I

Name _____

Roll No. _____ Year 20____ 20____

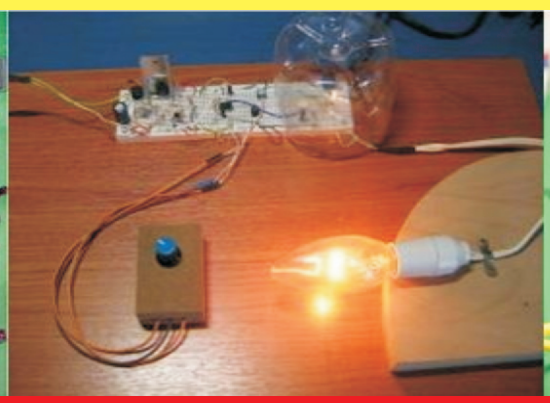
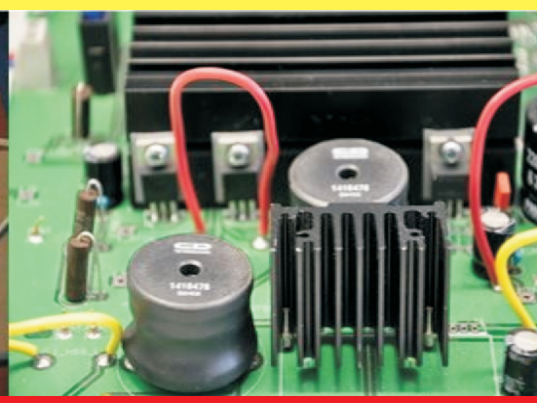
Exam Seat No. _____

ELECTRONICS GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

BASIC POWER ELECTRONICS (22427)

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 changing technological and 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 followings:

- 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

Basic Power Electronics

(22427)

Semester-IV

(EJ, DE, ET, EN, EX, EQ, IS, IC)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on November 2018)

Maharashtra State
Board of Technical Education
Certificate

This is to certify that Mr. / Ms …….
Roll No…….of Fourth Semester of Diploma in
…….of Institute
……..
(Code……..) has attained pre-defined practical outcomes (PROs) satisfactorily in course **Basic Power Electronics (22427)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No…….
Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

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 'I' Scheme curricula for engineering diploma programmes with outcome-base 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 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals 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 competency, industry relevant skills, course outcomes and practical outcomes which serve as a 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.

Electronic control circuits play major role in industries. In this era of automation in industry and manufacturing sector, the mechanical controls are largely replaced by power electronic devices. In this context this course aims at acquainting the pass outs with the basic principles and applications of basic power electronics devices, so that they can maintain the control circuits used in the field. Hence this course has been designed to achieve this aim.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course:

Following programme outcomes are expected to be achieved through the practical of this course:

PO1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.

PO2. **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.

PO3. **Experiments and practice:** Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

PO4. **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

PO5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics and Telecommunication engineering.

PO6. **Environment and sustainability:** Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in societal and environmental contexts.

PO7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Electronics and Telecommunication engineering.

PO8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO9. **Communication:** Communicate effectively in oral and written form.

PO10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

Program Specific Outcomes (PSO):-

PSO1. Electronics and Telecommunication Systems: Maintain various types of Electronics and Telecommunication systems.

PSO2. EDA Tools Usage: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits.

List of Industry Relevant Skills

- The following industry relevant skills of the competency ‘Maintain power electronic devices in electronic circuits. are expected to be developed in students by undertaking the practicals of this laboratory manual.

1. Identify the power electronic component.
2. Test power electronic component
3. Select the proper power electronic component of proper value as per the requirement.
4. Select the appropriate component with the help of data sheet.
5. Use the heat sink for relevant active component.
6. Mount the power electronic component as per circuit diagram.
7. Test the power circuit for the given application.
8. Compare the observed output with the expected output.
9. Find faults and trouble shoot the given circuit
10. Use appropriate EDA tool for simulation of power electronic circuit

Practical- Course Outcome matrix

Course Outcomes (COs)

- **a.** Identify power electronics devices in circuits.
- **b.** Maintain triggering and communication circuits.
- **c.** Use phase controlled rectifiers in different applications.
- **d.** Use choppers and inverters in different applications.
- **e.** Maintain control circuits consisting of power electronic devices.

S. No.	Practical Outcomes(PrO)	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Measure holding current (I_H) and latching current (I_L) of a given SCR from its V-I characteristic curve.	√	-	-	-	-
2.	Test the performance of given IGBT.	√	-	-	-	-
3.	Determine break over voltage of given DIAC from its V-I curve.	√	-	-	-	-
4.	Test the effect of variation of resistor, capacitor in R and RC triggering circuits of firing angle of SCR.	-	√	-	-	-
5.	Test the effects of variation of R on firing angle in synchronized UJT triggering circuit.	-	√	-	-	-
6.	Test the performance of Class C-Complimentary type commutation circuit.	-	√	-	-	-
7.	Test the performance of half wave controlled rectifier with R, RL load and measure load voltage.	-	-	√	-	-
8.	Determine firing angle and output voltage of 3-phase half wave controlled rectifier using Delta-star transformer.	-	-	√	-	-
9.	Test the performance of full wave controlled rectifier with R, RL load and measure load voltage.	-	-	√	-	-
10	Find output voltage of step-up chopper for different values of duty cycles.	-	-	-	√	-
11	Test parallel inverter to the measure frequency and output voltages.	-	-	-	√	-
12	Measure output voltages of step-down chopper for different values of duty cycles. Part I	-	-	-	√	-
13	Measure output voltages of step-down chopper for different values of duty cycles. Part II	-	-	-	√	-

14	Build/test SMPS for mobile phone charging. Part I	-	-	-	-	√
15	Build/test SMPS for mobile phone charging. Part II	-	-	-	-	√
16	Build Light dimmer circuit using TRIAC test the effect of resistance variation on intensity of lamp.	-	-	-	-	√

Guidelines to Teachers

1. Teacher is expected to refer complete curriculum document and follow guidelines for implementation before start of curriculum
2. Teacher should provide the guideline with demonstration of practical to the students with all features.
3. Teacher shall explain prior concepts to the students before starting of each practical
4. Involve students in performance of each practical.
5. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
6. Teachers should give opportunity to students for hands on experience after the demonstration.
7. Teacher is expected to share the skills and competencies to be developed in the students.
8. 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.
9. If practical is in two parts -Part I and Part II it should be conducted in two turns.
10. Assess the skill achievement of the students and COs of each unit.
11. At the beginning Teacher should make the students acquainted with any of the simulation software environment as few experiments are based on simulation.

Instructions for Students

1. Listen carefully the lecture given by teacher about course, curriculum, learning structure, skills to be developed.
2. Before performing the practical student shall read lab manual of related practical to be conducted.
3. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher***.
4. Organize the work in the group and make record of all observations.
5. Students shall develop maintenance skill as expected by industries.
6. Student shall attempt to develop related hand-on skills and gain confidence.
7. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
8. Student shall refer technical magazines, IS codes and data books.
9. Student should develop habit to submit the practical on date and time.
10. Student should well prepare while submitting write-up of exercise.

Content Page

List of Practicals and Progressive Assessment Sheet

11	Test parallel inverter to the measure frequency and output voltages.	80					
12*	Measure output voltages of step-down chopper for different values of duty cycles. Part I	87					
13*	Measure output voltages of step-down chopper for different values of duty cycles. Part II	94					
14	Build/test SMPS for mobile phone charging. Part I	101					
15	Build/test SMPS for mobile phone charging. Part II	108					
16*	Build Light dimmer circuit using TRIAC test the effect of resistance variation on intensity of lamp.	116					
Total							

- **The practical marked as '*' are compulsory,**
- **Column 6th marks to be transferred to Proforma of CIAAN-2017**.

Practical No.1: Measure holding current (I_H) and latching current (I_L) of a given SCR from its V-I characteristic curve

I Practical Significance

Performance of SCR can be decided by understanding the holding current (I_H) and latching current (I_L).If any one of the current is not appropriate defined by the manufacture then it will not make system efficient or usable for the defined applications like to control the motor speed, battery charging and power conversions. In this practical students will be able to determine switching voltage of the SCR.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Interpret the circuit diagrams.
- Use the power supply for various practicals.

IV Relevant Course Outcome(s)

- Identify power electronic devices in circuits.

V Practical Outcome

- Measure holding current (I_H) and latching current (I_L) of a given SCR from its V-I characteristic curve.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The SCR choice does not depend only on the V_{BO} voltage, but it also depends on the rated current and the sensitivity of SCR. Gate triggering is most commonly used method by applying positive signal at gate terminal of SCR it can be trigger much before the specified breakover voltage. The voltage at which SCR turns on with gate current is called switching voltage. The switching voltage of SCR is inversely proportional to gate current.

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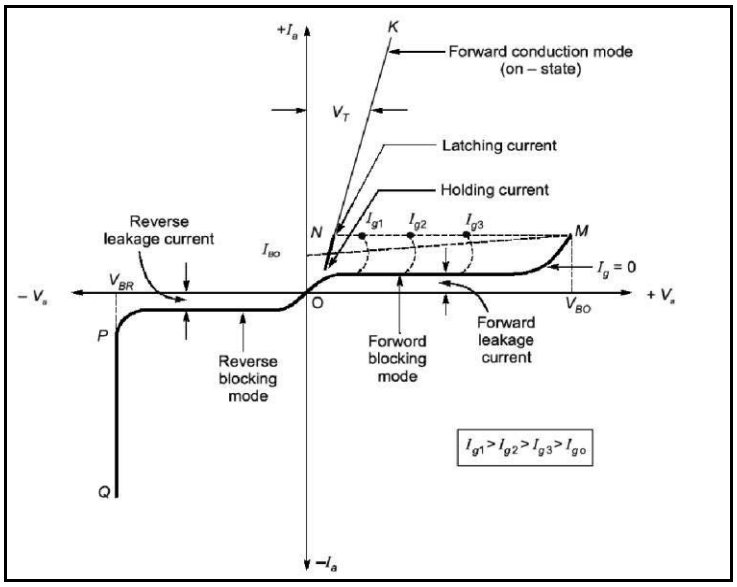

Fig. 1.1 Static V-I Characteristics of SCR

VIII Practical Circuit diagram :

- **Sample Circuit diagram**

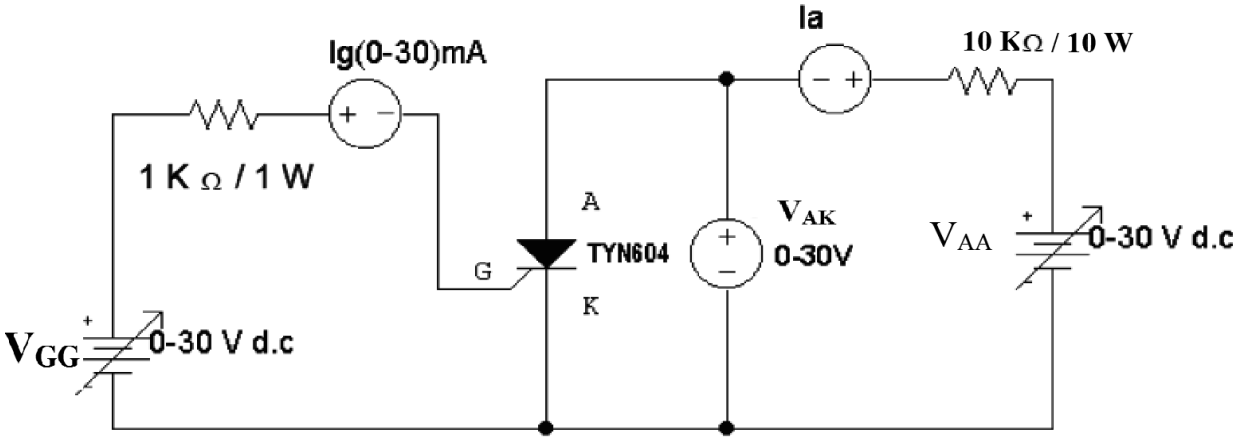

Fig. 1.2 Circuit diagram of V-I characteristics of SCR

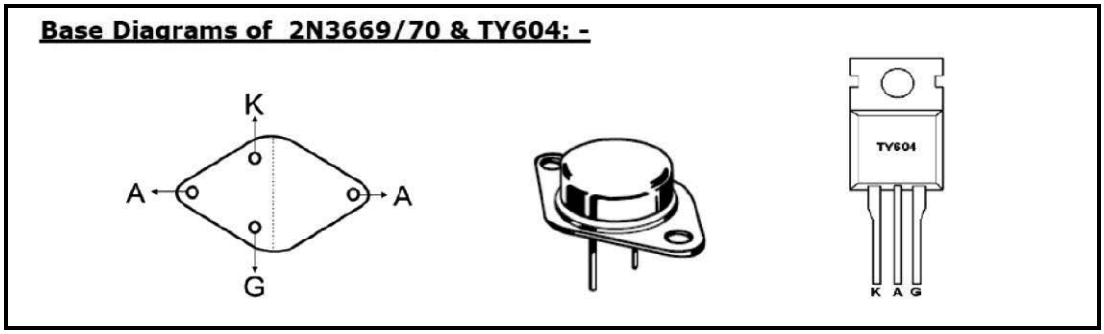

Fig. 1.3 Base Diagrams of SCR 2N3669/70 & TY604

- **Actual Circuit diagram**

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Digital Multimeter (Ammeter/Voltmeter)	Digital Multimeter: 3 1/2 digit display.	2
3	DC power supply	Variable power supply(0-30)V	2
4	SCR	TY604 Or any Other as per availability	1
5	Potentiometer	10 KΩ	1
6	Resistor	1 KΩ	1
7	Breadboards	General Purpose Breadboards	1
8	Connecting wires	Single strand 0.6 mm Teflon coating	As per requirement

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. The applied voltage, current should not exceed the maximum rating of the given SCR.

XI Procedure

- **Forward Characteristics**

1. Make the connection as per circuit diagram given in Fig. 1.2.
2. Initially keep the gate current at zero value.
3. Increase V_{AK} stepwise and note down Anode current (I_A). (In OFF state of SCR)
4. Fixed V_{AK} at particular value. Now increase gate current slowly till SCR trigger and note down the gate current.
5. Increase V_{AK}. Note down anode current. (In ON state of SCR)
6. Repeat the step 4 and 5 for different value of V_{AK}.
7. Draw the forward V-I characteristics of SCR on graph paper.

- **To determine Holding current**

1. Set the V_{AK} at any suitable value.
2. Apply sufficient gate current and turn on SCR.
3. After SCR has turn on remove the gate current.
4. Increase the value of R, I_A will go on decreasing. Find lowest value of I_A at which SCR remains on.
5. The lowest value of I_A is the latching current.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 1.1

Sr. No.	Ig_1 = 0 mA		Ig_2 = …….. mA		Ig_3 = …….. mA	
	$V_F = V_{AK}$ (Volts)	I_A (mA)	$V_R = V_{AK}$ (Volts)	I_A (mA)	$V_R = V_{AK}$ (Volts)	I_A (mA)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

XVI Results

- Holding current = …….
- Switching voltage for I_{g2} = ……, I_{g3} = …….

XVII Interpretation of Results

……
……
……
……

XVIII Conclusions and Recommendation

……
……
……

XIX Practical Related Questions (On the basis of observation table 1.1 answer the question 1 to 3)

1. Write the range of anode current in cut-off region of the SCR.
2. Write the voltage V_{AK} as soon as SCR turns on.
3. Write the minimum voltage for Gate terminal?
4. Write the various packages of SCR (Explore internet).

[Space for Answers]

……
……
……
……
……

XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd, New Delhi,1990, ISBN: 0070727937, 9780070727939.
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

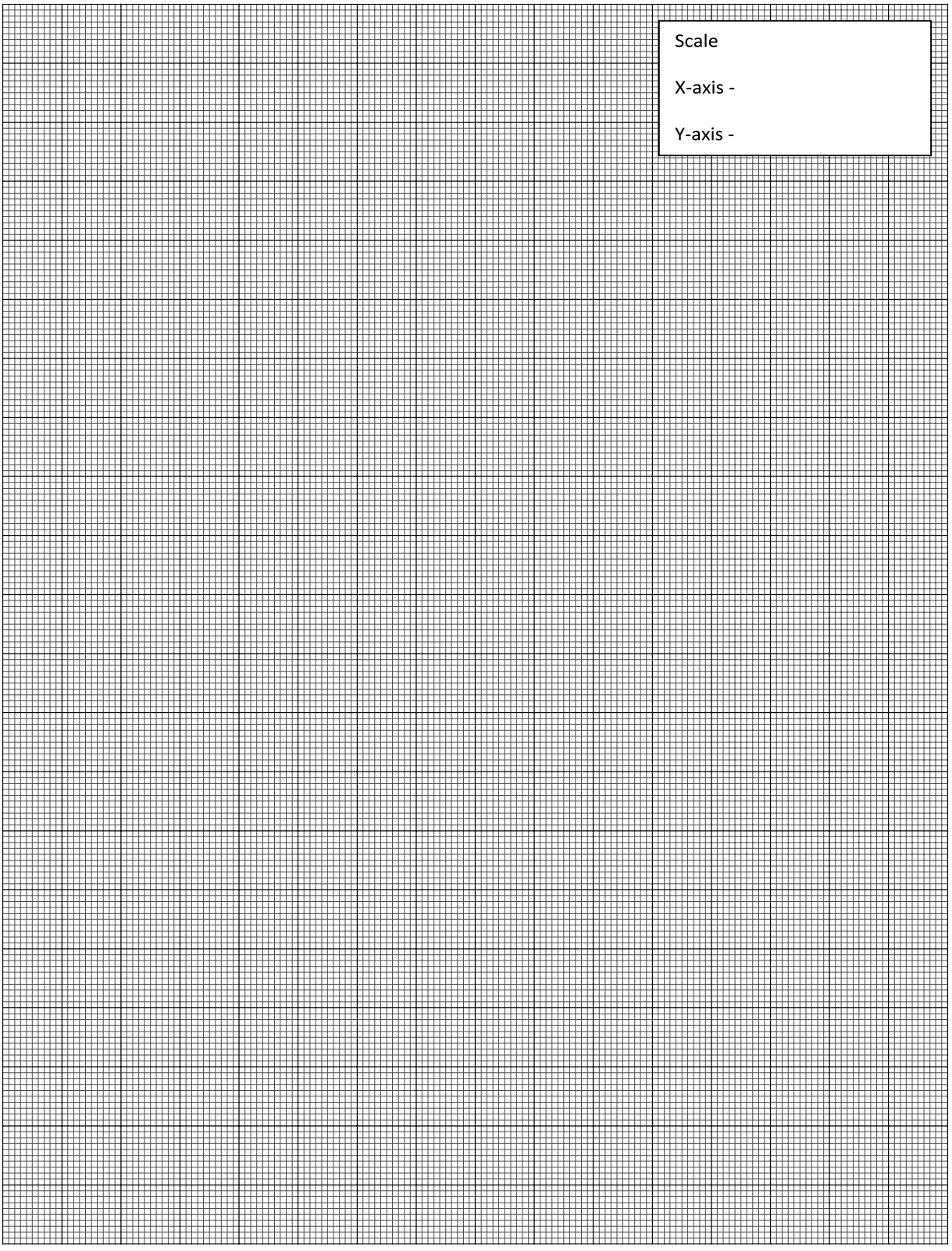
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

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

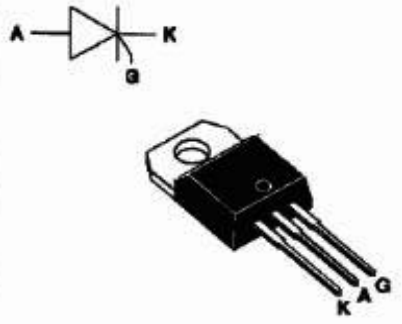

Scale
X-axis -
Y-axis -

SGS-THOMSON MICROELECTRONICS TYN 204 ---> TYN 1004

SCR

FEATURES

- HIGH SURGE CAPABILITY
- HIGH ON-STATE CURRENT
- HIGH STABILITY AND RELIABILITY



TO220AB
(Plastic)

DESCRIPTION

The TYN 204 ---> TYN 1004 Family of Silicon Controlled Rectifiers uses a high performance glass passivated technology.
This general purpose Family of Silicon Controlled Rectifiers is designed for power supplies up to 400Hz on resistive or inductive load.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)	Tc = 115 °C	4	A
$I_{T(AV)}$	Average on-state current (180° conduction angle, single phase circuit)	Tc = 115 °C	2.5	A
I_{TSM}	Non repetitive surge peak on-state current (Tj initial = 25°C)	tp = 8.3 ms	63	A
		tp = 10 ms	60	
I^2t	I^2t value	tp = 10 ms	18	A^2s
dI/dt	Critical rate of rise of on-state current Gate supply : I_G = 100 mA dI_G/dt = 1 A/µs		100	A/µs
Tstg Tj	Storage and operating junction temperature range		- 40 to + 150 - 40 to + 125	°C °C
Tl	Maximum lead temperature for soldering during 10 s at 4.5 mm from case		260	°C

Symbol	Parameter	TYN					Unit
		204	404	604	804	1004	
V_{DRM} V_{RRM}	Repetitive peak off-state voltage Tj = 125 °C	200	400	600	800	1000	V

TYN 204 --> TYN 1004

THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
Rth (j-a)	Junction to ambient	60	°C/W
Rth (j-c) DC	Junction to case for DC	2.5	°C/W

GATE CHARACTERISTICS (maximum values)

$P_{G\ (AV)}$ = 1W P_{GM} = 10W (tp = 20 µs) I_{FGM} = 4A (tp = 20 µs) V_{RGM} = 5 V.

