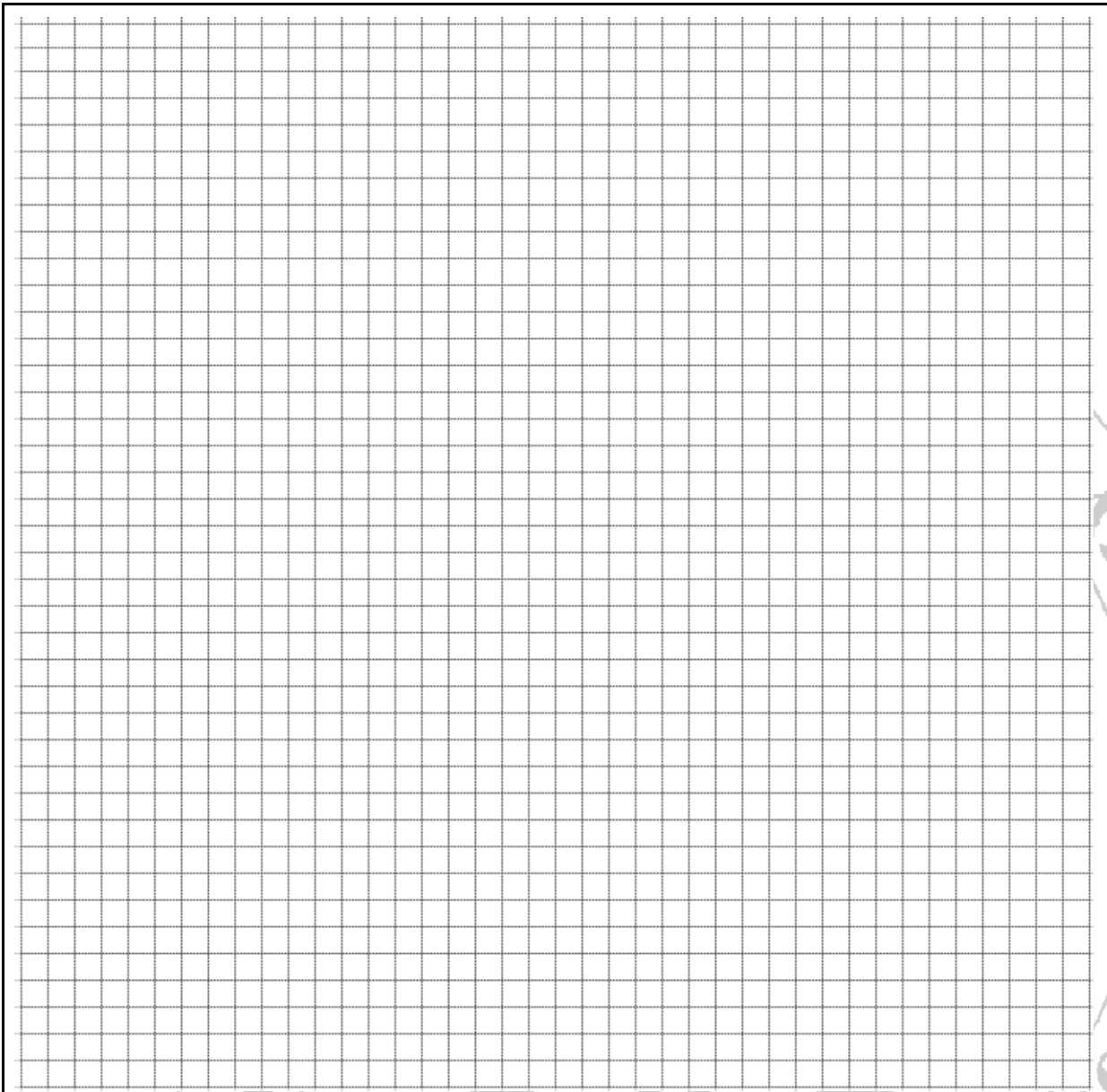
Performance indicators		Weightage
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7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

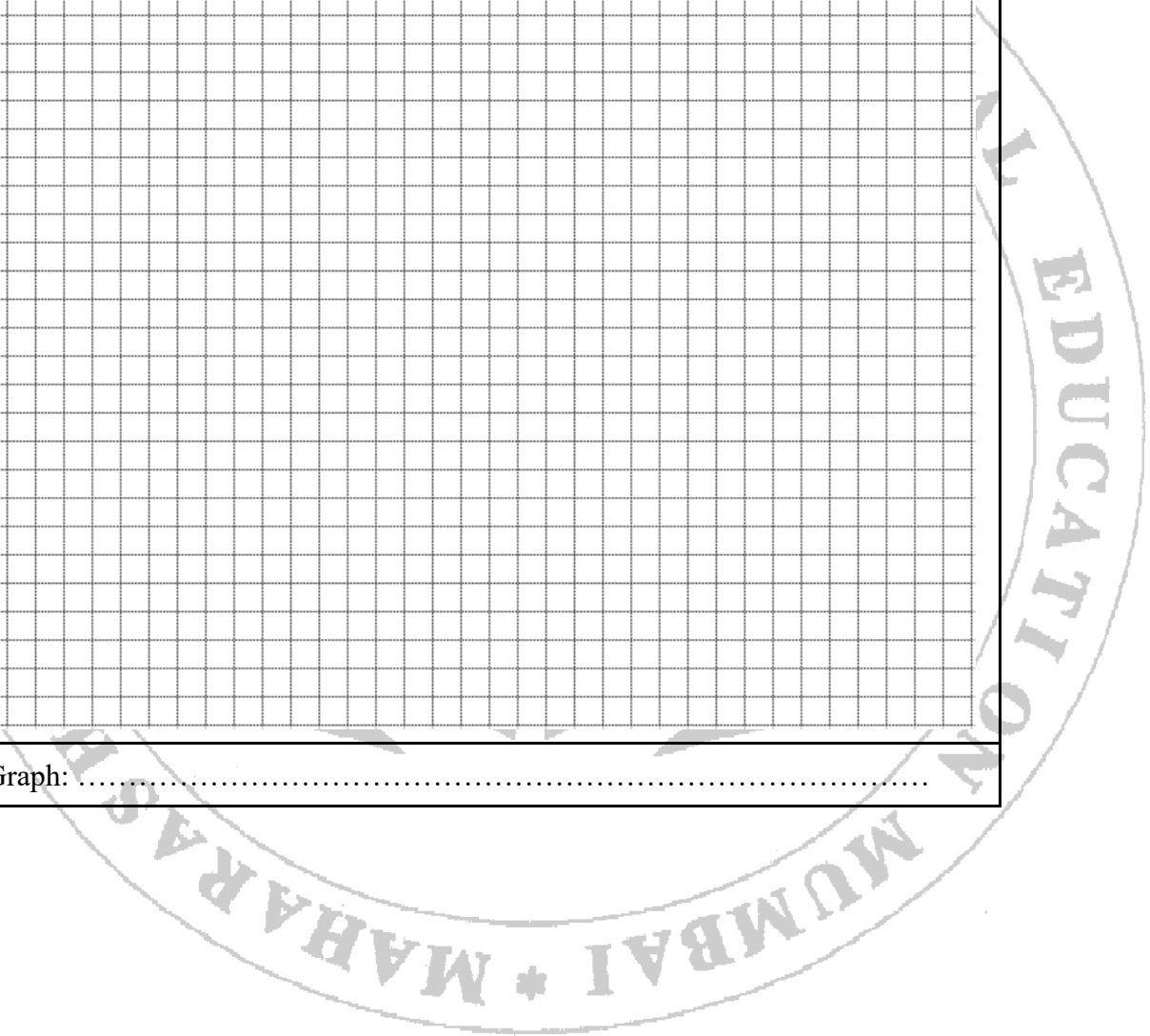
Students should use additional graph pages if required.

