KAMMAVARISANGHAM

K.S.INSTITUTE OF TECHNOLOGY

(APPROVED BY A.I.C.T.E AFFILIATED TO VTU BELGAUM)
#14, RAGHUVANAHALLI, KANAKAPURA MAIN ROAD,BANGALORE-560109

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG.

NAME OF THE LAB: BASIC ELELCTRICAL ENGG LAB

COURSE CODE: 18ELEL17/27

K. S. INSTITUTE OF TECHNOLOGY

VISION

"To impart quality technical education with ethical values, employable skills and research to achieve excellence".

MISSION

- To attract and retain highly qualified, experienced & committed faculty.
- To create relevant infrastructure.
- Network with industry & premier institutions to encourage emergence of new ideas by providing research & development facilities to strive for academic excellence.
- To inculcate the professional & ethical values among young students with employable skills & knowledge acquired to transform the society.

K.S. INSTITUTE OF TECHNOLOGY

DEPARTMENT OFELECTRONICS & COMMUNICATION ENGINEERING

VISION

"To achieve excellence in academics and research in Electronics & Communication Engineering to meet societal need".

MISSION

- To impart quality technical education with the relevant technologies to produce industry ready engineers with ethical values.
- To enrich experiential learning through active involvement in professional clubs & societies.
- To promote industry-institute collaborations for research & development.

K.S. INSTITUTE OF TECHNOLOGY

DEPARTMENT: ELECTRONICS AND COMMUNICATION ENGG.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

PEO1: Excel in professional career by acquiring domain knowledge.

PEO2: Motivation to pursue higher Education & research by adopting Technological innovations by continuous learning through professional bodies and clubs.

PEO3: To inculcate effective communication skills, team work, ethics And leadership qualities.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1: Graduate should be able to understand the fundamentals in the field of Electronics & Communication and apply the same to various areas like Signal processing, embedded systems, Communication & Semiconductor technology.

PSO2: Graduate will demonstrate the ability to design, develop solutions for Problems in Electronics & Communication Engineering using hardware and software tools with social concerns.

K S INSTITUTE OF TECHNOLOGY

PROGRAM OUTCOMES (PO'S)

Engineering Graduates will be able to:

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 anddesign 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 researchmethods 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 modernengineering 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 assesssocietal, 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 solutionsin 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 ofthe engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineeringcommunity 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 theengineering 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 inindependent and life-long learning in the broadest context of technological change.

K. S. INSTITUTE OF TECHNOLOGY
#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

<table>
<tr><td colspan="4">Course:Basic Electrical Engineering Laboratory</td></tr>
<tr><td colspan="4">Course Incharge : Vishalini Divakar</td></tr>
<tr><td colspan="2">Type: Core</td><td colspan="2">Course Code:18ELEL17/27</td></tr>
<tr><td colspan="4">No of Hours per week</td></tr>
<tr><td>Theory
(Lecture Class)</td><td>Practical/Field
Work/Allied Activities</td><td>Total/Week</td><td>Total teaching hours</td></tr>
<tr><td>0</td><td>2</td><td>2</td><td>50</td></tr>
<tr><td colspan="4">Marks</td></tr>
<tr><td>Internal Assessment</td><td>Examination</td><td>Total</td><td>Credits</td></tr>
<tr><td>40</td><td>60</td><td>100</td><td>1</td></tr>
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Aim/Objective of the Course:

This course will enable students to:

1. To provide exposure to common electrical components such as Resistors, capacitors and inductors, types of wires and measuring instruments.
2. To measure power and power factor measurement of different types of lamps and three phase circuits.
3. To explain measurement of impedance for R-L and R-C circuits.
4. To determine power consumed in a 3 phase load.
5. To determine earth resistance and explain methods of controlling a lamp from different places.

Course Learning Outcomes:

After completing the course, the students will be able to,

CO1	**Analyse** the effect of open circuit and short circuit in DC circuits using KCL &KVL.	Analyzing (K4)
CO2	**Compare** the power factor for different types of lamps	Evaluating (K5)
CO3	**Measure** the parameters of choke coil and earth resistance	Evaluating (K5)
CO4	**Measure**current and the power consumed in three phase load.	Evaluating (K5)
CO5	**Examine** the truth table for two-way and three-way control of lamps.	Analyzing (K4)

Sl.no	List of Experiments
1	Verification of Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL).
2	Two way and three way control of lamps and verification of truth table.
3	Study of effect of open and short circuit.
4	Measurement of Power and Power factor of different lamps.
5	Measurement of parameters of a choke coil using 3-voltmeter method.
6	Measurement of Earth resistance.
7	Determination of phase and line quantities in 3 phase Star and Delta connected loads.
8	Measurement of 3pahse power by 2 wattmeter method.

Text Books: -

1. Fundamentals of Electrical Engineering and Electronics, B. L. Theraja, S. Chand & Company Ltd, Reprint Edition 2013.
2. Electrical Technology, E. Hughes, International Students 9th Edition, Pearson, 2005
3. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2017

Web-Materials

1. http://www.nptelvideos.in/2012/11/basic-electrical-technology.html.
2. https://nptel.ac.in/courses/Webcourse /IIT Kharagpur.
3. http://nptel.ac.in.--Lecture Series on Basic Electrical Technology by Prof. L.Umanand,

Assessment:

Type of test/examination: Written examination
Continuous Internal Evaluation(CIE) : 40 marks
Semester End Exam(SEE) : 60 marks (students have to answer all main questions)
Test duration: 1 :30 hr
Examination duration: 3 hrs

CO to PO Mapping

PO1: Science and engineering Knowledge **PO2:** Problem Analysis **PO3:** Design & Development **PO4:**Investigations of Complex Problems **PO5:** Modern Tool Usage **PO6:** Engineer & Society	**PO7:**Environment and Society **PO8:**Ethics **PO9:**Individual & Team Work **PO10:** Communication **PO11:**Project Mngmt & Finance **PO12:**Life long Learning

PSO1: Graduate should be able to understand the fundamentals in the field of Electronics Communication and apply the same to various areas like Signal processing, embedded system Communication & Semiconductor technology.

PSO2: Graduate will demonstrate the ability to design, develop solutions for Problems in Electronics& Communication Engineering using hardware and software tools with social concerns

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2
CO1	3	3		-	-	-	-	-	2	1	-	1	3	1
CO2	3	3		-	-	-	-	-	2	1	-	1	3	1
CO3	3	3		-	-	-	-	-	2	1	-	1	3	1
CO4	3	3		-	-	-	-	-	2	1	-	1	3	1
CO5	3	3		-	-	-	-	-	2	1	-	1	3	1
18ELE17/27	**3**	**3**		-	-	-	-	-	**2**	**1**	-	**1**	**3**	**1**

Contents

EXPERIMENT – 01

Verification of Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)

Aim:

To verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL).