ELECTRICAL CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
I_{GT}	V_D=12V (DC) R_L=33Ω	Tj=25°C	MAX	15	mA
V_{GT}	V_D=12V (DC) R_L=33Ω	Tj=25°C	MAX	1.5	V
V_{GD}	V_D=V_{DRM} R_L=3.3kΩ	Tj= 110°C	MIN	0.2	V
tgt	V_D=V_{DRM} I_G = 40mA dI_G/dt = 0.5A/µs	Tj=25°C	TYP	2	µs
I_L	I_G= 1.2 I_{GT}	Tj=25°C	TYP	50	mA
I_H	I_T= 100mA gate open	Tj=25°C	MAX	30	mA
V_{TM}	I_{TM}= 8A tp= 380µs	Tj=25°C	MAX	1.8	V
I_{DRM} I_{RRM}	V_{DRM} Rated V_{RRM} Rated	Tj=25°C	MAX	0.01	mA
		Tj= 110°C		2	
dV/dt	Linear slope up to V_D=67%V_{DRM} gate open	Tj= 110°C	MIN	200	V/µs
tq	V_D=67%V_{DRM} I_{TM}= 8A V_R= 25V dI_{TM}/dt=30 A/µs dV_D/dt= 50V/µs	Tj= 110°C	TYP	70	µs

Practical No.2: Test the performance of given IGBT

I Practical Significance

Main features of Insulated Gate Bipolar Transistor over other types of transistor devices are its high voltage capability, low ON-resistance, ease of drive, relatively fast switching speeds and combined with zero gate drive current makes it a good choice for moderate speed, high voltage applications such as in pulse-width modulated (PWM), variable speed control, switch-mode power supplies or solar powered DC-AC inverter and frequency converter applications operating in the hundreds of kilohertz range. In this practical students will be able to determine dynamic input impedance of IGBT from its transfer characteristics.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Interpret the circuit diagrams.
- Use the power supply for various practicals.

IV Relevant Course Outcome(s)

- Identify power electronic devices in circuits.

V Practical Outcome

- Test the performance of given IGBT.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The Insulated Gate Bipolar Transistor also called an **IGBT** for short, is something of a cross between a conventional *Bipolar Junction Transistor*, (BJT) and a *Field Effect Transistor*, (MOSFET) making it ideal as a semiconductor switching device. It combines the simple gate-drive characteristics found in the MOSFET with the high-current and low-saturation-voltage capability of a bipolar transistor. It does this by using an isolated gate field effect transistor for the control input, and a bipolar power transistor as a switch.

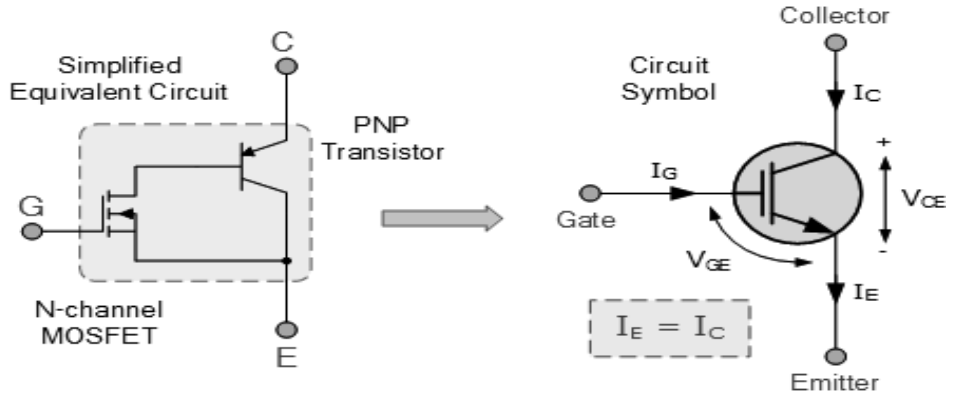


Fig.2.1 IGBT equivalent circiut and Symbol

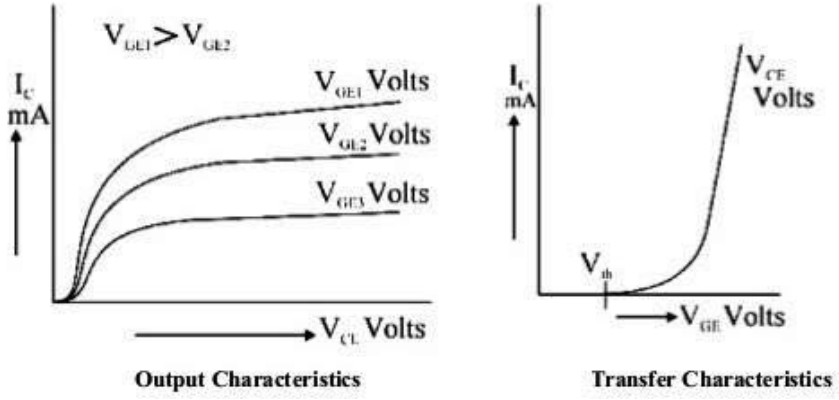


Fig.2.2 IGBT typical characteristics

VIII Practical Circuit diagram :

1. **Sample Circuit diagram**

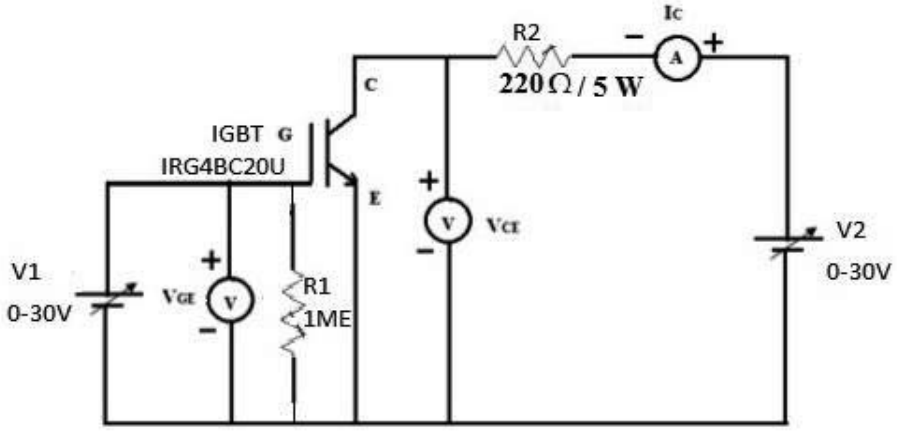


Fig. 2.3 Circuit diagram for V-I characteristics of IGBT

2. **Actual Circuit diagram**

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Digital Multi-meter (Ammeter/Voltmeter))	Digital Multi-meter: 3 1/2 digit display.	2
2	DC power supply	Variable power supply(0-30)V 2A With SC protection Digital meters	2
3	IGBT	IRG4BC20U	1
4	Resistor	1MΩ ,220 Ω	1 each
5	Breadboards	5.5 cm X 17cm	1
6	Connecting Wires	Single strand 0.6 mm Teflon coating	As Per Required

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in ‘off’ condition initially.
3. Ensure the use of proper settings of CRO.

XI Procedure

- **Transfer characteristics**

1. Initially Keep V_{CE} and V_{GG} to minimum voltage.
2. Set V_{CE} =1V and gradually vary V_{GE} in steps of 1V and note down I_C and V_{GE}.
3. The minimum gate voltage V_{GE} required for conducting of IGBT is called the Threshold voltage $V_{GE(Th)}$. Note Threshold voltage of IGBT in the given practical.
4. After $V_{GE(Th)}$, increase V_{GE} stepwise, take at least 5 reading and note the values in table 2.1
5. Plot the transfer characteristics on graph paper.

- **Output Characteristics**

1. Select V_{GE} gate voltage which gives some suitable value of I_C and record in the observation table no. 2.2.
2. Keeping V_{GE} at the set value, increase V_{CE} stepwise and note down I_C in table no2.2.
3. Repeat steps 1,2 for two more values of V_{GE}.
4. Plot graph of V_{CE} versus I_C.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 2.1: Transfer Characteristics

Sr. No.	V_{CE} = 1 V	
	V_{GE} (Volts)	I_G (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 2.2: Output Characteristics

Sr. No.	V_{GE1} .....Volts		V_{GE2} .....Volts	
	V_{CE} (Volts)	I_C (mA)	V_{CE} (Volts)	I_C (mA)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

XVI Results

- For Transfer characteristics, Threshold value $V_{GE\,(TH)}$……., I_C = ……
- For Output characteristics V_{CE} = …… .., I_C =……., (For V_{GE1}) at conducting point.

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

(Refer table 2.1 and 2.2 for question no. 1 to 3).

1. Write the threshold value of V_{CE} for V_{GE2}
2. Write the specification of IGBT used in practical.
3. Calculate dynamic input impedance from transfer characteristics.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939.

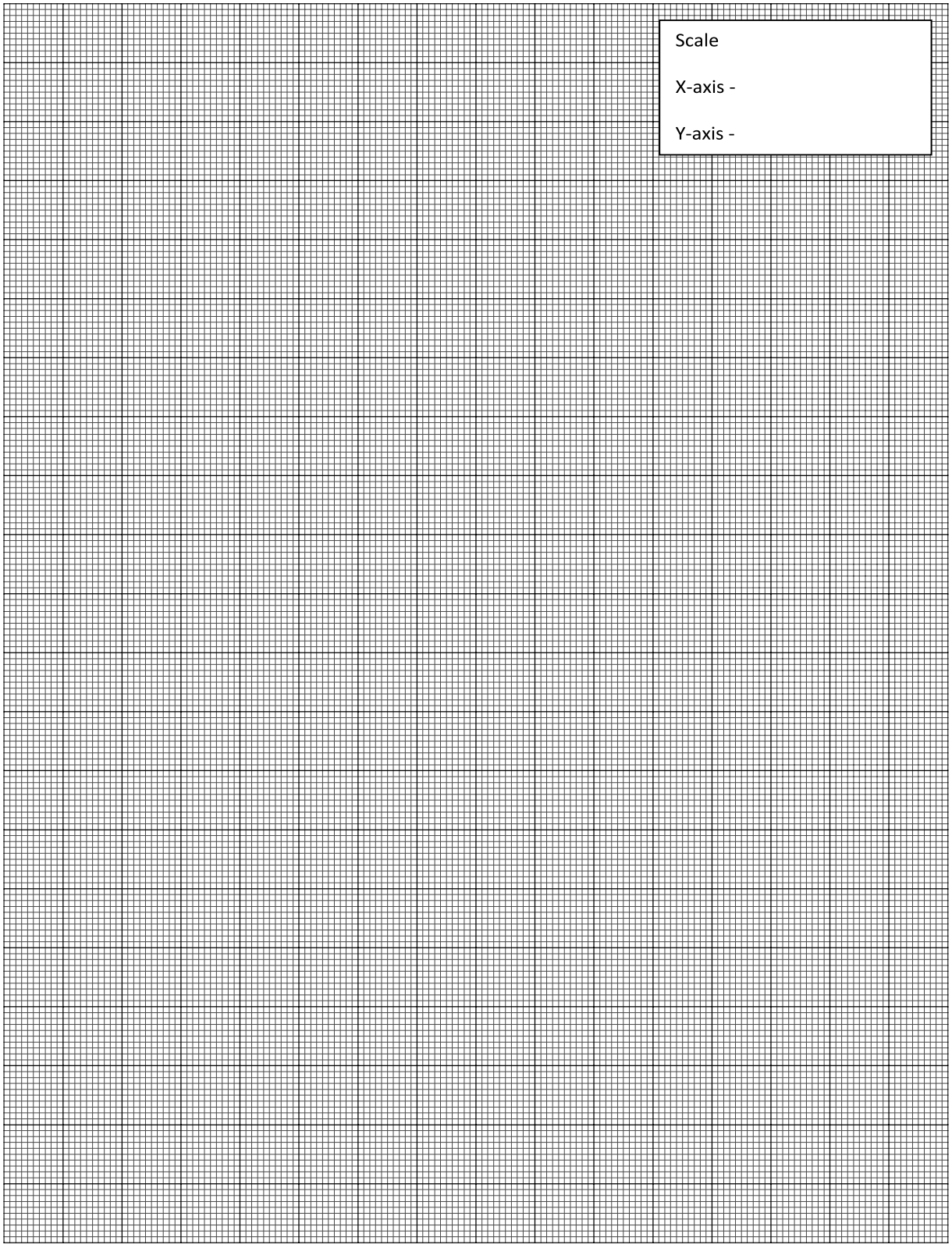
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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AND9068/D

Reading ON Semiconductor IGBT Datasheets

ON Semiconductor®

http://onsemi.com

APPLICATION NOTE

Table 1. ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–emitter voltage	V_{CES}	600	V
Collector current @ T_C = 25°C @ T_C = 100°C	I_C	 30 15	A
Pulsed collector current, T_{pulse} limited by T_{Jmax}	I_{CM}	60	A
Diode forward current @ T_C = 25°C @ T_C = 100°C	I_F	 30 15	A
Diode pulsed current, T_{pulse} limited by T_{Jmax}	I_{FM}	60	A
Gate–emitter voltage	V_{GE}	±20	V
Power dissipation @ T_C = 25°C @ T_C = 100°C	P_D	 130 55	W
Short circuit withstand time V_{GE} = 15 V, V_{CE} = 400 V, T_J ≤ +150°C	t_{SC}	10	μs
Operating junction temperature range	T_J	–55 to +150	°C
Storage temperature range	T_{stg}	–55 to +150	°C
Lead temperature for soldering, 1/8" from case for 5 seconds	T_{SLD}	260	°C

Practical No.3: Determine break over voltage of given DIAC from its V-I curve

I Practical Significance

DIAC is a full-wave or bi-directional semiconductor switch because of its symmetrical bidirectional switching characteristics. These are widely used as triggering devices in triac phase control circuits employed for lamp dimmer, heat control, universal motor speed control. In this practical students will be able to find break over voltage of given DIAC.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Interpret the circuit diagrams.
- Use the power supply for various practicals.

IV Relevant Course Outcome(s)

- Identify power electronic devices in circuits.

V Practical Outcome

- Determine break over voltage of given DIAC from its V-I curve.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The DIAC is a bidirectional, two terminal semiconductor device which can be turned on by either (Positive or Negative) polarity of alternating supply voltage. When the terminal MT1 is made positive with respect to MT2 and applied voltage less than the break over voltage, only leakage current flows through the device. It conducts only when the voltage applied to its terminal is equal to break over voltage.

VIII Practical Circuit diagram :

a. Sample Circuit diagram

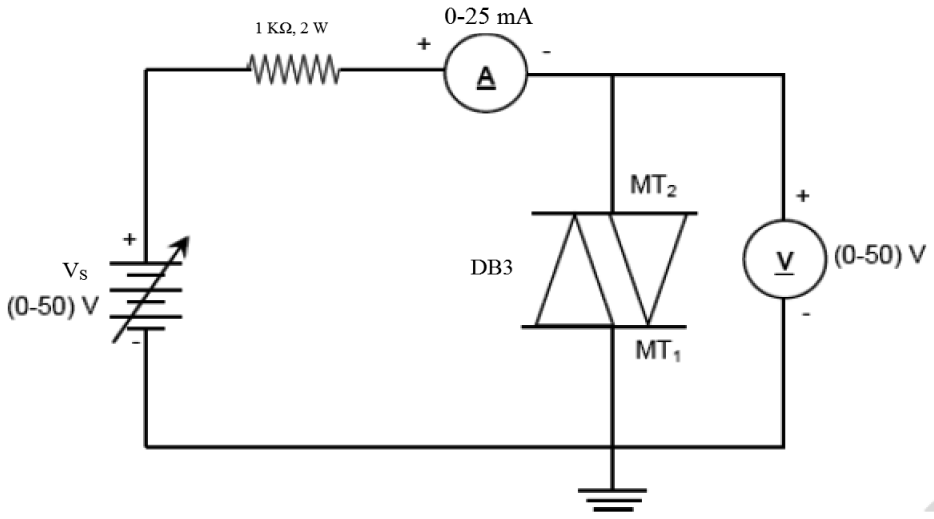

Fig. 3.1 Circuit diagram of V-I characteristics of DIAC

b. Actual Circuit diagram

IX Resources Required

SR. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Digital Multi-meter (Ammeter/Voltmeter)	Digital Multi-meter: 3 1/2 digit display.	2
2	DC power supply	Variable power supply(0-50)V 2 A with SC protection and digital meters	1
3	DIAC	DB3/DB4 SSD3A Or any Other as per availability	1
4	Resistor	1 KΩ	1
5	Connecting Wires	Single strand 0.6 mm Teflon coating	As Per required
6	Breadboards	5.5 cm X 17cm	1

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.

XI Procedure

- **MT2 positive with respect to MT1**

1. Make the connection as per circuit diagram in Fig. 3.1.
2. Set the voltage knob at zero value.
3. Switch on the dc power supply.
4. Increase the voltage of dc power supply in steps and note down voltage across DIAC and current.
5. Take at least four more reading of voltage and current after breakover voltage (V_{BO}).

- **MT1 positive with respect to MT2**

1. Repeat the step 2 to 5.
2. Plot the V-I characteristics of DIAC on graph paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 3.1

Sr. No.	MT2 is positive		MT1 is positive	
	V (Volts)	I (mA)	V (Volts)	I (mA)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

XVI Results

- V_{BO} = …… Volts (For MT2 positive)
- V_{BO} = …… Volts (For MT1 positive)

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. DIAC is …….. device. (Unidirectional / Bidirectional)
2. Write the current value of DIAC in this practical at V_{BO}.
3. Write the specification of DIAC used in this practical.
4. Check whether the break over voltage in first quadrant and third quadrant is same? (Refer plotted characteristics).

[Space for Answers]

XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939.

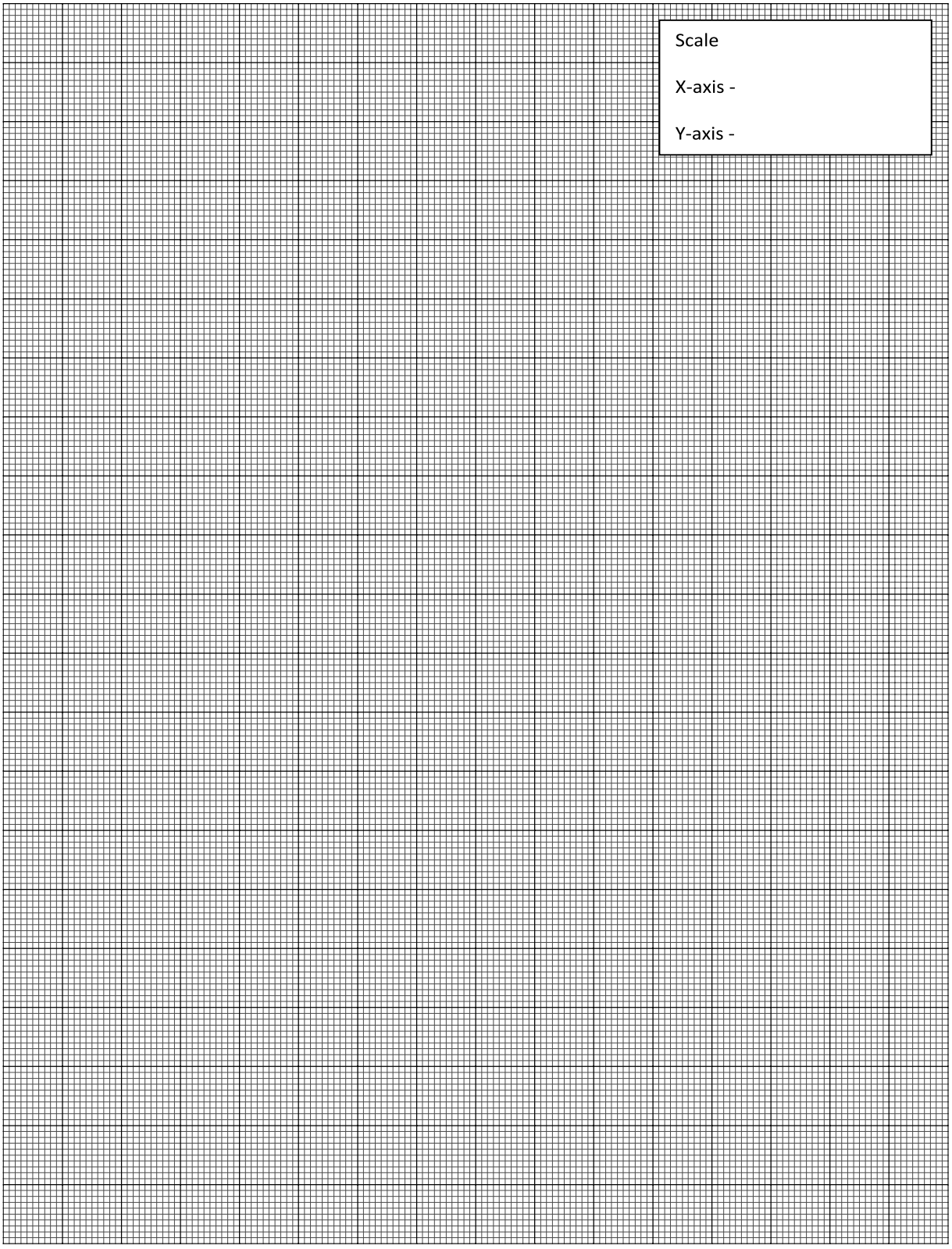
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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TAITRON components incorporated

Bidirectional DIAC Trigger Diode

DB3/DB4

Bidirectional DIAC Trigger Diode

DO-35

RoHS Compliant

Features

- Low breakover current
- Excellent symmetry
- Very low leakage current
- Trigger diode with a fixed voltage reference
- High temperature soldering guaranteed: 250°C/10s/9.5mm lead length at 5 lbs tension
- RoHS Compliance

