G. NARAYANAMMA INSTITUTE OF TECHNOLOGY AND SCIENCE
[AUTONOMOUS]
Accredited by NBA & NAAC, Affiliated to
JNTUH, Shaikpet, Hyderabad-104

YEAR: I-B.Tech I & II-SEM A.Y: 2023-2024

BASIC ELECTRICAL ENGINEERING LAB MANUAL

Name of Student: ……………………………………………………………………………

Roll NO :……………………………………………………………………………………………

Branch: …………………………….. Section: ………………………………………..

Year: ………………………………… Semester……………………………………..

Department of Electrical & Electronics Engineering
NBA & NAAC Accredited
Recognized Research Centre by JNTUH

PREFACE

Electrical engineering is a fundamental discipline that underpins many aspects of our technologically advanced world. It encompasses the study and application of electrical principles, circuits, and devices, which are essential in various industries and everyday life. The Basic Electrical Engineering Laboratory provides students with a hands-on opportunity to explore and experiment with the fundamental concepts and components that form the foundation of electrical engineering.

This laboratory course is designed to introduce students to the fundamental principles of electrical engineering and to equip them with practical skills that will be invaluable throughout their academic and professional journeys. By conducting experiments, analyzing data, and troubleshooting circuits, students will gain a deeper understanding of basic electrical concepts and build a strong foundation for more advanced coursework in the field.

By actively engaging in these laboratory exercises and following the outlined procedures, you will not only strengthen your understanding of basic electrical engineering but also develop the skills and knowledge necessary to excel in more advanced electrical engineering courses and real-world applications. Electrical engineering is a field with boundless opportunities, and this laboratory experience is the first step in your exciting journey.

HOD-EEE

Course Objectives:

1. To verify the Network Theorems and understand the usage of common electrical measuring instruments.
2. To understand the basic characteristics of Transformers and Electrical Machines.
3. To understand the VI characteristics of various Electronic components like Diode, BJT and SCR.

Course Outcomes:

After completion of the course students should be able to:

1. Perform and verify different theorems with D.C excitation.
2. Perform and analyse the simple D.C circuits .
3. Perform the characteristics of DC Machines.
4. Perform different tests on the transformers and various AC Machines.
5. Perform various characteristics on Electronic devices like Diode and SCR.

CO-PO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3										
CO 2	3	3	3	3										
CO 3	3	3	2	2										
CO 4	3	3	2	2										
CO 5	3	3	2	3										
CO	3	3	2.4	2.6										

Program Outcomes:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research – based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to asses societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team ,to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Safety Instructions to Students

The Electrical & Electronic Engineering (EEE) Department is committed to providing a safe laboratory environment for all students. Using laboratory equipment to perform any kind of experiments contains some elements of risk, particularly in BEE lab. Safe working habits are essential for your safety and the safety of others around you.

1. Shoes shall be worn that provide full coverage of the feet, and appropriate personal clothing (apron) should be used in laboratory.
2. Students shall be familiar with the locations and operation of safety and emergency equipment such as, emergency power off, emergency telephones, and emergency exits.
3. Do not displace or remove laboratory equipment without instructor or technician authorization.
4. After making, the connections on the breadboard show the layout to the faculty and then switch on the Regulated power supply (RPS).
5. Current knob of the RPS should be always in the maximum position.
6. Remove metal bracelets or watchstraps.
7. Report all problems to the EEE Lab Technician

LIST OF EXPERIMENTS

CYCLE-I

1. Verification of KCL & KVL.

2. Verification of Superposition Theorem with DC Excitation.

3. Verification of Thevenin's & Norton's Theorem with DC Excitation.

4. Direct Load Test on Single Phase Transformer.

5. OCC Test on DC Shunt Generator.

CYCLE-II

6. Torque-Speed characteristics of a 3-Ø Induction Motor by conducting Load Test

7. V-I characteristics of PN Junction Diode and Zener Diode.

8. V-I characteristics of SCR.

9. Determination of Resonant frequency & Bandwidth for a series RLC resonance circuit.

10. Output waveforms of Half wave and Full wave bridge Rectifiers.

GNITS- EEE DEPARTMENT

BASICS ELECTRICAL ENGINEERING LAB

I B.Tech, I & II Semester Experiment No:

S.No	Date	Title of Experiment	Page No	Grade	Signature
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
Additional Experiment					

Verification of KCL & KVL

AIM: To verify the Kirchhoff's laws namely KVL and KCL by conducting suitable experiment using Resistors on bread board.

APPARATUS:

Equipment	Range	Quantity
RPS	0-30V	1
Resistor	1 KΩ	Required
Ammeter	0-200ma	3
Voltmeter	0-50V	4

CIRCUITDIAGRAM:

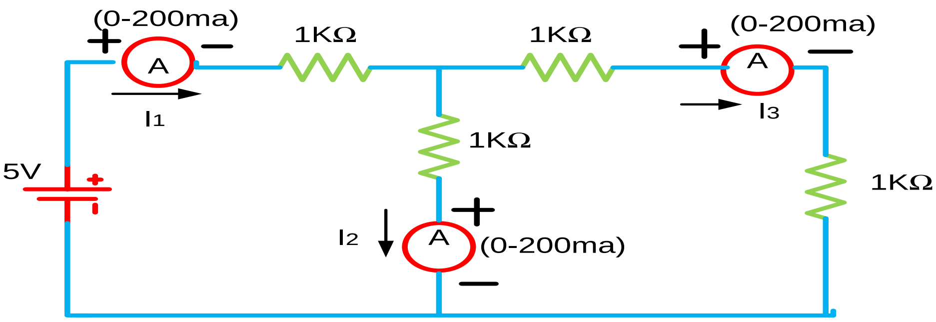


Figure 1: Circuit Diagram for KCL

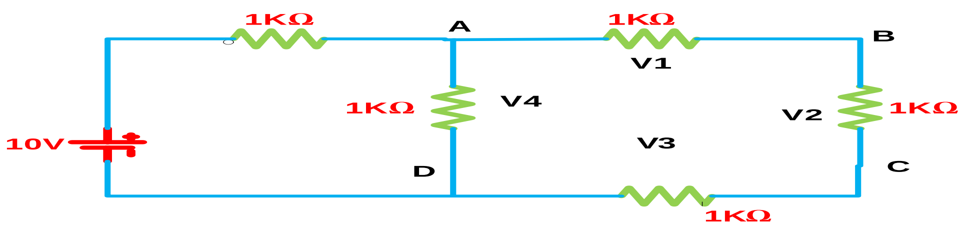


Figure 2 : Circuit diagram for KVL

THEORY:

Ohm's law by itself is not sufficient to analyse circuits. However, when it is coupled with Kirchhoff's two laws, we have a sufficient, powerful set of tools for analysing a large variety of electric circuits .Kirchhoff's laws were first introduced in 1847 by the German physicist **Gustav Robert Kirchhoff** (1824–1887).These laws are formally known as **Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL).**

Kirchhoff's first law is based on the law of conservation of charge, which requires that the algebraic sum of charges within a system cannot change.

Kirchhoff's current law (KCL) states that the algebraic sum of currents entering a junction / node (or a closed boundary) is equal to zero.

Kirchhoff's second law is based on the principle of conservation of energy:

Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a closed path (or loop) is zero.

Expressed mathematically, KVL states that

$$\sum_{m=1}^{M} v_m = 0$$

where *M* is the number of voltages in the loop (or the number of branches in the loop) and V_m is the *m*th voltage.

Sum of the Voltage Rise = Sum of the Voltage drops.

PROCEDURE:

a) Verification of KCL

1. Connect the circuit as shown in the circuit diagram 1.
2. Measure the currents at nodes A and B using the ammeters provided.
3. Note down and tabulate the readings of ammeter currents at two nodes.
4. At any instant of time the sum of incoming currents should be equal to outgoing currents.

Input Voltage (V)	Currents at Node A (ma)	
	I_1	$I_2 + I_3$
5		
10		
15		

b) Verification of KVL

1. Connect the circuit as shown in the circuit diagram 2.
2. Measure the voltages across the closed loop ABCDA and DCFED with the help of voltmeters.
3. Tabulate the readings

Input Voltage(V)	Voltage drops in loop ABCDA(V)			
	V_1	V_2	V_3	V_4
5				
10				
15				

THEORETICAL CALCULATIONS:

RESULT:

Name of Student	Roll No	Date	Marks	Signature

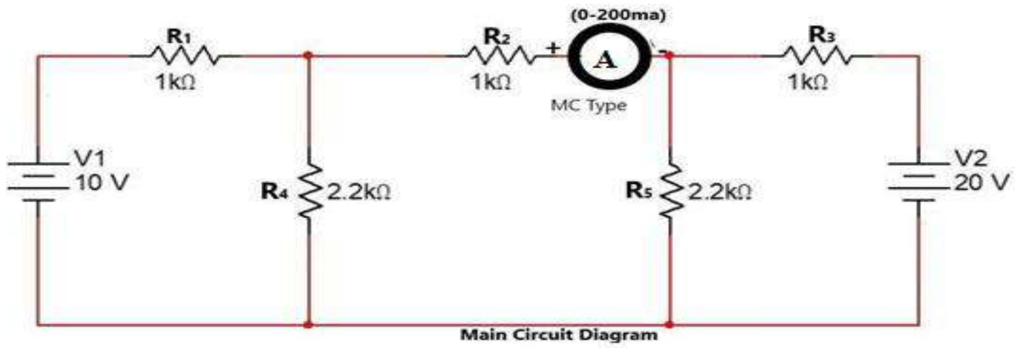
Verification of Superposition Theorem

AIM: Experimental Verification of Superposition Theorem with DC Excitation.