Apparatus Required:

1. DC Ammeter (0-100 mA) - 3 nos.
2. DC Voltmeter (0-100 V) - 3 nos.
3. Resistor (1kΩ) - 2 nos.
4. DC Power Supply (0-30 V)/1A - 1 no.
5. Connecting wires

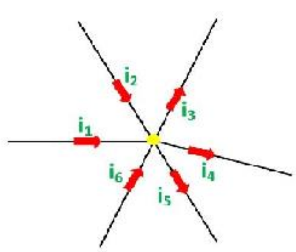
<u>THEORY</u>

Kirchhoff's laws are basic analytical tools in order to obtain the solutions of currents and voltages for any electric circuit when it is supplied from a direct-current or an alternating current.

(i) Statement of Kirchhoff's Current Law: Kirchhoff's current law states that at any instantthe algebraic sum of all the currents meeting at a junction in a circuit is zero.

In other word, the sum of currents flowing away from the junction is equal to the sum of currents flowing towards that junction.

$\Sigma I_{junction} = 0$



Considering the above figure as per the Kirchhoff's Current Law

$$i_1 + i_2 - i_3 - i_4 - i_5 + i_6 = 0 \text{ .... (1)}$$

The direction of incoming currents to a node is taken as positive while the outgoing currents is taken as negative. The reverse of this can also be taken, i.e. incoming current as negative or outgoing as positive. It depends upon your choice.

The equation (1) can also be written as

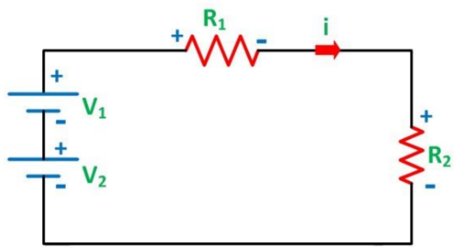
$$\mathbf{i_1 + i_2 + i_6 = i_3 + i_4 + i_5}$$

Sum of incoming currents = Sum of outgoing currents

(ii)Statement of Kirchhoff's Voltage law: The algebraic sum of all the potentials/voltages acting around a closed loop is zero.

$$\Sigma V_{loop} = 0$$

It states that in a closed circuit, the algebraic sum of all source voltages must be equal to the algebraic sum of all the voltage drops. Voltage drop is encountered when current flows into an element (resistance or load) from the higher-potential terminal toward the lower potential terminal.



The above figure shows closed circuit also termed as a mesh. As per the Kirchhoff's Voltage Law

$$-V_1 + (-V_2) + iR_1 + iR_2 = 0 \quad \dots\dots\dots (2)$$

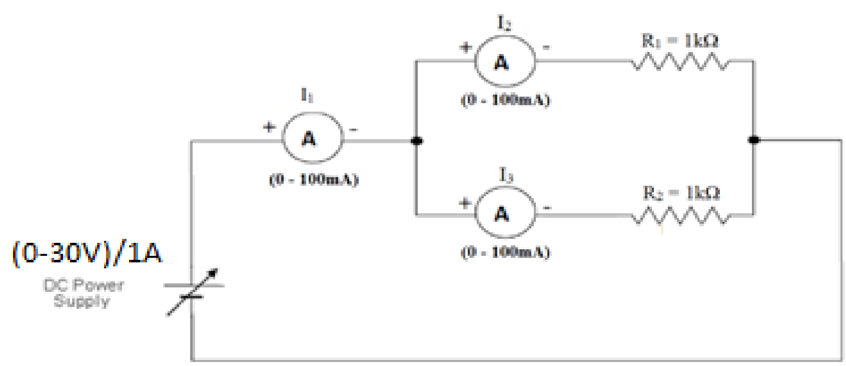
Here, the assumed current I causes a positive voltage drop of voltage when flowing from the positive to negative potential while negative potential drop while the current flowing from negative to the positive potential.

$$i(R_1 + R_2) = V_1 + V_2 \quad \text{or}$$

$$i = \frac{V_1 + V_2}{(R_1 + R_2)}$$

Kirchhoff's Current Law (KCL):

Circuit Diagram:



Procedure:

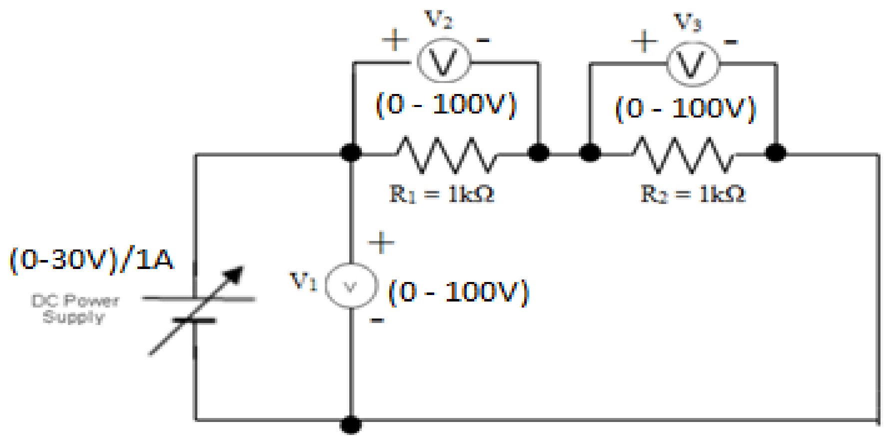
1. Make the connections as given in the circuit diagram.
2. Switch ON regulated power supply.
3. Using regulated power supply set a current of 5mA and note down the readings of all the ammeters [I_1, I_2, I_3] in the tabular column.
4. Repeat the same for different values of currents by varying power supply in steps.

Tabular Column

Sl.No	I_1 mA	I_2 mA	I_3 mA	$I_1 = I_2 + I_3$ mA
01				
02				
03				
04				
05				

Kirchhoff's Voltage Law (KVL)

Circuit Diagram:



Procedure:

1. Make the connections as given in the circuit diagram.
2. Switch ON regulated power supply.
3. Using regulated power supply apply a voltage of 5V and note down the readings of all the volt meters [V_1, V_2, V_3] in the tabular column.
4. Repeat the same for different voltages by varying power supply in steps.

Tabular Column

Sl.No	V_1 Volts	V_2 Volts	V_3 Volts	$V_1 = V_2 + V_3$ Volts
01				
02				
03				
04				
05				

Result:

Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) for the given DC network were studied and verified.