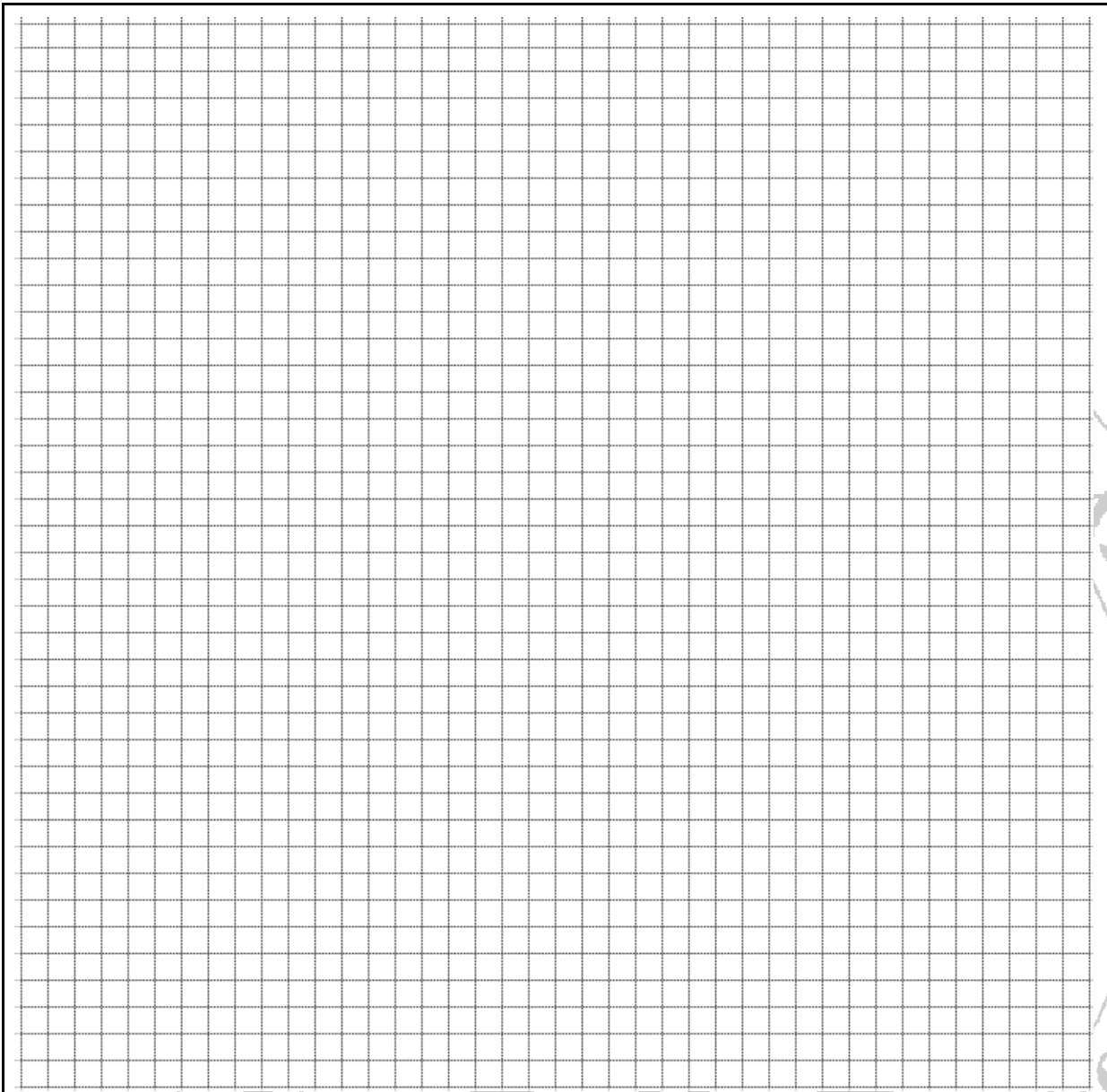


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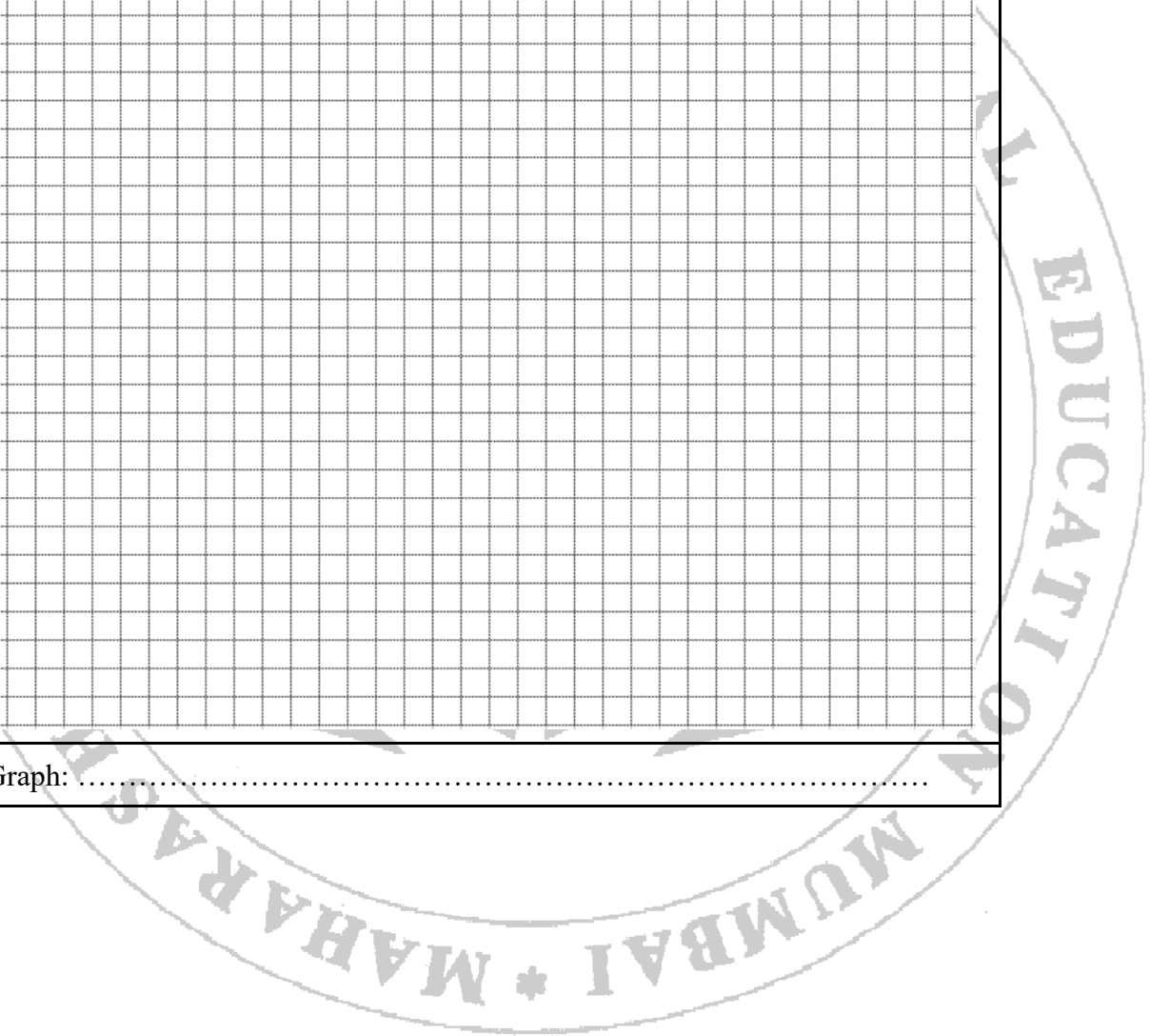


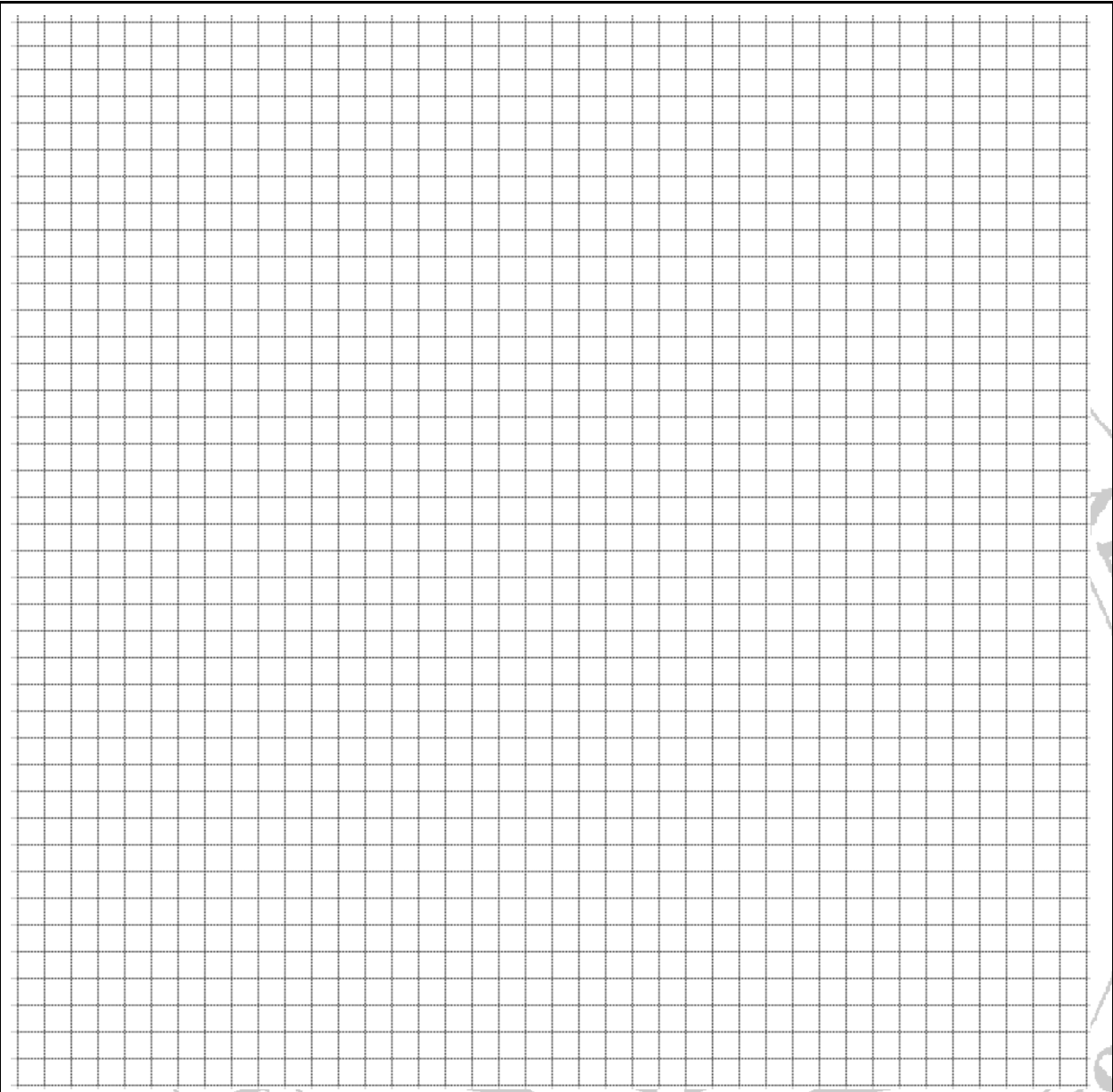