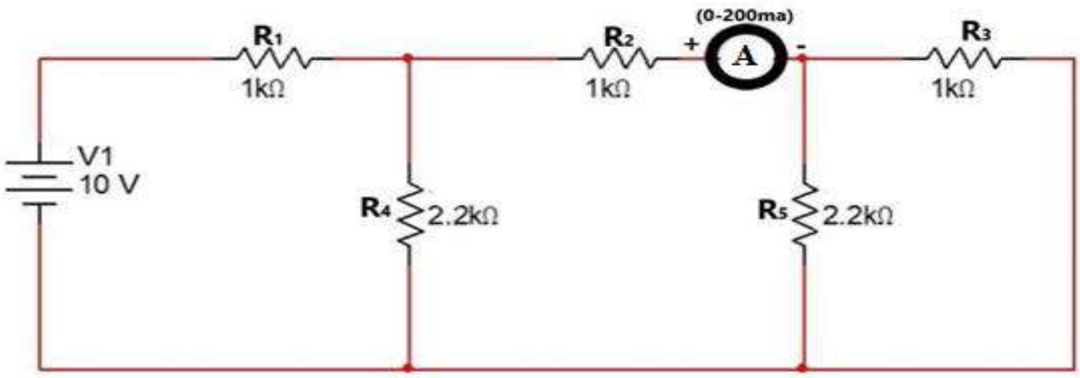
APPARATUS:

S.No	Equipment	Range	Quantity
1	Regulated Power Supply(RPS)	0-30V	1
2	Resistors	2.2KΩ	2
3	Resistors	1KΩ	3
4	Ammeter	0-200 mill amperes	1
5	Connecting Wires	------	Required

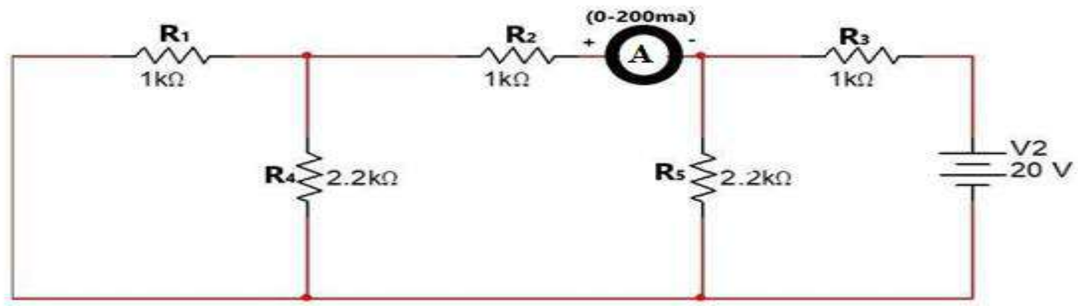
CIRCUIT DIAGRAMS:



CASE 1: When only 10V is Active and 20 V is Short-circuited



CASE 2: When 20V is Active and 10V is Short-circuited.



THEORY:

Statement: "The superposition theorem for electrical circuits states that for a linear system the response (voltage or current) in any branch of a bilateral linear circuit having more than one independent source equals the algebraic sum of the responses caused by each independent source acting alone, where all the other independent sources are replaced by their internal impedances".

To ascertain the contribution of each individual source, all of the other sources first must be "turned off" (set to zero) by:

- Replacing all other independent voltage sources with a short circuit (thereby eliminating difference of potential i.e. V=0; internal impedance of ideal voltage source is zero (short circuit)).
- Replacing all other independent current sources with an open circuit (thereby eliminating current i.e. I=0; internal impedance of ideal current source is infinite (open circuit)).

The theorem is applicable to linear networks (time varying or time invariant) consisting of independent sources, linear dependent sources, linear passive elements (resistors, inductors, capacitors) and linear transformers.

Superposition works for voltage and current but not power. In other words, the sum of the powers of each source with the other sources turned off is not the real consumed power. To calculate power we first use superposition to find both current and voltage of each linear element and then calculate the sum of the multiplied voltages and currents.

PROCEDURE:

1) Make the connections as per the circuit diagram given in Case 1.
2) Set the voltage V1=10volts and V2=0 volts or short-circuited it and note down thereading of ammeter and mark it as I1.
3) Now apply the voltage on secondary side say V2=20V and short-circuit the otherside as shown in Case 2 and note down the reading of ammeter and call it as I2.
4) Apply the voltage on both sides as shown in Case 3 and note down the ammeterreading as I.
5) The current measured in Case 3 that is I= I1 + I2 then the superposition theorem isverified experimentally.

TABULAR COULMN:

Voltage (V1)	Voltage (V2)	Current (I1)	Current (I2)	Current (I)
10V	0		-----------	---------
0	20V	-------------		---------
10V	20V	-------------	-------------	

THEORETICAL CALCULATIONS:

RESULT:

Name of Student	Roll No	Date	Marks	Signature

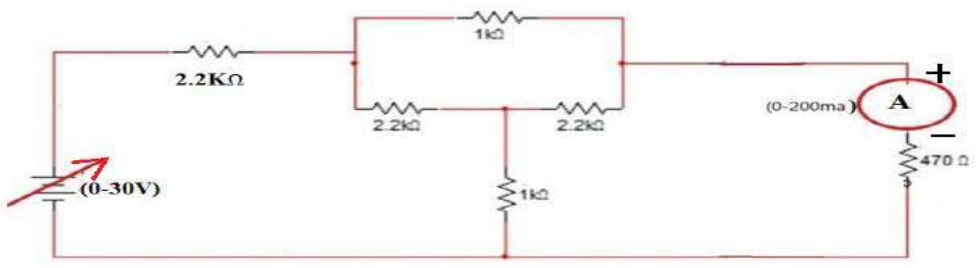
Verification of Thevenin's & Norton's Theorem

AIM: Experimental Verification of Thevenin's and Norton's Theorem Equivalent circuitswith a suitable Circuit diagram.

APPARATUS:

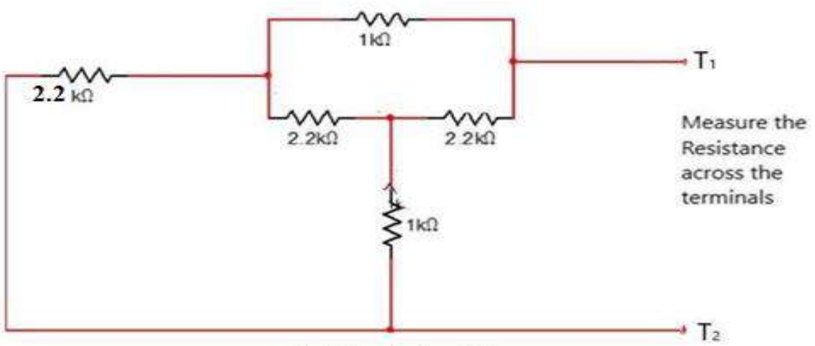
S.No	Equipment	Range	Quantity
1	Regulated Power Supply(RPS)	0-30V	1
2	Resistors	2.2KΩ	3
3	Resistors	1KΩ	2
4	Load Resistance	470Ω	1
5	Ammeter	0-200 mill amperes	1
6	Connecting Wires	------	Required

CIRCUIT DIAGRAMS:

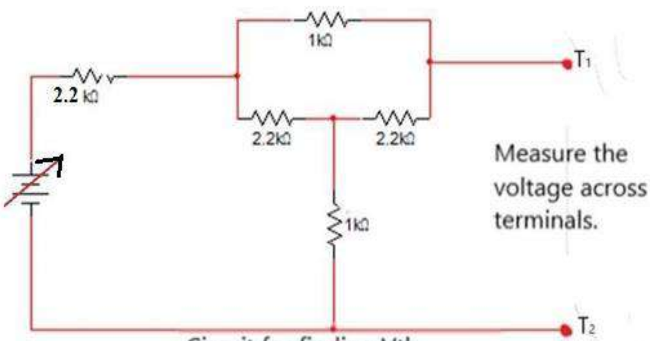


Main Circuit Diagram

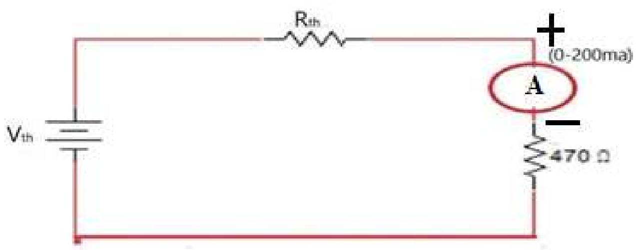
THEVENIN'S THEOREM:



Circuit for finding Rth



Circuit for finding Vth



Thevenin Equivalent circuit

THEORY:

Statement: "Any linear electric network with voltage and current sources and resistances only can be replaced at by an equivalent voltage source Vth in series connection with an equivalent resistance Rth ".