EXPERIMENT – 02

TWO WAY AND THREE WAY CONTROL OF LAMPS

AND VERIFICATION OF TRUTH TABLE

Aim:

To Control the lamps in two - way and three - Way using two - way and intermediate switch.

Apparatus:

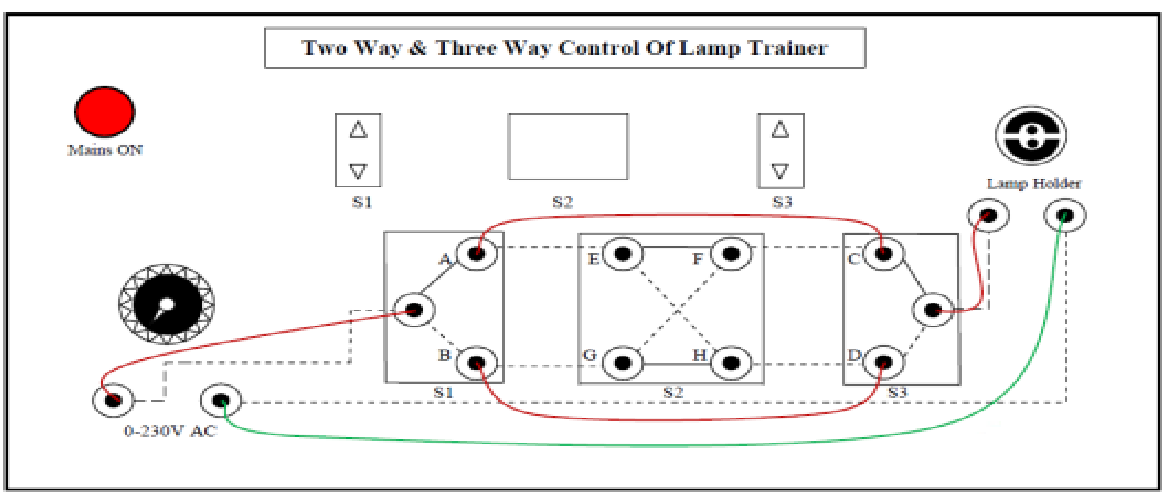
1. Two way switch - 2 nos.
2. Intermediate switch - 1 no
3. Lamp - 1 no
4. Connecting wires

Two – way control:

Theory:

2 way switching means having two or more switches in different locations to control one lamp. They are wired so that operation of either switch will control the light. This arrangement is often found in stairways, with one switch upstairs and one switch downstairs.when we turn ON/OFF the switch at any end the light present state changes to opposite state, if light presents in ON condition then it becomes OFF, if light present in OFF condition then it becomes ON. It is also used in long hallways with a switch at either end.

Connection Diagram:



Procedure

1. Make the connections as given in the circuit diagram for 2 way control.
2. Set the voltage to 230V after switching on the main supply.
3. Initially keep the positions of the two way switches S1 and S2 as per the tabular column.
4. Repeat the above step by changing the switch positions.
5. Note down the lamp condition.
6. Switch off the supply.

Truth Table:

Sl.No	SW1	SW2	Lamp
01	A	C	ON
02	A	D	OFF
03	B	C	OFF
04	B	D	ON

Three – way control:

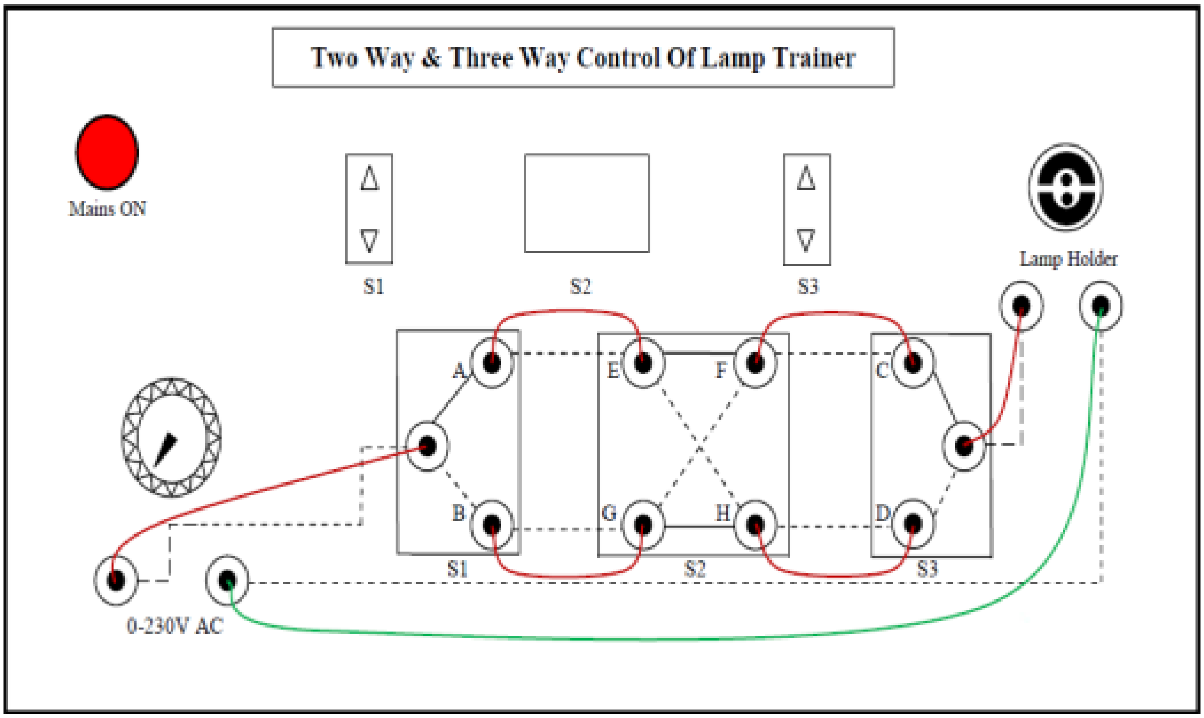
Theory:

A light or lights can be controlled by more than one switch. The usual practice in home construction is to use 3-way switches.A lamp can be controlled from three different locations. The circuit needs an intermediate switch along with two number 2-way switches. Intermediate has two states namely straight and cross connection. Application of three - way control is corridor lighting, stair case lighting, bedroom lighting, cellars lighting etc.