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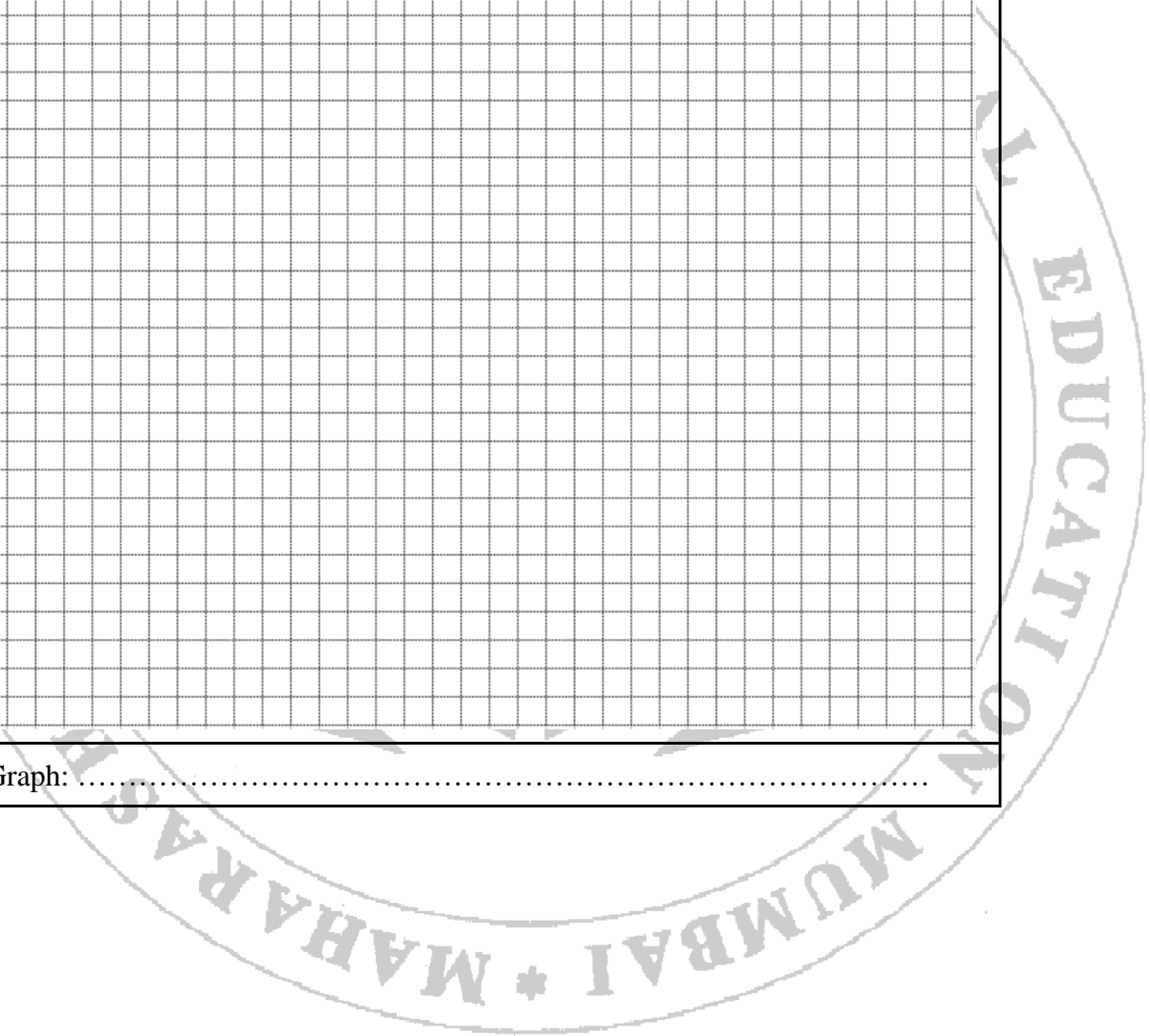


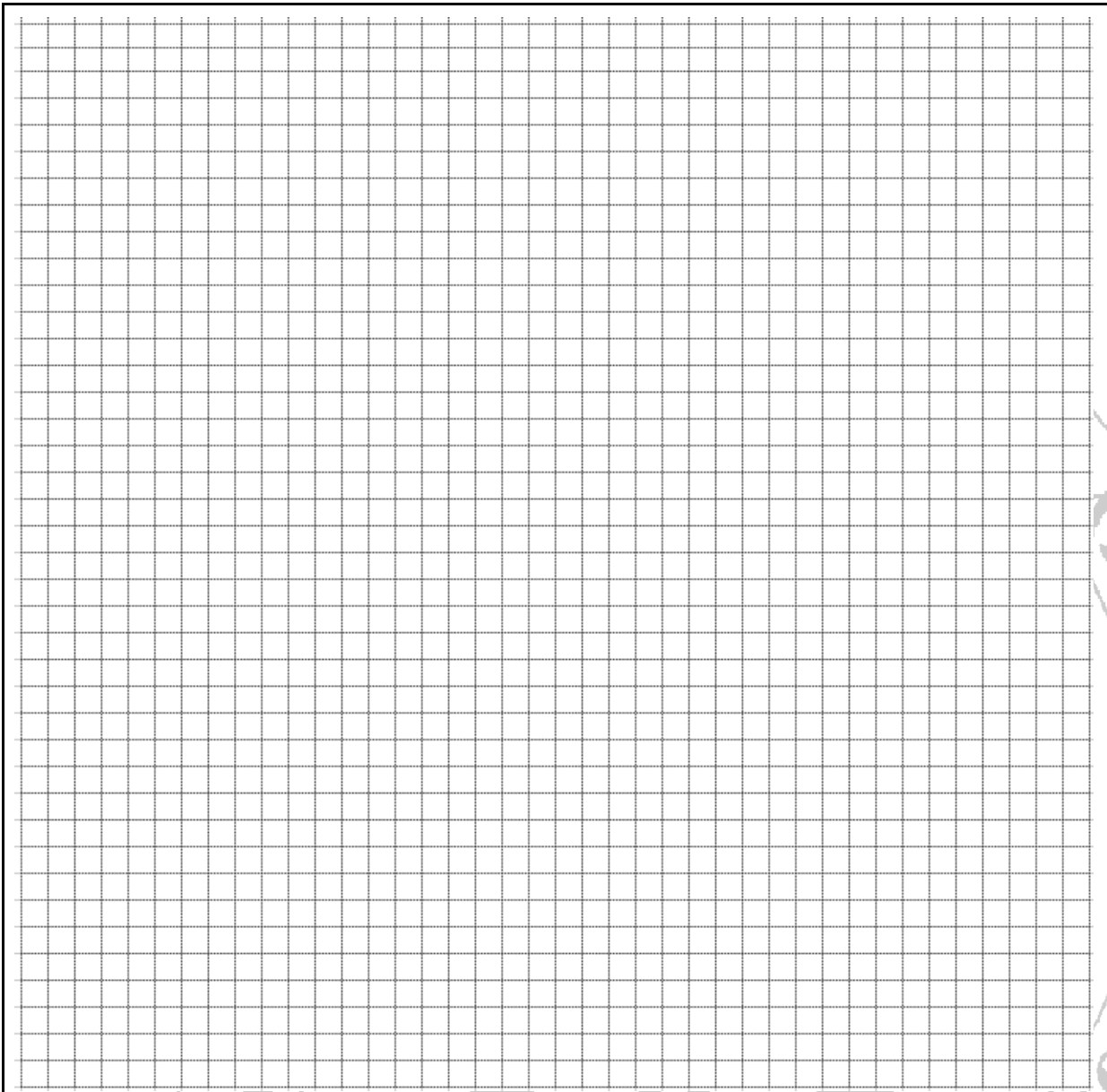