1. The equivalent voltage Vth is the voltage obtained at terminals T1 & T2 of the networkwith terminals T1 & T2 open circuited.
2. The equivalent resistance Rth is the resistance that an open circuit replaced the circuit between terminals T1 & T2 would have if a short circuit replaced all ideal voltage sources in the circuit and all ideal current sources are open circuited.

Thevenin's theorem can be used as another type of circuit analysis method and is particularly useful in the analysis of complicated circuits consisting of one or more voltage or current source and resistors that are arranged in the usual parallel and series connections.

PROCEDURE:

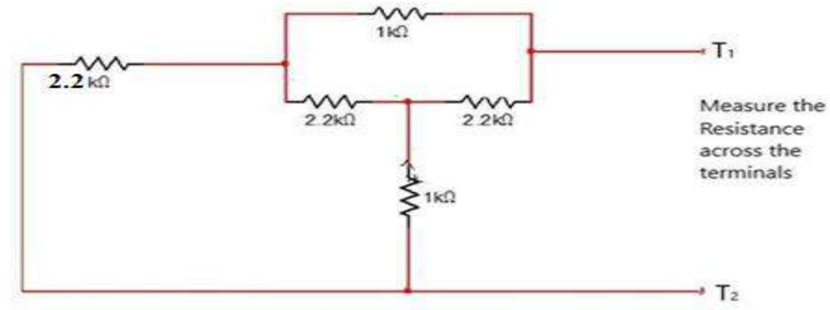
1. Make the connections as shown in circuit diagram to determine Rth..Here Rth remains the same independent of input voltage.
2. Now apply a particular voltage for Vth circuit, determine Open circuit voltage or Thevenin voltage, and tabulate the results as shown below.
3. After determining Vth & Rth for a particular voltage value form an Thevenin's Equivalent circuit and measure the current Il.
4. Determine the current in main circuit diagram and name it as Il
5. If the current measured in Il & Il are found equal then Thevenin's theorem is verified experimentally.
6. Repeat the steps 2,3,4 & 5 for different values of input voltage.

TABULAR COLUMN:

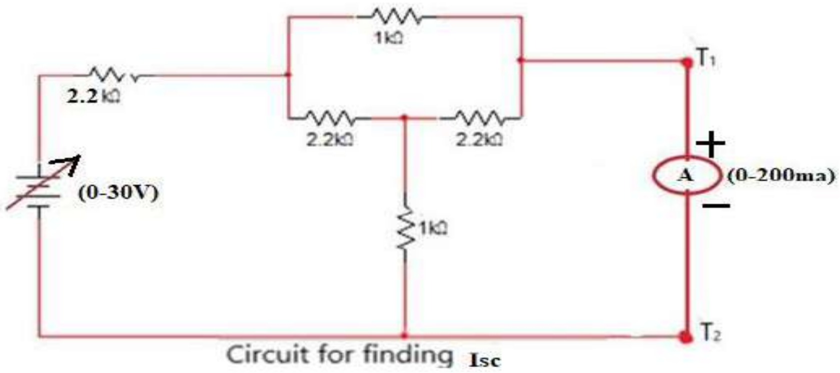
Input Voltage	Open circuit voltage (Vth)	Thevenin's Resistance (Rth)	Equivalent circuit current(ma)	Main circuit current(ma)
5V				
10V		--------------------		
15V		--------------------		

THEORETICAL CALCULATIONS:

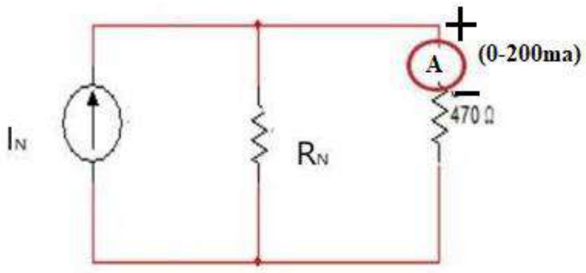
NORTONS THEOREM:



Circuit for finding R_N



Circuit for finding I_{sc}



Norton Equivalent circuit

THEORY:

Statement: "Any linear electric network with voltage and current sources and resistances only can be replaced at by an equivalent current source IN in parallel connection with an equivalent resistance RN".

- ✓ The equivalent short circuit current Isc is the current obtained at terminals T1 & T2 of the network with terminals T1 & T2 short-circuited.
- ✓ The equivalent resistance RN is the resistance that an open circuit replaced the circuit between terminals T1 & T2 would have if a short circuit replaced all ideal

voltage sources in the circuit and all ideal current sources are open circuited.

Norton's theorem can be used as another type of circuit analysis method and is particularlyuseful in the analysis of complicated circuits consisting of one or more current source and resistors that are arranged in the usual parallel and series connections.

PROCEDURE:

1. Make the connections as shown in circuit diagram to determine RN..Here RN remains the same independent of input voltage.
2. Now apply a particular voltage for Isc circuit, determine Short circuit current or Norton's current, and tabulate the results as shown below.
3. After determining Isc & RN for a particular voltage value form an Norton's equivalent circuit and measure the current Il.
4. Determine the current in main circuit diagram and name it as Il
5. If the current measured in Il & Il are found equal then Norton's theorem is verified experimentally.
6. Repeat the steps 2,3,4 & 5 for different values of input voltage.

TABULAR COLUMN:

Input Voltage	Short circuit current (I_{SC})	Norton's Resistance (R_N)	Equivalent circuit Current(ma)	Main circuit current(ma)
5V				
10V		--------------------		
15V		--------------------		

THEORETICAL CALCULATIONS:

RESULT:

Name of Student	Roll No	Date	Marks	Signature

Direct Load Test on Single Phase Transformer

AIM: To conduct the load test on given single phase transformer for finding the Efficiency and itsRegulation.

APPARATUS:

S.No	Equipment	Type	Range	Quantity
1	Ammeters	MI	(0-10A) (0-20A)	1 1
2	Voltmeters	MI	(0-150V) (0-300V)	1 1
3	Wattmeter's	UPF	150V,20A 300V,10A	1 1
4	Auto Transformer	1-Ø	0-270V	1
5	Load bank	Resistive	0-15A	1

CIRCUIT DIAGRAM:

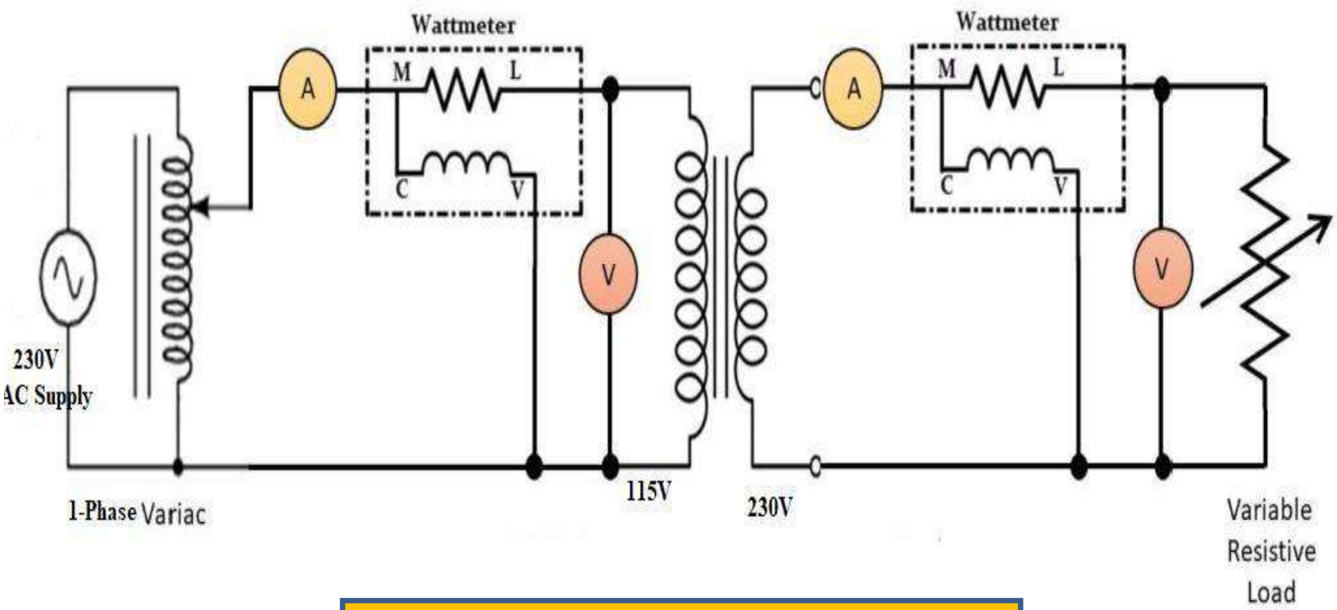


Figure 1: Direct Load Test on 1-Ø Transformer

THEORY:

A transformer is a static piece of equipment used either for raising or lowering the voltage of an a.c. supply with a corresponding decrease or increase in current. It essentially consists of two windings, the primary and secondary, wound on a common laminated magnetic core . The winding connected to the a.c. source is called primary winding (or primary) and the one connected to load is called secondary winding (or secondary). The alternating voltage V1 whose magnitude is to be changed is applied to the primary. Depending upon the number of turns of the primary (N1) and secondary (N2), an alternating e.m.f. E2 is induced in the secondary. This induced e.m.f. E2 in the secondary causes a secondary current I2. Consequently, terminal voltage V2 will appear across the load. If V2 > V1, it is called a step up-transformer. On the other hand, if V2 < V1, it is called a step-down transformer.