Procedure

1. Make the connections as given in the circuit diagram for 3 way control.
2. Set the voltage to 230V after switching on the main supply.
3. Initially keep the positions of the two way switches S1, intermediate and S2 as per the tabular column.
4. Repeat the above step by changing the switch positions.
5. Note down the lamp condition.
6. Switch off the supply.

Connection Diagram:



Truth Table:

Sl.No	SW1	SW2	SW3	Lamp
01	A	Straight Connection EF GH	C	ON
02	A		D	OFF
03	B		C	OFF
04	B		D	ON
05	A	Cross Connection EH GF	C	OFF
05	A		D	ON
07	B		C	ON
08	B		D	OFF

Result:

Two - way Control and three - way control of a lamp are studied and the truth tables are verified.

EXPERIMENT – 03

STUDY OF EFFECT OF OPEN AND SHORT CIRCUIT

Aim:

To study and verify the effect of open and short circuit in simple DC Circuits.

Apparatus:

6. Voltmeter (0-100V) - 2 nos.
7. Ammeter (0-100mA) - 1 no
8. DC Power Supply (0-30V) - 1 no
9. Resistors (1kΩ) - 3 nos.
10. Connecting wires

Theory:

Learning Objectives:

1. To realize the effect of open and short circuit tests in an electric circuit.
2. To realize the existence of voltage on open circuit.
3. To realize the effect of current on short circuit.

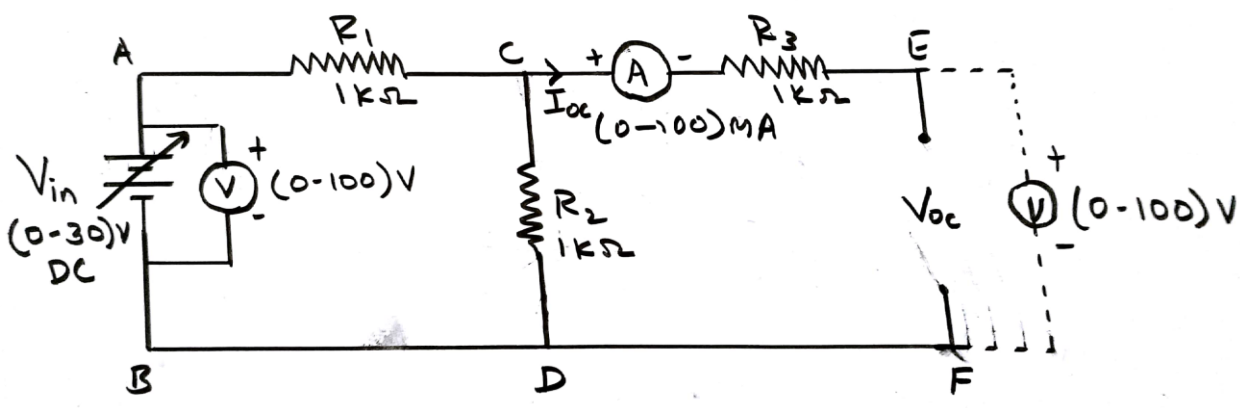
An electric circuit in which the normal path of current has been interrupted either by the disconnection of one part of its conducting pathway from another or any interruption in the circuit such as an open switch / a break in the wiring referred as open circuit. Open circuit means there will be no flow of current but availability of voltage is present.

An open circuit is a very high resistance (almost infinite resistance) path between the two points of a circuit element. An open circuit results in zero current flow, but high voltage across the terminals. A short circuit results in extreme large current flow in a circuit and may cause the power source and other devices to be damaged.

A short circuit is simply a very low resistance connection between the two conductors supplying electric power to any circuit. This results in excessive current flow in the power source and may even cause the power source to be damaged.

Open Circuit Test:

Circuit Diagram:



Procedure:

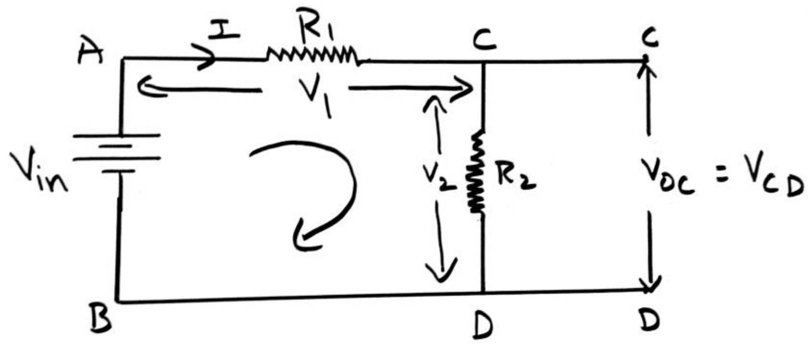
1. Make the connections as per the circuit diagram given.
2. Apply the DC power supply voltages and note down the readings of voltage and current.
3. Calculate the V_{oc} and I_{oc} theoretically.
4. Now increase the supply voltage in steps and note down the readings of voltage and current.
5. Tabulate both the practical and theoretical values in a tabular column.

Tabular Column

Sl.No	Practical			Theoretical
	V_{in} Volts	V_{oc} Volts	I_{oc} mA	V_{oc} Volts
01				
02				
03				
04				
05				

Calculations:

Equivalent circuit for open circuit:



Apply KVL to the loop ACDBA

$V - IR_1 - IR_2 = 0$

$V - I(R_1 + R_2) = 0$

$I = \frac{V}{R_1+R_2}$

$V_{CD} = IR_2$

$V_{CD} = \frac{V}{R_1+R_2} \times R_2$

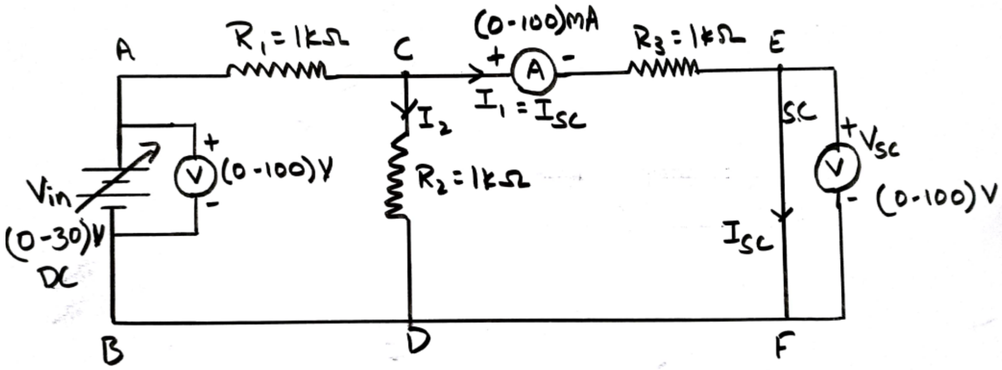
But, $V_{CD} = V_{OC}$

$\therefore V_{OC} = \frac{V}{R_1+R_2} \times R_2$ V

$I_{oc} = 0$ A

Short Circuit:

