Shri Guru Gobind Singhji Institute of Engineering and Technology
Vishnupuri, Nanded (Maharashtra State) INDIA PIN 431606
Government Aided Autonomous Institute DTE Code: 2020
NAAC Accredited institute GRADE B++, CGPA 2.91 (2020 -2025)
Vision Statement: Education of Human Power for Technological Excellence

BASIC ELECTRICAL ENGINEERING
LABORATORY MANUAL

Student Name:………………………………………………….

Batch:…………………………………………………………….

Branch:…………………………….Section……………………

Reg No……………………Semester……………………….

DEPARTMENT OF ELECTRICAL ENGINEERING

PREFACE

It gives us immense pleasure to present this laboratory manual for the **BASIC Electrical Engineering Laboratory**, prepared in accordance with the syllabus prescribed by **SGGSIE&T**. This manual is designed to provide practical knowledge and hands-on experience in fundamental and advanced topics of electrical engineering, thereby complementing theoretical understanding with real-world application.

The aim of this lab is to inculcate in students a deep understanding of electrical principles, circuit behavior, characteristics, measurement techniques, and safety procedures. Through carefully designed experiments, students are expected to develop analytical thinking, diagnostic skills, and technical expertise that are essential in the field of electrical engineering.

This manual includes detailed procedures, circuit diagrams, precautions, and observation tables for each experiment, ensuring that students can perform experiments with clarity and confidence. The lab exercises are intended to foster teamwork, critical observation, and a disciplined approach to scientific inquiry.

We acknowledge the efforts of the teaching and technical staff whose support and dedication made this manual possible. Suggestions and feedback from students and faculty are always welcome to further improve the quality and utility of this manual.

We hope this lab experience will greatly enhance the learning journey of our students and contribute meaningfully to their professional development.

Faculty of BEE

SGGSIE&T

BASIC ELECTRICAL ENGINEERING LAB

SAFETY PRECAUTIONS TO STUDENTS

1. **Enter in to the Lab with Uniform**.
2. **Do not touch live circuits** or energized components. Always assume conductors are live
3. **Never work alone** in the lab. Perform experiments only under faculty or lab technician supervision.
4. **Report all accidents or equipment damage** to the lab instructor immediately.

Do's

1. Do wear appropriate safety attire in the lab
2. Perform experiments only when authorized by the faculty.
3. All the apparatus taken should be returned to the concerned Lab Assistant, before leaving the lab.
4. Report immediately to the Lab Incharge for any damages to equipment.
5. All students must follow the Dress Code while in the laboratory.
6. The lab timetable must be strictly followed.
7. Experiment must be completed within the given time.
8. Handle all apparatus with care.
9. All students are liable for any damage to equipment due to their own negligence.
10. Be aware of all the safety devices.
11. Immediately After entering into the lab, fill the login details.
12. Avoid loose connections.

DONT'S

1. Do not wear open-toed shoes (sandals) in the lab.
2. Never overload a circuit by plugging in too many appliances.
3. Do not use any equipment unless you are trained and approved as a user by your faculty or staff.
4. Don't switch on the power supply without getting your circuit connections verified
5. Foods, drinks and smoking are NOT allowed
6. Students are strictly PROHIBITED from taking out any items from the laboratory.

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BASIC ELECTRICAL ENGINEERING LAB

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1	Verification of KVL and KCL for DC Network using breadboard			
2	Verification of Superposition theorem for DC Network using breadboard			
3	Verification of Thevenin and Norton theorem for DC Network using breadboard			
4	Verification of Maximum power transfer theorem for DC Network using breadboard.			
5	Measurement of power and power factor in a single phase circuit.			
6	Measurement of active power and power factor for 3-phase circuit.			
7	To find out polarity of single-phase Transformer			
8	To Perform OC and SC test on single phase Transformer			

Certificate

This is to certify that Mr./Miss. ________________________________Reg. No.:________ of Div:__________ has satisfactorily completed the practical of the subject **Basic Electrical Engineering Lab.**

Faculty In-Charge **Head of the Department**

BASIC ELECTRICAL ENGINEERING LAB

Experiment No: 01

Title: Introduction to Measuring Instruments and Basic Electrical Elements

AIM: Working and use of multi-meters, measuring instruments - voltmeter, ammeter, Wattmeter, and basic electrical elements- Resistor, Inductor, and Capacitor.

Theory:

Measuring Instruments:

1. Ammeter: -

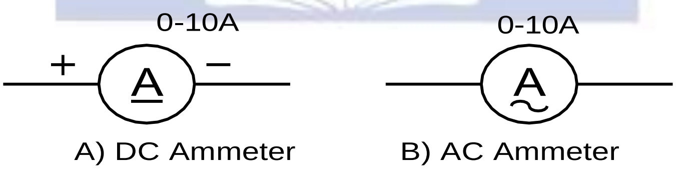
Ammeter is used to measure current in electrical circuit and is required to be connected always in series. As ammeter resistance is low hence voltage drop across ammeter is low . The current coil of ammeter has low current carrying capacity using shunt .

Classification or Types of Ammeter-

- Permanent Magnet Moving Coil (PMMC) ammeter.
- Moving Iron (MI) Ammeter.
- Electrodynamometer type Ammeter.
- Induction Type Ammeter.
- Digital Ammeter (DAM).
- Depending on type of supply i.e.AC or DC , ammeter is selected .

DC Ammeter are mainly PMMC instruments, MI can measure both AC and DC currents, also Electrodynamometer type thermal instrument can measure DC and AC, induction meters are not generally used for ammeter construction due to their higher cost, inaccuracy in measurement.

Symbol

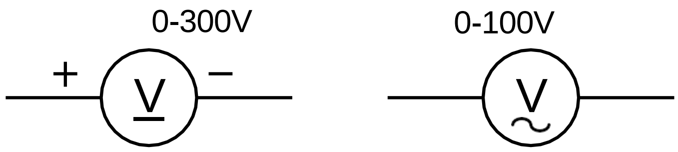


2. Voltmeter: -

Voltmeter is employed to measure the potential difference (Voltage) across any two points of a circuit. It is connected in the parallel across any element in the circuit. The resistance of voltmeter is kept very high by connecting a high resistance in series of the voltmeter with the coil of the instrument.

For DC voltmeters PMMC instruments are used, MI instrument can measure both AC and DC voltages, electrodynamometer type, thermal instrument can measure DC and AC voltages as well. Induction meters are not used because of their high cost, inaccuracy in measurement. Rectifier type voltmeter, electrostatic type and also digital voltmeter (DVM) can measure both AC and DC voltages.

Symbol

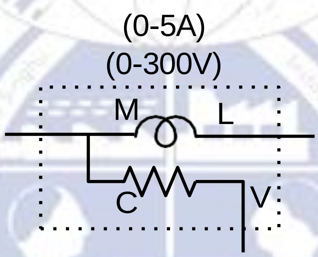


A) DC Voltmeter B) AC Voltmeter

3. Wattmeter: -

The measurement of real power (Active power) in AC circuits is done by using Wattmeter. The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeters are used for measurement of Active power at fundamental frequency. It consists of two coils i.e., pressure coil (parallel) and current coil (series). As the current coil is connected in series with load, it measures the load current and whereas the pressures coil which is connected across the load is used to measure the voltage across the load. Mainly electro-dynamic type of wattmeter is used its construction is as follows. The real power in AC circuits is given by expression.