Mechanical Data

Case:	Glass Case DO-35
Terminals:	Plated axial leads, solderable per MIL-STD-750, method 2026
Weight:	Approx. 0.13 gram

Maximum Ratings *($T_{Ambient}$=25ºC unless noted otherwise)*

Symbol	Description	DB3	DB4	Unit
P_D	Power Dissipation on Printed Circuit (L=10mm) (T_a=50°C)	150		mW
I_{TRM}	Repetitive Peak on-state Current (t_p=20µs, f=100Hz)	2		A
T_J	Operating Temperature Range	-40 to +110		° C
T_{STG}	Storage Temperature Range	-40 to +125		° C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient Air	400		° C/W
$R_{\theta JL}$	Thermal Resistance Junction to Case	150		° C/W

Electrical Characteristics *($T_{Ambient}$=25ºC unless noted otherwise)*

Symbol	Description		Min.	Max.	Unit	Conditions
*V_{BO}	*Breakover Voltage	DB3	28	36	V	**C=22nF See Fig.4
		DB4	35	45	V	
[I+V_{BO}I-I-V_{BO}I]	Breakover Voltage Symmetry		-3	3	V	**C=22nF, See Fig.4
| ±ΔV |	**Dynamic Breakover Voltage		5	-	V	Δ1=[I_{BO} to I_F=10mA] See Fig.4
V_O	*Output Voltage		5	-	V	See Fig.6
I_{BO}	*Breakover Current		-	50	µA	**C=22nF
Tr	*Rise Time		Typ.1.5		µs	See Fig.5
I_B	*Leakage Current		-	10	µA	V_B=0.5, V_{BO} Max. See Fig.4

***Electrical characteristic applicable in both forward and reverse directions.**
****Connected in parallel with the devices.**

Typical Characteristics Curves

Fig.1-Max. Power Dissipation

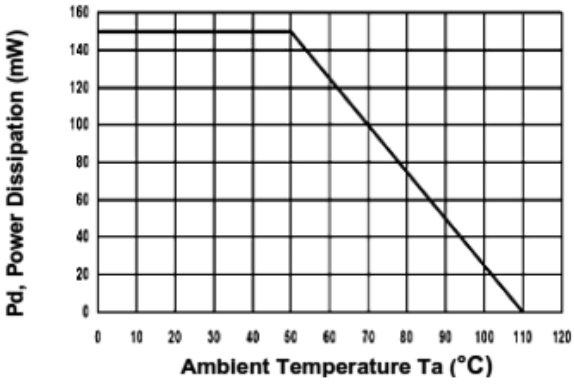
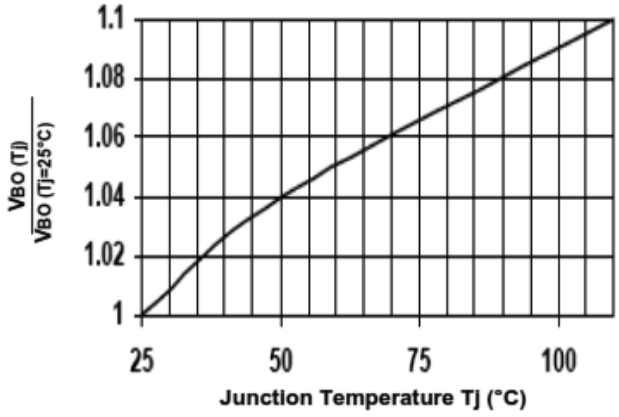


Fig.2- Typical Relative Variation of V_{BO}



Practical No.4: Test the effect of variation of resistor, capacitor in R and RC triggering circuits on firing angle of SCR

I Practical Significance

The output power deliver to load is controlled through triggering circuit. Resistance 'R' triggering is the simplest and economical type of triggering but limited for few applications. In R triggering circuit firing angle is limited to 90^0 only and the RC triggering circuit which provides the firing angle control from 0 to 180^0.In this practical students will able to turn on the SCR under the gate triggering.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe the waveform.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain triggering and commutation circuits.

V Practical Outcome

- Test the effect of variation of resistor, capacitor in R and RC triggering circuits on firing angle of SCR.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The key factor in use of SCR for controlling power is their ability to switch from non-conducting to conducting states. The basic requirement for the firing of SCR is the current supplied to the gate should be adequate. SCR can be turned on by gate triggering method with this triggering method SCR can be triggered much below the breakover voltage.

VIII Practical Circuit diagram:

a. Sample Circuit diagram

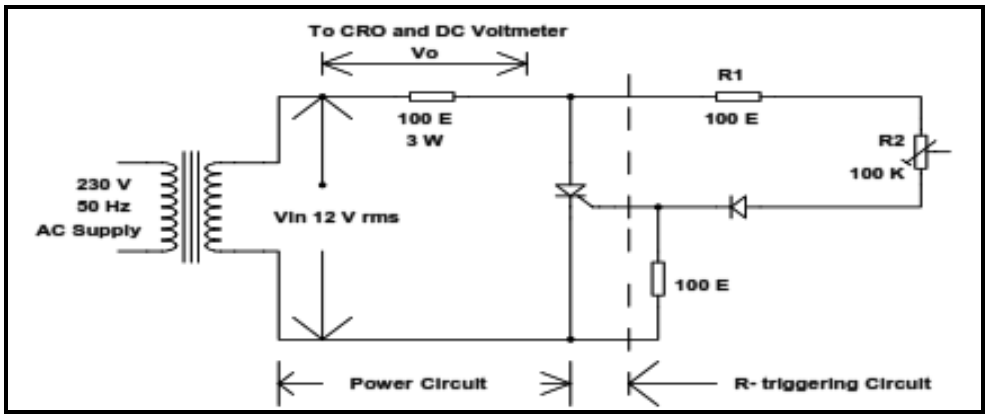


Fig. 4.1 R-triggering Circuit

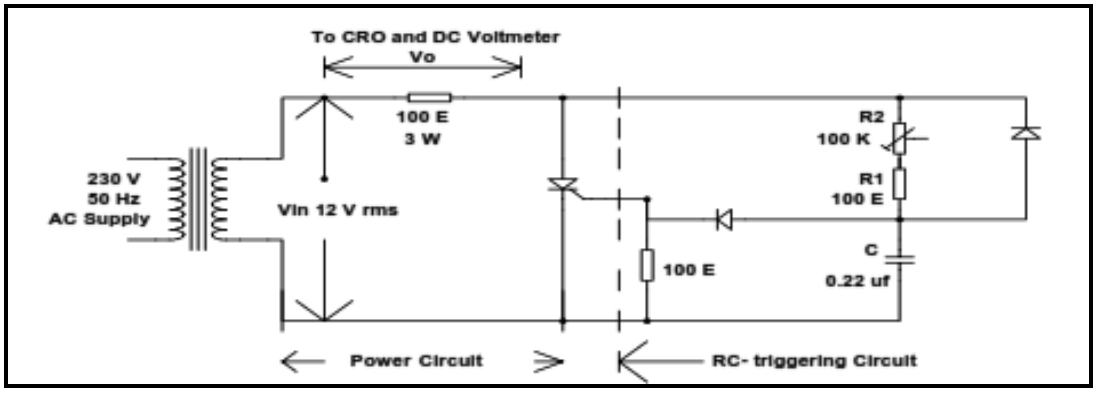


Fig. 4.2 RC-triggering Circuit

B Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	AC power supply	230 V, 50 Hz	1 No.
2	Voltmeter	0-30 V	1 No.
3	CRO	20 MHz	1 No.
4	Transformer	0-12V 500 mA	1 No.
5	SCR	TYN 612 or any other available	1 No.
6	Diode	D_1 and D_2	2 No.
7	Capacitor	0.22μF	1 No.
8	Resistors	R_1 = 100 Ω , R_2 , potentiometer = 100KΩ, R_G=100 Ω, R_L= 100 Ω, 3watts	1 Each

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure the use of proper settings of CRO.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig.4.1
2. Keep Potentiometer R_2 at maximum value.
3. Switch on Mains supply.
4. Decrease the resistance R_2 of Potentiometer in steps, note down the corresponding values of output voltage.
5. Also record the corresponding firing angle by measuring in time period from CRO.
6. Calculate firing angle in degree.
7. Draw the corresponding wave form on Graph Paper for any two firing angles.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 4.1: R –triggering:

Vin = …. Vrms

Sr. No.	Resistance	Firing angle in time	Firing angle $\alpha(^0)$	Average output voltage (V)
1				
2				
3				
4				
5				

Table 4.2: RC – triggering :

Vin = …. Vrms

Sr. No.	Resistance	Firing angle in time	Firing angle $\alpha(^0)$	Average output voltage (V)
1				
2				
3				
4				
5				

XVI Results

a) R-triggering

- For high resistance R= ……Ω, α(^{o})= …….
- For low resistance R= ……Ω, α(^{o})= …….

b) RC-triggering

- For high resistance R= ……Ω, α(^{o})= …….
- For low resistance R= ……Ω, α(^{o})= …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Refer fig. 4.1 and 4.2; state the effect on load voltage if diode is open.
2. Refer fig. 4.1 and 4.2; state the effect on load voltage if R1 and R2 are short circuited.
3. State the range of firing angle with R, RC- triggering circuit (refer observation table 4.1 and 4.2).

[Space for Answers]

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XX. References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939.

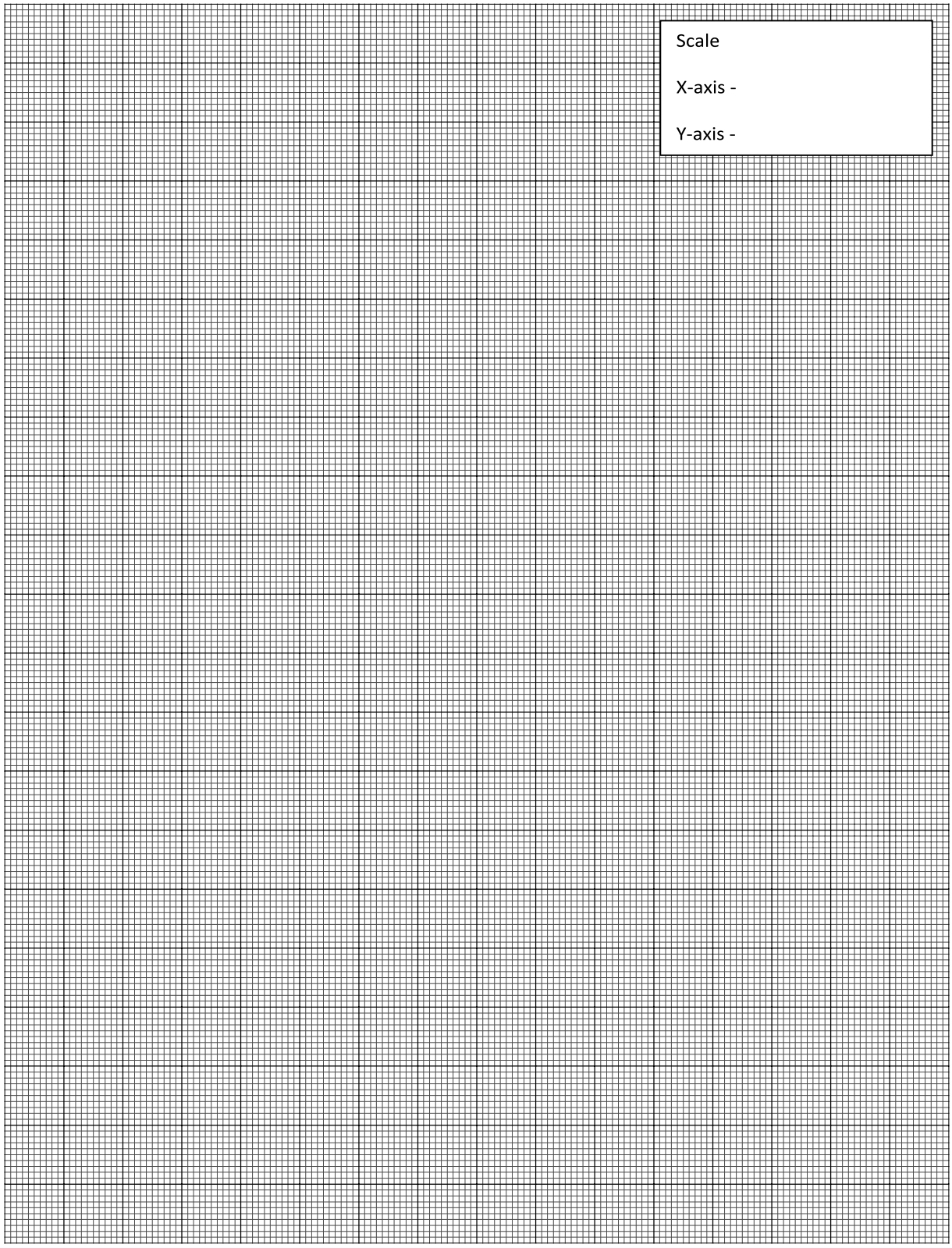
XXI. Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Practical No.5: Test the effect of variation of R on the firing angle in synchronized UJT triggering circuit

I Practical Significance

To control the power UJT is used in synchronized type triggering circuit where firing angle can be change from 0^o to 180^o. In this practical students will able to turn on the Thyristor under the gate triggering through UJT.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain triggering and commutation circuits.

V Practical Outcome

- Test the effect of variation of R on the firing angle in synchronized UJT triggering circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

A Unijunction transistor (UJT) is an electronic semiconductor device that has only one junction. The UJT has three terminals: an emitter (E), Base 1(B1) and Base 2 (B2). The capacitor is connected between Emitter and Base 1. Charging time constant of capacitor decides the firing angle. Signal at B1 is connected to the gate terminal of SCR.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

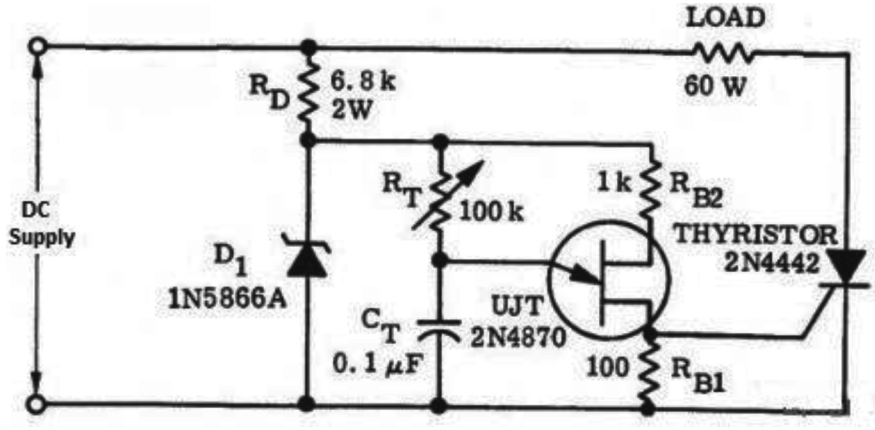

Fig. 5.1 UJT triggering Circuit

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	0-30 V 2 A with SC protection	1 No.
2	UJT	2N4870 or any other	1 No.
3	Capacitor	C_T = 0.1 μF	1 No.
4	Resistors	RB1 = 100 Ω RB2 = 1 KΩ R_T(pot) = 100 KΩ RD = 6.8 KΩ Lamp Load = 60 W	1 Each
5	Connecting wires	As per kit requirement.	As per requirement
6	AC supply	230 V, 50 Hz	1 No.

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. The applied voltage, current should not exceed the maximum rating of the given UJT.
4. Ensure the use of proper settings of CRO.

XI Procedure

1. Make the circuit connection as per the circuit diagram in Fig. 5.1.
2. Switch on power supply.
3. Increase R_T in steps till waveform observe across capacitor C_T and resistor RB1on CRO
4. Observe the output voltage across the load.
5. Measure the firing angle (in time) for various value of resistance R_T.
6. Calculate firing angle in degree.
7. Draw the waveform across the load and SCR for different value of firing angle.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 5.1

Sr. No.	Firing angle in time	Firing angle $\alpha(^0)$	Average output voltage (V)
1			
2			
3			
4			

XVI Results

- For high resistance R= ……Ω, $\alpha(^o)$= …….
- For low resistance R= ……Ω, $\alpha(^o)$= …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Note down the voltage across zener diode used in fig. 5.1.
2. Write the procedure of testing of UJT.
3. Write the effect on intensity of lamp load with respect to variation of R_T in between maximum and minimum position.

[Space for Answers]

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XX. References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939

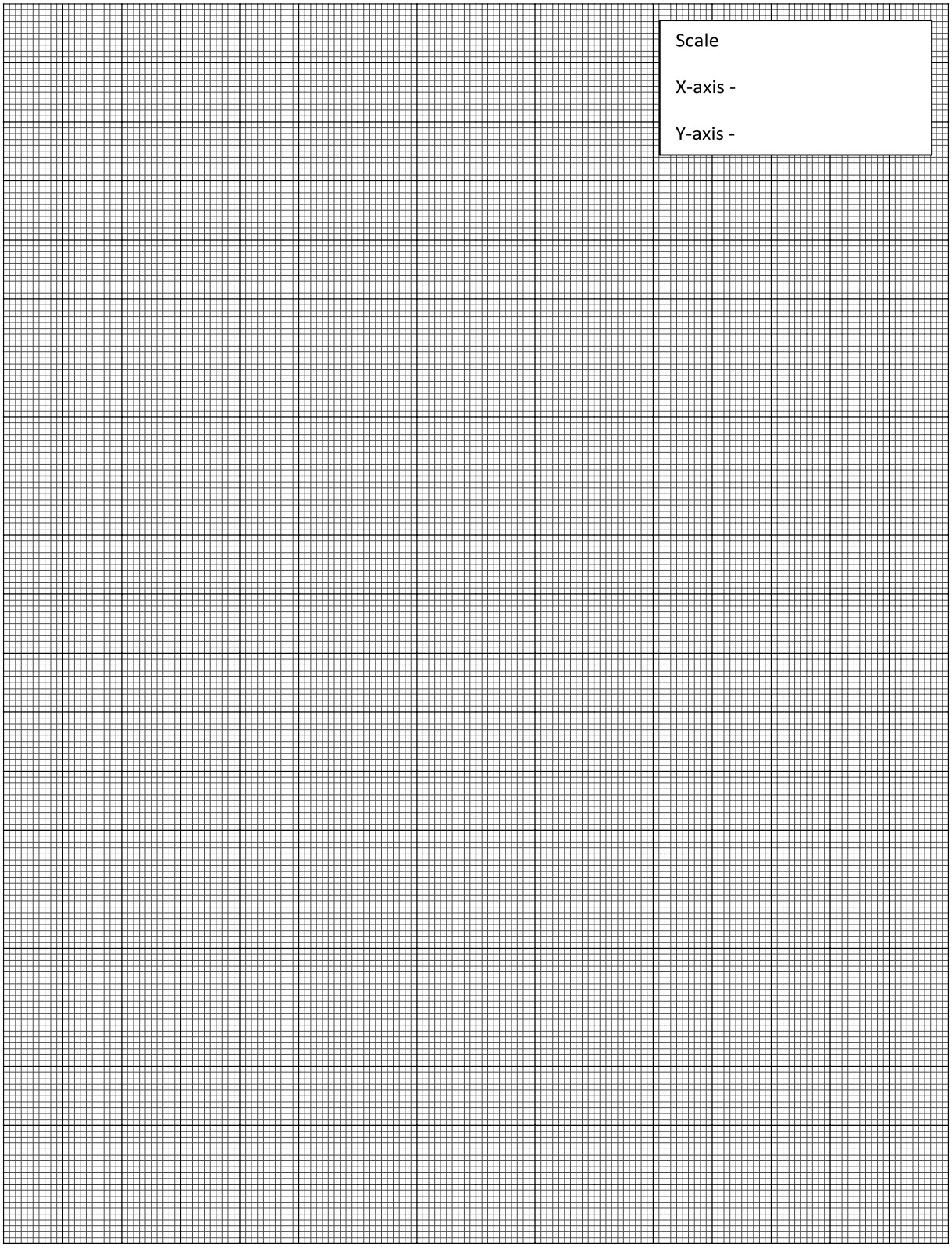
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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2N4870
2N4871

SILICON
PN UNIJUNCTION TRANSISTORS

TO-92 CASE

Central Semiconductor Corp.

www.centralsemi.com

DESCRIPTION:

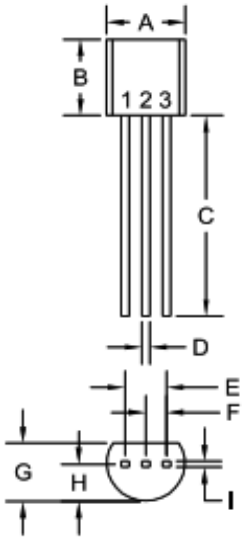
The CENTRAL SEMICONDUCTOR 2N4870 and 2N4871 are silicon PN unijunction transistors designed for oscillator, triggering and timing applications.