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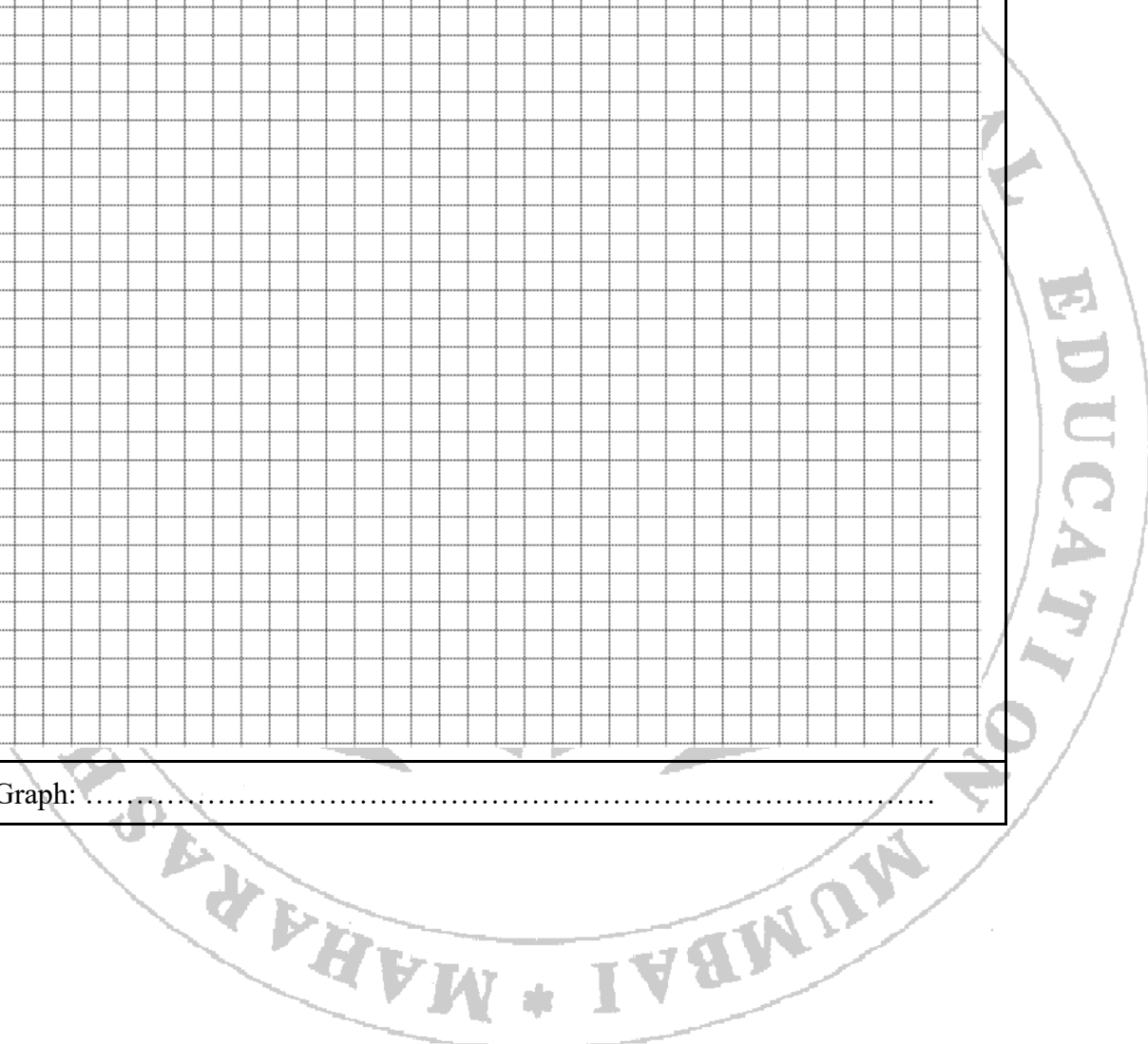


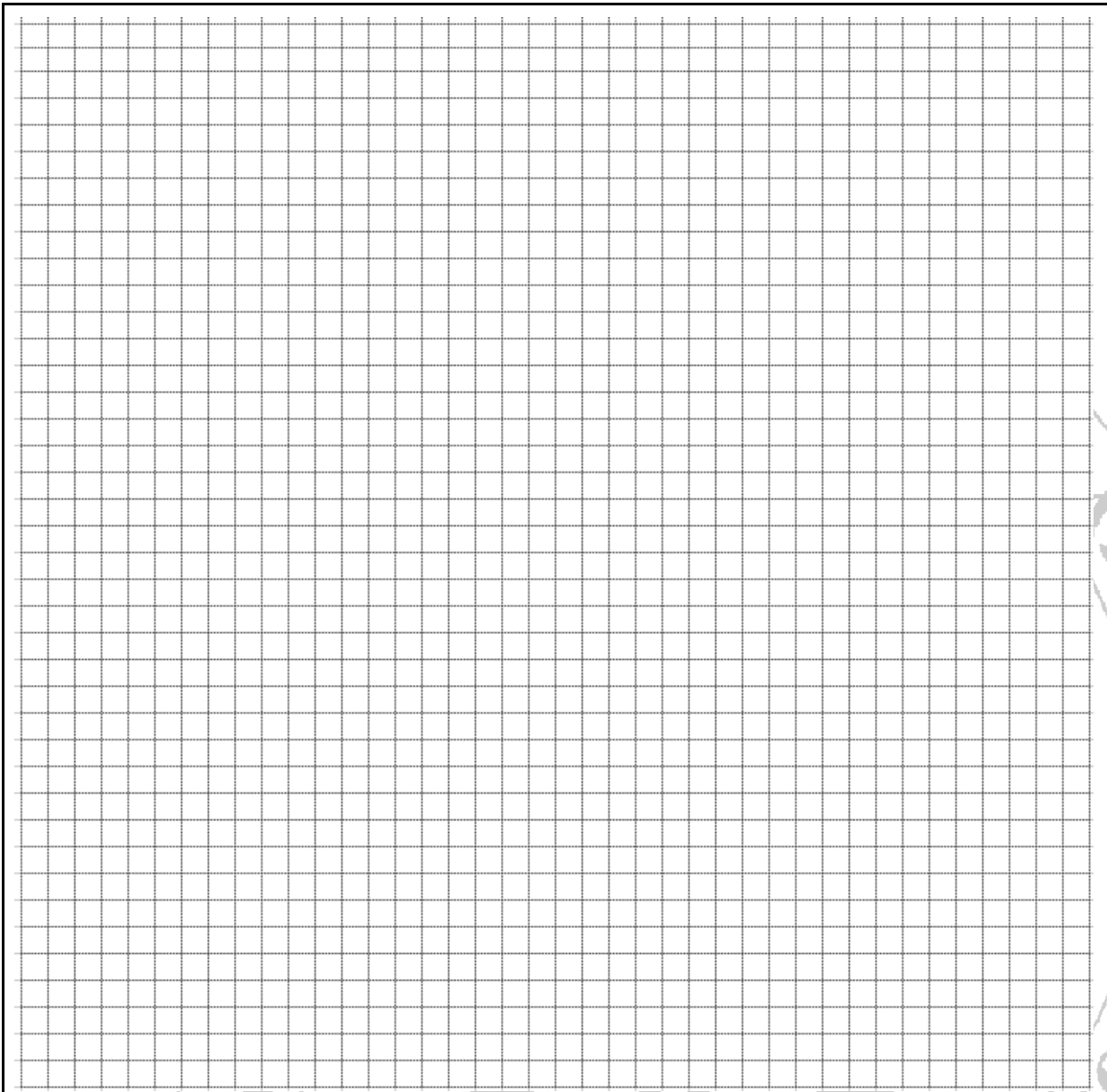
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