Symbol:



4. Digital Multimeters

A digital multimeter is a test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries. Digital multimeters long ago replaced pointer-based analog meters due to their ability to measure with greater accuracy, reliability and increased impedance. Digital multimeters combine the testing capabilities of single-task meters—the voltmeter (for measuring volts), ammeter (amps) and ohmmeter (ohms). Often, they include several additional specialized features or advanced options. Technicians with specific needs, therefore, can seek out a model targeted to meet their needs.

Digital multimeter typically includes four components:

- Display: Where measurement readouts can be viewed.
- Buttons: For selecting various functions; the options vary by model.
- Dial (or rotary switch): For selecting primary measurement values (volts, amps, ohms).
- Input jacks: Where test leads are inserted.

Basic Electrical Elements:

- **Passive components:** Passive components are those which require external energy source for their operation e.g. Resistors, Capacitors, inductors, etc.

- **Active Components:** Active components are those which do not require any external energy source for their operation e.g. Diode, Zener diode, transistor, FET (Field Effect Transistor), UJT (Uni-Junction Transistor), SCR (Silicon Controlled Rectifier), DIAC, TRIAC, photodiode, photo-transistor etc.

- **Resistors:**

Resistors are passive electronic components mainly used for controlling flow of electric current. If the electrical values are going to be constant, it is a fixed resistor. If the values of electrical resistance are adjustable, it is variable resistor (e.g. Rheostat & potentiometer).

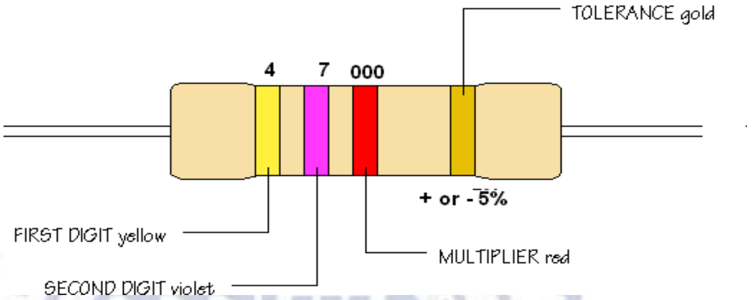


Figure.1.1: 4700Ω Resistor

Table 1.1: Resistance color code system:

Color	First Digit	Second Digit	Decimal Multiplier	Tolerance
Black	0	0	10^0	-
Brown	1	1	10^1	-
Red	2	2	10^2	-
Orange	3	3	10^3	--
Yellow	4	4	10^4	-
Green	5	5	10^5	-
Blue	6	6	10^6	-
Violet	7	7	10^7	-
Grey	8	8	10^8	-
White	9	9	10^9	-
Gold	-	-	-	5%
Silver	-	-	-	10%
No Color	-	-	-	20%

First three rings give value of resistor, while last ring gives tolerance range in which the value of that resistor may lie.

For e.g. Bands of resistors are,

Brown	Red	Orange	Gold
1	2	x 10^3	with 5% tolerance

Value of Resistor = 12 x 10^3 Ω with 5 % tolerance.

Fixed Resistors: A fixed resistor is a two terminal resistor whose electrical resistance is constant. There are three basic types of fixed resistors as follows:

- Carbon composition resistors.
- Wire wound resistors.
- Metal film resistors.
- **Carbon composition resistors:** These are the common low wattage fixed type resistor. Resistive material used is of carbon day composition.
- **Wire wound resistors:** When higher power rating is required, these resistors are used. This resistor is wound with single layer, single element of high resistance wire on ceramic rod substrate.
- **Film resistors:** In this type of resistor a thin layer of a resistive material is put up on a ceramic or glass rod.
- **<u>Capacitors:</u>**

Capacitor is a passive electronic component which has an ability to charge or store energy. It is made up of two parallel plates separated by an insulating material called as dielectric. Energy is stored in this field and may be returned by discharging the capacitor through a load.

It may be defined as the amount of charge required to create a unit potential difference between its plates. If Q is the charge on one of the plates of capacitor & if P.D. of 'V' volts is established between them, then

$$C = \frac{Q}{V}$$

Figure. 1.2: Types of capacitors (ceramic, electrolytic capacitors)

In practical applications generally ceramic & electrolytic capacitors are used.

- **Electrolytic Capacitors**: An electrolytic capacitor contains two aluminum electrodes having oxide film which acts as a dielectric. The value and voltage rating is marked on the capacitor.
- **Ceramic Capacitors:** This is also called as disc type and the dielectric used is a ceramic material.

Table 1.2 Types and Dielectric used

Paper Capacitor	Waxed paper
Plastic film capacitor	Plastic film
Mica capacitors	Thin sheet of mica
Ceramic	Ceramic
Glass	Flexible glass ribbon
Electrolyte	Oxide layer

- **<u>Inductors:</u>**

Inductors are passive components used to minimize the alternating current while permitting the flow of direct current. It is a single winding of conducting wire on an insulating or magnetic core. Inductance is the property of electric circuit. Inductors may be fixed or variable type.

Figure. 1.3: Types of inductors (fixed, L-variable, variable)

Conclusion: In the practical session, we identify different types of basic electrical measuring instruments and learn how to operate them. We also study various passive components, such as resistors, capacitors, and inductors.

Viva Voice Questions:

1. What is the function of a voltmeter?
2. How do you use an ammeter to measure current?
3. What is a multimeter, and how do you use it to measure voltage?
4. What is a resistor, and how do you test it with a multimeter?
5. Can you explain what a capacitor does in a circuit?
6. What is the difference between active and passive components?
7. What is the function of a wattmeter in an electrical circuit?
8. How are the current and voltage coils of a wattmeter connected in a circuit?
9. What is an inductor, and what is the unit of inductance?
10. What is the difference between an inductor and a capacitor in terms of energy storage?

Experiment No. 02

Title: Verification of KVL and KCL for DC Network using breadboard

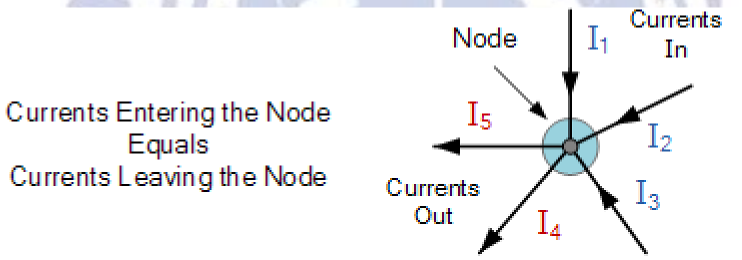
AIM: Verification of dc circuits: Kirchhoff Voltage Law (K.V.L) and Kirchhoff Current Law (K.C.L).

APPARATUS REQUIRED:

S.No	Name of the equipment	Range	Type	Quantity
1	RPS		-	
2	Voltmeter		Digital	
3	Ammeter		Digital	
4	Bread board		-	
5	Connecting wires		-	
6	Resistors			

THEORY:

(1) Kirchhoff's current Law (KCL): The algebraic sum of all the currents at any node in a circuit equals zero, ∑ I = 0.