1. Efficiency:

The efficiency of transformer calculates from the input power from W_1 and output power from W_2.

Input power to the transformer = $W_1 = V_1 I_1$.

Output power to the transformer = $W_2 = V_2 I_2$.

For the lamp load, we will assume the power factor is one.

Therefore Efficiency of Transformer $\eta = \frac{OutPut\ Power}{Input\ Power} X\ 100$

$$\eta = \frac{W2}{W1} \quad X\ 100$$

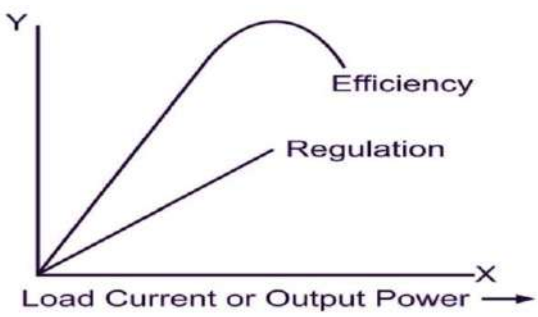
PROCEDURE:

1. First of all, set up all measuring instrument as shown in circuit diagram.
2. Apply a rated voltage of 115V to the primary of the transformer with the help of variac.
3. For first reading, keep the secondary side of the transformer under no load condition.
4. Increase the load with the step of 25%, 50%, 75%,and 100% till the load current reaches tothe full load value.
5. At each step, note the value of V1, I2 and W1 from primary side and V2, I2, and W2from secondary side and tabulate them.
6. Bring the entire system to initial conditions and switch off the supply.

TABULAR COLUMN:

S.NO	V_1	I_1	W_1	V_2	I_2	W_2	$\%\eta = \frac{W_2}{W_1} \times 100$	$\%\ V.R = \frac{E_2 - V_2}{V_2} \times 100$

MODEL GRAPH :



Load vs efficiency of single phase transformer

THEORITICAL CALCULATIONS:

RESULT:

Name of Student	Roll No	Date	Marks	Signature

OCC Test on A DC Shunt Generator

AIM: To determine the magnetization (open circuit) characteristics of DC shunt generator, the critical field resistance and critical speed.

NAME PLATE DETAILS:

Motor			Generator	
Voltage			Voltage	
Current			Current	
Rating			Rating	
Speed			Speed	

APPARATUS:

S.No.	Item	Type	Range	Quantity
1	Ammeter			
2	Voltmeter			
3	Rheostat			
4	Tachometer			

CIRCUIT DIAGRAM:

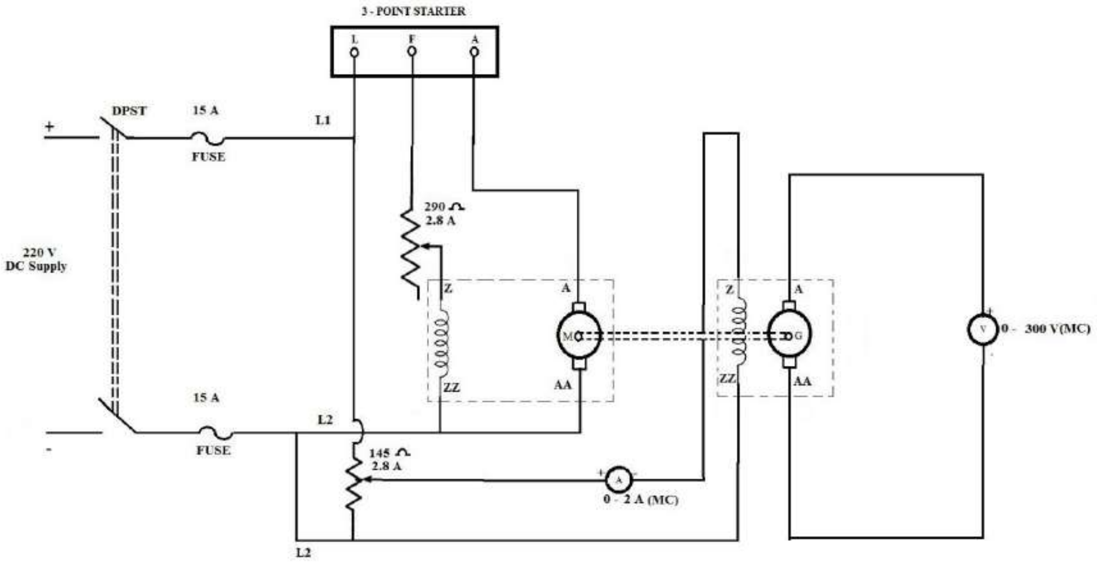
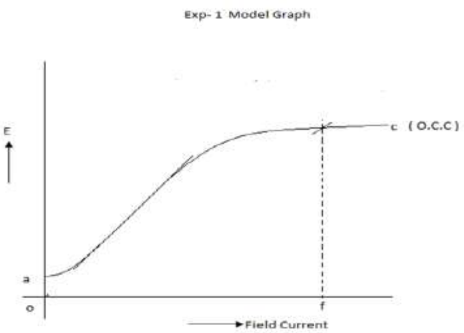


Fig - 1 DC Shunt Motor - Generator Set

THEORY:

Magnetization characteristic of DC shunt generator is defined as "The flux vs field current" graph at constant speed. Since, the induced emf in DC generator is directly proportional to the flux, at constant speed, induced emf vs field current can be treated as magnetization characteristic. In this experiment the characteristic is drawn by separately exciting the field circuit. When the field current is zero there will be a small amount of flux due to residual magnetism. Due to this residual flux a small voltage is induced and that is given as 'oa' on the graph. As the field current is increased the flux increases in direct proportion to it. At the point c, the core is almost saturated and any further increase in field current does not produce a change in the flux or EMF. Hence the characteristic is almost horizontal line beyond 'c'.



PROCEDURE:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.
2. Keep the motor field rheostat in the minimum resistance position.
3. Keep the generator field rheostat in the maximum resistance position
4. Observe the speed of the generator using a tachometer and adjust to the rated value (1500 rpm) by varying the motor field rheostat. Keep the same speed throughout the experiment.
5. Note down the terminal voltage of the generator. This is the e.m.f. due to residual magnetism.
6. Increase the generator field current I_f (ammeter) by gradually moving the rheostat for every value and note down the corresponding voltmeter reading. Increase the field current till induced e.m.f is about 120% of rated value or up to saturation.
7. Draw the characteristics of generated emf (E_g) versus field current (I_f) and Field resistance line.

TABULAR COLUMN:

S No	Field Current I_f (Amp)	Generated Voltage E_o (Volts)
1	0	
2	0.1	
3	0.2	
4	0.3	
5	0.4	
6	0.5	
7	0.6	
8	0.7	
9	0.8	
10	0.9	
11	1	

PRECAUTIONS:

1. Field rheostat of motor should be at minimum position
2. Avoid parallax errors and loose connections

RESULT:

Name of Student	Roll No	Date	Marks	Signature

Brake Test on Three Phase Induction Motor

AIM:

To obtain the performance characteristics of a three phase induction motor by conducting brake test.