MARKING: FULL PART NUMBER

MAXIMUM RATINGS: (T_A=25°C)	**SYMBOL**		**UNITS**
Emitter Reverse Voltage	V_{B2E}	30	V
Interbase Voltage	V_{B2B1}	35	V
RMS Emitter Current	I_e	1.5	A
Peak Emitter Current (Duty Cycle ≤1%, PRR=10pps)	i_e	1.0	A
RMS Power Dissipation	P_D	300	mW
Operating Junction Temperature	T_J	-65 to +125	°C
Storage Temperature	T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS: (T_A=25°C)		**2N4870**		**2N4871**		
SYMBOL	**TEST CONDITIONS**	**MIN**	**MAX**	**MIN**	**MAX**	**UNITS**
η	V_{B2B1}=10V	0.56	0.75	0.70	0.85	
R_{BB}	V_{B2B1}=3.0V	4.0	9.1	4.0	9.1	kΩ
I_{EB2O}	V_{B2E}=30V	-	1.0	-	1.0	μA
I_V	V_{B2B1}=20V, R_{B2}=100Ω	2.0	-	4.0	-	mA
I_P	V_{B2B1}=25V	-	5.0	-	5.0	μA
V_{OB1}	V_1=20V	3.0	-	5.0	-	V

TO-92 CASE - MECHANICAL OUTLINE



R1

DIMENSIONS				
	INCHES		MILLIMETERS	
SYMBOL	MIN	MAX	MIN	MAX
A (DIA)	0.175	0.205	4.45	5.21
B	0.170	0.210	4.32	5.33
C	0.500	-	12.70	-
D	0.016	0.022	0.41	0.56
E	0.100		2.54	
F	0.050		1.27	
G	0.125	0.165	3.18	4.19
H	0.080	0.105	2.03	2.67
I	0.015		0.38	

TO-92 (REV: R1)

LEAD CODE:
1) Base 1
2) Emitter
3) Base 2

MARKING:
FULL PART NUMBER

Practical No.6: Test the performance of Class C-Complimentary type commutation circuit.

I Practical Significance

The process of turning OFF a SCR by using external circuits is one type of Commutation known as Forced Commutation By selecting appropriate method students will be able to understand turning off process for SCR .Commutation method plays important role in developing SCR based applications. In this practical student will be able to commutate the SCR.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain triggering and commutation circuits.

V Practical Outcome

- Test the performance of Class C-Complimentary type commutation circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The term commutation means the transfer of currents from one path to another. So the commutation circuit does this job by reducing the forward current to zero so as to turn OFF the SCR or Thyristor. To turn OFF the conducting SCR the below conditions must be satisfied. The anode or forward current of SCR must be reduced to zero or below the level of holding current and then, a sufficient reverse voltage must be applied across the SCR to regain its forward blocking state.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

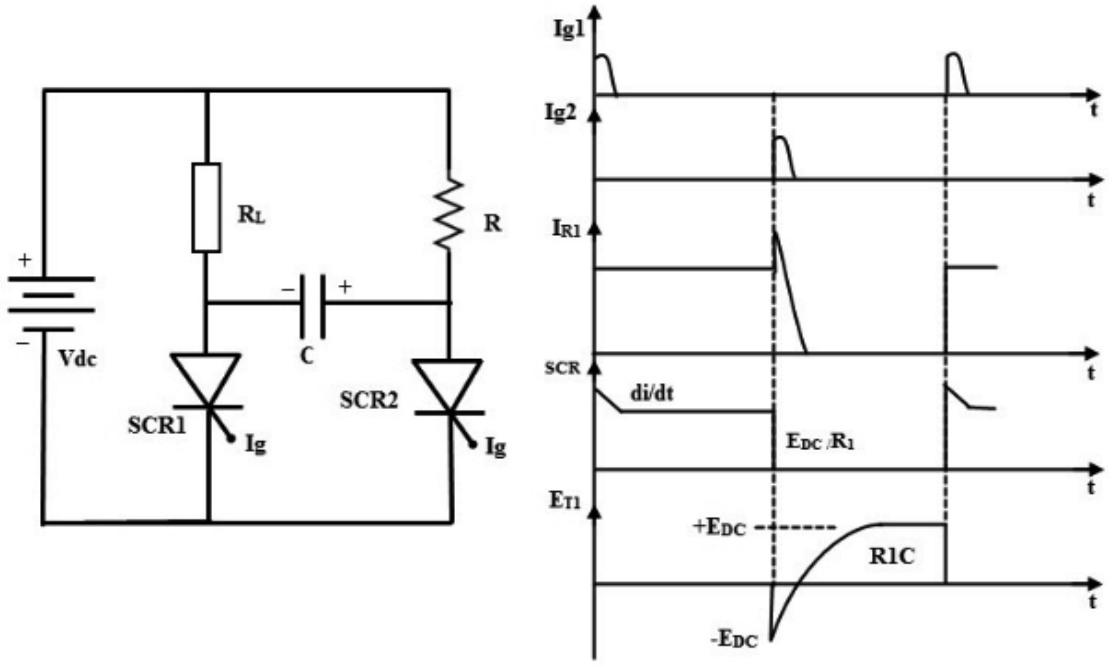


Fig. 6.1 Class C commutation circuit

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Regulated power supply	Variable DC power supply 0-30 V 2 A with SC protection and digital meters suitable for trainer kit	1 No.
2	Practical Kit	Trainer kit for Class C Commutation of SCR	1 No.
3	CRO /Power scope	30 MHz Dual trace	1 No.
4	Connecting wires	As per kit requirement.	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. The applied voltage, current should not exceed the maximum rating of the given SCR.
4. Ensure the use of proper settings of CRO.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in fig. 6.1.
2. Switch on power supply.
3. Observe the output voltage waveform across the load and SCR on CRO.
4. Measure and note down the amplitude and time period in ON and OFF condition of the SCR.
5. Draw the waveform across the load and SCR on graph paper.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 6.1

Sr. No.	Observation	Amplitude	Time period	
			T_{ON}	T_{OFF}
1	Voltage across SCR			
2	Voltage across load			
3				
4				
5				

XVI Results

- Voltage across SCR when it is in ON condition =……
- Voltage across SCR when it is in OFF condition =……

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Write the specification of SCR used in Practical kit.
2. State the effect on class C commutation circuit if capacitor is short circuited.
3. Measure the voltage across SCR1 when SCR2 is in ON state.
4. Measure the voltage across capacitor in working condition of trainer kit.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

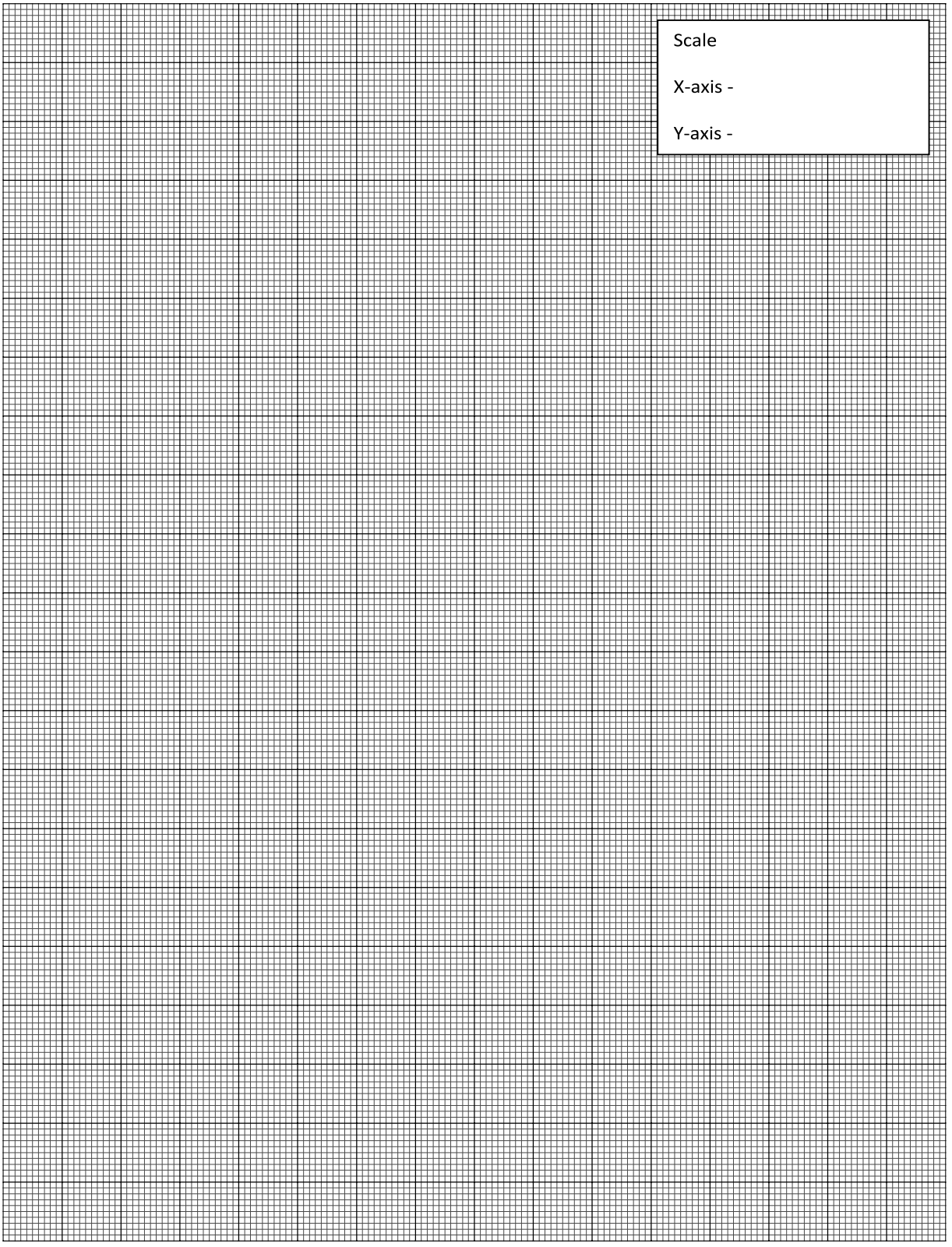
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Y-axis -

Practical No.7: Test the performance of half wave controlled rectifier with R and RL load and measure load voltage

I Practical Significance

To run the DC motor on high DC power, controlled rectifier circuit is used. Controlled rectifier circuit plays important role for converting AC power to DC power. It is also used in Battery charger circuit, high voltage DC transmission. In this practical student will able to control the output power deliver to the load.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use Phase controlled rectifier in different applications.

V Practical Outcome

- Test the performance of half wave controlled rectifier with R and RL load and measure load voltage.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

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.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

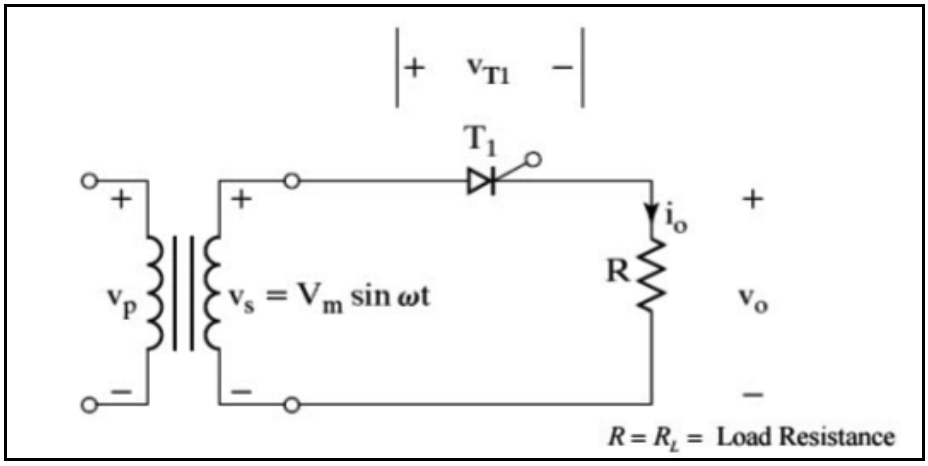

Fig. 7.1 Half wave controlled rectifier for R load

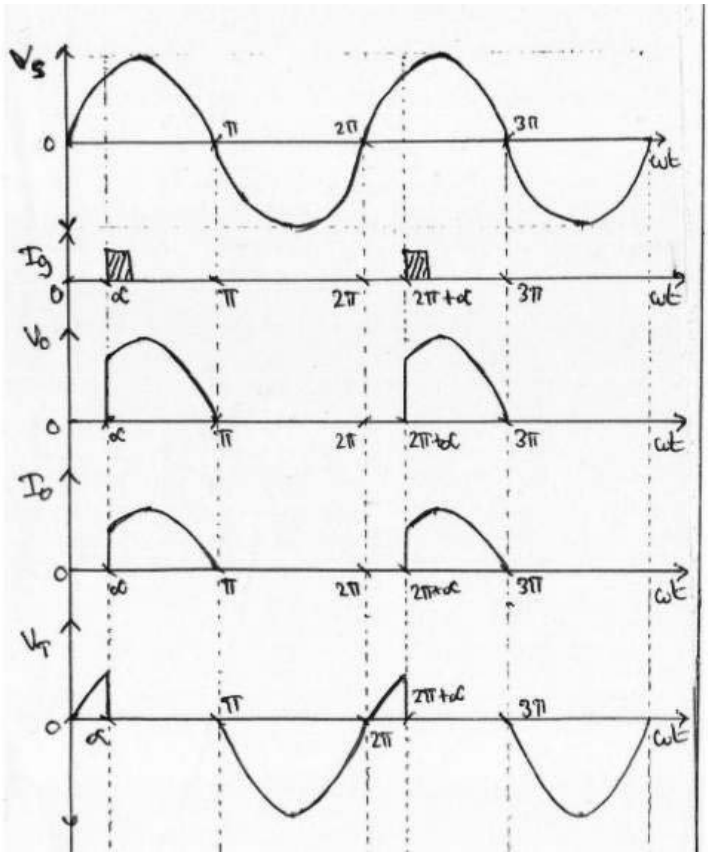

Fig. 7.2 Half wave controlled rectifier waveform (R-load)

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	AC power supply	230 V, 50 Hz	1 No.
2	Voltmeter	0-30 V	1 No.
3	CRO /Power Scope	20 MHz	1 No.
4	Practical kit	Trainer kit of Half wave controlled rectifier with R and RL load with various test point	1 No.
5	Connecting wires	As per kit requirement.	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. The applied voltage, current should not exceed the maximum rating of the given SCR
3. Reading should be noted without parallax error

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 7.1.
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. Calculate the average output voltage. $V_L = V_m / 2\pi (1 + \cos \alpha)$
8. Draw input and output waveform on graph paper for different firing angle.
9. Make the circuit connections as per diagram shown in 7.2.
10. Repeat the same procedure from step 2 to 7 for RL Load.
11. Calculate the average output voltage $V_L = V_m / 2\pi (\cos \alpha)$ and draw waveform for the same.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 7.1

Vin = …….. Vm

Sr. No.	Firing angle in time	Firing angle $\alpha(^0)$	Measured output voltage (V)	Calculated output voltage (V)
1				
2				
3				
4				
5				

XVI Results

- For firing angle at (α =30 ^{o}), Output voltage ……..,
- For firing angle at (α =90 ^{o}), Output voltage …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions (Refer practical kit for question 1 to 3)

1. State the effect on output if no gate pulse is applied.
2. State the effect on output if gate pulse is applied at 180^0.
3. Write the value of output voltage at 0^0 firing angle and draw the waveform across the load.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939

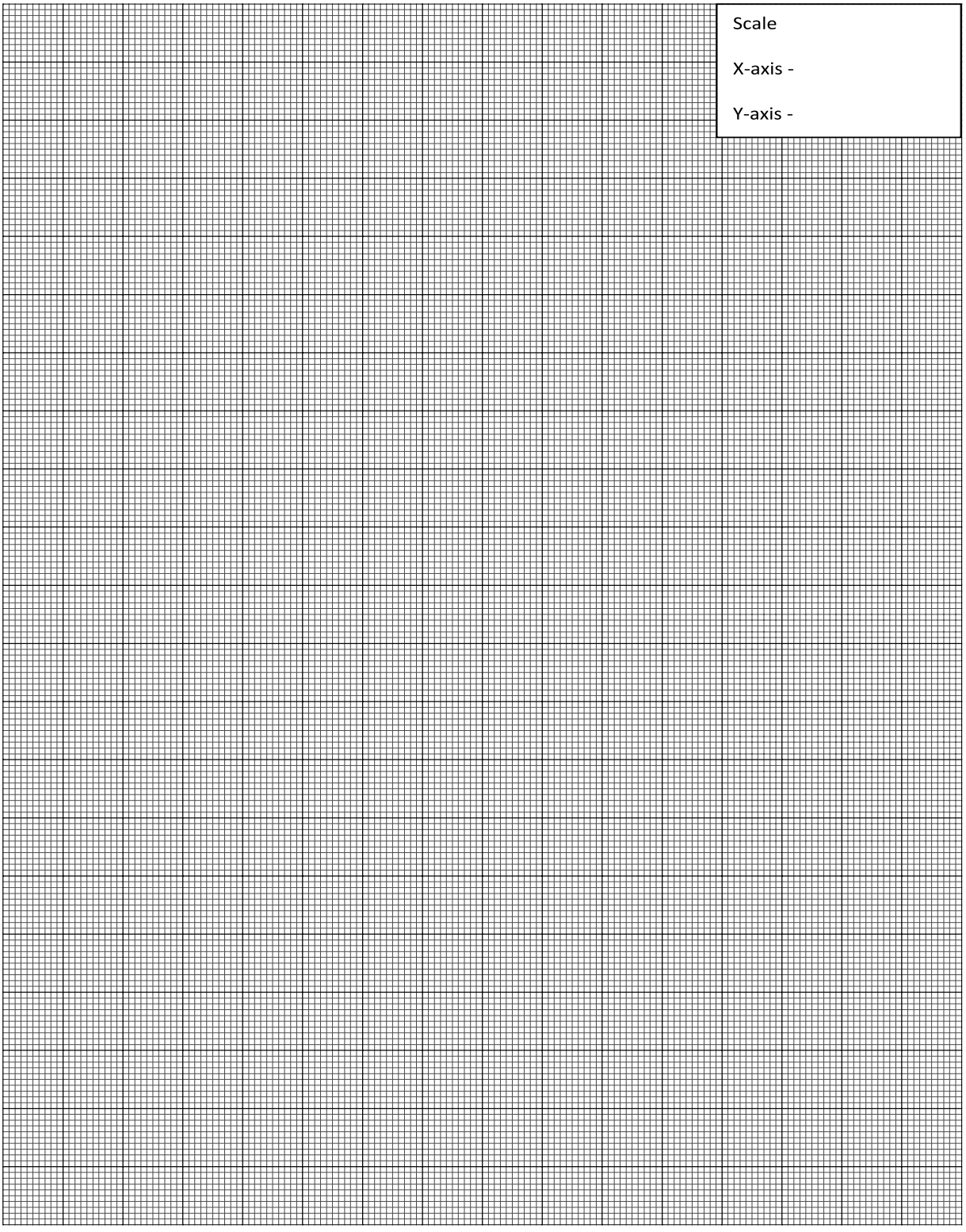
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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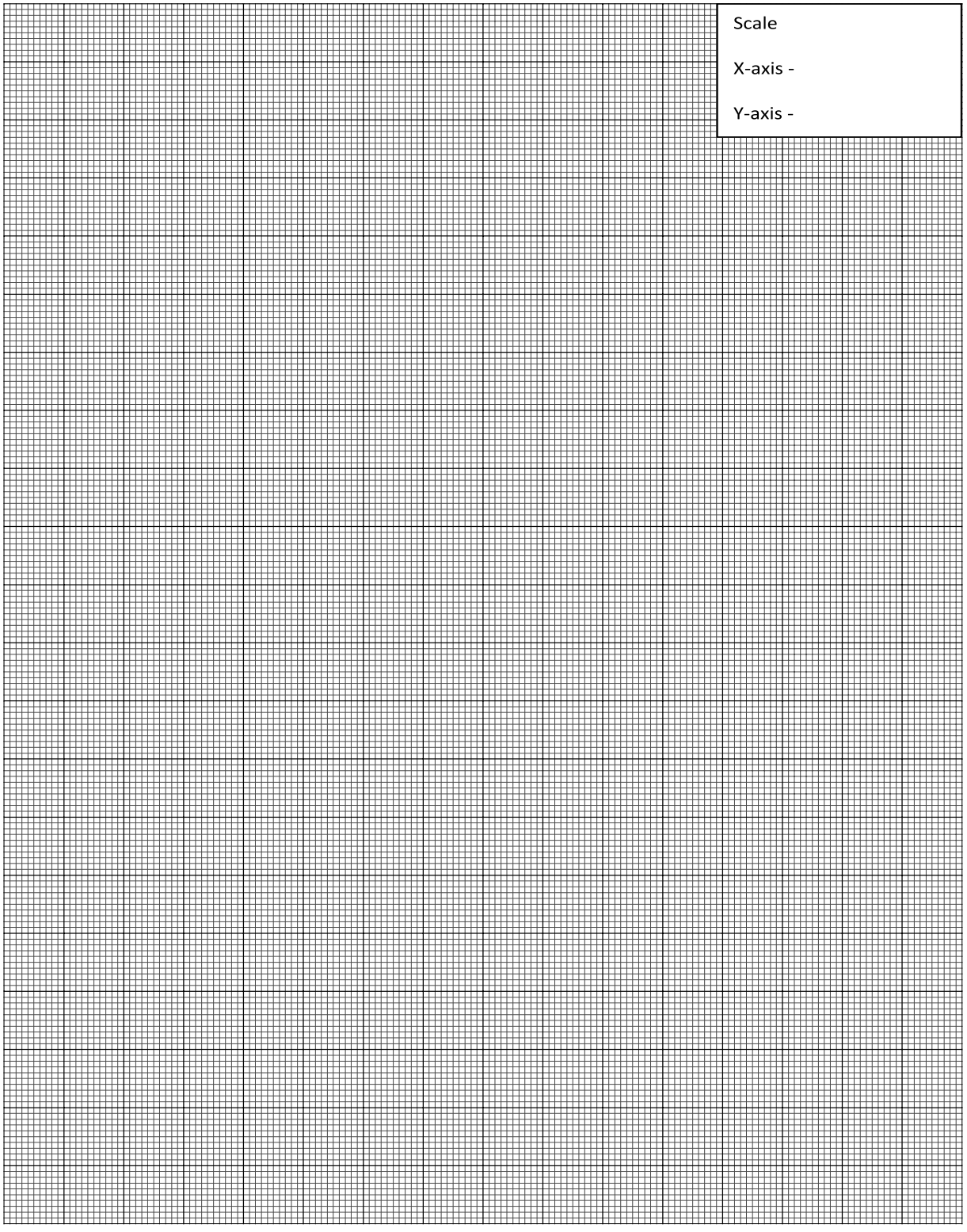
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Practical No.8: Determine firing angle and output voltage of 3-phase half wave controlled rectifier using Delta-Star transformer

I Practical Significance

Three phase rectifier circuits convert 3 phase ac voltage to pulsating dc voltage with the help of SCR. Which provide higher average output voltage and power, have low ripple factor, high efficiency, high transformer utilization factor. Output voltage controlled through firing angle. In this practical student will able to convert 3-phase AC voltage to pulsating DC voltage

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use Phase controlled rectifier in different applications.