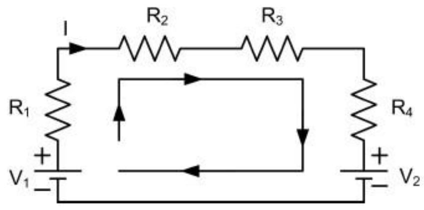


$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

Here, the three currents entering the node, I1, I2, I3 are all positive in value and the two currents leaving the node, I4 and I5 are negative in value. Then this means we can also rewrite the equation as;

$$I1 + I2 + I3 - I4 - I5 = 0$$

(2) Kirchhoff's voltage Law (KVL): The algebraic sum of all the voltages around any closed path in a circuit equals zero, ∑ U = 0. That means "in any closed loop network, the total



$$V_1 - IR_1 - IR_2 - IR_3 - IR_4 - V_2 = 0$$

$$V_1 - I\,(R_1 + R_2 + R_3 + R_4) - V_2 = 0$$

voltage around the loop is equal to the sum of all the voltage drops within the same loop" which is also equal to zero. This idea by Kirchhoff is known as the Conservation of Energy. Starting at any point in the loop continue in the same direction noting the direction of all the voltage drops, either positive or negative, and returning back to the same starting point. It is important to maintain the same direction either clockwise or anti-clockwise or the final voltage sum will not be equal to zero. We can use Kirchhoff's voltage law when analyzing series circuits.

CIRCUIT DIAGRAMS:

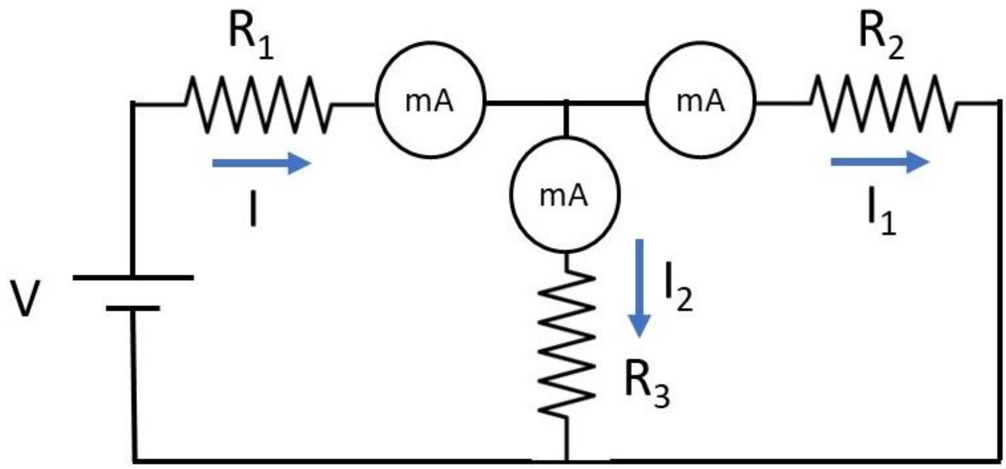


Figure: 2.1: Circuit diagram for Verification of KCL

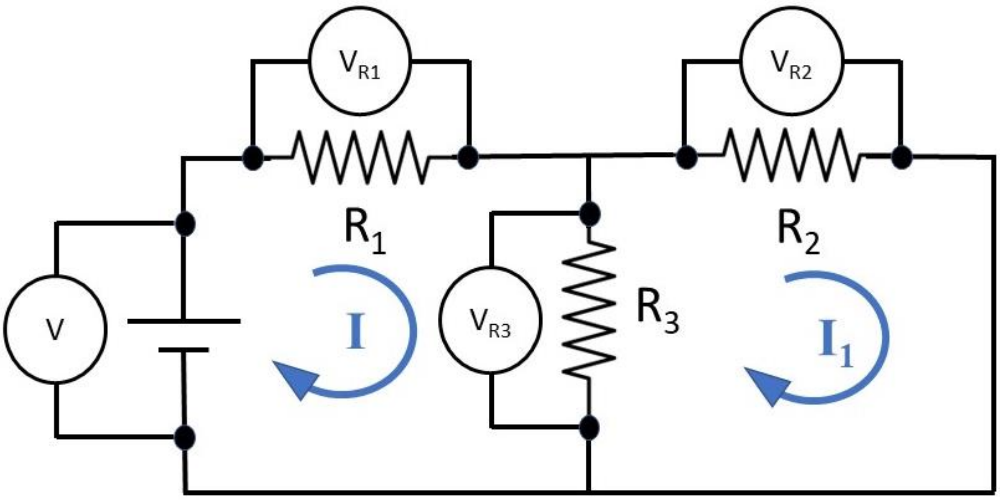


Figure: 2.2: Circuit diagram for Verification of KVL

PROCEDURE:

Procedure for KCL:

1. Give the connections as per the circuit diagram.
2. Set a particular value of voltage sources RPS.
3. Note down the corresponding ammeter reading
4. Repeat the same for different voltages

Procedure for KVL:

1. Give the connections as per the circuit diagram.
2. Set a particular value of voltage sources RPS.
3. Note all the voltage reading
4. Repeat the same for different voltages

OBSERVATION TABLE AND RESULT

KCL Observations:

Table.2.1. Theoretical values of KCL circuit

Sr.No.	Input supply voltage (V)	I_1 in mA	I_2 in mA	Total current, I(mA)
1				
2				

Table.2.2. Practical values of KCL circuit

Sr.No.	Input supply voltage (V)	I_1 in mA	I_2 in mA	Total current, I(mA)
1				
2				

KVL Observations:

Table.2.3. Theoretical values of KVL circuit

Sr.No.	Input supply voltage (V)	Voltage drop across R_1, V_{R1} (V)	Voltage drop across R_2, V_{R2} (V)	Voltage drop across R_3, V_{R3} (V)	Algebraic sum of voltages (V) in mesh.
1					
2					

Table.2.4. Practical values of KVL circuit

Sr.No.	Input supply voltage (V)	Voltage drop across R_1, V_{R1} (V)	Voltage drop across R_2, V_{R2} (V)	Voltage drop across R_3, V_{R3} (V)	Algebraic sum of voltages (V) in a mesh
1					
2					

CONCLUSION:

Viva Voice Questions:

1. What does KCL state?
2. Does KCL work for AC and DC circuits?
3. What is the basic idea of KVL?
4. What is a voltage drop?
5. Can KCL and KVL be used in circuits with batteries and resistors?
6. Define network and circuit?
7. What is the property of inductor and capacitor?
8. What is Breadboard?
9. What is regulated power supply?

Experiment No. 03

Title: Verification of Superposition theorem for DC Network using breadboard

AIM: To verify Superposition theorem for the given circuit.