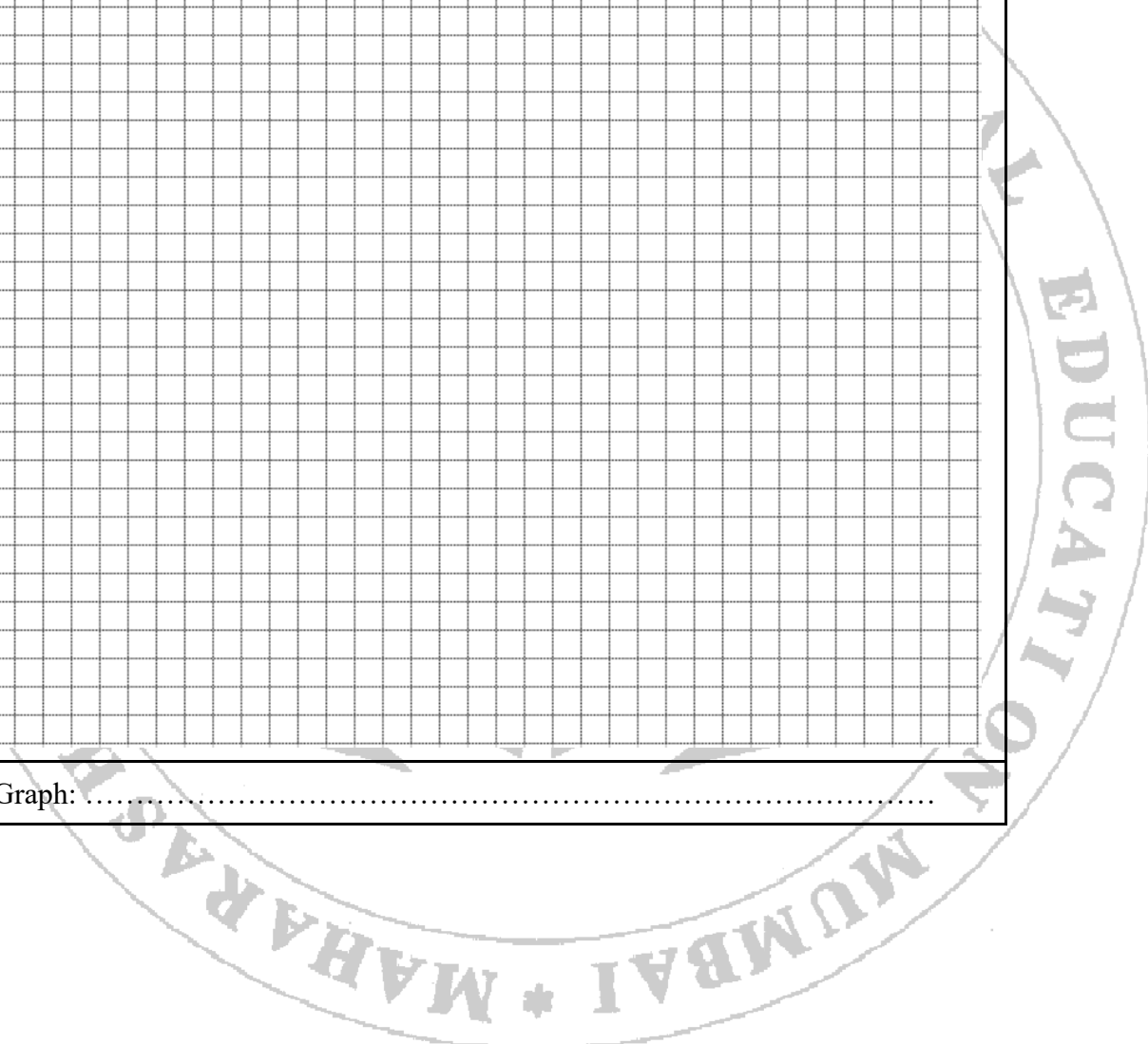


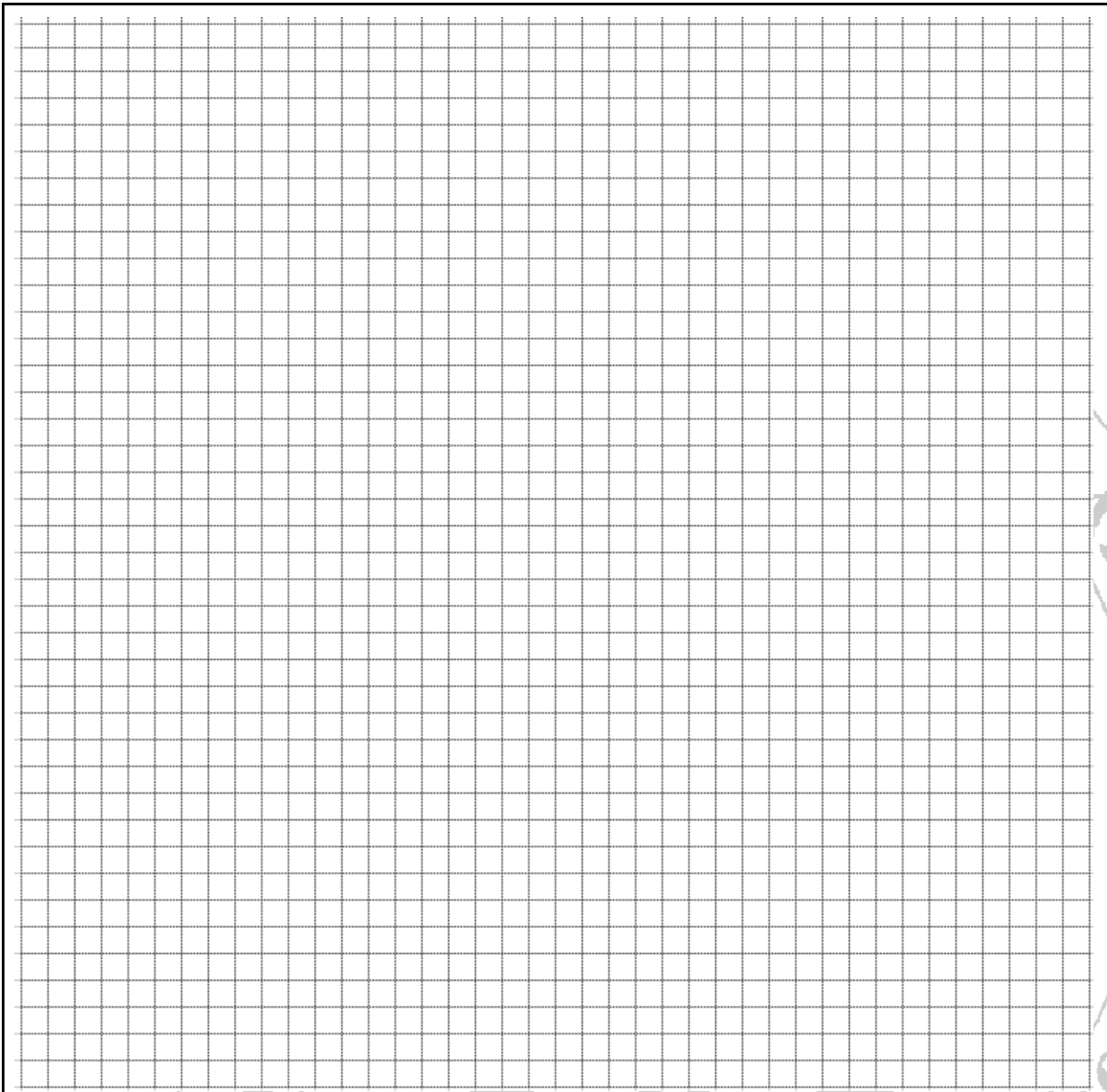
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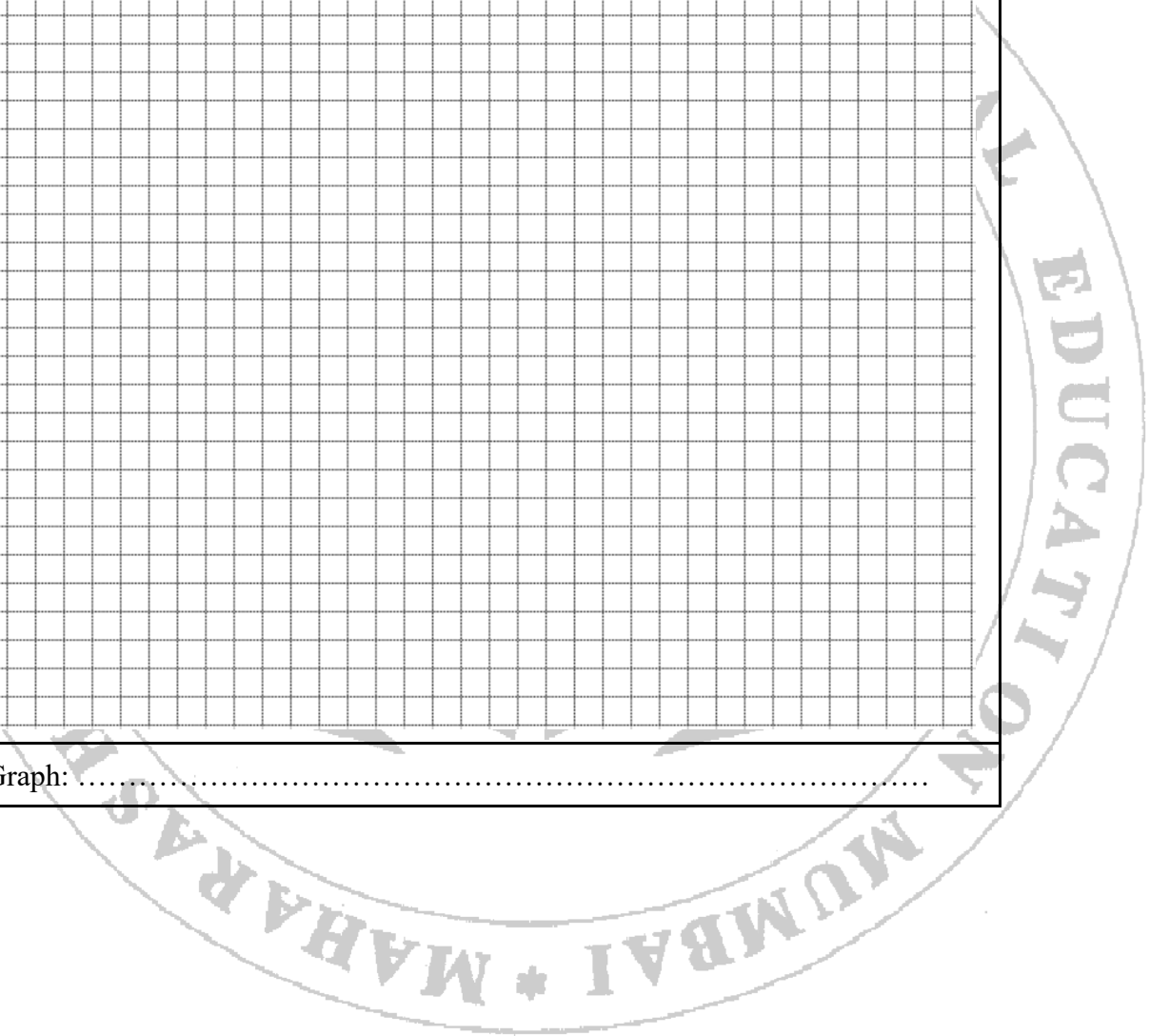