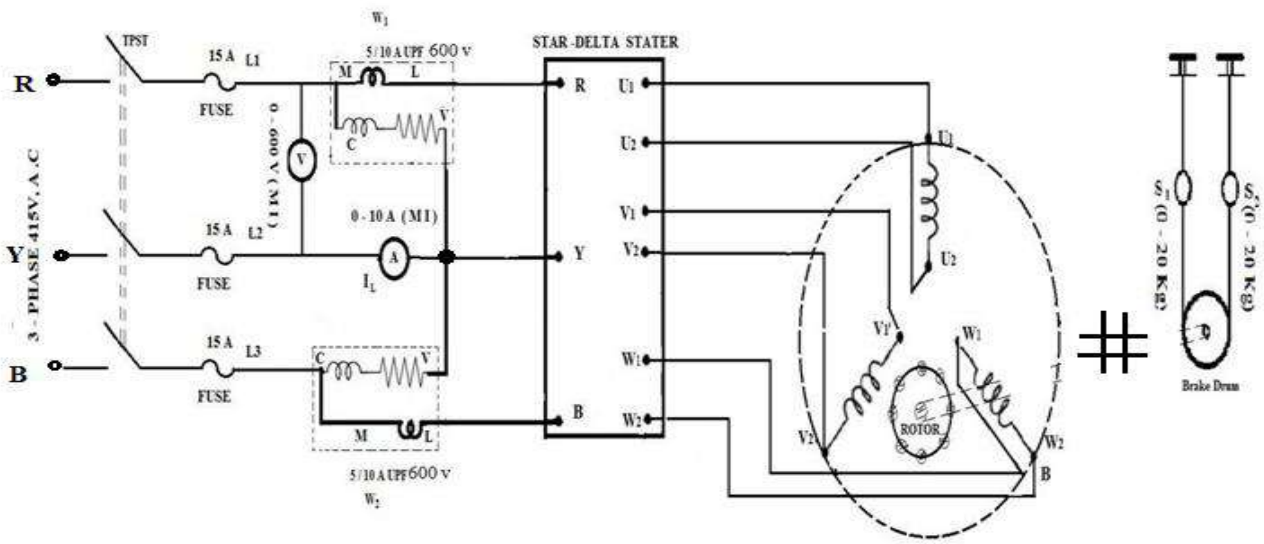
NAME PLATE DETAILS:

Rating	
Voltage	
Current	
Speed	

APPARATUS:

S. No.	Equipment	Type	Range	Quantity
1	Ammeter	MI	0-10A	1
2	Voltmeter	MI	0-600V	1
3	Wattmeter	UPF	600V/10A	2
4	Tachometer	Digital	0-3000 RPM	1

CIRCUIT DIAGRAM:



THEORY:

As a general rule, conversion of electrical power into mechanical power takes place in the rotating part of an electric motor. In d.c. motors, the electric power is conducted directly to thearmature (i.e. rotating part) through brushes and commutator. Hence, in this sense, a d.c. motor can be called a conduction motor. However, in A.C. motors, the rotor does not receive electric power by conduction but by induction. That is why such motors are known as induction motors. In fact, an induction motor can be treated as a rotating transformer i.e. one in which primary winding is stationary but the secondary is free to rotate..

When the 3-phase stator windings, are fedby a 3-phase supply then, as seen from above, a magnetic flux of constant magnitude, but rotatingat synchronous speed, is set up. The flux passes through the air-gap, sweeps past the rotor surfaceand so cuts the rotor conductors which, as yet, are stationary. Due to the relative speed between the rotating flux and the stationary conductors, an e.m.f. is induced in the latter, according to Faraday's laws of electro-magnetic induction. The frequency of the induced e.m.f. is the same as the supply frequency. Its magnitude is proportional to the relative velocity between the flux and the conductors and its direction is given by Fleming's Right-hand rule. Since the rotor bars or conductors form a closed circuit, rotor current is produced whose direction, as given by Lenz's law, is such as to oppose the very cause producing it. The brake test is a direct method of testing. It consists of applying a break to a water –cooled pulley mounted on the shaft of the motor. A belt is wound round the pulley and its two ends are attached to two spring balances S1 and S2.

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Start the 3-Φ IM on No Load with the help of Star-Delta starter.
3. Note down all meters reading and the speed at no load.
4. Apply mechanical load by tightening the belt on the brake drum and notedown the readings

of the meters, spring balances, and the speed.

5. Repeat the above step-4 until the motor draws full load current.
6. Calculate the torque, slip, output, efficiency and power factor for each set ofreadings as per the model calculations.

OBSERVATION TABLE :

S.No	V_L	I_L	S_1	S_2	W_1	W_2	N Speed	T Torque	ω (rad/sec)	I/p Power	O/p Power	Efficiency

THEORITICAL CALCULATIONS:

Motor Input Power = W1 + W2 (Watts)

Torque = (S1 – S2) * g * R (N-m) [g = 9.81 m/s^2, (radius of pulley) = 0.15 m]

Output Power = ω*T (Where ω = 2πN/60) (Watts)

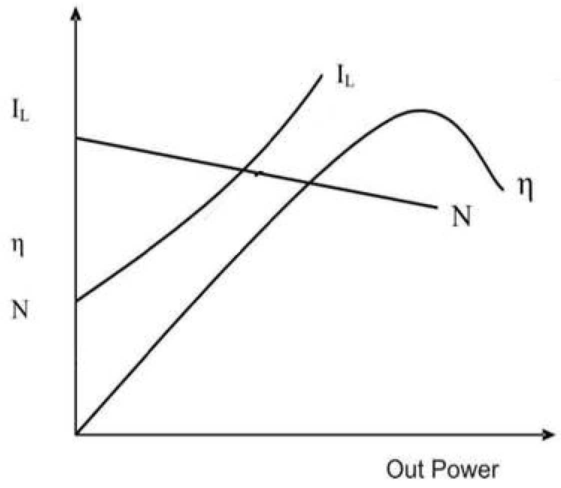
Motor Speed = N rpm

% Efficiency = Output/Input *100

$$\%Slip = \frac{(N_S - N)}{N_S} x100$$

MODEL GRAPHS:

Performance characteristics of Three – Phase Induction Motor:



RESULTS:

Name of Student	Roll No	Date	Marks	Signature

V-I CHARACTERTICS OF PN JUNCTION DIODE

AIM:

1. To plot Volt-Ampere Characteristics of Silicon P-N Junction.
2. To find cut-in Voltage for Silicon P-N Junction diode

APPARATUS:

S.No	Equipment	Range	Quantity
1	DC Regulated Power Supply(RPS)	0-30V	1
2	Diode IN4007 Si, Zener Diode		2
3	Resistors	1KΩ,10 KΩ	2
4	Digital Voltmeter	0-50V	1
5	Digital Ammeter	0-200 mA	1
6	Bread board		1
7	Connecting Wires	------	Required

CIRCUIT DIAGRAM:

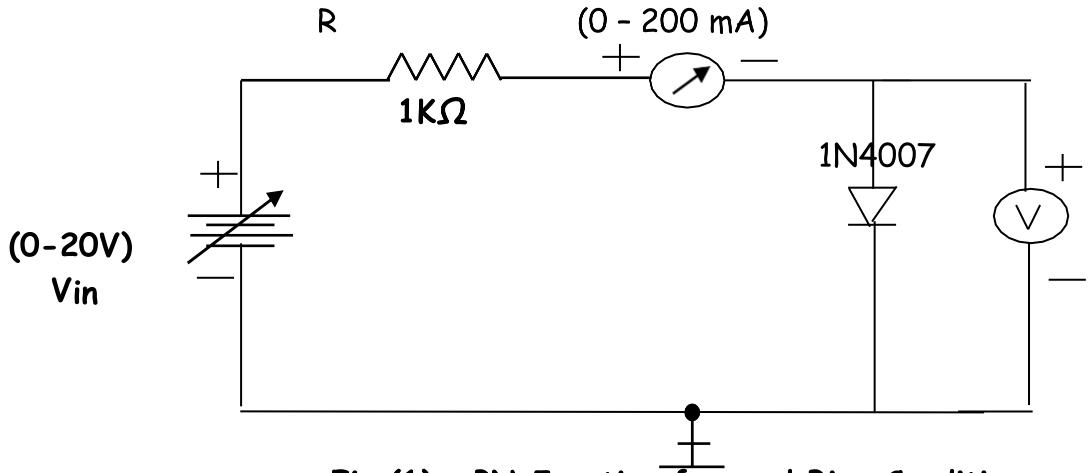


Fig (1) – PN Junction forward Bias Condition

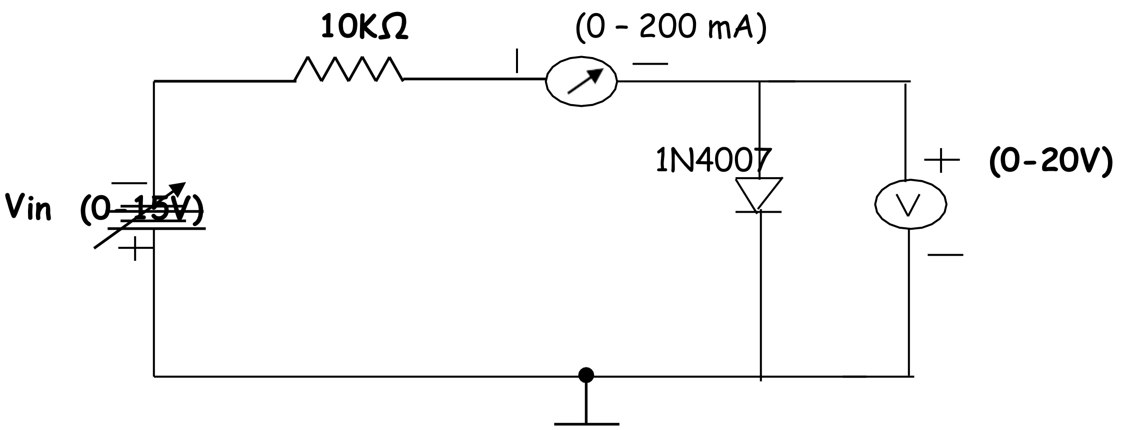


Fig (2) – PN Junction Reverse Bias Condition

THEORY:

Donor impurities (pentavalent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a junction called depletion region (this region is depleted off the charge carriers). This region gives rise to a potential barrier V_γ called ***Cut- in Voltage***. This is the voltage across the diode at which it starts conducting. The P-N junction can conduct beyond this Potential.The P-N junction supports uni-directional current flow.