APPARATUS REQUIRED:

S.No	Name of The Equipment	Range	Type	Quantity
1	Voltmeter			
2	Ammeter			
3	RPS			
4	Resistors			
5	Breadboard			
6	DMM			
7	Connecting wires			

CIRCUIT DIAGRAM:

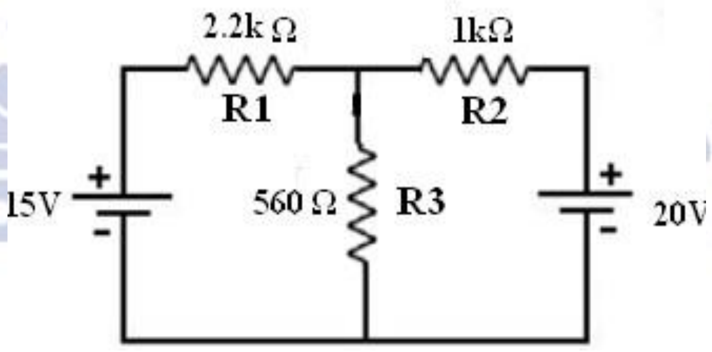


Figure: 3.1. Circuit Diagram

PRACTICAL CIRCUITS:

When V_1 & V_2 source acting(To find I_L):-

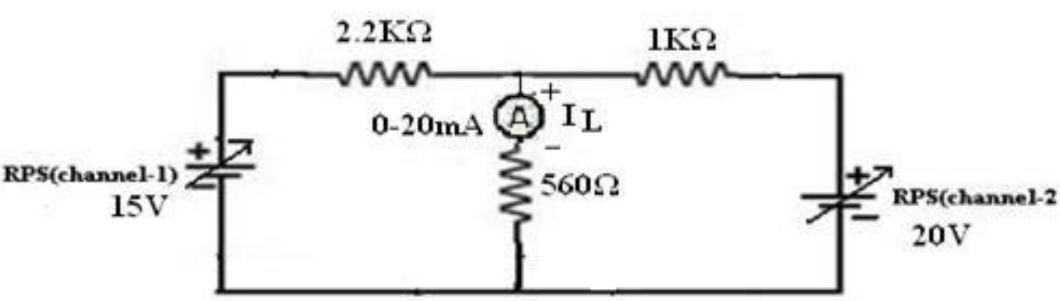


Figure: 3.2: Circuit Diagram

When V_1 Source Acting (To Find I_L^I)

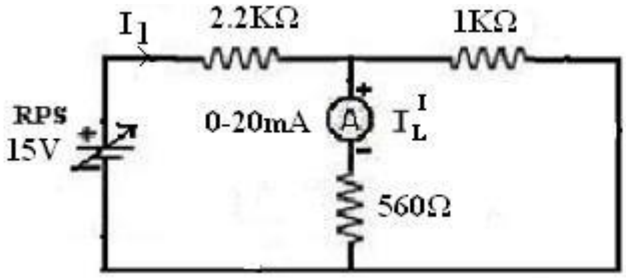


Figure: 3.3. Circuit Diagram

When V_2 source acting (To find I_L^{II}):

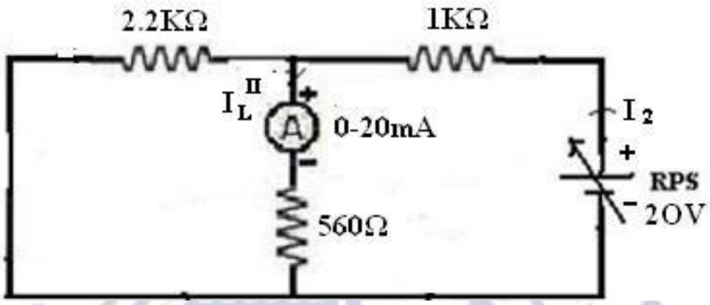


Figure: 3.4. Circuit Diagram

THEORY:

SUPERPOSITION THEOREM:

Superposition theorem states that in a lumped, linear, bilateral network consisting more number of sources each branch current(voltage) is the algebraic sum all currents (branch voltages), each of which is determined by considering one source at a time and removing all other sources. In removing the sources, voltage and current sources are replaced by internal resistances.

PROCEDURE:

1. Connect the circuit as per the figure 3.2.
2. Adjust the voltage of sources. i.e., RPS (channel-1) and RPS (channel-2) to appropriate values (Say 15V and20V respectively).
3. Note down the current (I_L) through the 560 0hm resistor by using the ammeter.
4. Connect the circuit as per figure 3.3. Set the RPS (channel-2) to 0V, such that short circuit the RPS (channel-2) and source RPS (channel-1) to 15 V.
5. Note down the current I_L^I through 560 Ohm resistor by using ammeter.
6. Connect the circuit as per figure 3.4 and set the RPS (channel-2) to 20V and RPS (channel-1) to 0V such that short circuit the RPS (channel-1).
7. Note down the current (I_L^{II}) through the 560 Ohm resistor branch by using ammeter.
8. Reduce the output voltage of the sources RPS (channel-1) and RPS (channel-2) to 0V and switch off the supply.
9. Disconnect the circuit.

THEORITICAL CALCULATIONS:

From Figure 3.3,

$$I_1 = \frac{V_1}{R_1 + (R_2//R_3)}$$

$$I_L^I = I_1 \times \frac{R_2}{R_2 + R_3}, \quad \textit{by current division rule}$$

From Figure 3.4,

$$I_2 = \frac{V_2}{R_2 + (R_1//R_3)}$$

$$I_L^{II} = I_2 \times \frac{R_1}{R_1 + R_3}, \quad \textit{by current division rule}$$

$$I_L = I_L^I + I_L^{II}$$

TABULAR COLUMNS:

From figure 3.2.

Sr. No.	**Applied Voltage (V_1) Volt**	**Applied Voltage (V_2) Volt**	**Current** I_L (mA)

From figure 3.3.

Sr. No.	**Applied Voltage (V_1) Volt**	**Current** I_L^I (mA)

From figure 3.4

Sr. No.	**Applied Voltage (V_2) Volt**	**Current** I_L^{II} (mA)

Sr. No.	Load Current	Theoretical Values	Practical Values
1	When both sources are acting, I_L		
2	When only one source, RPS-1 is acting, I_L^I		
3	When only one source, RPS-2 is acting, I_L^{II}		

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:____

____

____

____

____

VIVA QUESTIONS:

1. What is the Superposition Theorem?
2. What do you mean by "turning off" a source in superposition?
3. Is Superposition Theorem applicable to both AC and DC circuits?
4. Can we use the superposition theorem to find power in a circuit? Why or why not?
5. What do you mean by Unilateral and Bilateral network? Give the limitations of Superposition Theorem?
6. What are the equivalent internal impedances for an ideal voltage source and for a Current source?
7. Transform a physical voltage source into its equivalent current source.
8. Superposition can be used to find the voltage across a resistor in a linear circuit. (*True /False)*

Experiment No. 04 (A)

Title 4 (A): Verification of Thevenin theorem for DC Network using breadboard

AIM: To verify Thevenin's and Norton theorem for the given circuit.