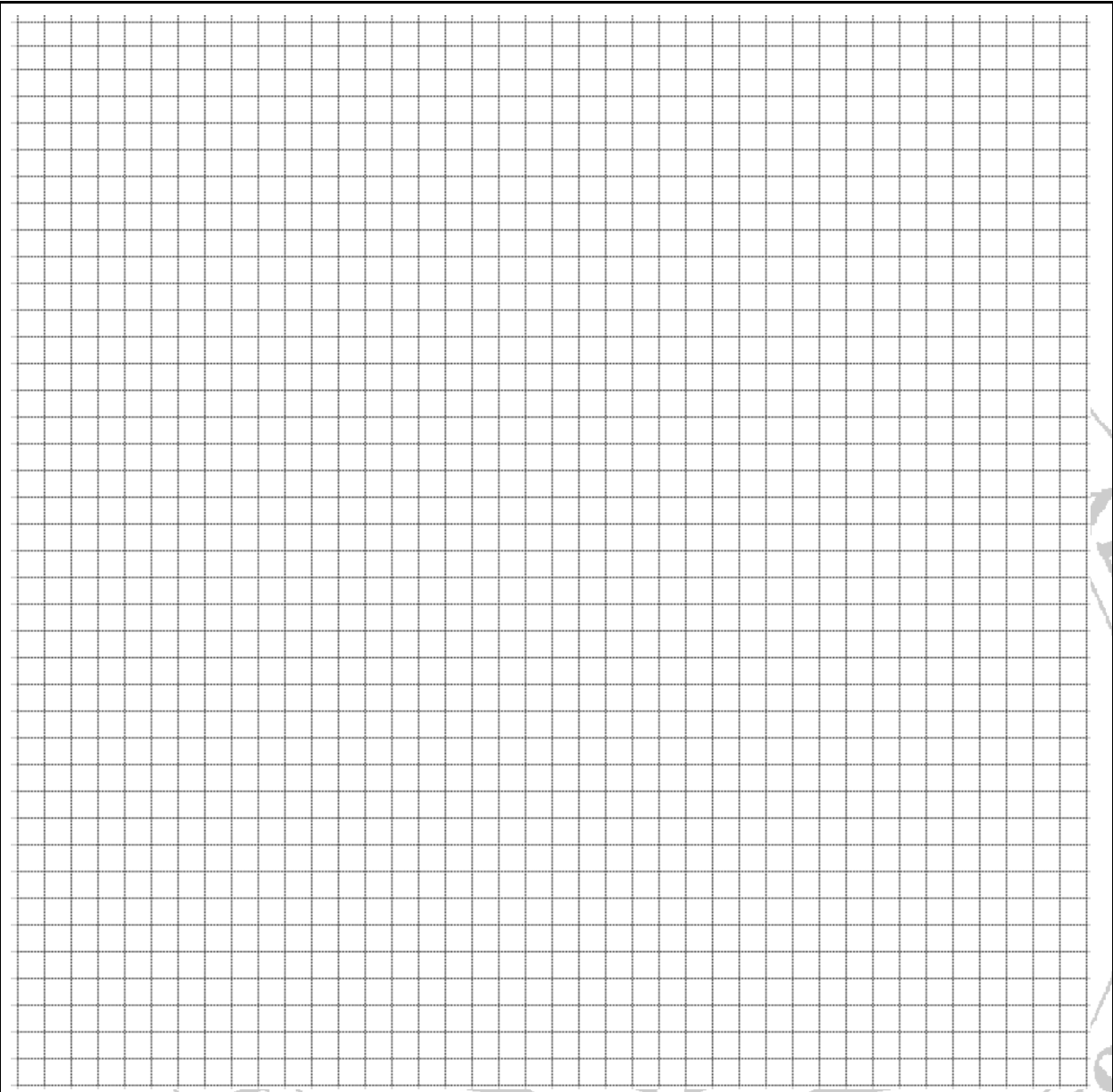
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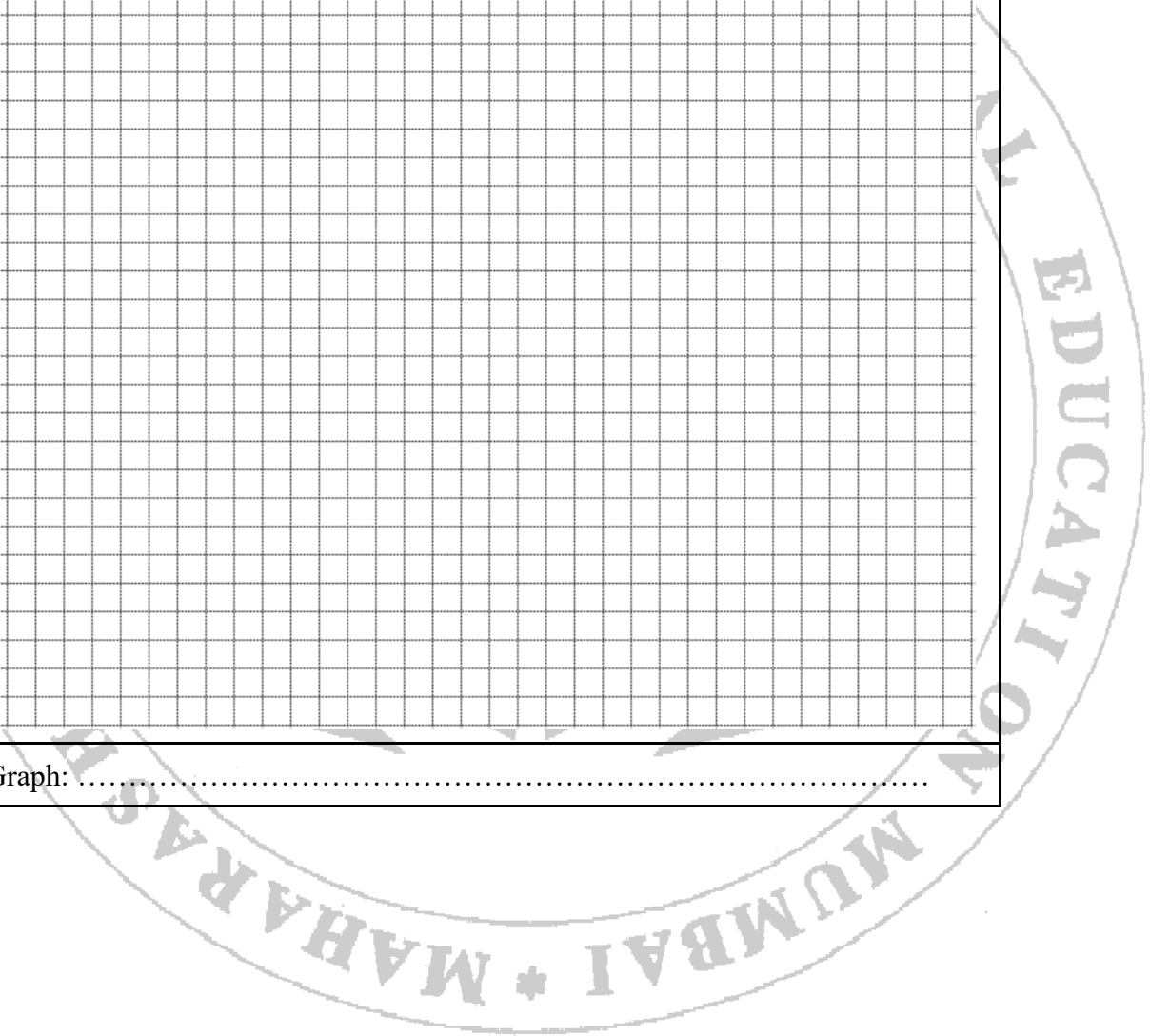


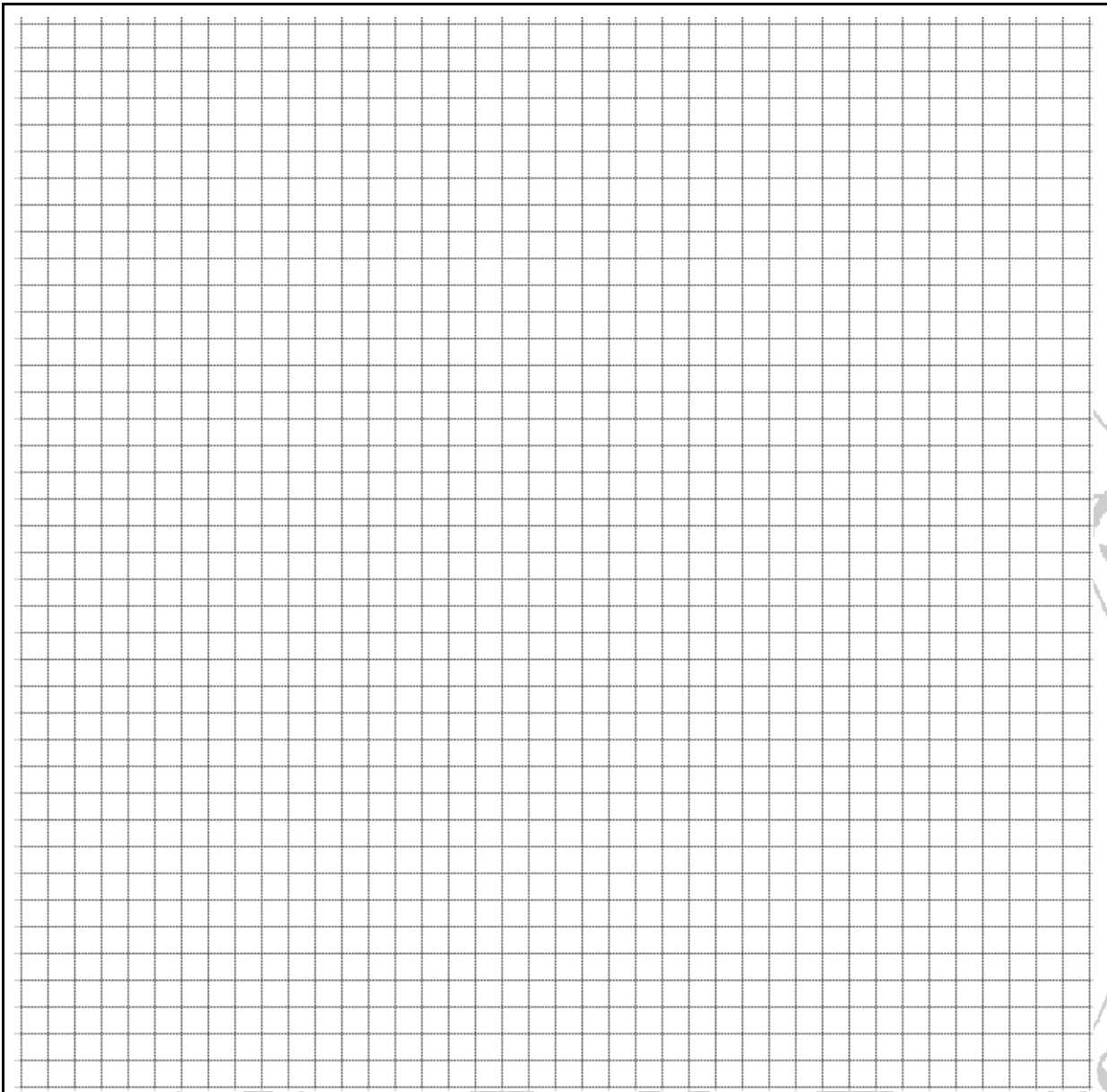