If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected to cathode (N- side) then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered byan amount equal to given forward biasing voltage. Both the holesfrom p-side and electrons from n-side cross the junction simultaneously and constitute a forward current (***injected minority current*** – due to holes crossing the junction and entering N-side of the diode, due to electrons crossing the junction and entering P-side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short-circuited switch.

If –ve terminal of the input supply is connected to anode (p- side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be reverse biased. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier atthe junction. Both the holes on p-side and electrons on n-side tend to move away from the junction thereby increasing the depleted region. However the process cannot continue indefinitely, thus a small current called ***reverse saturation current*** continues to flow in the diode. This small current is due to thermally generated carriers. Assuming current flowing through the diode to be negligible, the diode can be approximated as an open circuited switch.

PROCEDURE:

Forward Biased Condition:

1. Connect the circuit as shown in Fig (1) using silicon PN Junction diode.
2. Vary Vf gradually and note down the corresponding readings of If .
3. Step Size is not fixed because of non linear curve and vary the X-axis variable(i.e. if output variation is more, decrease input step size and vice versa).
4. Tabulate different forward currents obtained for different forward voltages.

Reverse Biased Condition:

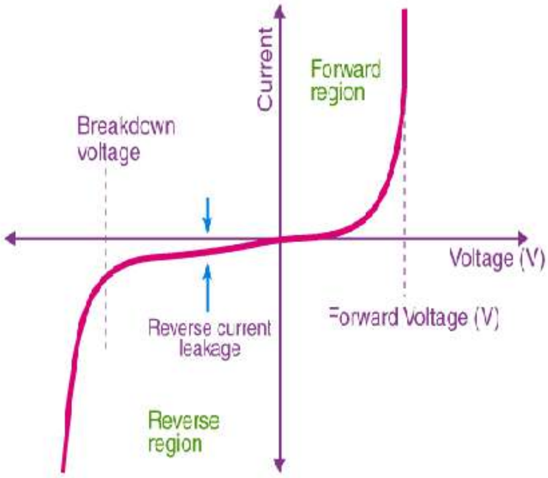
1. Connect the circuit as shown in Fig (2) using silicon PN Junction diode.
2. Vary Vr gradually and note down the corresponding readings of Ir .
3. Step Size is not fixed because of non linear curve and vary the X-axis variable(i.e. if output variation is more, decrease input step size and vice versa).
4. Tabulate different reverse currents obtained for different reverse voltages

TABULAR COLUMN:

1. Forward & Reverse bias Condition (PN Junction Diode)

Supply Voltage (V_{in})	Forward Voltage across diode (V_f)	Forward Current through diode (I_f)	Supply Voltage (V_{in})	Reverse Voltage across diode (V_r)	Reverse Current through diode (I_r)

MODEL GRAPHS:



RESULT:

Name of Student	Roll No	Date	Marks	Signature

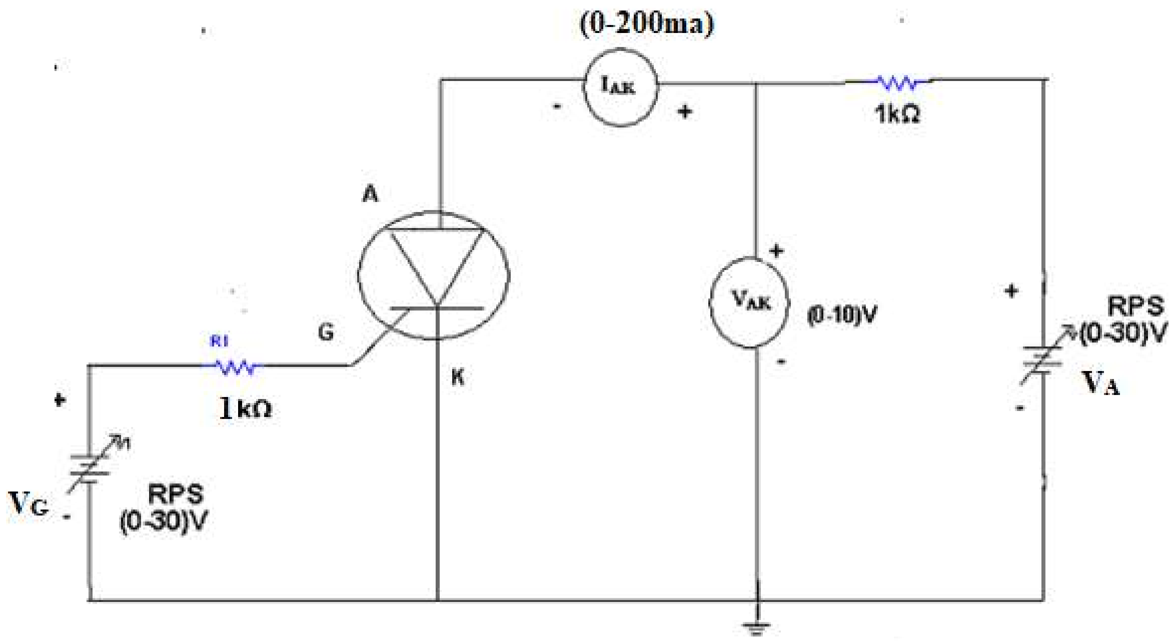
V-I characteristics of SCR

AIM: To plot the V-I characteristics of SCR and determine latching, holding current

APPARATUS REQUIRED:

S.No	Apparatus	Range	Quantity
01	RPS	0-30V	01
02	AMMETER	0-10 MICRO AMPS	01
03	MULTIMETER		01
04	POWER MODULES	--	--
05	REHOSTAT	(0-100Ohm/5A)	02

CIRCUIT DIAGRAM :



THEORY:

The V-I Characteristic of SCR (Silicon Controlled Rectifier) is the voltage current characteristics.The current through the SCR varies as the Anode to Cathode terminal voltage and Gate to Cathode terminal voltage is varied. The graphical representation of current through the SCR and voltage across the anode to cathode terminal is known as V-I Characteristics of SCR.

To obtain V-I characteristics of SCR, its anode and cathode are connected to the sourcethrough the load. The Gate and cathode are fed through a separate source which is meant to provide positive gate current from gate to cathode. The elementary circuit diagram for obtaining characteristics of SCR is shown above. In the above diagram, Anode and Cathode terminals A & K are connected to variable voltage source E through Load and Gate terminal G is connected to the source Es to provide positive gate current through G to K when switch S is closed. V_a and I_a represents the voltage across the anode to cathode terminals and current through the SCR. A plot between V_a and I_a is drawn by varying the source voltage E and noting the corresponding current through SCR. This plot gives the V-I characteristics of SCR.

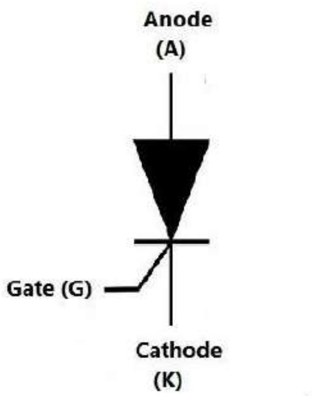
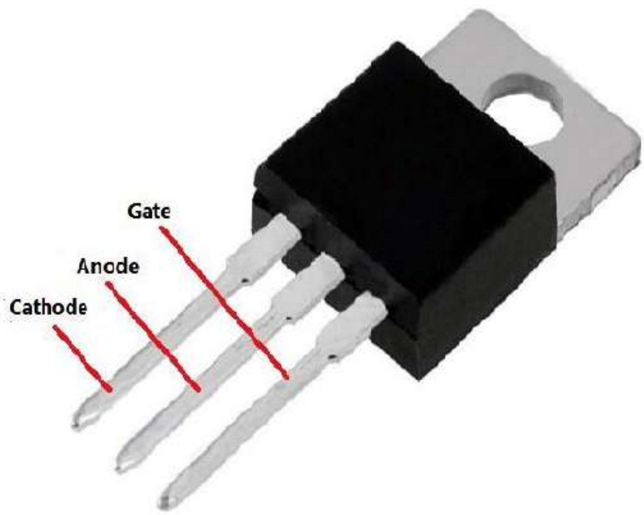