APPARATUS REQUIRED:

S.No	Name of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:

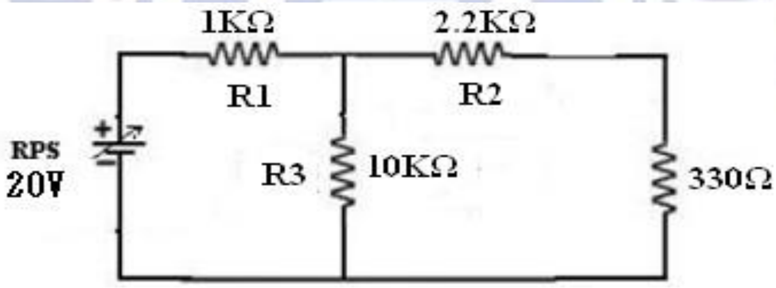


Figure 4.1: Circuit Diagram

PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:

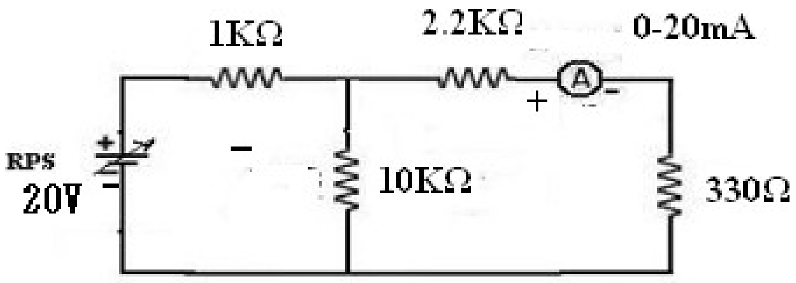


Figure 4.2: Circuit Diagram

To find V_{th}:

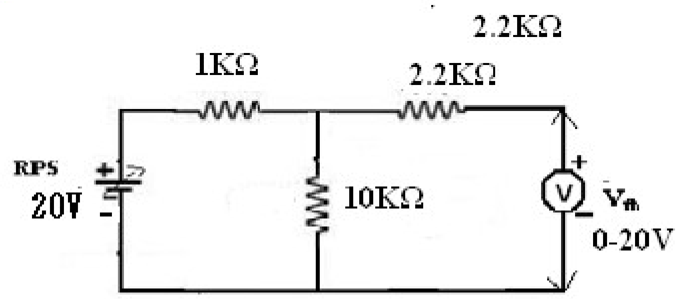


Figure 4.3: Circuit Diagram

To find R_{th}:

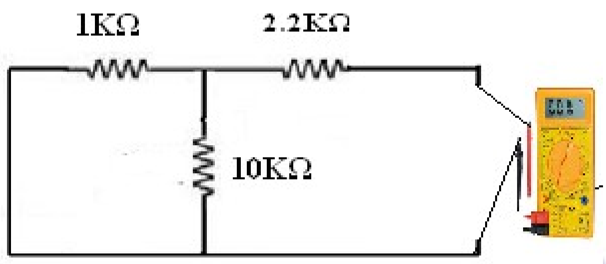


Figure 4.4: Circuit Diagram

THEORY:

THEVENIN'S THEOREM:

It states that in any lumped, linear network having more number of sources and elements the equivalent circuit across any branch can be replaced by an equivalent circuit consisting of Theremin's equivalent voltage source Vth in series with Theremin's equivalent resistance Rth. Where Vth is the open circuit voltage across (branch) the two terminals and Rth is the resistance seen from the same two terminals by replacing all other sources with internal resistances.

The values of V_{th} and R_{th} are determined as mentioned in thevenin's theorem. Once the Thevenin equivalent circuit is obtained, then current through any load resistance RL connected across Ab is given by,

$$I = \frac{V_{th}}{R_{th} + R_L}$$

Thevenin's theorem is applied to D.C circuits as stated below.

Any network having terminals A and B can be replaced by a single source of e.m.f. Vth in series with a source resistance Rth.

1) The Vth is the voltage obtained across the terminals A and B with load, i.e., it is open circuited voltage between terminals A and B.
2) The Rth is the reistance of the network measured between the terminals A and B with load removed and sources of e.m.f replaced by their internal resistance. Ideal voltage sources are replaced with short circuits and ideal current sources are replaced with open circuits.

PROCEDURE:

1. Connect the circuit as per figure 4.2.
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, I_L) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the figure 4.3.
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the voltage across the load terminals AB (Voltmeter reading) that gives Vth.
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the figure 4.4.
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Thevenin's resistance (R_{Th}).

THEORITICAL VALUES:

Tabulation for Thevenin's Theorem:

THEORITICAL VALUES	PRACTICAL VALUES
V_{th}= R_{th}= I_L=	V_{th}= R_{th}= I_L=

RESULT:

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Experiment No. 04 (B)

Title 4 (A): Verification of Norton's theorem for DC Network using breadboard

AIM: To verify Norton's theorem for the given circuit.

APPARATUS REQUIRED:

S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:

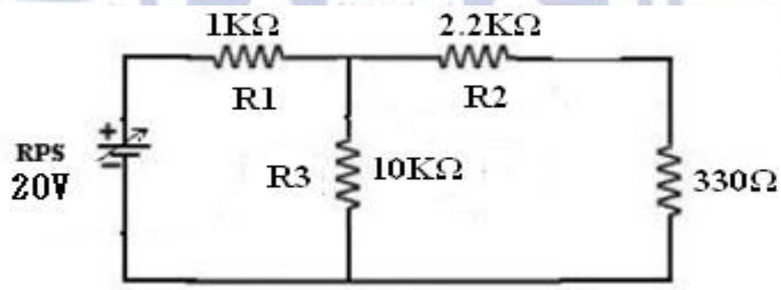

Figure: 4.5: Circuit Diagram

PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:

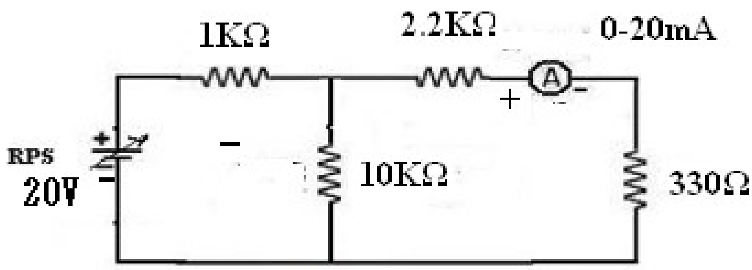

Figure: 4.6: Circuit Diagram

TO FIND I_N:

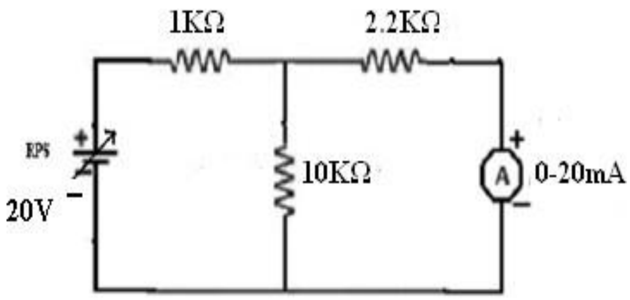

Figure: 4.7: Circuit Diagram

To find R_N:

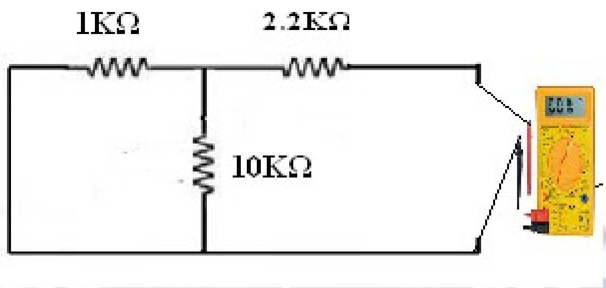

Figure: 4.8: Circuit Diagram

THEORY:

NORTON'S THEOREM:

Norton's theorem states that in a lumped, linear network the equivalent circuit across any branch is replaced with a current source in parallel a resistance. Where the current is the Norton's current which is the short circuit current though that branch and the resistance is the Norton's resistance which is the equivalent resistance across that branch by replacing all the sources sources with their internal resistances

for source current,

$$I = \frac{V}{R^I} = \frac{V(R_2 + R_3)}{R_1R_2 + R_1R_3 + R_2R_3}$$

FOR NORTON's CURRENT

$$I_N = I \times \frac{R_3}{R_3 + R_2} = \frac{VR_3}{R_1R_2 + R_1R_3 + R_2R_3}$$

Load Current through Load Resistor

$I_L = I_N \times [R_N / (R_N + R_L)]$

PROCEDURE:

1. Connect the circuit as per figure 4.6.
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, IL) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the figure 4.7.
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the response (current, I_N) through the branch AB (ammeter reading).
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the figure 4.8.
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Norton's resistance (R_N).