V Practical Outcome

- Determine firing angle and output voltage of 3-phase half wave controlled rectifier using Delta-Star transformer.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Three phase controlled rectifier converts either positive or negative half cycle of three phase ac voltage to pulsating dc voltage using three SCRs. The maximum conduction angle of each SCR is 120^0. The filtering requirement for smoothing out the load current and load voltage are simpler.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

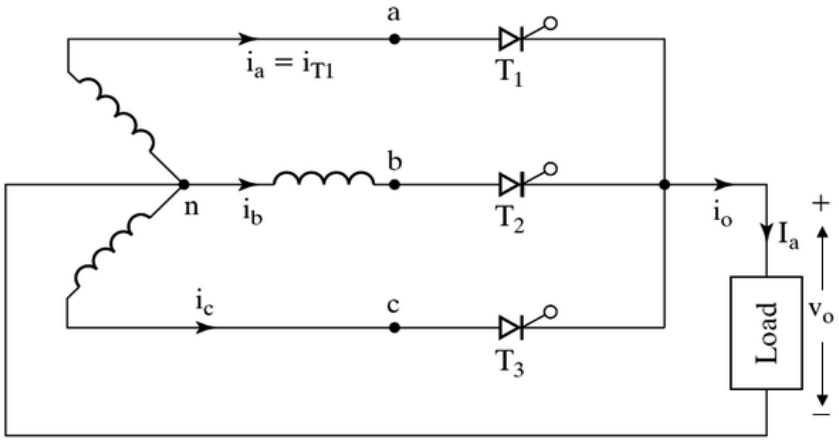

Fig. 8.1 Three-phase Half wave controlled rectifier circuit

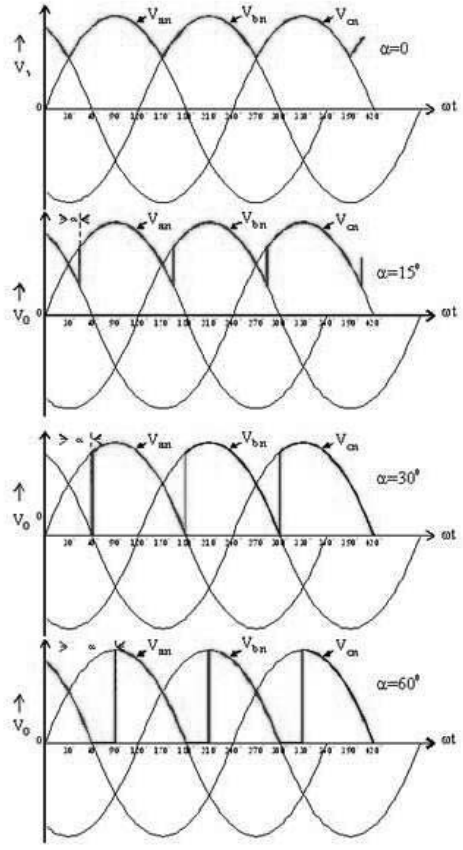

Fig. 8.2 Three-phase Half wave controlled rectifier waveform (R-load)

b) Actual Circuit diagram

IX Resources Required

SR. No.	Name of Resource	Suggested Broad Specification	Quantity
1	3-phase AC power supply	230 V, 50 Hz	1 No.
2	Voltmeter	0 to 230 V	1 No.
3	CRO /Power scope	20 MHz	1 No.
4	Practical kit	Trainer kit for three phase half wave controlled rectifier with various test points	1 No.
5	Connecting wires	As per kit requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment as per 3-phase supply.
2. The applied voltage, current should not exceed the maximum rating of the given SCR
3. Reading should be noted without parallax error

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig 8.1.
2. Switch on three phase 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 for different firing angle.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 8.1

Vin = …….. Vm

Sr. No.	Firing angle in time	Firing angle $\alpha(^{o})$	Measured output voltage (V)	Calculated output voltage (V)
1				
2				
3				
4				
5				

XVI Results

- For firing angle at ($\alpha = 30^{o}$), Output voltage ……..,
- For firing angle at ($\alpha = 90^{o}$), Output voltage …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions (Refer table 8.1 for question 1 to 3)

1. Write the effect on output if firing angle increases.
2. Write the output voltage at firing angle $\alpha = 0^{o}$
3. Calculate the conduction angle of each SCR when firing angle $\alpha = 30^{o}$.
4. Write any four electrical specification of transformer used in practical kit.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939

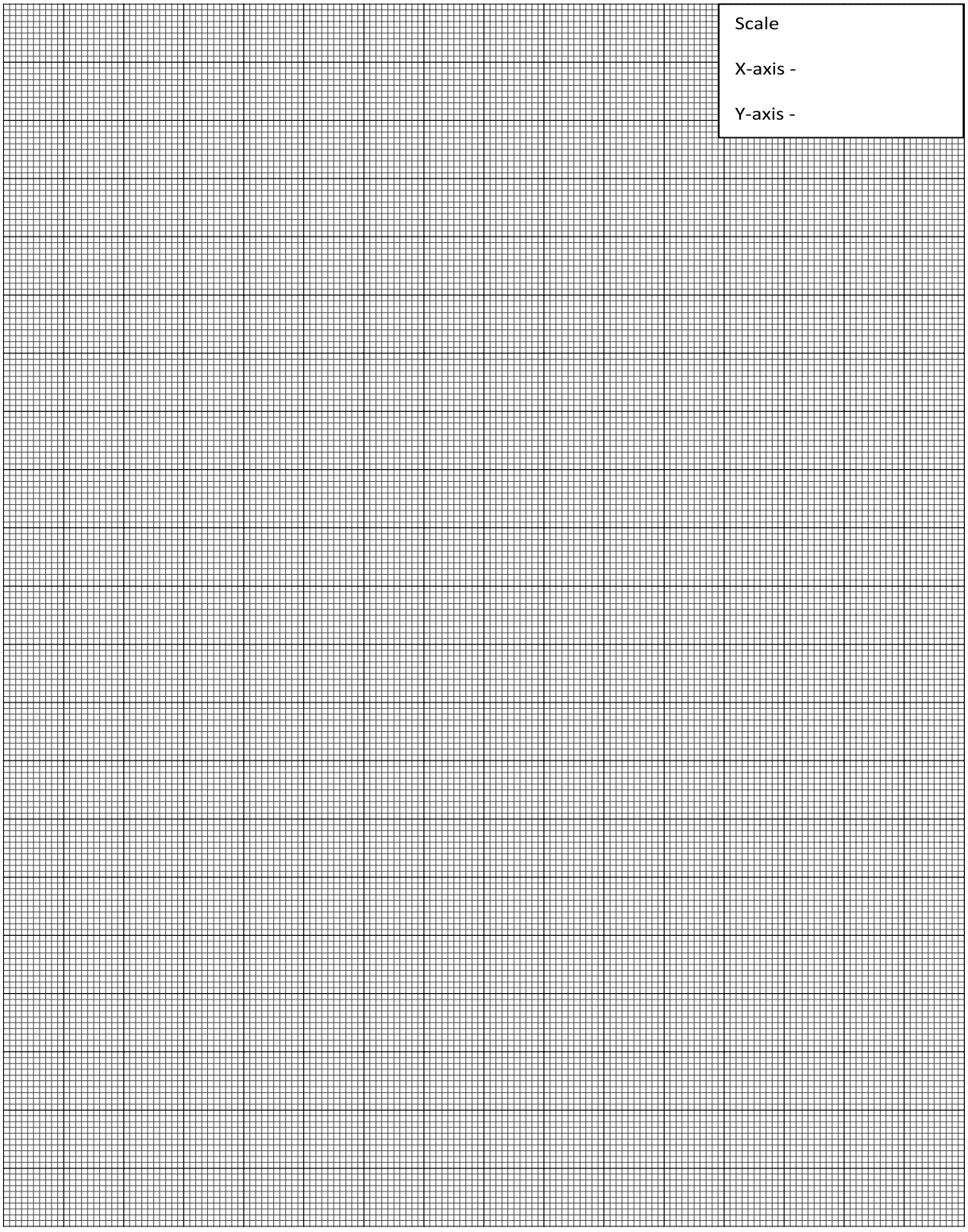
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Practical No.9: Test the performance of full wave controlled rectifier with R and RL load and measure load voltage

I Practical Significance

To run the DC motor on high DC power controlled rectifier circuit is used. Controlled rectifier circuit plays 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 also used in Battery charger circuit, high voltage DC transmission. In this practical student will able to convert ac input power to pulsating dc output power.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use Phase controlled rectifier in different applications.

V Practical Outcome

- Test the performance of full wave controlled rectifier with R and RL load and measure load voltage.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

It is an AC to DC converter circuit which converts an AC input voltage to a controllable DC output voltage using SCR the basic principle of phase controlled rectifier is to control the point in time at which the SCRs are allowed to conduct during each AC cycle and hence average output voltage is controlled.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

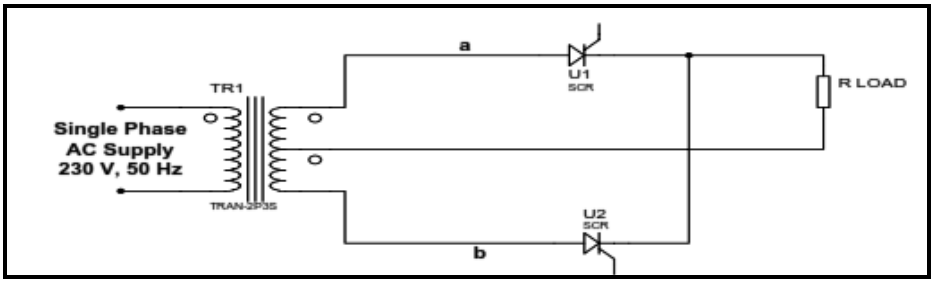

Fig. 9.1 Full wave controlled rectifier with R load

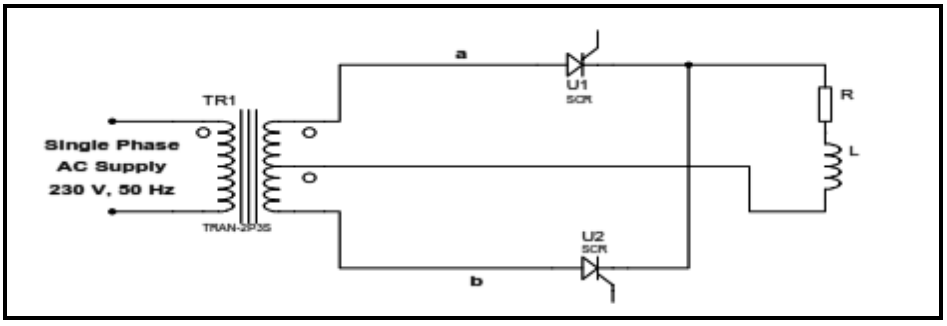

Fig. 9.2 Full wave controlled rectifier with RL load

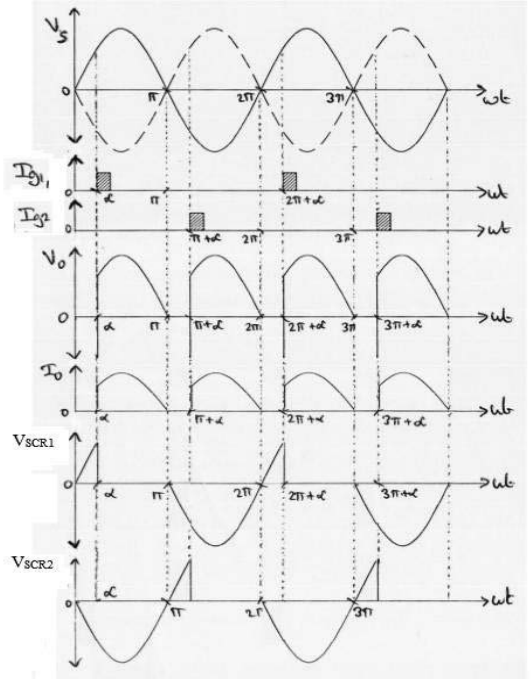

Fig. 9.3 Full wave controlled rectifier with R load waveforms

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Full wave controlled rectifier trainert kit	With center tap transformer(12-0-12), connecting facility for i) R Load ii)RL Load	1 No.
2	Triggering circuit for full wave rectifier	Synchronized UJT triggering circuit with pulse Transformer for isolation	1 No.
3	Multimeter	0-200V, 0-200mA, 1A	1 No.
4	Connecting Wires	As per kit requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. The applied voltage, current should not exceed the maximum rating of the given SCR.
3. Reading should be noted without parallax error

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 9.1.
2. Switch on power supply.
3. Measure the AC input voltage by the multimeter 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 (V_m).
6. Observe the output waveforms at different firing angles for R and RL load.
7. Calculate the average output voltage. $V_L = V_m / \pi (1 + \cos \alpha)$.
8. Draw input and output waveform on graph paper for different firing angle.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 9.1: For R load

Vin = …….. Vm

Sr. No.	Firing angle in time	Firing angle $\alpha(^{o})$	Measured output voltage (V)	Calculated output voltage (V)
1				
2				
3				
4				

Table 9.2: For RL load

Vin = …….. Vm

Sr. No.	Firing angle in time	Firing angle $\alpha(^{o})$	Measured output voltage (V)	Calculated output voltage (V)
1				
2				
3				
4				

XVI Results

- For firing angle at ($\alpha = 30^{o}$, R load), Output voltage …….,
- For firing angle at ($\alpha = 30^{o}$, RL load), Output voltage …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Find whether the output voltage is more in R or RL load, for 90^{0} firing angle.
2. Write the value of output voltage at 0^{0} in this practical.
3. Write the effect on output voltage if load is changed from R to RL.
4. Write the effect of freewheeling diode on observed output waveform and draw the waveform.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

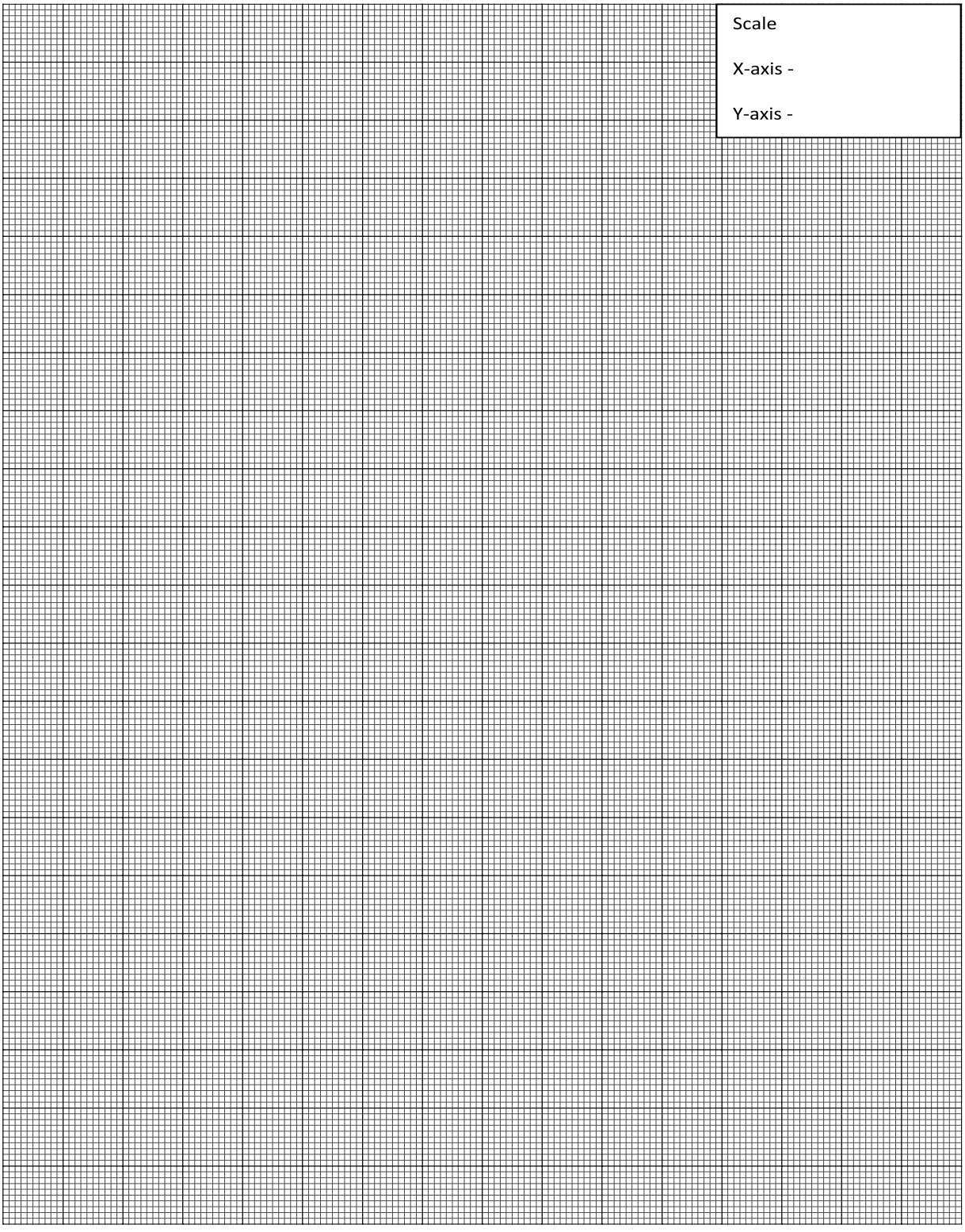
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
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: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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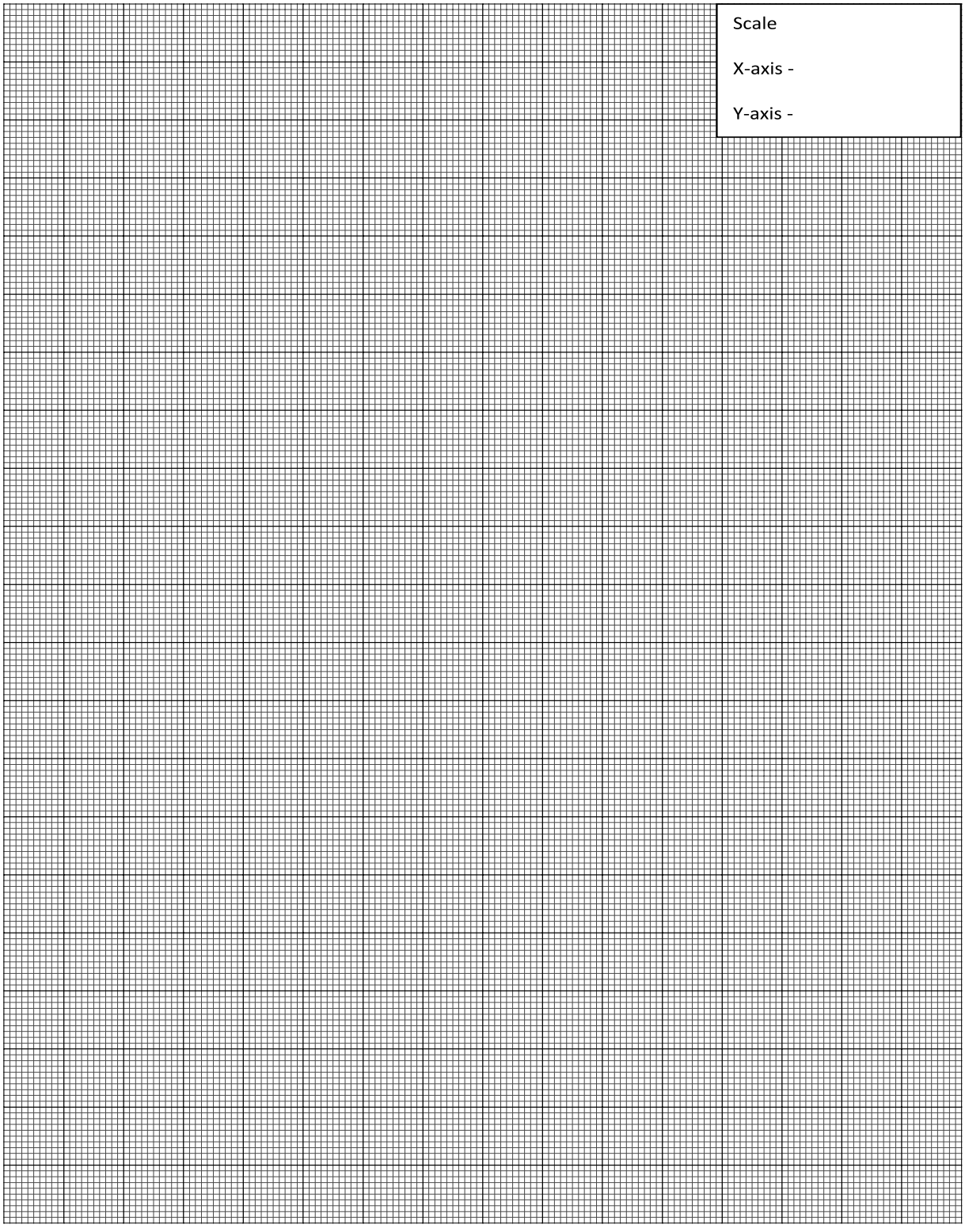
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X-axis -
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Practical No.10: Find output voltage of step-up chopper for different values of duty cycles.