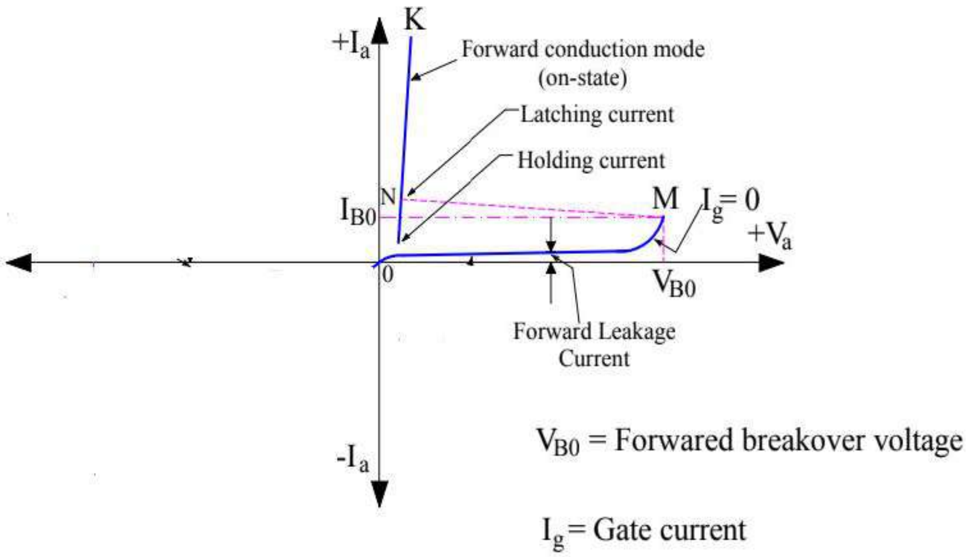
Fig: SCR Symbol



PROCEDURE:

1. Make the connections on the breadboard as per the circuit diagram.
2. Voltage on the gate side of SCR is named as $\boldsymbol{V_G}$ ***and*** voltage on the other side of RPS is named as $\boldsymbol{V_A}$.
3. Now vary the voltage $\boldsymbol{V_A}$ **in steps** until 10 Volts and note down the readings of $\boldsymbol{V_{AK}}$ & $\boldsymbol{I_{AK}}$.
4. Once $\boldsymbol{V_A}$reaches 10 volts value , pause it and vary $\boldsymbol{V_G}$ in steps until the SCR starts conducted. During this process also note down the values of $\boldsymbol{V_{AK}}$ & $\boldsymbol{I_{AK}}$.
5. Now stop varying $\boldsymbol{V_G}$ and again vary $\boldsymbol{V_A}$ and note down the values of holding current and latching current in the forward conduction mode i.e both $\boldsymbol{I_{AK}}$ values.

MODEL GRAPH:



I B.Tech, I & II Semester Experiment No:

TABULAR COLUMN:

S.No	Voltages	V_{AK}	I_{AK}
	V_A (0-10V)		
	V_G (Until SCR Conducts)		
	V_A		

RESULT:

Name of Student	Roll No	Date	Marks	Signature

Series Resonance

AIM: Determination of Resonant frequency, Bandwidth and Quality factor for a Series Resonance circuit.

APPARATUS:

S.No	Equipment	Range	Quantity
1	Series Resonance Kit		1
2	Function Generator	2 MHz	1
3	CRO	30MHz	1
4	CRO Probes		2

CIRCUIT DIAGRAM:

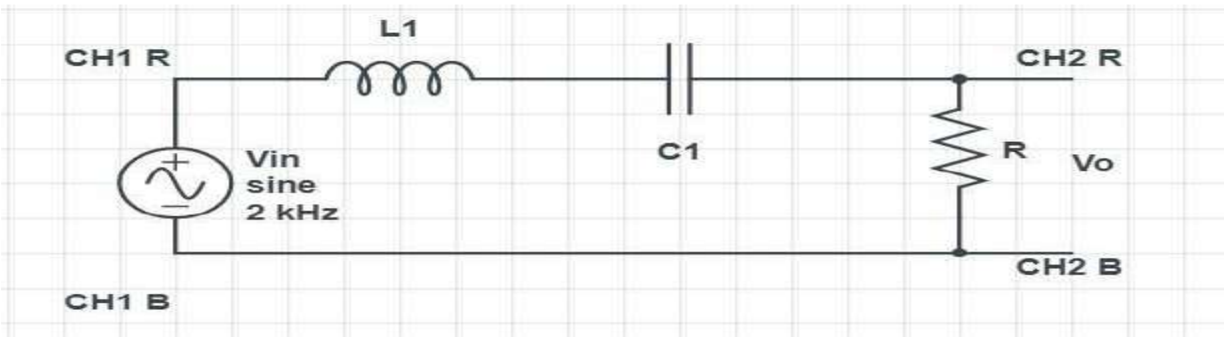


Figure 1: Circuit Diagram for Series Resonance Circuit

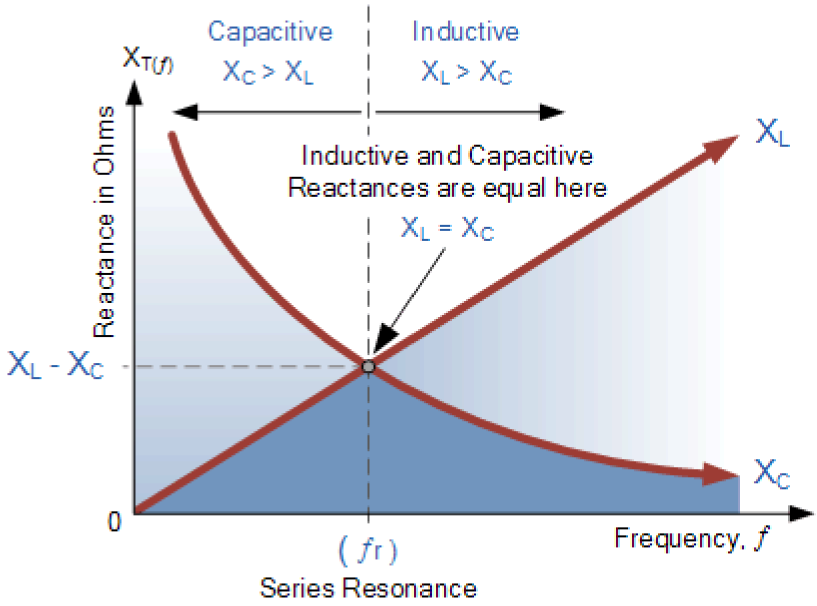
THEORY:

Series Resonance circuits are one of the most important circuits used electrical and electronic circuits. They can be found in various forms such as in AC mains filters, noise filters and also in radio and television tuning circuits producing a very selective tuning circuit for the receivingof the different frequency channels.

In a series RLC circuit there becomes a frequency point were the inductive reactance of the inductor becomes equal in value to the capacitive reactance of the capacitor. In other words, XL = XC. The point at which this occurs is called the **Resonant Frequency** point, (*ƒr*)of the circuit, and as we are analysing a series

RLC circuit this resonance frequency produces a **Series Resonance**.

Series Resonance Frequency



where: *fr* is in Hertz, L is in Henries and C is in Farads.

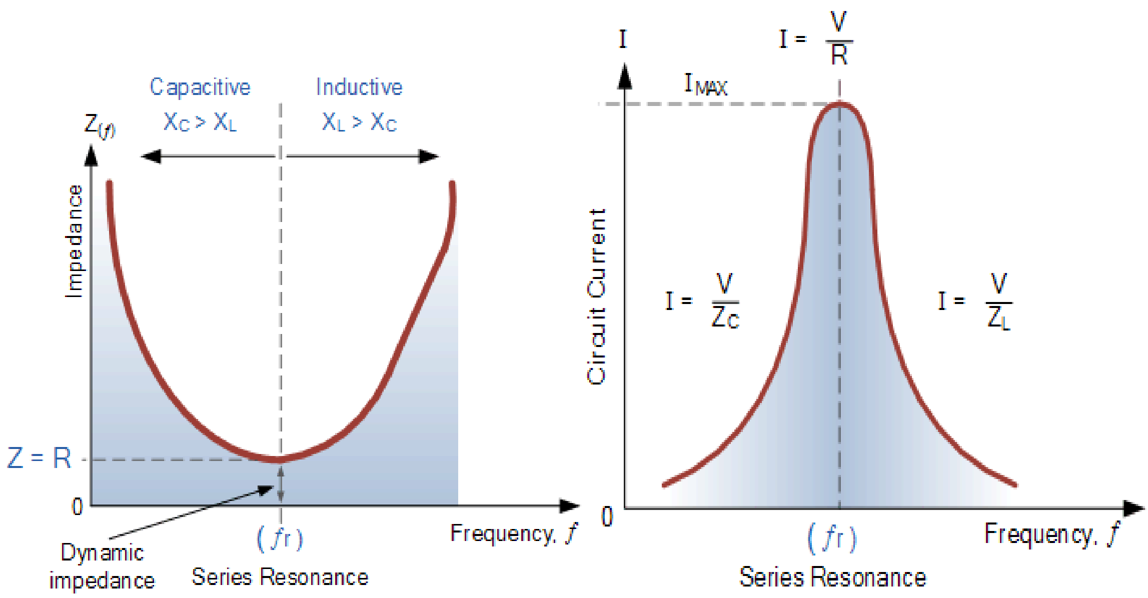
Electrical resonance occurs in an AC circuit when the two reactances which are opposite and equal cancel each other out as XL = XC and the point on the graph at which this happens is werethe two reactance curves cross each other.