Circuit Diagram:



Procedure:

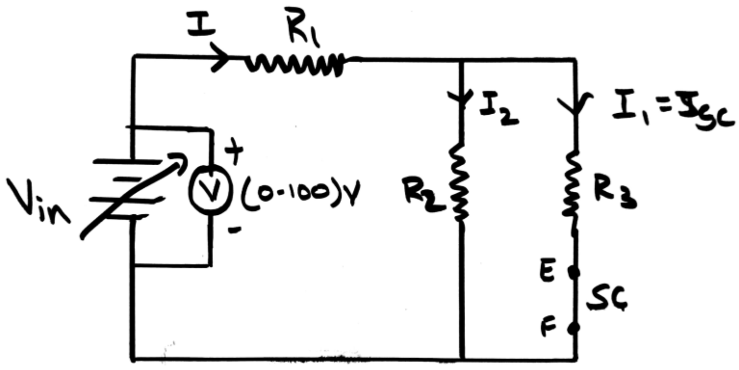
1. Make the connections as per the circuit diagram given.
2. Apply the DC power supply voltages and note down the readings of voltage and current.
3. Calculate the V_{sc} and I_{sc} theoretically.
4. Now increase the supply voltage in steps and note down the readings of voltage and current.
5. Tabulate both the practical and theoretical values in a tabular column.

Tabular Column

Sl.No	Practical			Theoretical
	V_{in} Volts	V_{sc} Volts	I_{sc} mA	I_{sc} mA
01				
02				
03				
04				
05				

Calculations:

Equivalent circuit for short circuit:



R_2 and R_3 are in parallel

$R_P = \frac{R_2 R_3}{R_2+R_3}$

$R_{eff} = R_1 + R_P$

$R_{eff} = R_1 + \frac{R_2 R_3}{R_2+R_3}$

$I = \frac{V}{R_{eff}}$

Apply current division rule to find I_{sc}:

$I_{sc} = \frac{I R_2}{R_2+R_3}$ A

$V_{sc} = 0$ V

Result:

The effect of Open circuit and short circuit have been studied and tabulated.

EXPERIMENT – 04

Measurement of Power and Power factor of different lamps.

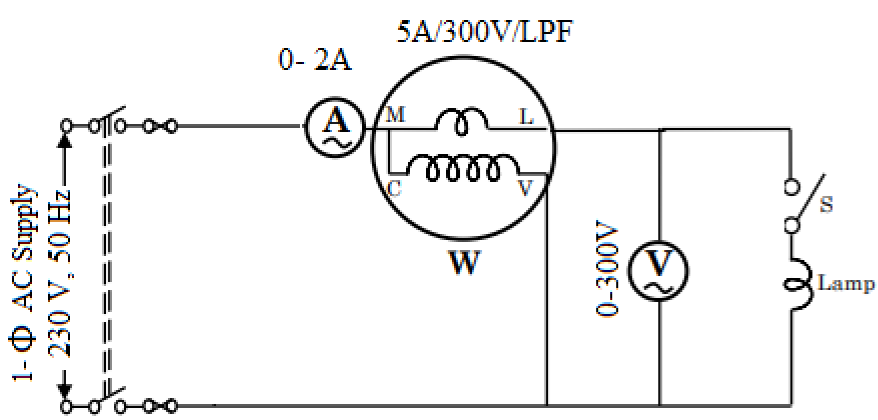
Aim:

To measure the power and power factor of incandescent lamp, fluorescent lamp CFL and LED lamps.

Apparatus Required:

1. Incandescent lamp (60 W) -1 no.
2. Fluorescent Lamp (40W) -1 no.
3. CFL (14W) -1 no.
4. LED Lamp (15W) -1 no.
5. Multi-Function Meter -1 no.
6. Connecting wires

Circuit Diagram



THEORY:

Apparent Power:

The product of RMS values of voltage and current is called as apparent power and is measured in Volt amperes (VA) or kilo Volt amperes (KVA).

S=VI

Unit **VA** or **KVA**

AC Circuits:

Energy storage elements such as inductance and capacitance results in periodic reversals of the direction of energy flow which are alternating in nature.

Active Power:

This is the actual power consumed in an AC Circuit which is obtained by multiplying the apparent power by the power factor and is expressed in watts or kilo Watts. This is also known as active power (watt-full power) or average power.

Real power P=VI cosØ

Where,

P= Power in Watts
I = Current through the load in Ampere
V= Voltage across the load in volts.
Ø= Power factor of the load.
P = volt * amps * p.f

Units – **Watts (W) or kilo Watts (kW)**

P=VI cosØ

But, $\cos\emptyset = \frac{R}{Z}$ and V = IZ

$P = (IZ)(I)\left(\frac{R}{Z}\right)$

$P = I^2R$ **Watts**

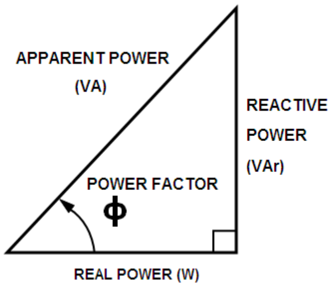
Reactive power:

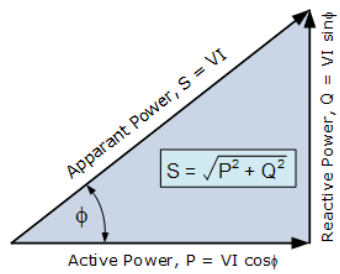
It is the Power developed in the reactance of the circuit. It is given by,

Q=VI sinØ and is measured in VAR.

Units – Reactive Volt Ampere.

Power triangle is as shown below:





From power triangle,

$S^2 = P^2 + Q^2$

$(KVA)^2 = (kW)^2 + (kVAR)^2$

P.F = cosØ = $\frac{kW}{kVA} = \frac{P}{S}$

Cos Ø = $\frac{kVIcos\emptyset}{kVI}$

Power Factor and its significance:

Power factor can be defined as,

1. Cosine of the angle between voltage and current.
2. cosØ = $\frac{R}{Z} = \frac{Resistance}{Impedance} = \frac{R}{\sqrt{R^2+X^2}}$
3. cosØ = $\frac{P}{S} = \frac{RealPower}{ApparentPower} = \frac{VIcos\emptyset}{VI} = \frac{kW}{kVA}$

NOTE:

1. If the current, I lags the voltage V, power factor is lagging (Inductive load).
   If the current, I leads the voltage V, power factor is leading (Capacitive load).
   If the current, I is in phase with the voltage V, power factor is unity (Resistive load).