I Practical Significance

To improve controllability of the equipment a constant DC voltage is varied and controlled with the help of a **chopper**. It is a high speed switch which connects and disconnects the load from source at a high rate to get variable or chopped voltage at the output for applications like subway cars, trolley and buses etc. In this practical student will able to calculate output voltage of the chopper.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use choppers and inverters in different applications.

V Practical Outcome

- Find output voltage of step-up chopper for different values of duty cycles.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Chopper known as DC Transformer is a static device that converts fixed dc 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.

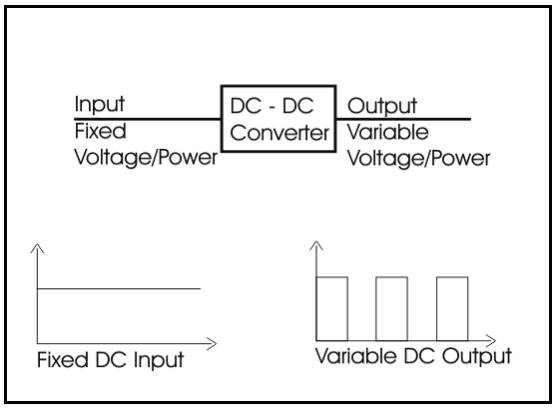

Fig 10.1 Block diagram of Chopper

VIII Practical Circuit diagram :

a) Sample Circuit diagram

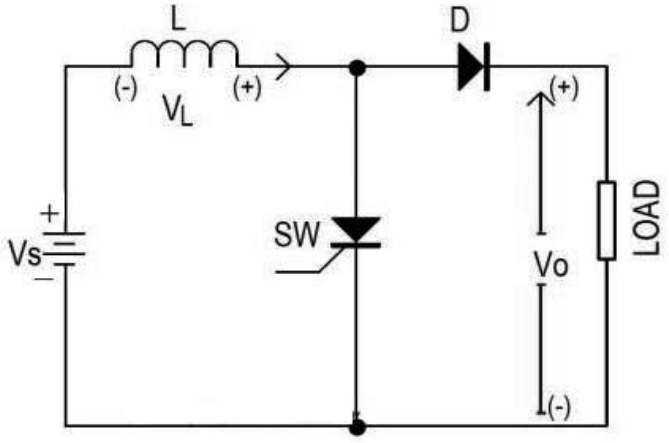

Fig. 10.2 Step up chopper

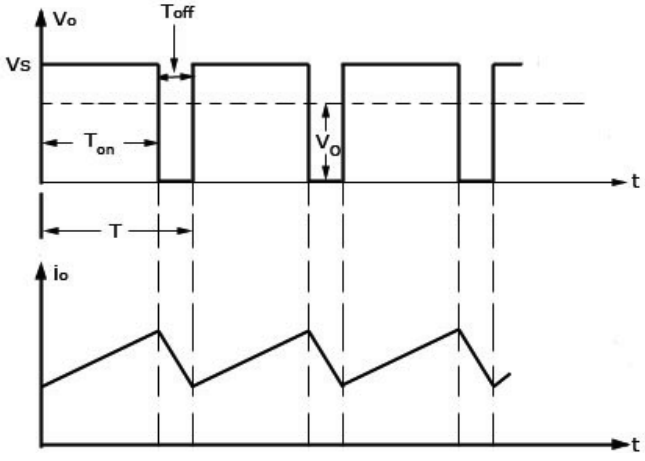

Fig. 10.3 Output voltage and current waveform

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	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 No.
2	CRO	30 MHz	1 No.
3	Multimeter	0-200V	1 No.
4	Connecting wires	As per kit requirement.	

X 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.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 10.2.
2. Switch on power supply.
3. Set duty cycle below 50% and observe the output waveform on the CRO.
4. Measure the RMS value of output with 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.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 10.1:-

Sr. No.	Input DC voltage (V)	Output voltage (V)	Time period (ms)	
			T_{ON}	T_{OFF}
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

XVI Results

- Output voltage ……,
- Duty cycle …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Write the relation between duty cycle and output voltage.
2. Write the specification of SCR used in practical kit.
3. Find whether the load voltage of a chopper can be controlled by varying the duty cycle or firing angle.
4. (SCR / diode) used in a chopper circuit?

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

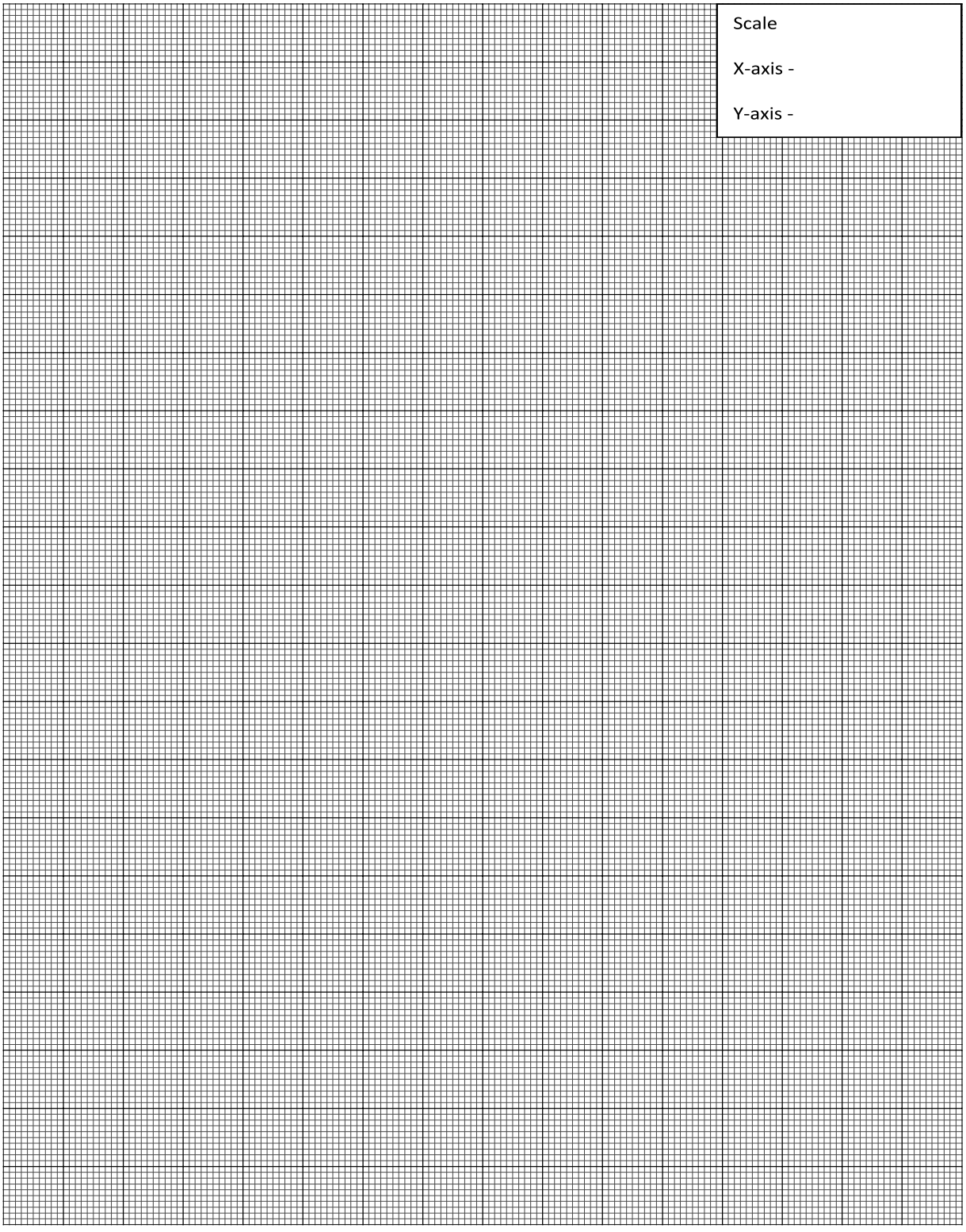
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Y-axis -

Practical No.11: Test parallel inverter to the measure frequency and output voltages.

I Practical Significance

An inverter has the capability to convert the DC power into AC power that are useful for generating equipment like household items, computers, power tools and much more by simply plugging typically equipment into the inverter. In this practical student will be able to convert DC input voltage to AC output voltage.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use choppers and inverters in different applications.

V Practical Outcome

- Test parallel inverter to the measure frequency and output voltages.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

The function of an inverter is to convert dc input voltage to symmetrical ac voltage of desired magnitude or frequency. The output voltage could be fixed or variable frequency. The frequency of output waveform depends upon inductance (L) and Capacitance (C) used in the circuit. A variable output voltage can be obtained by varying the input dc voltage.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

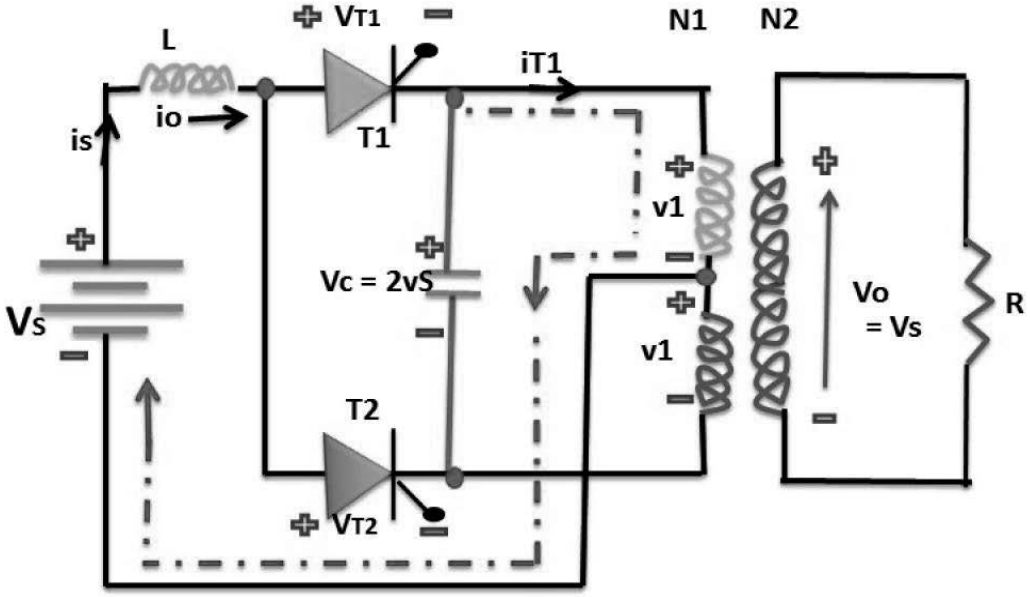

Fig. 11.1 Parallel inverter

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Parallel inverter circuit trainer kit	Trainer kit of Parallel inverter based on SCR with various test points	1 No.
2	CRO	30 MHz	1 No.
3	Multimeter	0-600V AC	1 No.
4	Connecting wires	As per kit requirement	

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. The applied voltage, current should not exceed the maximum rating of the given SCR.
3. Reading should be noted without parallax error

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 11.1.
2. Switch on power supply.
3. Observe the output waveforms across the load.
4. Measure the output voltage and time period of output waveform.
5. Calculate the frequency of output waveform.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 11.1

Sr. No.	Input DC voltage (V)	Output voltage (V)	Time period (ms)	Frequency (Hz)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

XVI Results

- Output voltage ……..,
- Frequency …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Write the value of capacitors used in the practical kit.
2. Write the effect on amplitude of output voltage waveform with increase in input voltage in the given practical.
3. Write the specification of 2N6394 SCR.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939

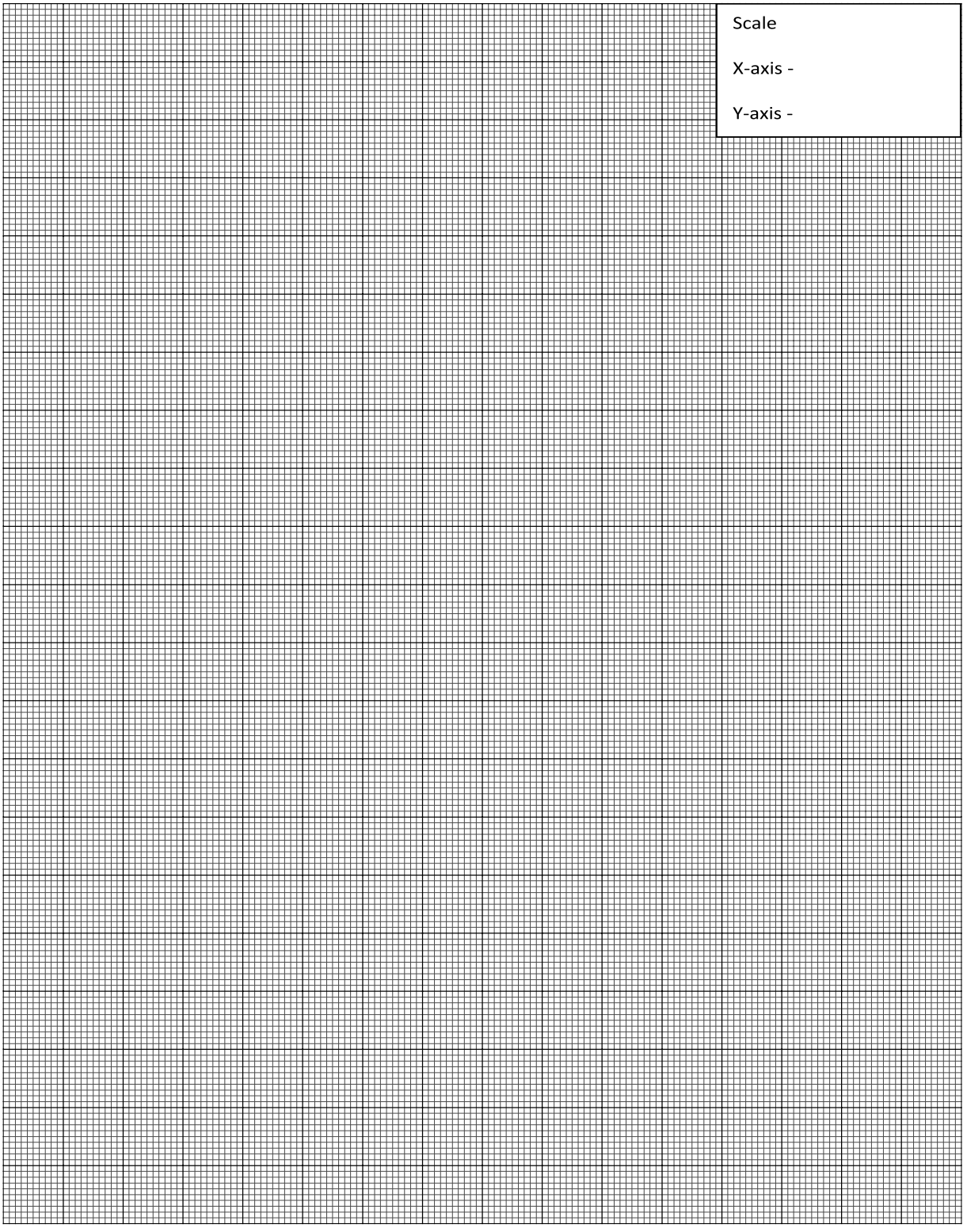
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Practical No.12: Measure output voltage of step-down chopper for different values of duty cycles. (Part-I)

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 able to convert fixed input DC voltage to variable DC output voltage.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use choppers and inverters in different applications.

V Practical Outcome

- Measure output voltage of step-down chopper for different values of duty cycles. Part-I

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Chopper is a static device that converts fixed dc 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.

VIII Practical Circuit diagram :

I Sample Circuit diagram

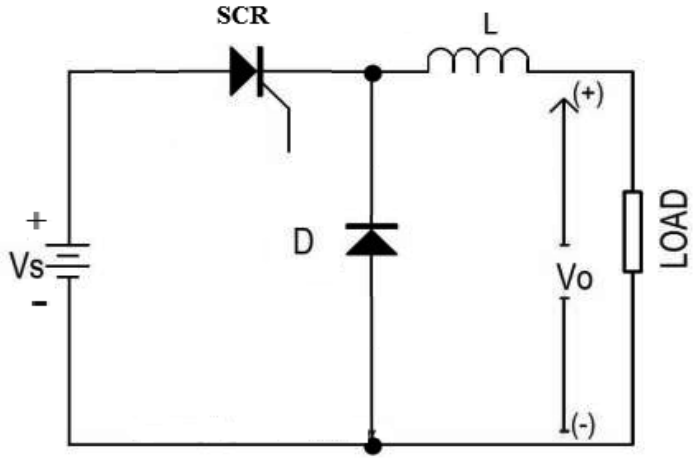

Fig. 12.1 Step down chopper with RL load

II Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	1 phase DC to DC converter practical kit (step down chopper)	Trainer kit of Chopper	1 No.
2	CRO	30 MHz	1 No.
3	Multimeter	0-200V	1 No.
4	Connecting wires	As per kit requirement.	

X 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.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 12.1.
2. Switch on power supply.
3. Set duty cycle below 50% and observe the output waveform on the CRO.
4. Measure the RMS value of output using 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.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 12.1

Sr. No.	Input DC voltage (V)	Output voltage (V)	Time period (ms)		Duty Cycle (%) = T_{ON} /(T_{ON} + T_{OFF})
			T_{ON}	T_{OFF}	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

XVI Results

- Output voltage ……..,
- Duty cycle …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Write the value of output voltage at 50% duty cycle refer table 12.1.
2. State the function of diode used in practical kit.
3. Write the relation between duty cycle and output voltage.
4. Write the specification of SCR used in practical kit.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

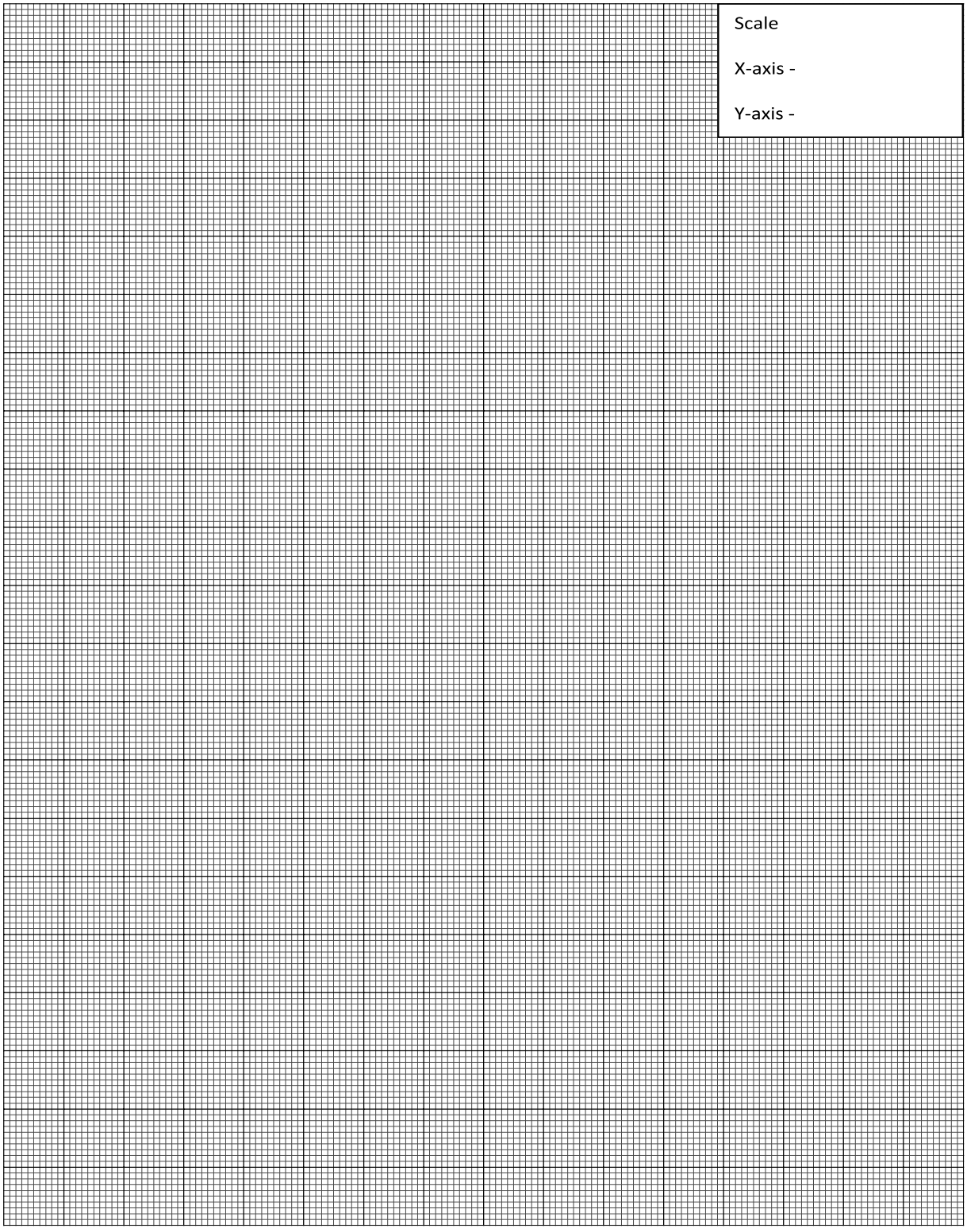
XX1 Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Practical No.13: Measure output voltage of step-down chopper for different Values of duty cycles. (Part-II)

I Practical Significance

Choppers are very much needed 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 able to convert fixed input DC voltage to variable DC output voltage.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Use choppers and inverters in different applications.