In complex form, the resonant frequency is the frequency at which the total impedance of a series RLC circuit becomes purely *"real"*, that is no imaginary impedance's exist. This is because at resonance they are cancelled out. So the total impedance of the series circuit becomes just the value of the resistance and therefore: Z = R.

Then at resonance the impedance of the series circuit is at its minimum value and equal only to the resistance, R of the circuit. The circuit impedance at resonance is called the "dynamic impedance" of the circuit and depending upon the frequency, XC (typically at high frequencies)or XL (typically at low frequencies) will dominate either side of resonance as shown below.

I B.Tech, I & II Semester **Experiment No:**

Impedance and Current in a Series Resonance Circuit



PROCEDURE:

1. Make the connections as shown in the circuit diagram. Apply 5V input sinewave fromthe Function generator
2. Check the applied voltage value by connecting the probes to the channel 1 of theCathode Ray Oscilloscope.
3. Determine the Resonant frequency(fr) for the given values of L & C.
4. Observe the output voltage waveform in the channel 2 of CRO by fine tuningarrangement.
5. Enter the values in a tabular column as given below.

THEORETICAL CALCULATIONS:

1) Resonant frequency (Fr) = $\frac{1}{2\pi\sqrt{LC}}$

2) Quality factor = $\frac{X_L}{R}$

3) Bandwidth $= \frac{Resonant\ frequency(f_r)}{Quality\ Factor}$

NOTE: The Practical Calculations have to be calculated from the graph paper and thesecalculations have to be matched with theoretical calculations.

TABULAR COLUMN:

Given Input Voltage Vi = 5 Volts

S.No	**Frequency(Hz)**	**Output Voltage(Vo)**	**Current (Io =** $\frac{Vo}{R}$**)**

RESULT:

Name of Student	Roll No	Date	Marks	Signature

Half Wave & Full Wave Rectifiers

AIM: To Study the Half – wave & Full wave Rectifier circuits and determine its

1. Efficiency
2. Ripple factor

.APPARATUS:

S.No	Equipment	Range	Quantity
1	Rectifier Circuit Kit		1
2	Digital Voltmeter	0-50V	1
3	Digital Ammeter	0-200mA	1
4	Connecting Probes		Required

CIRCUIT DIAGRAMS:

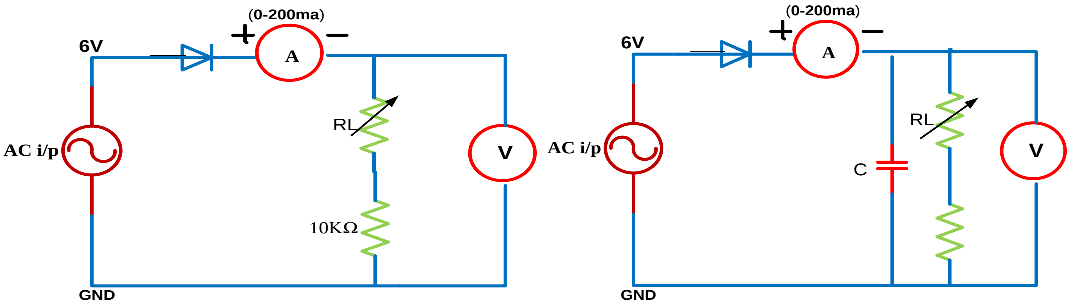


Figure 1: Circuit Diagram for Half rectifier without and with filters

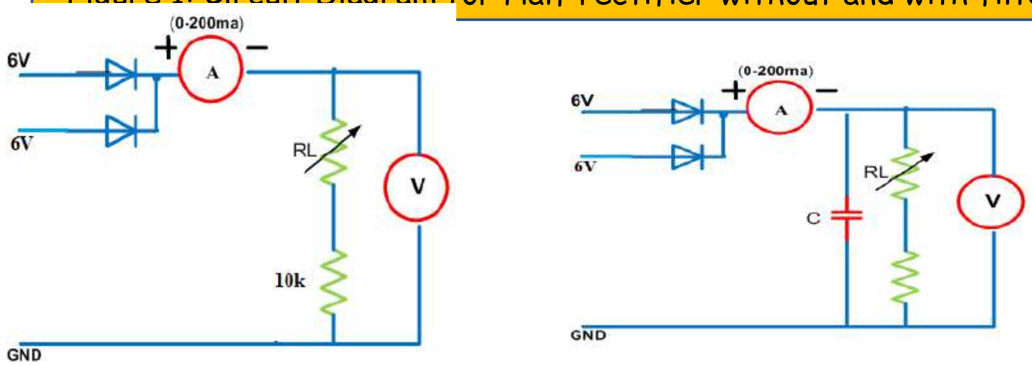


Figure 2: Circuit Diagram for Full Rectifier without and with filters

THEORY:

The conversion of AC into DC is called Rectification. Electronic devices can convert AC power into DC power with high efficiency

Half wave Rectifier:

Consider the given circuit. Assume the diode to be ideal i.e $V_f = 0, R_r = \infty, R_s = 0$. During the positive half cycle, the diode is forward biased and it conducts and hence a current flows through the load resistor. During the negative half cycle, the diode is reverse biased and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus the diode conducts only for one half cycle and results in a half wave rectified output. **The ripple factor and efficiency are two important parameters used to evaluate the performance of a rectifier circuit, including the half-wave rectifier.**

Ripple Factor:

The ripple factor of a rectifier circuit quantifies the amount of AC ripple voltage present in the output DC voltage. It is typically represented by the symbol 'γ' (gamma). The formula for calculating the ripple factor is:

Ripple Factor (γ) = V_rms / V_dc

Where: V_rms is the root mean square value of the AC ripple voltage.

V_dc is the average DC voltage.

For a half-wave rectifier, the ripple factor is relatively higher compared to other rectifier configurations like the full-wave rectifier. This is because a half-wave rectifier only allows one half-cycle of the AC input to pass through, resulting in a more pulsating output.

Efficiency:

The efficiency of a rectifier circuit indicates how effectively it converts the AC input power into the DC output power. It's an important parameter because losses in the rectifier circuit reduce the overall efficiency.

Efficiency (%) = (P_dc / P_ac) * 100

where:

- P_dc is the DC output power.
- P_ac is the AC input power.

Full wave Rectifier:

A full-wave rectifier is a type of rectifier circuit that converts the entire AC (alternating current) input signal into a pulsating DC (direct current) output signal. It allows both half-cycles of the input AC signal to pass through, effectively doubling the output frequency compared to a half-wave rectifier.

Let's discuss the ripple factor and efficiency of a full-wave rectifier:

Ripple Factor:

The ripple factor of a rectifier circuit quantifies the amount of AC ripple voltage present in the output DC voltage. For a full-wave rectifier, the ripple factor is generally lower compared to a half-wave rectifier due to the fact that it utilizes both half-cycles of the AC input waveform, resulting in a more frequent switching of the polarity.

The formula for calculating the ripple factor of a full-wave rectifier is:

Ripple Factor (γ) = V_rms / V_dc

Where: V_rms is the root mean square value of the AC ripple voltage.

V_dc is the average DC voltage.

Since a full-wave rectifier uses both half-cycles of the AC input, the output waveform is smoother, and the ripple factor is reduced compared to a half-wave rectifier.

Efficiency:

The efficiency of a rectifier circuit indicates how effectively it converts the AC input power into the DC output power. The efficiency of a full-wave rectifier is generally higher than that of a half-wave rectifier due to its ability to utilize both half-cycles of the AC input waveform.

The efficiency formula remains the same:

Efficiency (%) = (P_dc / P_ac) * 100

Where: - P_dc is the DC output power.

- P_ac is the AC input power.

Since a full-wave rectifier rectifies both half-cycles of the AC input waveform, it effectively doubles the frequency of the pulsations in the output waveform compared to a half-wave rectifier. This reduces the time during which the output voltage drops close to zero, leading to lower losses and a higher efficiency.

	Half-wave	Center-tapped transformer	Bridge
Frequency	f_{in}	$2f_{in}$	$2f_{in}$
PIV	V_m	$2V_m$	V_m
RMS Value	$V_m/2$	$V_m/\sqrt{2}$	$V_m/\sqrt{2}$
Efficiency	40.6	81.2	81.2
Ripple Factor	1.21	0.482	0.482

PROCEDURE:

1. Connect circuit as shown in figure.
2. Measure and record the output voltages Vac and Vdc in no load condition.
3. Short the 10KΩ load resistance with the help of spring given
4. By varying the load resistance 250Ω in steps note down the load current Idc using ammeter, Corresponding output voltages of Vac and Vdc using multimeter and tabulate them as shown below.
5. Calculate the ripple factor for each value of Idc.

TABULAR COLUMN:

	Half wave Rectifier				Full wave Rectifier			
	V_{ac}	V_{dc}	I_{ac}	I_{dc}	V_{ac}	V_{dc}	I_{ac}	I_{dc}
No load Condition								
Full load Condition								
Ripple Factor								
Efficiency								

THEORITICAL CALCULATIONS:

RESULT:

Name of Student	Roll No	Date	Marks	Signature