2. For heaters and incandescent lamps the power factor is unity.
   For motors and tube light the power factor is lagging.
   For capacitors and condensers the power factor is leading.

3. The magnitude of power factor varies from 0 to 1.

Fluorescent Lamp

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 120 cm and 60 cm; its power rating is 28 W at 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light. The typical luminous efficacy of fluorescent lighting systems is 50–100 lumens per watt, several times the efficacy of incandescent bulbs with comparable light output.

Incandescent Lamp

Incandescent lamp is an electric light with a wire filament heated to such a high temperature that it glows with visible light (incandescence). The filament is protected from oxidation with a glass or fused quartz bulb that is filled with inert gas or a vacuum. Incandescent bulbs are manufactured in a wide range of sizes, light output, and voltage ratings, from 1.5 volts to about 300 volts. They require no external regulating equipment, have low manufacturing costs, and work equally well on either alternating current or direct current. As a result, the incandescent bulb is widely used in household and commercial lighting, for portable lighting such as table lamps, car headlamps, and flashlights, and for decorative and advertising lighting.

Incandescent bulbs have been replaced in many applications by other types of electric light, such as fluorescent lamps, Compact fluorescent lamp compact fluorescent lamps (CFL), cold cathode fluorescent lamps (CCFL), high-intensity discharge lamps, and light-emitting diode lamps (LED).

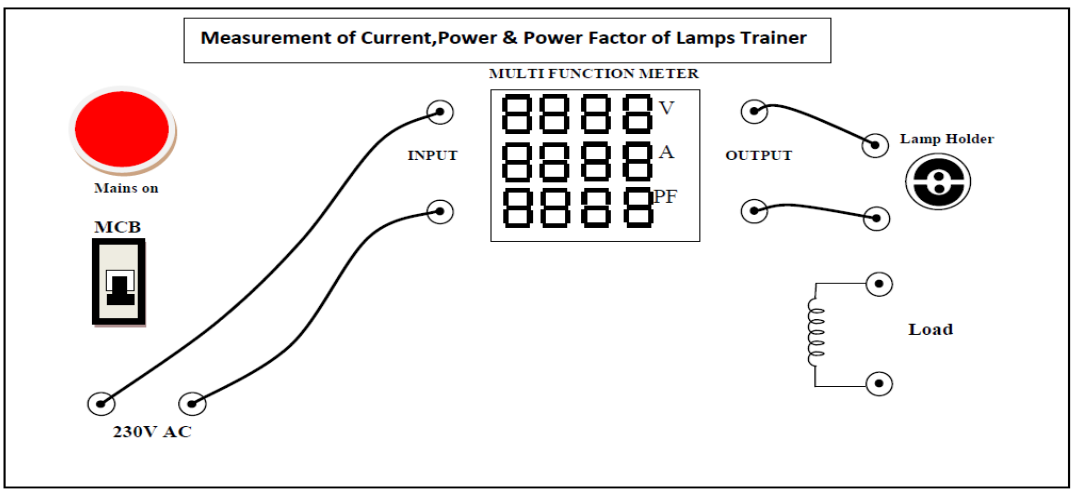
LED Lamp

LED light bulb is an electric light for use in light fixtures that produces light using light-emitting diode (LED). LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamp.

CFL Lamp:

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light, and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and a compact electronic ballast in the base of the lamp.

CONNECTION DIAGRAM



Procedure:

5. Connect the circuit as shown in the diagram with Incandescent bulb in the holder.
6. Switch on A.C supply, close the switch and observe the voltage, current, power and Power factor values in multifunction meter.
7. Repeat the same for Fluorescent Lamp, CFL bulb and LED Bulb.
8. **Now compare power factor.**

Tabular Column

Sl.No	Lamp Type	V Volts	I Amps	Power Factor CosΦ		Power Watts	
				Theoretical	Practical	Rated	Practical
01	Incandescent						
02	Fluorescent						
03	CFL						
04	LED						

Result:

The power and power factor of incandescent lamp, fluorescent lamp, CFL lamp and LED lamp is tabulated.

EXPERIMENT – 05

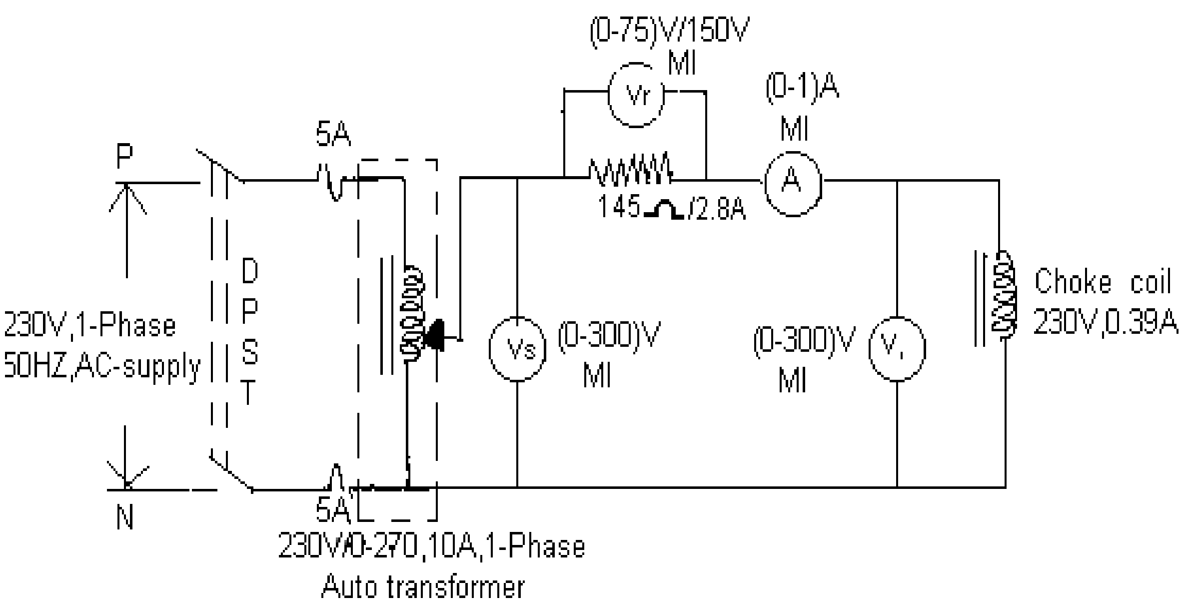
MEASUREMENT OF PARAMETERS OF A CHOKE COIL USING 3-VOLTMETER METHOD

Aim: To measure parameters of a choke coil by 3 voltmeter method.