TABULATION FOR NORTON'S THEOREM:

THEORITICAL VALUES	PRACTICAL VALUES
I_N= R_N= I_L=	I_N= R_N= I_L=

RESULT:

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VIVA QUESTIONS:

1. The internal resistance of a source is 2 Ohms and is connected with an External Load of 10 Ohms Resistance. What is Rth?
2. In the above question if the voltage is 10 volts and the load is of 50 ohms. What is the load current and Vth? Verify I_L?
3. If the internal resistance of a source is 5 ohms and is connected with an ExternalLoad of 25 Ohms Resistance. What is Rth?
4. In the above question if the voltage is 20V and the load is of 50 Ohms. What is the load current and I_N ? Verify I_L ?

Experiment No: 05

Title: Verification of Maximum Power Transfer theorem for DC Network using breadboard.

AIM: To verify the Maximum Power Transfer Theorem for the given circuit.

APPARTUS REQUIRED:

SI. No	Equipment	Range	Qty
1	Bread board	-	1 NO
2	DC Voltage source.	0-30V	1 NO
3	Resistors	470 Ω	1 NO
4	Decade resistance box	0-10k Ω	1 NO
5	Ammeter	0-20mA	1 NO
6	Connecting wires	1.0.Sq.mm	As required

CIRCUIT DIAGRAM:

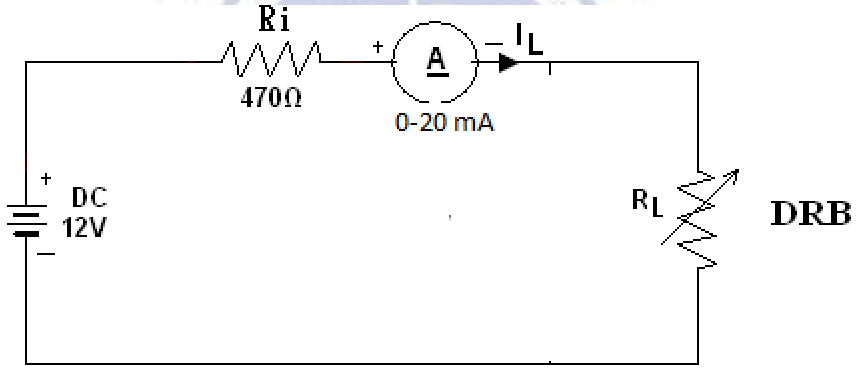

Figure 5.1: Circuit Diagram

THEORY:

STATEMENT:

It states that the maximum power is transferred from the source to load when the load resistance is equal to the internal resistance of the source.

(or)

The maximum transformer states that "A load will receive maximum power from a linear bilateral network when its load resistance is exactly equal to the Thevenin's resistance of network, measured looking back into the terminals of network.

Consider a voltage source of V of internal resistance R_i delivering power to a load Resistance R_L

Circuit current = $\frac{V}{R_L+R_i}$

Power delivered $P = I^2 R_L$

$$= \left[\frac{V}{R_L+R_i}\right]^2 R_L$$

for maximum poewer $\frac{d(p)}{dt} = 0$

RL+Ri cannot be zero,

Ri – RL = 0

$$R_L == Ri$$

$$Pmax = \frac{V^2}{4R_L} \text{ watts}$$

PROCEDURE:

1. Connect the circuit as shown in the above figure 5.1.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance (R_L) in steps and note down the corresponding Ammeter Reading (I_L) in milli amps and Load Voltage (V_L) volts
6. Tabulate the readings and find the power for different load resistance values.
7. Draw the graph between Power and Load Resistance.
8. After plotting the graph, the Power will be Maximum, when the Load Resistance will be equal to source Resistance.

TABULAR COLUMN:

S.No	R_L	I_L(mA)	Power(P max)=I_L^2*R_L(mW)
1			
2			
3			
4			
5			
6			
7			
8			

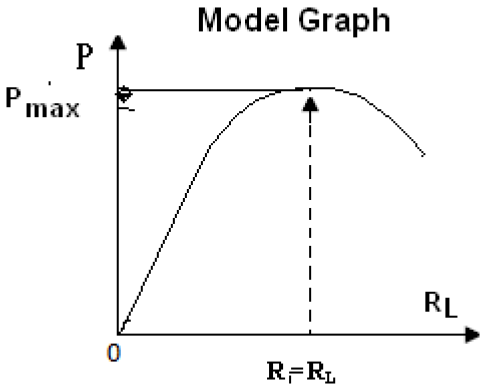

Figure 5.2: Graph for Power Vs Load Resistance

Theoretical Calculations: -

$R = (R_i + R_L)$ =........**Ω**

$I_L = V / R$ =……..**mA**

Power = (I_L^2) **R_L** =……..…**mW**

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:____

VIVA QUESTIONS:

1) What is maximum power transfer theorem?
2) What is the application of this theorem?
3) Write the condition for maximum power transfer in AC circuit.

Experiment No: 06

Title: Measurement of active power and power factor in a single phase circuit

AIM: Measurement of power and power factor in a single-phase ac series inductive circuit.

APPARATUS REQUIRED:

S.No	Name of the Equipment	Range	Type	Quantity
1				
2				
3				
4				
5				
6				
7				
8				

CIRCUIT DIAGRAM:

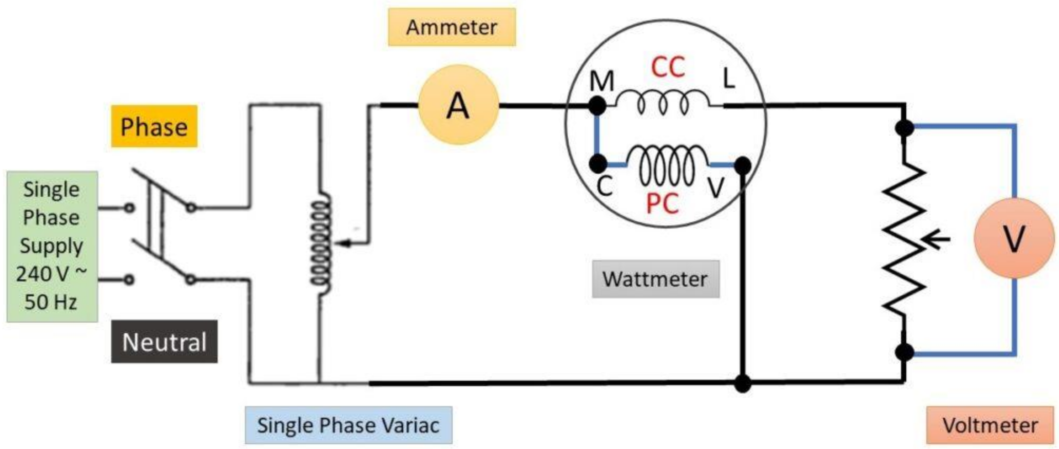

Figure 6.1: Circuit diagram for measurement of power and power factor with R-L Load.