V Practical Outcome

- Measure output voltage of step-down chopper for different values of duty cycles. Part-II

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

Chopper is a static device that converts fixed dc 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.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

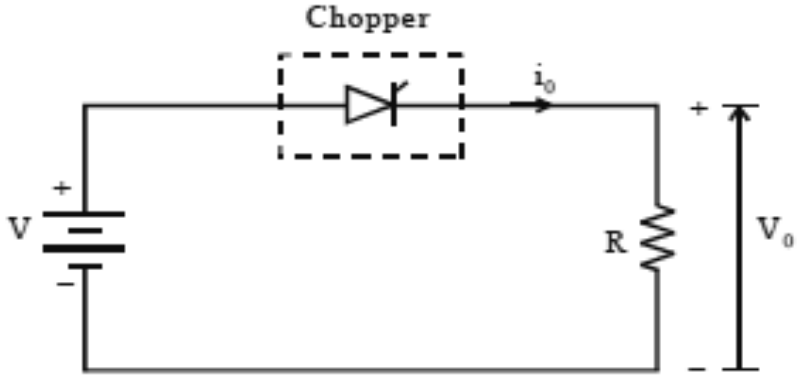

Fig. 13.1 Step down chopper with R load

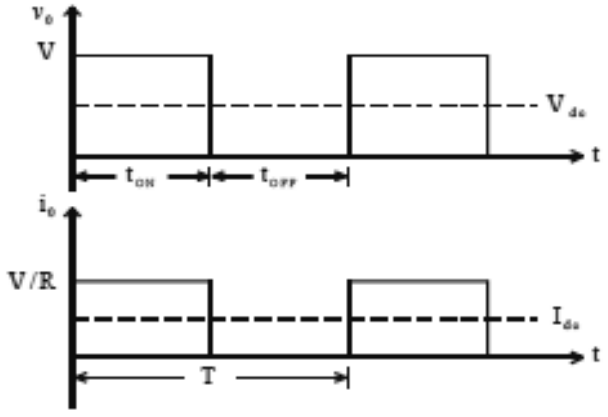

Fig. 13.2 Step down chopper output waveform with R load

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	1 phase DC to DC converter practical kit (step down chopper)	Trainer kit of step down chopper with various test point	1 No.
2	CRO /Power scope	30 MHz	1 No.
3	Multimeter	0-200V	1 No.
4	Connecting wires	As per kit requirement	

X 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.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 13.1.
2. Switch on power supply.
3. Set duty cycle below 50% and observe the output waveform on the CRO.
4. Measure the RMS value of output using 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 for different duty cycle.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 13.1

Sr. No.	Input DC voltage (V)	Output voltage (V)	Time period (ms)		Duty Cycle (%) = T_{ON} /(T_{ON} + T_{OFF})
			T_{ON}	T_{OFF}	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

XVI Results

- Output voltage ……..,
- Duty cycle …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Write the difference between applied dc input voltage and output voltage at 50% duty cycle refer table no. 13.1.
2. Calculate the theoretical output voltage.
3. Write the value of load resistance used in practical kit.
4. Write the specification of multimeter used in performing the practical.

[Space for Answers]

XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939

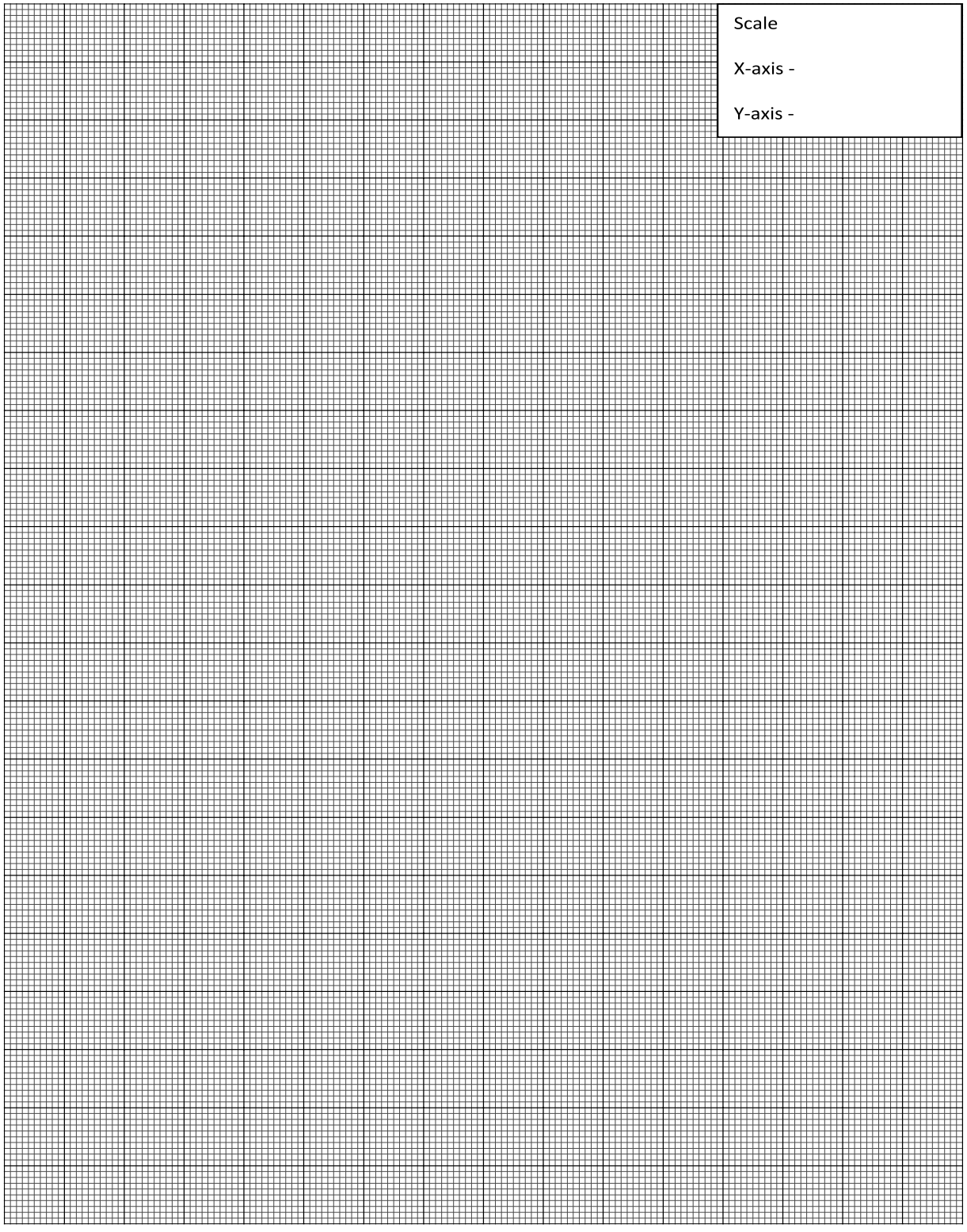
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Practical No.14: Build/test SMPS for mobile phone charging. (Part I)

I Practical Significance

Switch mode power supplies (SMPS) have become the architecture of choice for power Conversion because of their economy, higher efficiency and lighter weight. In this lab Students will investigate the basic operating principles of a switch mode power supply, and then design, build and test a simple supply given a few basic components and able to determine line Regulation. In this practical student will able to regulate the voltage for mobile charger.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain control circuits consisting of power electronic devices.

V Practical Outcome

- Build/test SMPS for mobile phone charging. Part-I

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

SMPS uses solid-state switches to convert an unregulated DC input voltage to a regulated and smooth DC output voltage at different voltage levels. The input supply can be a true DC voltage from a battery or solar panel, or a rectified DC voltage from an AC supply using a diode bridge along with some additional capacitive filtering. MOSFET is operated in its switching mode were it is repeatedly turned "ON" and "OFF" at high speed. Regulation of the output voltage is achieved by the percentage control of the time that the switching transistor is in the "ON" state compared to the total ON/OFF time. This ratio is called the duty cycle and by varying the duty cycle VOUT can be controlled.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

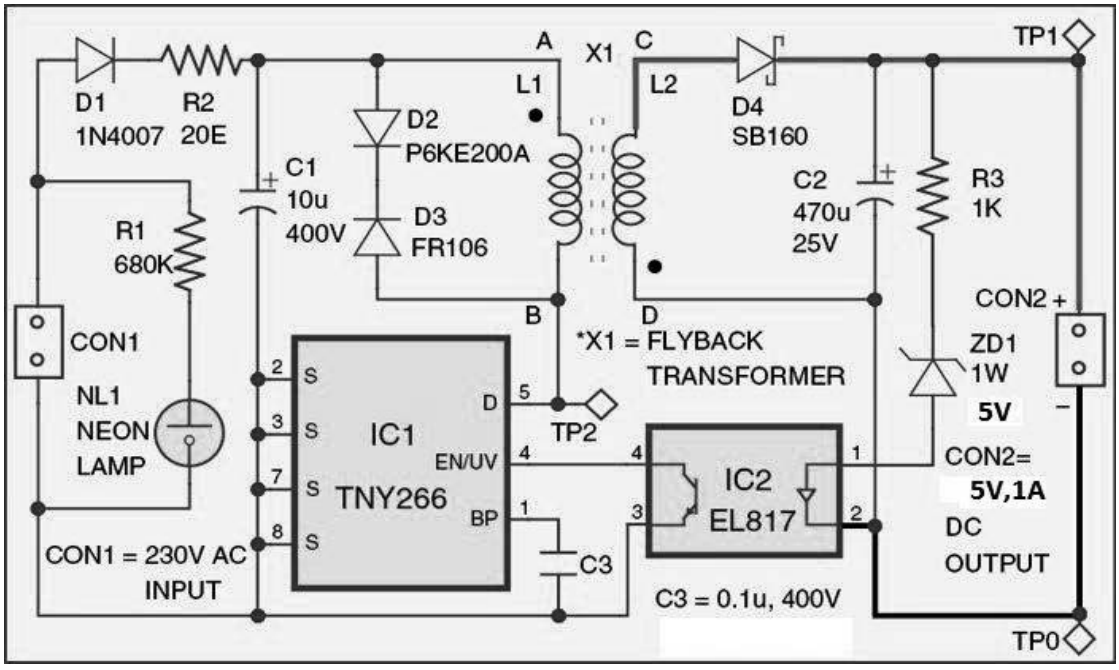

Fig. 14.1 SMPS 5V 1Amp circuit

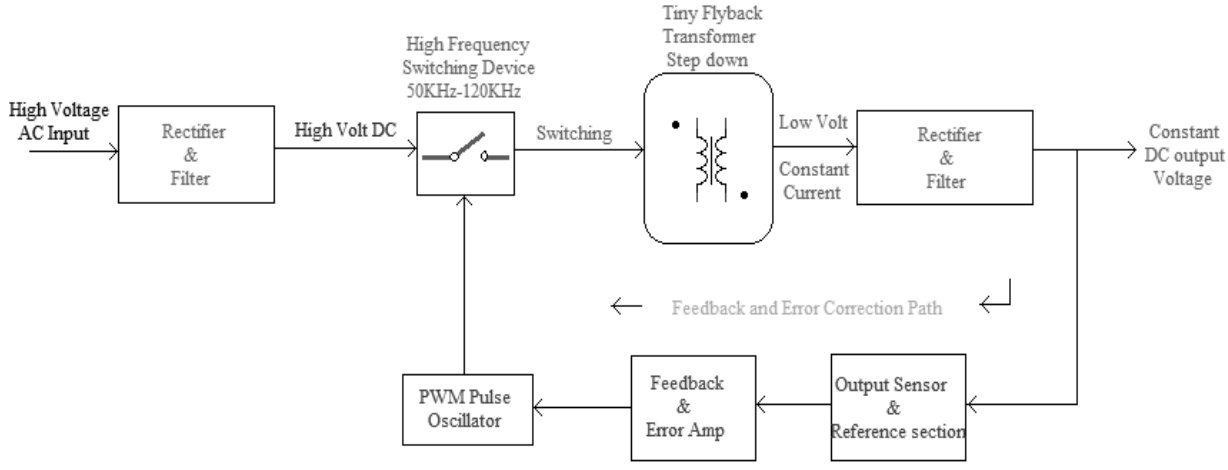

Fig. 14.2 Block diagram of SMPS

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	VARIAC	0-270V/2AMP	1
2.	Practical Setup Of SMPS	Mobile charger SMPS component set	1
3.	Digital Multimeter	3 ½ True RMS	1
4.	Connecting wires	As per Setup	1Set

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Use rubber door mats to insulate yourself from ground, when working in the Lab.

XI Procedure

1. Connect the circuit as per the diagram shown in Fig 14.1.
2. Connect Variac to Input of Circuit.
3. Make sure that your Variac switch is "off" and that its output voltage control knob is fully anticlockwise (to the 0V position).
4. Connect Voltmeter (Digital Multimeter) across load to measure output voltage.
5. Vary the input voltage through Variac from 75 to 220V AC.
6. Note down the output voltage for variation in input voltage.
7. Calculate Line regulation.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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Observations and Calculations (use blank sheet provided if space not sufficient)

Table 14.1: Line Regulation: (Keeping Load resistance constant at ……..)

Sr. No.	AC(Input)(V)	Output Voltage(V)
1	75	
2	100	
3	120	
4	140	
5	160	
6	180	
7	200	
	220	

XV Results

- **Line regulation:**

$$\frac{\Delta VO}{\Delta Vi} X\ 100 \quad =$$

XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions and Recommendation

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XVIII Practical Related Questions (Refer fig. 14.1)

1. Which Component of SMPS decides the output current capacity?
2. To obtain 12V at the output of SMPS what changes can be made in circuit?
3. Draw the waveform at the output of high frequency switch used in practical kit.

[Space for Answers]

XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

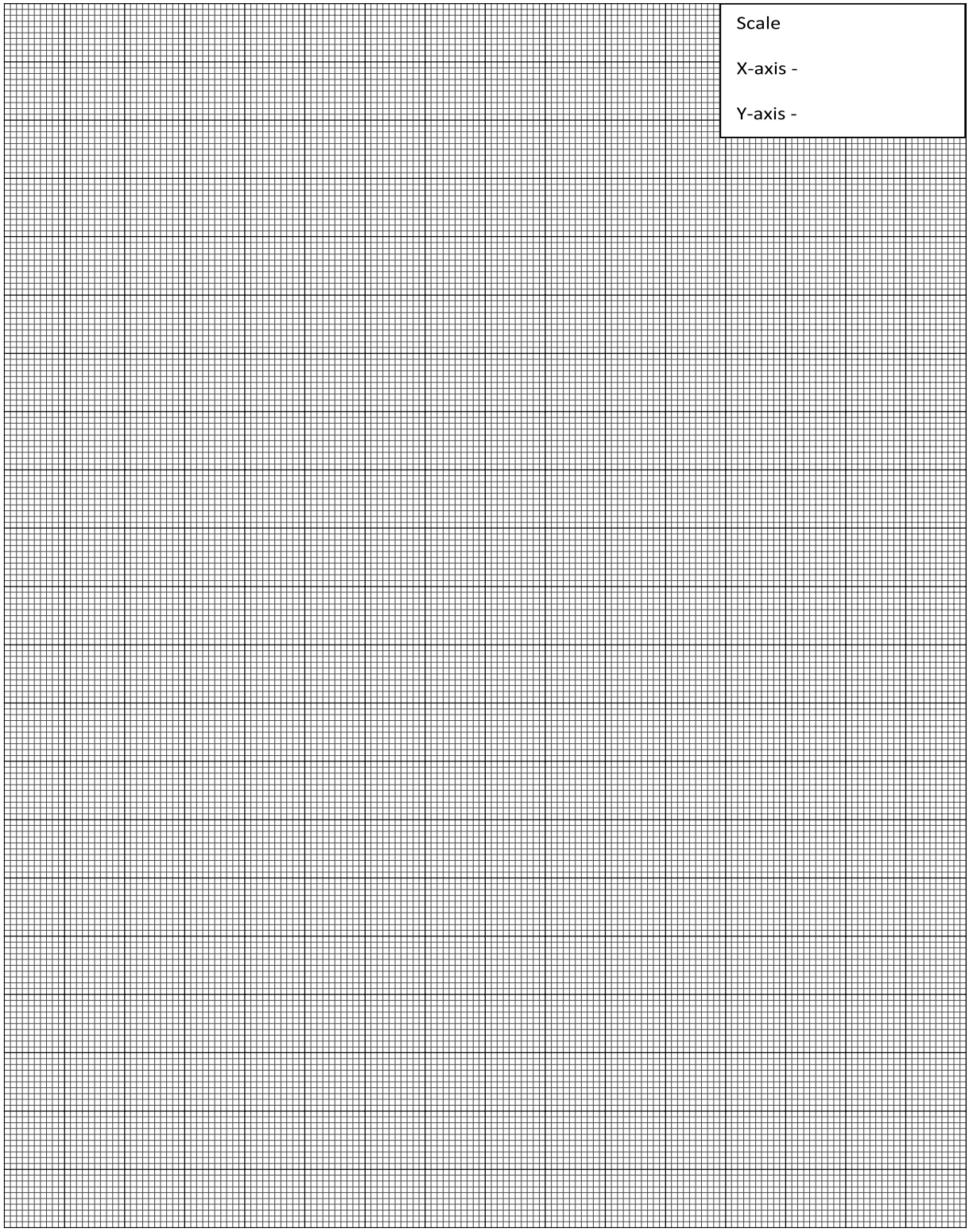
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Practical No.15: Build/test SMPS for mobile phone charging. Part II

I Practical Significance

Switch mode power supplies (SMPS) have become the architecture of choice for power conversion because of their economy, higher efficiency and lighter weight. In this lab Students will investigate the basic operating principles of a switch mode power supply, and then design, build and test a simple supply given a few basic components and will be able to determine load Regulation.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain control circuits consisting of power electronic devices.

V Practical Outcome

- Build/test SMPS for mobile phone charging. Part-II

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

SMPS uses solid-state switches to convert an unregulated DC input voltage to a regulated and smooth DC output voltage at different voltage levels. The input supply can be a true DC voltage from a battery or solar panel, or a rectified DC voltage from an AC supply using a diode bridge along with some additional capacitive filtering. MOSFET is operated in its switching mode were it is repeatedly turned "ON" and "OFF" at high speed. Regulation of the output voltage is achieved by the percentage control of the time that the switching transistor is in the "ON" state compared to the total ON/OFF time. This ratio is called the duty cycle and by varying the duty cycle VOUT can be controlled.