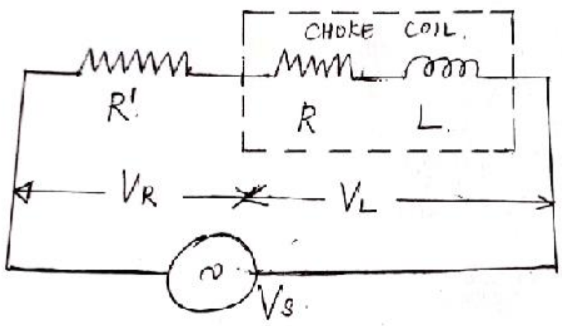
Apparatus Required:

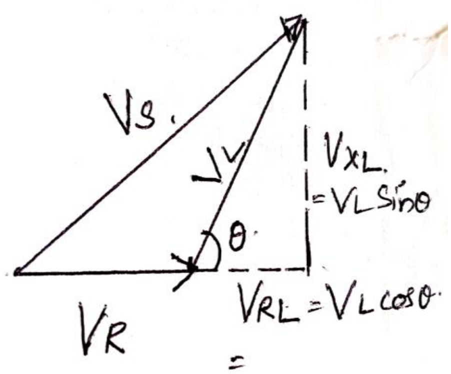
Sl. No	Apparatus	Range	Type	Quantity
1	Choke coil	230 V, 0.39A	Copper wound	1 No
2	Voltmeter	0-300V	Digital	3 Nos
3	Ammeter	0-1000mA	Digital	1 No
4	1 Phase auto transformer	0-270V,2A		1 No
5	Resistance	145Ω /2.8A		1No

Circuit diagram:



THEORY





Ciruit diagram **Phasor diagram**

The choke coil parameters we are going to measure in this 3-voltmeter method are – the inductance and resistance as all choke coils have inherent resistance in addition to their inductance. A given choke coil is usually represented by a pure inductance (L) in series with equivalent resistance (R). This equivalent resistance takes into effect the iron losses in the core of the choke coil and the inherent resistance of the choke coil. 3-Voltmeter method is the best method to measure these two parameters. Thus the equivalent resistance accounts for the copper loses in the choke coil and the

Iron losses in the iron cor.

Voltmeter reading across the resistance = IR

Voltmeter reading across the choke coil = $I\left(\sqrt{r^2+\omega^2 L^2}\right)$

$$V_s^2 = V_L^2 + V_R^2 + 2V_L V_R \cos\theta$$

$$\cos\theta = \frac{V_s^2 - V_L^2 - V_R^2}{2V_L V_R}$$

$$Also\ I = \frac{V_R}{R}\ and\ Z = \frac{V_L}{I}$$

Now, coil resistance $r = Z\cos\theta$

coil reactance $X_L = Z\sin\theta$

$$Q\text{-}factor = \frac{X_L}{r}$$

$$Power\ absorbed\ by\ the\ choke\ coil\ (P) = V_L I \cos\theta$$

Hence, R = Z Cos Θ = $\frac{V_L \cos\theta}{I}$

X_L = Z Sin Θ = $\frac{V_L \sin\theta}{I}$,

And L = X_L / 2π f

Procedure:

1. Make the connections as per the circuit diagram shown in figure.
2. Initially keep the autotransformer in minimum position.
3. Close supply DPST switch.
4. Vary the autotransformer and apply some voltage across the circuit say, 150V and and note down the readings of all the meters.
5. Vary the applied voltage in steps by varying the auto-transformer and note down the readings of all the meters.
6. Calculate the resistance and the inductance of the choke coil as given in the tabular column.

Tabular Column:

Sl. No.	V_S Volts	V_R Volts	V_L Volts	I Amps	**Power Factor of Coil Cos θ** = $\frac{V_s^2 - V_R^2 - V_L^2}{2V_RV_L}$	**Resistance (ohms)** **R**= $\frac{V_L \cos\theta}{I}$	**Inductive reactance(ohms)** X_L= $\frac{V_L \sin\theta}{I}$	**Inductance** (Henrys) **L = $X_L/2\pi f$**
01	150							
02	170							
03	190							
04	210							
05	230							

R (Avg) = **L (Avg)=**

Calculations:

Power Factor of the coil **cosθ** = $\frac{V_s^2 - V_R^2 - V_L^2}{2V_RV_L}$

Resistance **R** = $\frac{V_L \cos\theta}{I}$ Ohms

Inductive reactance of the coil X_L = $\frac{V_L \sin\theta}{I}$ Ohms

Inductance **L =2 π f Henry**

Where f is the frequency of supply in hertz = 50Hz

Result:

The parameters i.e. Resistance and inductance of a given choke coil are calculated by 3 voltmeter method and their values are found to be -R (Avg) = ________ **Ω** andL (Avg) = __________ H.

EXPERIMENT – 06

MEASUREMENT OF EARTH RESISTANCE

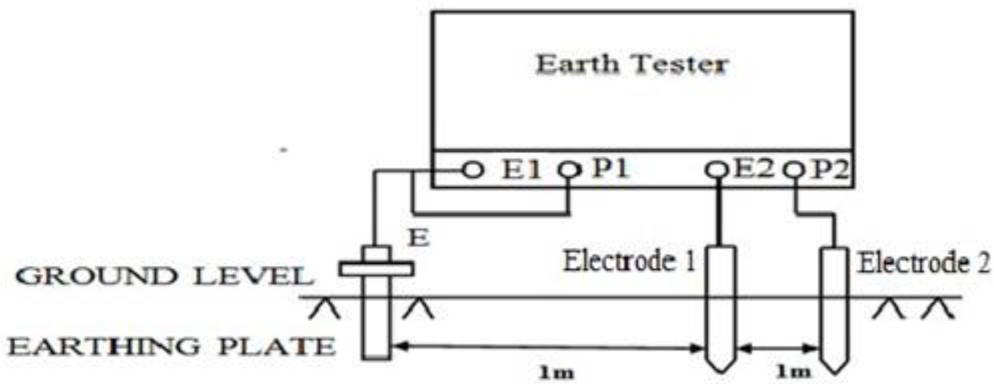
Aim:

To measure earth resistance of an installation with the help of an Digital earth resistance Tester (Megger)

Apparatus Required:

Sl. No	Name of the Apparatus	Quantity
1	Digital earth resistance Tester	1
2	Spikes (Electrodes	3
3	Connecting wires	

Circuit Diagram:



Theory:

All the electrical installations and appliances should be earthed properly for ensuring human safety. A separate wire, known as earth wire runs along the supply line and is ultimate connected to the ground through an earth electrode, the total resistance of the earthing system should be small so that in the event of any fault, the fault current is sufficiently high to blow off the fuse. The earth resistance is the resistance offered by the soil and the electrode to the flow of earth leakage current which will flow in case of earth fault only. The earth tester is a special type of ohmmeter which sends ac through earth and dc through the measuring instruments as shown in circuit diagram.