Theory:

In R-L series AC circuit a resistor of resistance R ohm, and Inductor of inductance L henry are connected across single phase ac supply of V volts as shown in above figure.

Power consumed by the Inductive load is given by

$$P=VI\cos\phi$$
$$\text{Powerfactor}=(\cos\phi)=P/VI$$

where, P is active power in watt, V is supplied voltage in volts, I is current flowing through the circuit elements in Amp. Thus, by using above formula the power consumed by the load and power factor can be determined.

PROCEDURE:

1. Connect all the instruments as per circuit diagram given above.
2. Before switch on the main power supply make sure that single-phase auto transformer knobe is at zero position.
3. Now slowly increase the supply voltage to the circuit after giving supply to the single-phase auto-transformer.
4. Take all the corresponding readings of the connected instruments in the circuit as per observation table.
5. Now power factor Cosϕ and % error as per formula given in observation table.
6. Now connect the capacitor in parallel with the R-L load and take readings as per observation table and analyze the power factor.

PRECAUTION: –

1. Don't switch on power supply without concerning teacher.
2. Single phase autotransformer must be kept at minimum potential point before switch on the experiment.

TABULAR COLUMN:

Sl. No.	V (in volts.)	I (in Amp.)	P (in watts.)	Cosϕ= {P/(V*I)}
1				
2				
3				
4				
5				

CONCLUSION:

____

____

____

____

____

VIVA QUESTIONS:

1. What is power factor in an AC circuit?
2. How does an inductive load affect power factor?
3. How is power measured in a single-phase AC series inductive circuit?
4. What is the significance of power factor in electrical systems?
5. How can power factor be improved in a single-phase AC series inductive circuit?
6. Define apparent power and reactive power in an AC circuit. What is power factor correction, and why is it necessary?
7. How do capacitors improve power factor?
8. Can you explain the difference between leading and lagging power factor?

Experiment No: 07

Title: To find out polarity of single-phase Transformer

AIM: To perform Polarity test on single phase transformer.

APPARATUS REQUIRED:

S.No	Name of the Equipment	Range	Type	Quantity
1				
2				
3				
4				
5				
6				

CIRCUIT DIAGRAM:

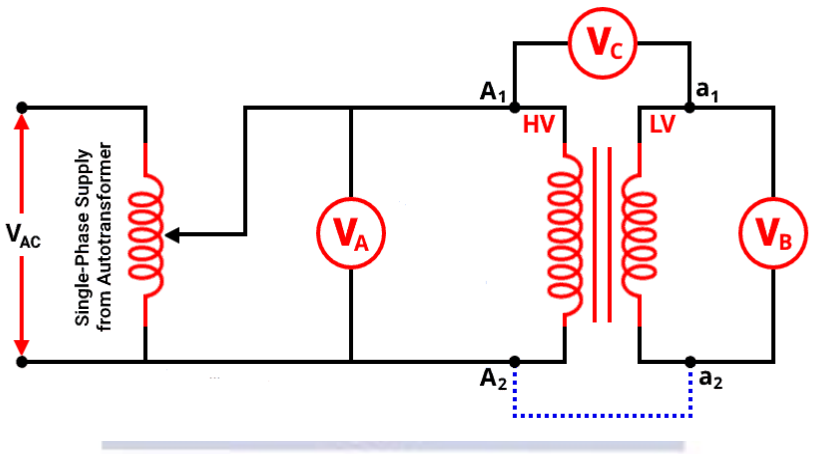

Figure: 7.1: Circuit diagram for Polarity test of transformer

Additive Polarity:

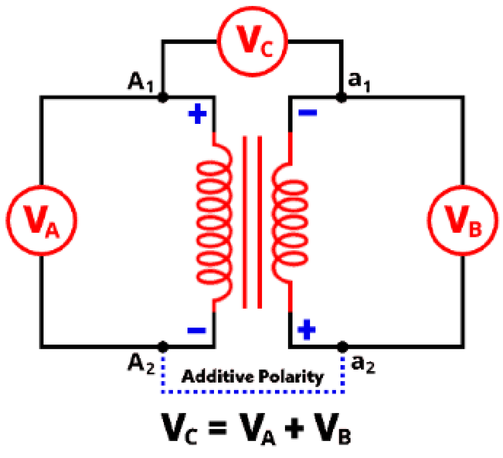

Figure 7.2: Circuit diagram for additive polarity test on single phase transformer

Subtractive Polarity:

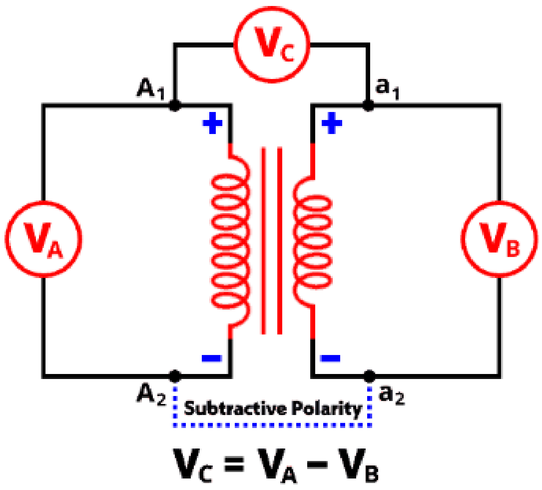

Figure 7.3: Circuit diagram for subtractive polarity test on single phase transformer

THEORY:

The polarity of a transformer can be additive or subtractive. To find the additive or subtractive polarity, connect one terminal of primary winding with one terminal of the secondary winding and connect the remaining terminals of primary and secondary winding with a voltmeter.

There are two types of the polarity test:

Additive Polarity
In additive polarity, the voltmeter reads the voltage of summation of primary and secondary voltages. The voltmeter reading is denoted as V_C. And the primary and secondary voltage is denoted as V_A and V_B respectively. In additive polarity, the voltmeter reads;

$$V_C = V_A + V_B$$

Subtractive Polarity
In subtractive polarity, the voltmeter reads the voltage of subtraction of primary and secondary voltages. The voltmeter reading is denoted by VC and the equation of voltmeter reading is;

$$V_C = V_A – V_B$$

PROCEDURE:

1. Connect the circuit as shown above with a voltmeter (V_A) across the primary winding and another voltmeter (V_B) across the secondary winding.
2. If available, take down the ratings of the transformer and the turn ratio.
3. We connect a voltmeter (Vc) between secondary and primary windings.
4. We apply some voltage to the primary side.
5. By checking the value in the voltmeter (Vc), we can find whether it is additive or subtractive polarity.

If subtractive polarity – Vc should show the difference between Va and Vb.
If additive polarity – Vc should show the sum of Va and Vb.

Note: If we require additive polarity, but we have subtractive polarity, we can simply change it by keeping any of the secondary or primary windings in the same fashion and reversing the winding connection of the other one. Similarly, if we require subtractive polarity but have additive polarity, we could do the same procedure as above.