VIII Practical Circuit diagram :

a) Sample Circuit diagram

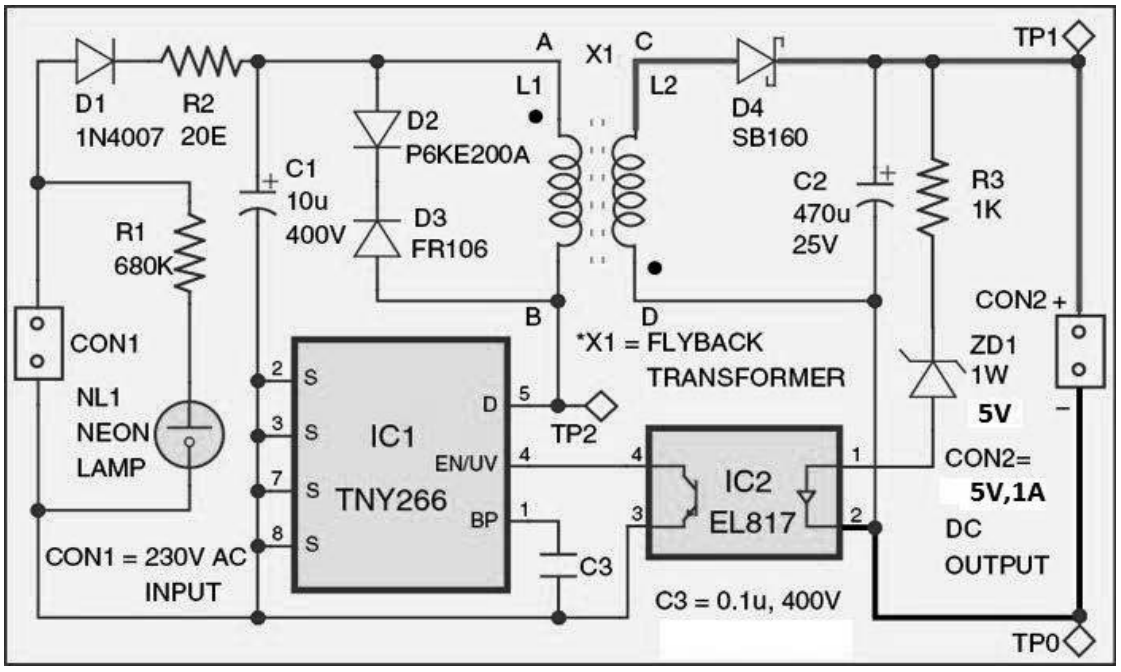

Fig. 15.1 SMPS 5V 1Amp circuit

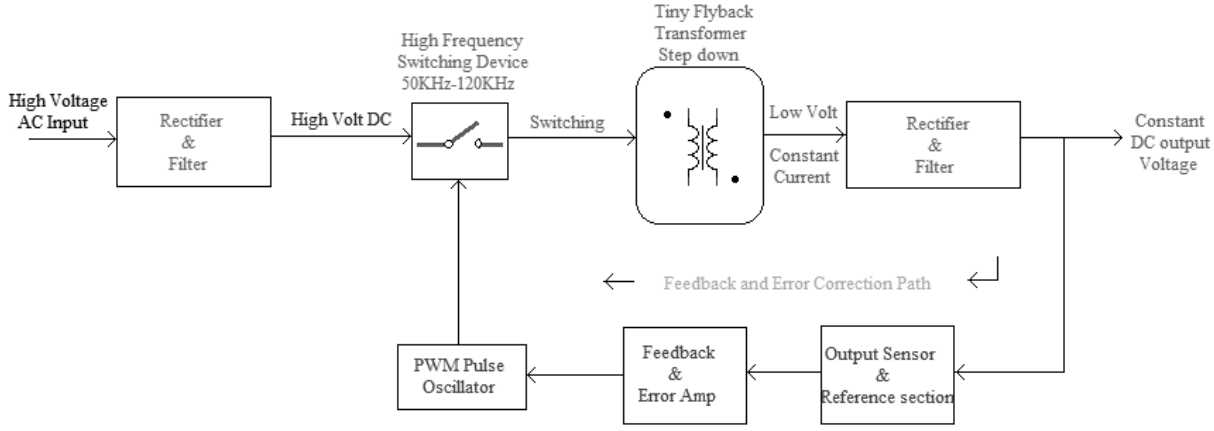

Fig. 15.2 Block diagram of SMPS

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	VARIAC	0-270V/2AMP	1
2.	Practical Setup Of SMPS	Mobile charger SMPS component set	1
3.	Digital Multimeter	3 ½ True RMS	1
4.	Connecting wires	As per Setup	1Set

X Precautions to be Followed

1. Ensure proper connections are made to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Use rubber door mats to insulate yourself from ground, when working in the Lab.

XI Procedure

1. Connect the circuit as per the diagram shown in Fig. 15.1.
2. Connect Variac to Input of Circuit.
3. Make sure that your Variac switch is "off" and that its output voltage control knob is fully anticlockwise (to the 0V position).
4. Connect Voltmeter (Digital Multimeter) across load.
5. Fix the input voltage at particular value (say 100 V).
6. Vary the load resistance in steps.
7. Measure and note down the load current.
8. Measure and note down the output voltage.
9. Calculate Load regulation.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 15.1: Load Regulation: (Keeping input voltage constant at ……..)

S.No.	Load resistance (RL)	Load current (mA)	Output Voltage(V)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

XVI Results

- Load Regulation =

$$\text{Load regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} 100\%$$

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Which component provides isolation in SMPS in the given practical diagram?
2. List components which provide switching in SMPS in the given practical diagram.
3. Write the value of resistance at which value of voltage remains constant (refer Table 15.1).
4. Measure the voltage at the output of Feedback and error amplifier. (Refer Fig. 15.2)

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

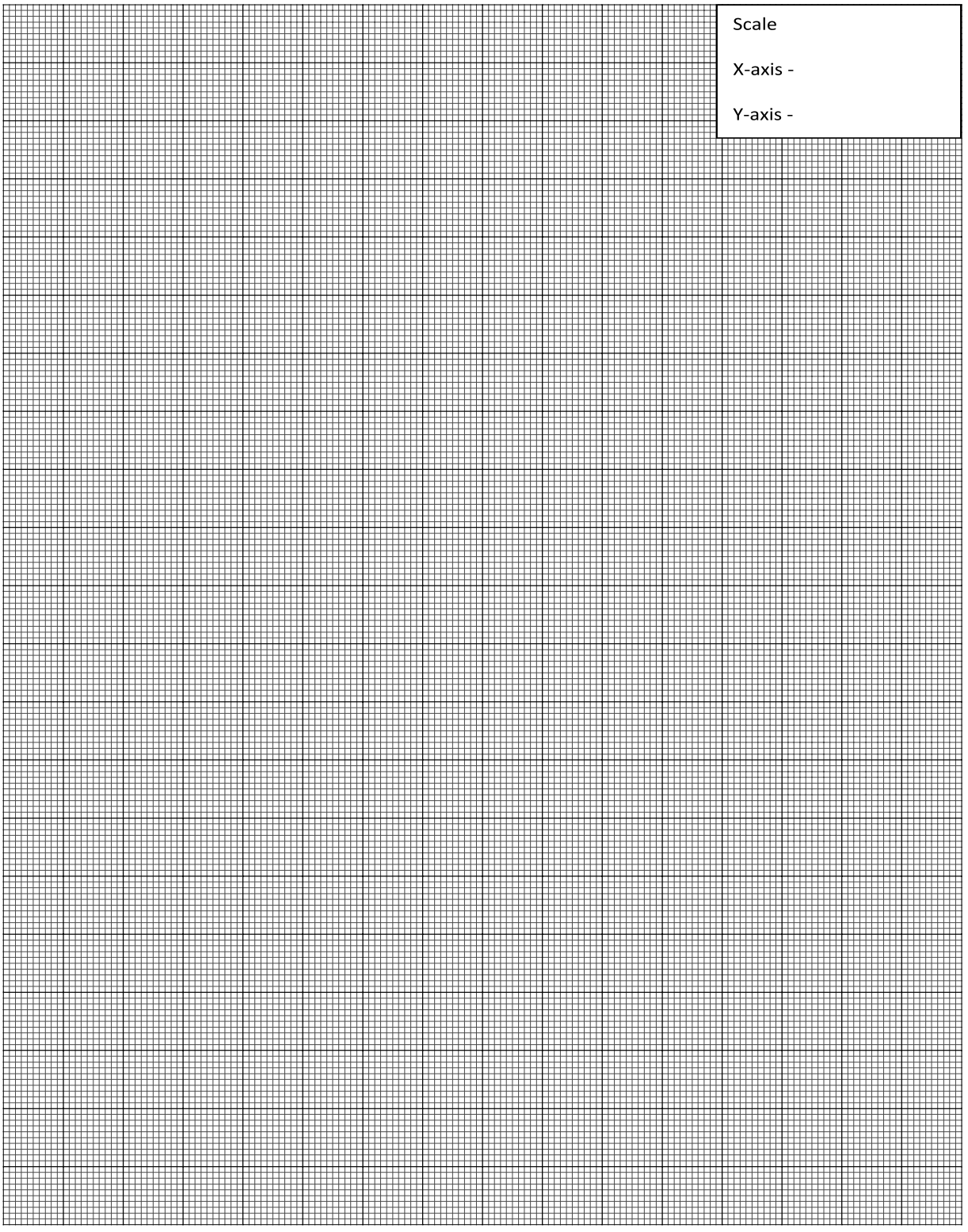
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Y-axis -

Practical No.16: Build Light dimmer circuit using TRIAC. Test the effect of resistance variation on intensity of lamp

I Practical Significance

Intensity of the lamp can be varied over wide range by TRIAC. It is a bidirectional device which requires triggering pulse at its gate terminal during both half cycles. The intensity of lamp depends upon the value firing angle of the TRIAC. Less the value of firing angle more will be the intensity of lamp. In this practical student will able to control intensity of lamp.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain the proper functioning of power electronic devices** ':

- Use multimeter to measure various electrical parameters.
- Use the CRO to observe waveforms.
- Interpret the circuit diagrams.

IV Relevant Course Outcome(s)

- Maintain control circuits consisting of power electronic devices.

V Practical Outcome

- Build Light dimmer circuit using TRIAC. Test the effect of resistance variation on intensity of lamp.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Demonstrate working as a leader/a team member

VII Minimum Theoretical Background

In this circuit a lamp 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 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 intensity of lamp will depend upon the value of firing angle of the TRIAC. Less the value of the firing angle (α) of the TRAIC, more will be the voltage across the lamp and hence more will be its intensity of illumination and vice-versa.

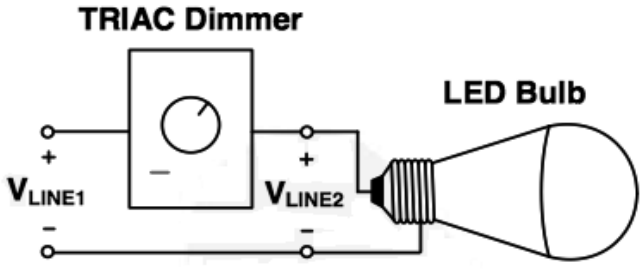

Fig 16.1 Schematic diagram of Light Dimmer

VIII Practical Circuit diagram :

a) Sample Circuit diagram

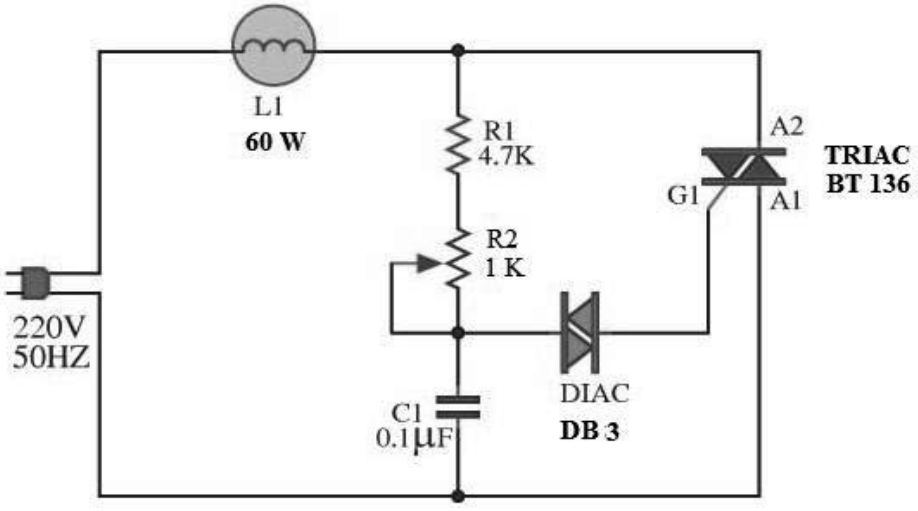

Fig. 16.2 Light dimmer using TRIAC

b) Actual Circuit diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	TRIAC	BT 136	1 No.
2	DIAC	DB 3	1 No.
3	Lamp (L1)	60 W	1 No.
4	Resistors, capacitor	R1= 4.7 KΩ, R2 = 1 KΩ, C1 = 0.1 μF	1 Each
5	Multimeter	0-200V	1 No.
6	Connecting wires	AS per requirement	

X Precautions to be Followed

1. Check all the connection before switching on the connections.
2. Do not touch live wires.
3. Keep potentiometer at minimum position.

XI Procedure

1. Make the circuit connection as per the circuit diagram shown in Fig. 16.2
2. Switch on power supply.
3. Vary the potentiometer R_2 slowly and observe its effect on the load-lamp/bulb.
4. Measure the voltage across lamp and TRIAC at different value of R_2.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precautions Followed (use blank sheet provided if space not sufficient)

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 16.1

Sr. No.	Intensity of Lamp	Resistance R2 (Ω)	Voltage across TRIAC (V)	Voltage across Load (Lamp) (V)
1	Low			
2	Moderate			
3	High			

XVI Results

At high intensity

- Resistance = …….,
- Voltage across load = …….

XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Find whether the minimum intensity of lamp is at higher or lower conduction angle.
2. Measure and note down voltage across TRIAC and lamp at high intensity.
3. Write the specification of triggering device used in this practical circuit.

[Space for Answers]

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XX References / Suggestions for further reading

1. www.en.wikibooks.org/wiki/Power_Electronics
2. www.books.google.co.in/books/about/Power_Electronics
3. A text – Lab Manual, Zbar, , Paul B. McGraw Hill Publishing Co. Ltd,New Delhi,1990, ISBN: 0070727937, 9780070727939
4. http://bitsavers.trailing-edge.com/components/ge/1972_GE_SCR_Manual_5ed.pdf

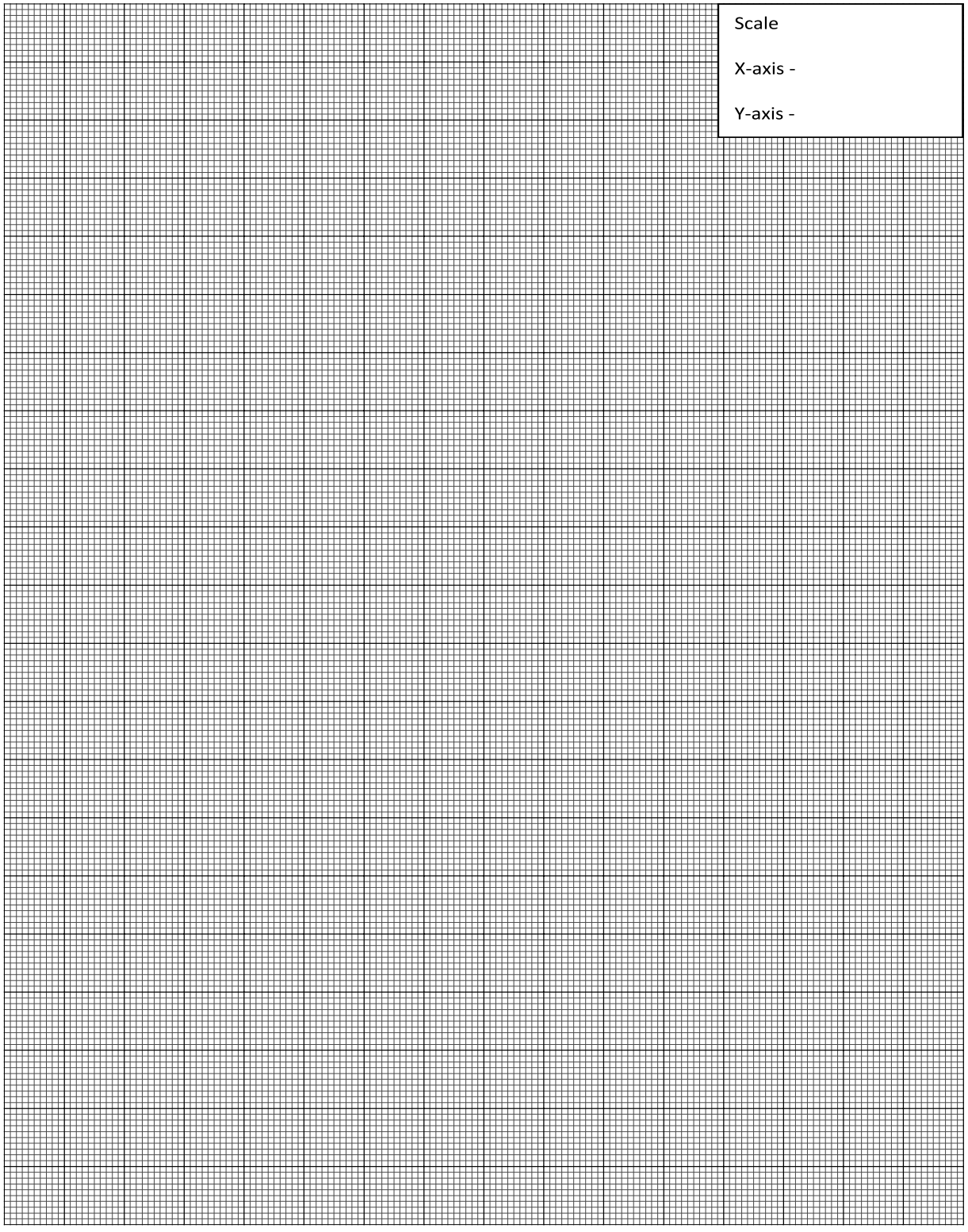
XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of equipment	10 %
2	Identification of component	10 %
3	Measuring value using suitable instrument	30 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate the firing angle	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. …….....
2. …….....
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Philips Semiconductors **Product specification**

Triacs BT136 series

GENERAL DESCRIPTION

Glass passivated triacs in a plastic envelope, intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance. Typical applications include motor control, industrial and domestic lighting, heating and static switching.

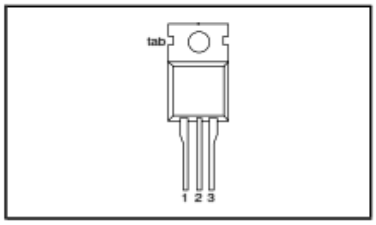
QUICK REFERENCE DATA

SYMBOL	PARAMETER	MAX.	MAX.	MAX.	UNIT
	BT136-	500	600	800	
	BT136-	500F	600F	800F	
	BT136-	500G	600G	800G	
V_{DRM}	Repetitive peak off-state voltages	500	600	800	V
$I_{T(RMS)}$	RMS on-state current	4	4	4	A
I_{TSM}	Non-repetitive peak on-state current	25	25	25	A

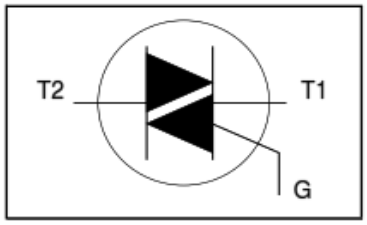
PINNING - TO220AB

PIN	DESCRIPTION
1	main terminal 1
2	main terminal 2
3	gate
tab	main terminal 2

PIN CONFIGURATION



SYMBOL



LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.			UNIT
				-500	-600	-800	
V_{DRM}	Repetitive peak off-state voltages		-	500[1]	600[1]	800	V
$I_{T(RMS)}$	RMS on-state current	full sine wave; $T_{mb} \leq 107$ ˚C	-		4		A
I_{TSM}	Non-repetitive peak on-state current	full sine wave; $T_j = 25$ ˚C prior to surge					
		t = 20 ms	-		25		A
		t = 16.7 ms	-		27		A
I^2t	I^2t for fusing	t = 10 ms	-		3.1		A^2s
dI_T/dt	Repetitive rate of rise of on-state current after triggering	I_{TM} = 6 A; I_G = 0.2 A; dI_G/dt = 0.2 A/µs					
		T2+ G+	-		50		A/µs
		T2+ G-	-		50		A/µs
		T2- G-	-		50		A/µs
		T2- G+	-		10		A/µs
I_{GM}	Peak gate current		-		2		A
V_{GM}	Peak gate voltage		-		5		V
P_{GM}	Peak gate power		-		5		W
$P_{G(AV)}$	Average gate power	over any 20 ms period	-		0.5		W
T_{stg}	Storage temperature		-40		150		˚C
T_j	Operating junction temperature		-		125		˚C

1 Although not recommended, off-state voltages up to 800V may be applied without damage, but the triac may switch to the on-state. The rate of rise of current should not exceed 3 A/µs.

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$R_{th\ j\text{-}mb}$	Thermal resistance junction to mounting base	full cycle	-	-	3.0	K/W
		half cycle	-	-	3.7	K/W
$R_{th\ j\text{-}a}$	Thermal resistance junction to ambient	in free air	-	60	-	K/W

STATIC CHARACTERISTICS

T_j = 25 ˚C unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.			UNIT
		BT136-			...	...F	...G	
I_{GT}	Gate trigger current	V_D = 12 V; I_T = 0.1 A						
		T2+ G+	-	5	35	25	50	mA
		T2+ G-	-	8	35	25	50	mA
		T2- G-	-	11	35	25	50	mA
		T2- G+	-	30	70	70	100	mA
I_L	Latching current	V_D = 12 V; I_{GT} = 0.1 A						
		T2+ G+	-	7	20	20	30	mA
		T2+ G-	-	16	30	30	45	mA
		T2- G-	-	5	20	20	30	mA
		T2- G+	-	7	30	30	45	mA
I_H	Holding current	V_D = 12 V; I_{GT} = 0.1 A	-	5	15	15	30	mA
V_T	On-state voltage	I_T = 5 A	-	1.4		1.70		V
V_{GT}	Gate trigger voltage	V_D = 12 V; I_T = 0.1 A	-	0.7		1.5		V
		V_D = 400 V; I_T = 0.1 A; T_j = 125 ˚C	0.25	0.4		-		V
I_D	Off-state leakage current	$V_D = V_{DRM(max)}$; T_j = 125 ˚C	-	0.1		0.5		mA

DYNAMIC CHARACTERISTICS

T_j = 25 ˚C unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN.			TYP.	MAX.	UNIT
		BT136-	...	...F	...G			
dV_D/dt	Critical rate of rise of off-state voltage	V_{DM} = 67% $V_{DRM(max)}$; T_j = 125 ˚C; exponential waveform; gate open circuit	100	50	200	250	-	V/µs
dV_{com}/dt	Critical rate of change of commutating voltage	V_{DM} = 400 V; T_j = 95 ˚C; $I_{T(RMS)}$ = 4 A; dI_{com}/dt = 1.8 A/ms; gate open circuit	-	-	10	50	-	V/µs
t_{gt}	Gate controlled turn-on time	I_{TM} = 6 A; $V_D = V_{DRM(max)}$; I_G = 0.1 A; dI_G/dt = 5 A/µs	-	-	-	2	-	µs

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics Engineering	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	C Language programming	22218
15	Basic Electronics	22225
16	Programming in C	22226
17	Fundamental of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemical	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurement	22420
12	Digital Electronic And Microcontroller Application	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Micro Project & Industrial Training Assessment Manual	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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