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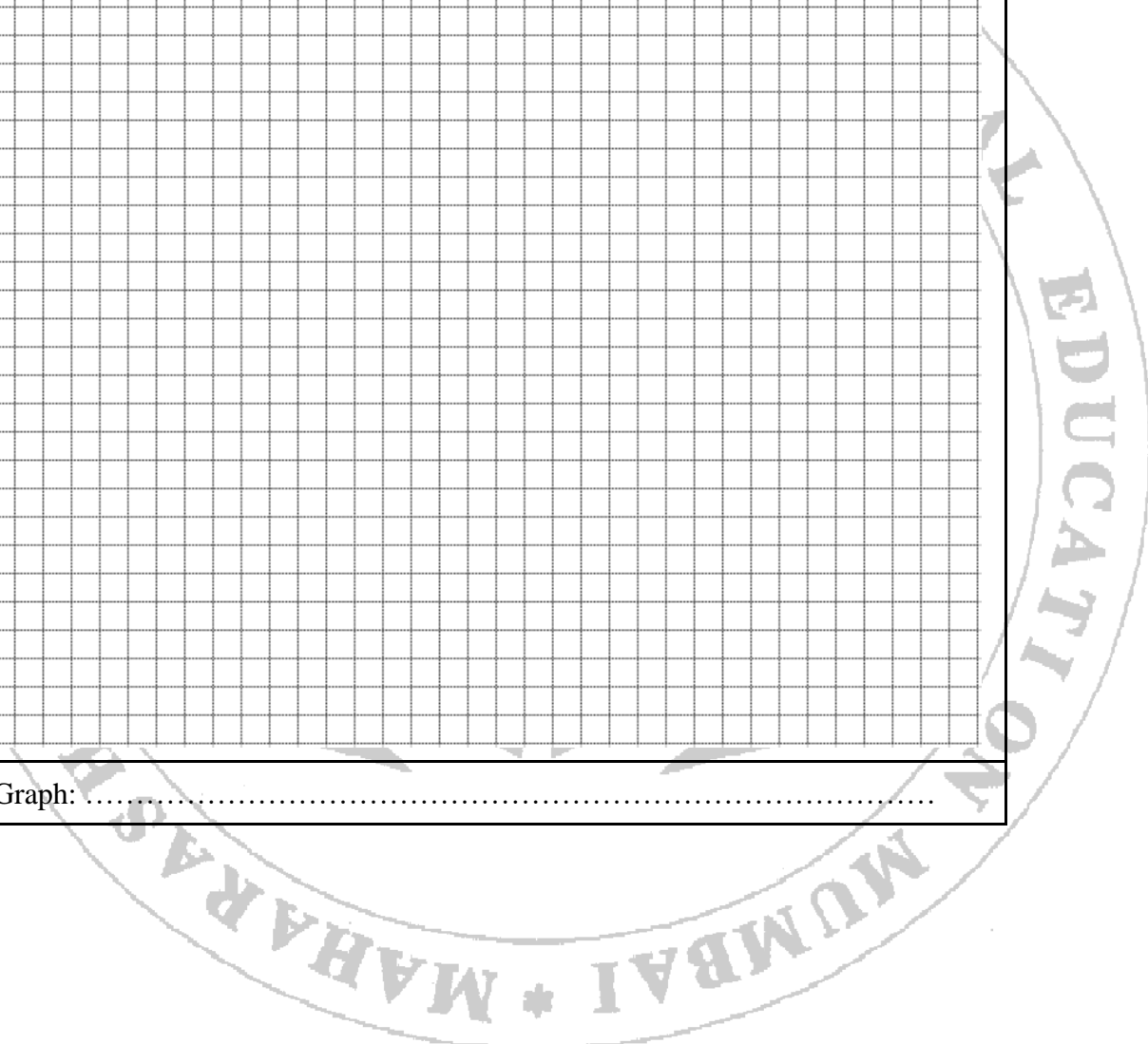


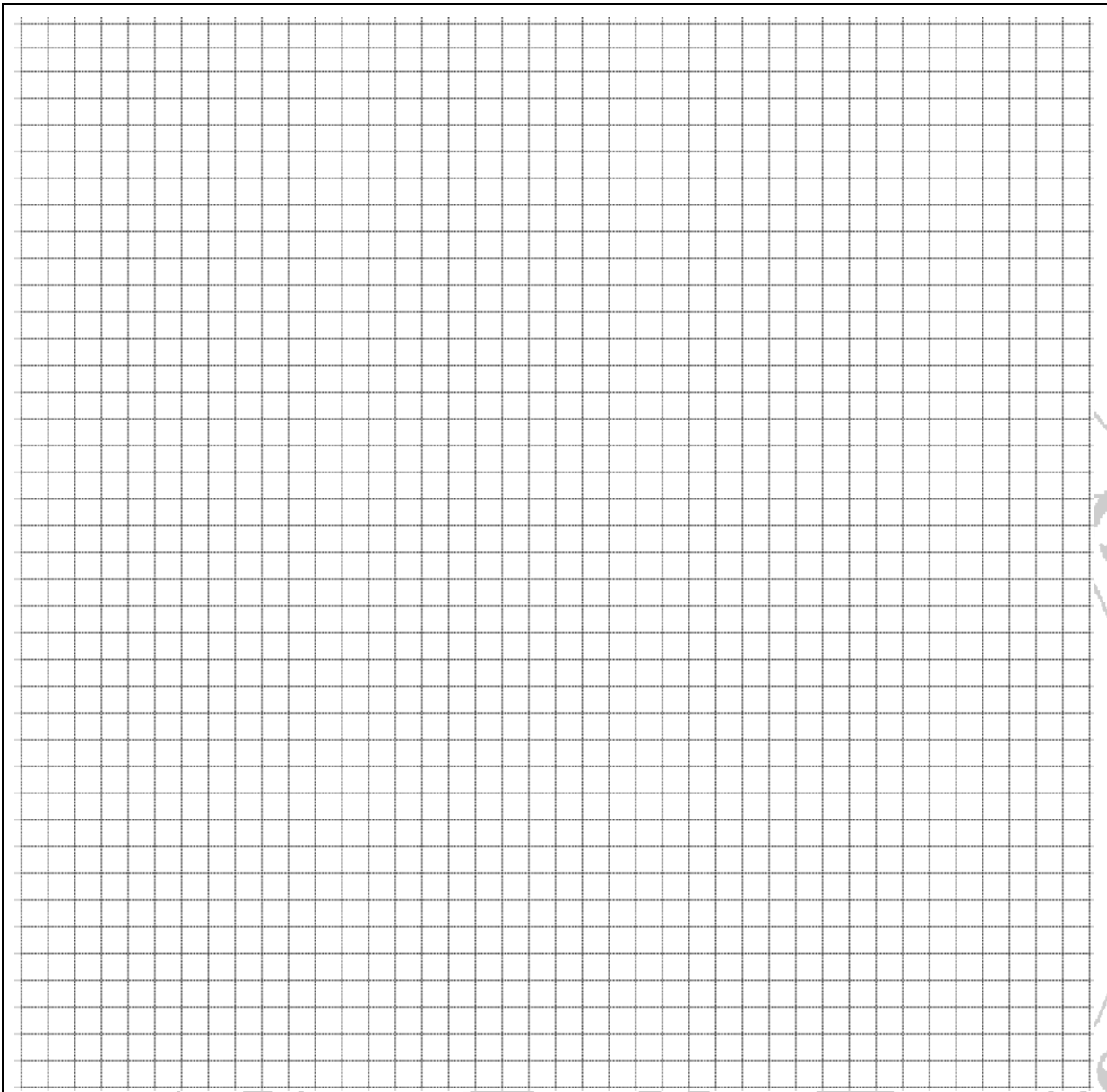