TABULAR COLUMN:

Additive polarity			
Sr. No.	V_A	V_B	$V_C=VA+VB$

Subtractive polarity			
Sr. No.	V_A	V_B	$V_C=VA-VB$

PRECAUTIONS:

1. All connections should be tight.
2. The circuit should be according to circuit diagram.
3. The power should be on when the circuit is checked completely

RESULT:

VIVA QUESTIONS:

1. What is transformer?
2. What do you mean by turns ratio of transformer?
3. What is transformation ratio of transformer?
4. What are the different polarities of transformer?
5. What is the condition of additive polarity?
6. What is the condition for subtractive polarity.
7. What are the different types of transformer?
8. What is the use of autotransformer?

Experiment No: 08

Title: To Perform OC and SC test on Single Phase Transformer

AIM: To perform the open and short circuit test on single phase transformer.

APPARATUS REQUIRED:

S.No	Name of the Equipment	Range	Type	Quantity
1				
2				
3				
4				
5				
6				
7				
8				

CIRCUIT DIAGRAM:

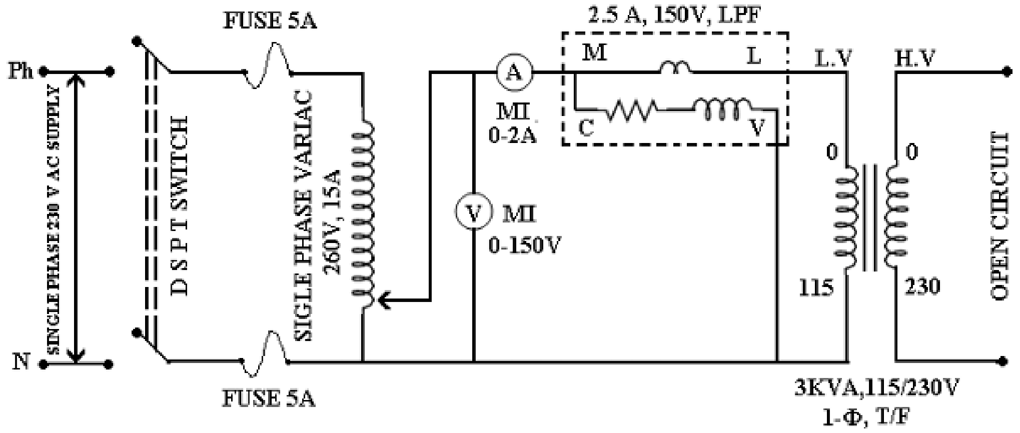

Figure 8.1: Circuit diagram for Open Circuit test on single phase transformer

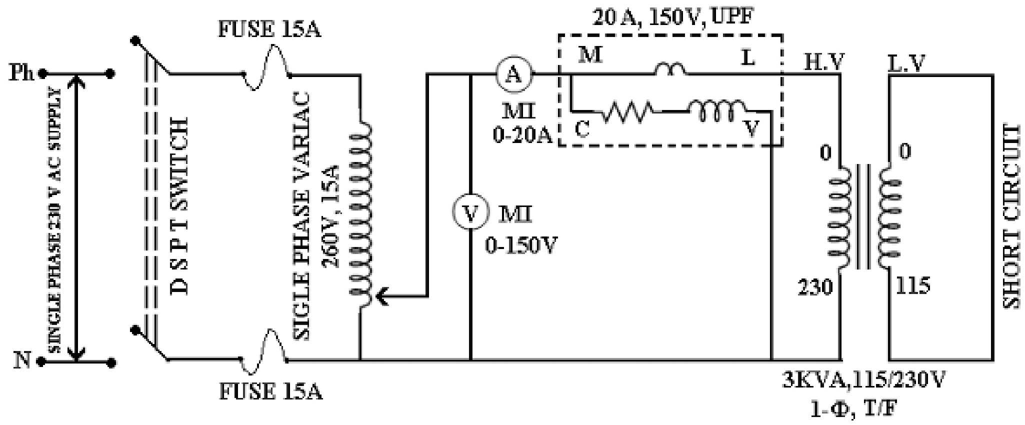

Figure 8.2: Circuit diagram for Short Circuit test on single phase transformer

THEORY:

Open Circuit Test: In this test low voltage winding (primary) is connected to a supply of normal voltage and frequency (as per the rating of transformer) and the high voltage winding (secondary) is left open as shown in fig. The primary winding draws very low current hardly 3 to 5 percentage of full load current (may be upto 10% for very small rating transformer used for laboratory purpose) under this condition. As such copper losses in the primary winding will be negligible. Thus mainly iron losses occur in the transformer under no load or open circuit condition, which are indicated by the wattmeter connected in the circuit.

Short Circuit Test*:* In this test, low voltage winding is short circuited and a low voltage hardly 5 to 8 percent of the rated voltage of the high voltage winding is applied to this winding. This test is performed at rated current flowing in both the windings. Iron losses occurring in the transformer under this condition is negligible, because of very low applied voltage. Hence the total losses occurring under short circuit are mainly the copper losses of both the winding, which are indicated by the wattmeter connected in the circuit as shown in figure 8.2.

PRECAUTIONS:

1. All connections should be tight.
2. The circuit should be according to circuit diagram.
3. The power should be on when the circuit is checked.

PROCEDURE:

Open Circuit Test:

1. Connect the circuit as per attached panel layout diagram for single phase transformer O.C. test.
2. Connect the AC input terminals through Variac on panel.
3. Connect the transformer terminals C and 100% on primary side to terminals marked PRIMARY on panel and the SECONDARY should be left open.
4. Now connect the various instruments i.e. voltmeter, ammeter and wattmeter required for open circuit test as per above figure 8.1
5. Ensure that the setting of the variac is at low output voltage.
6. Switch on the supply and adjust rated voltage across the transformer circuit.
7. Record no load current, voltage applied and no load power, corresponding to the rated voltage of the transformer winding.
8. Switch-off the AC supply.

Short Circuit Test:

1. Connect the AC input terminals through Variac on panel.
2. Connect the transformer terminals C and 100% on primary side to terminals marked PRIMARY on panel and short the secondary terminals on transformer plate.
3. Now connect the various instruments i.e. voltmeter, ammeter and wattmeter required for short circuit test as per above figure.
4. Ensure that the setting of the variac is at low output voltage.
5. Switch on the supply and increase the voltage across voltmeter 0-30 volt till the rated current (i.e. full load current as per nameplate date) is indicated on ammeter 0-5 A on primary side.

6. Record short circuit current, corresponding voltage applied and power with full load current flowing under short circuit conditions.
7. Switch-off the AC supply.
8. Tabulate the readings as given below.

TABULAR COLUMN:

Observation Table:

Sr. No.	Open Circuit Test			Short Circuit Test		
	V_0	I_0	W_0	V_{sc}	I_{sc}	W_{sc}

Calculation Table:

Sr. No.	Cos(Øo)	I_0	W_0	Ro	X_m	R_{eq}	X_{eq}	Load	η	Regulation

RESULT:

VIVA QUESTIONS:

1. What information do you get from open circuit test on single phase transformer?
2. Which side is kept open in case of open circuit test?
3. What is the power factor of a transformer under no load condition?
4. What is the magnitude of no load current w.r.t . Full load current?
5. What do you mean by equivalent circuit of transformer?
6. Why indirect testing of transformers is necessary?
7. How does the copper losses vary with variation of load on transformer?
8. What do you understand by all day efficiency of transformer?
9. Why do you perform short circuit test on transformer?
10. Which side is short circuited in short circuit test?
11. Which supply is given in short circuit test?
12. What is the power factor of transformer?
13. What is working principle of transformer?