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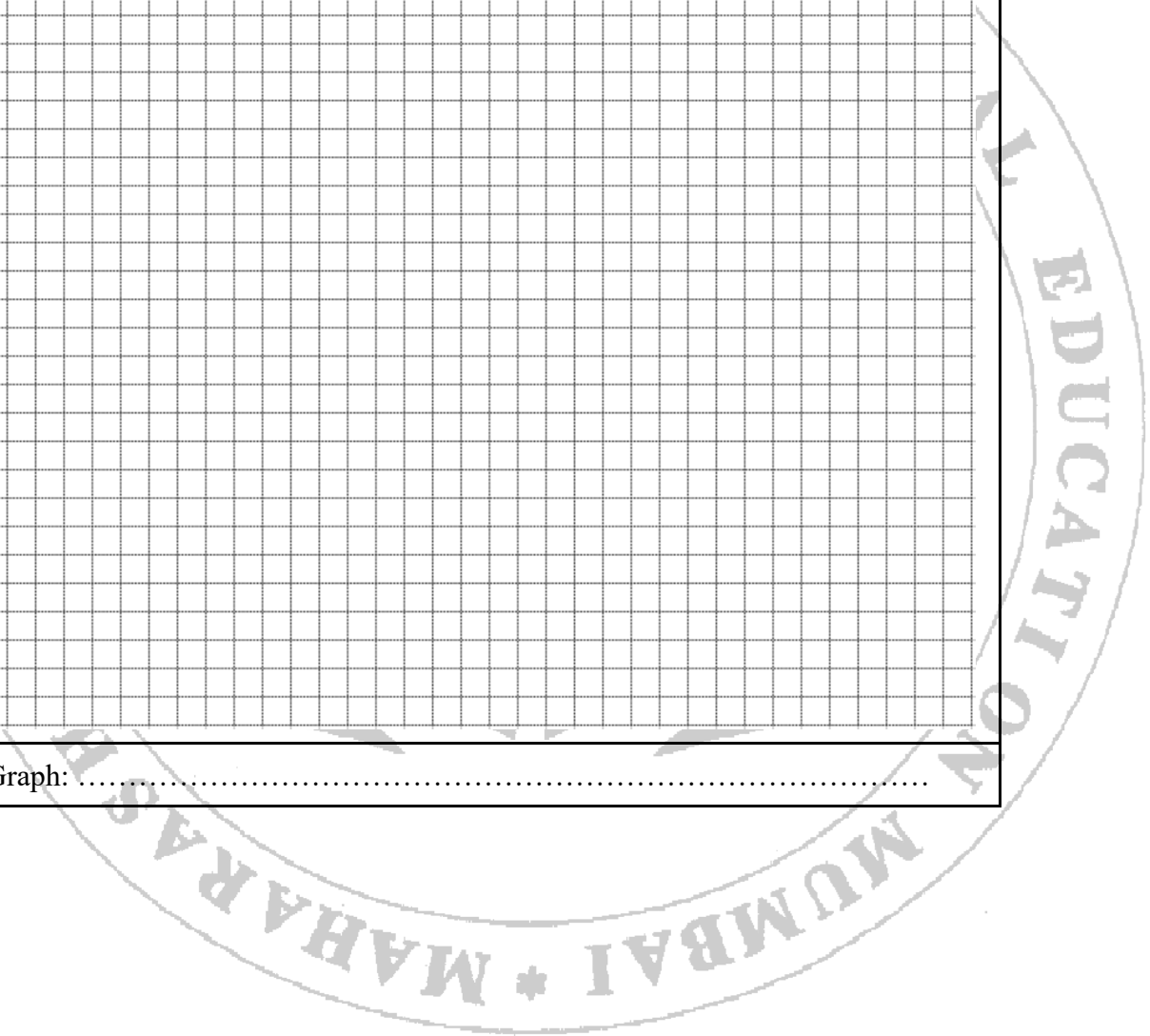


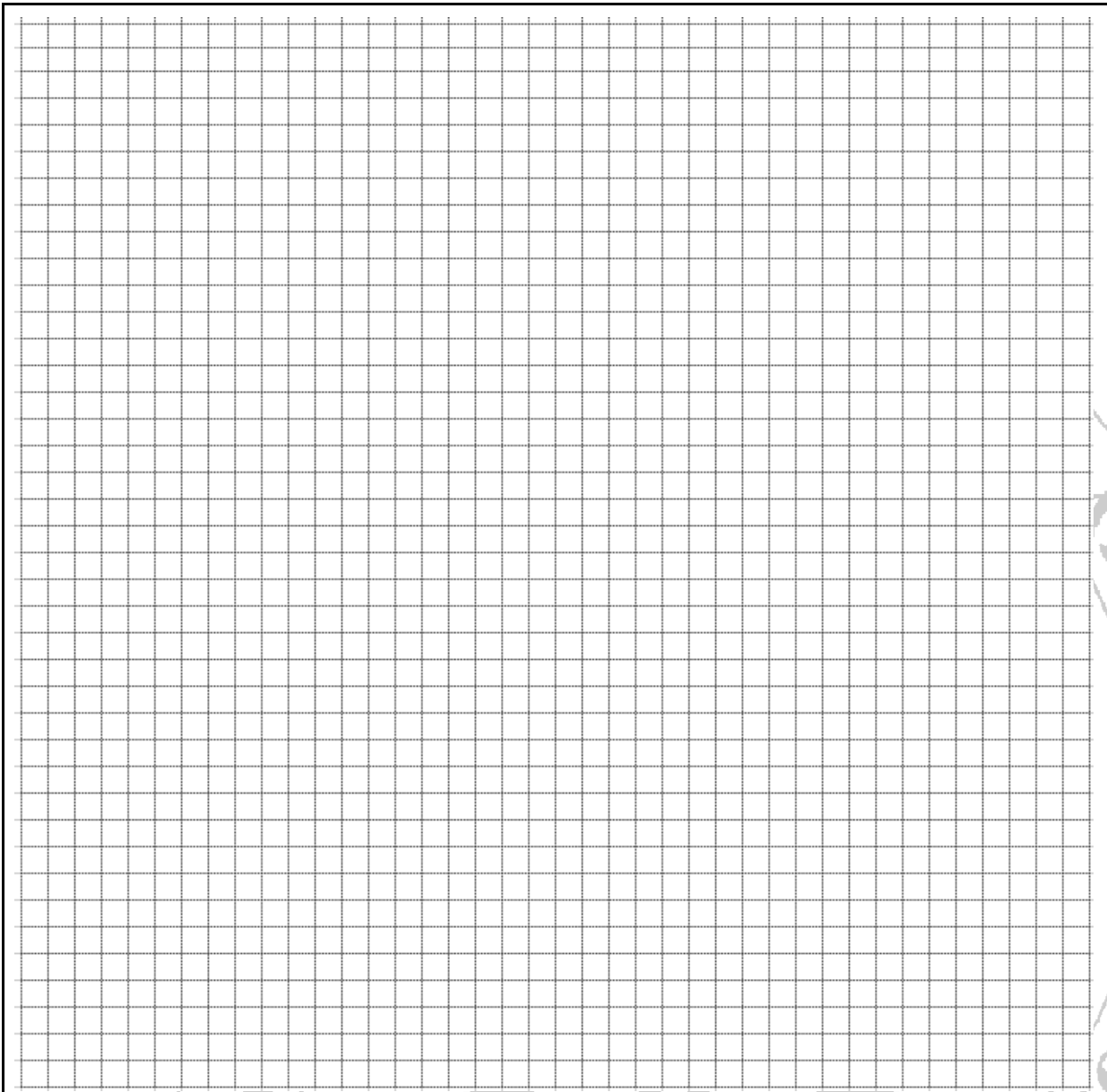
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