The working principle of an earth tester is identical to that of megger. There are two moving coil viz. potential and current coil which are deflected in the magnetic field of a permanent magnet. The hand driven generator or a set of batteries supply power to these coils. It has got four terminals P1, E1, P2 and E2. Terminals P1 and E1 are shorted to form a common point which is connected to the earth electrode under test. The other two terminals E2 and P2 are connected to the auxiliary electrodes 1 and 2 respectively. The value of earth resistance is indicated directly on the scale when the test button is pressed. The value of earth resistance depends upon the soil condition and its moisture contents. In hilly areas the earth resistance is higher if electrodes are not place properly in contact with the earth. Water content in the soil decreased the earth resistance. The normal value of earth resistance should lie between 1 to 2Ω.

Tabular Column:

Sl.no	Different Position of Electrode	Earth Resistance(Re)in Ohm	Mean Of Re
1	Trial 1		
2	Trial 2		
3	Trial 3		

Procedure:

1. Connect the earth resistance tester to all electrodes.

2. Short E1 and P1.Connect E2 to electrode 1 and P2 electrode 2

3. Switch on the earth tester.

4. Adjust the resistance range button between 10Ω to 1000Ω and set to 10Ω.

5. Change the position of electrode 1 and electrode 2 by 1m on the either side and observe the earth resistance by pressing the test button.

6. Take the mean of observations of earth resistance.

Result: Earth resistance of the given installation is measured with digital earth resistance tester and its mean value is found to be ------------ohm.

EXPERIMENT – 07

DETERMINATION OF PHASE AND LINE QUANTITIES IN THREE PHASE STAR AND DELTA CONNECTED LOADS

Aim: To determine the phase and line quantities in three phase star and delta connected loads.

Apparatus:

Sl.No.	Apparatus	Range	Quantity
1	3 phase Resistive Load	5A in 5 Steps	1 No
2	AC Voltmeter	0-500V	2 Nos
3	AC Ammeter	0-10A	2 Nos

Theory:

Line Voltage: Potential difference between any two lines is the line voltage of three phase supply.

For a balanced system, $V_{RY}=V_{YB}=V_{BR}=V_L$=line voltage.

Phase Voltage: Potential difference between two ends of any one phase winding is phase voltage of three phase supply. In star connection, it is the voltage between any one phase(R-phase or Y-phase or B-phase) and the neutral (V_{RN},V_{YN},V_{BN}).

Line Current: Current flowing in the supply line(I_R,I_Y,I_B) are line currents,

For a balanced system, $I_R=I_Y=I_B=I_L$=Line currents.

Phase Current: Current flowing in each of the phase winding of the load or supply ($I_{RR'}$,$I_{YY'}$,$I_{BB'}$) are Phase currents.

Star Connection: Similar ends of three impedances are connected together to form common point called neutral point N as shown in fig 1.

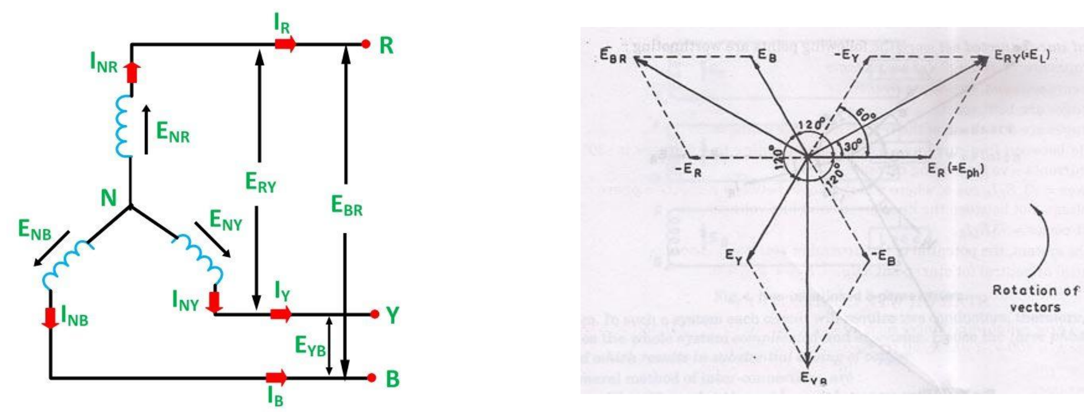


FIG :1

For "Y" circuits:

$E_{line} = \sqrt{3}\ E_{phase}$

$I_{line} = I_{phase}$

$P = \sqrt{3} E_L I_L \cos \emptyset$

I_R, I_Y, I_B are called supply line currents (line currents)I_{NR}, I_{NY}, I_{NB} are called phase currents.

Delta Connection: Two dissimilar ends of three impedances are connected in series to form delta connection as shown in figure 2.

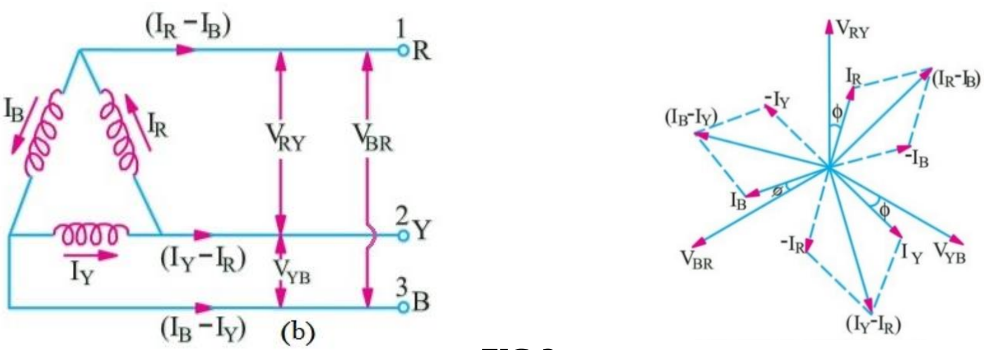


FIG:2

For Δ ("delta") circuits:

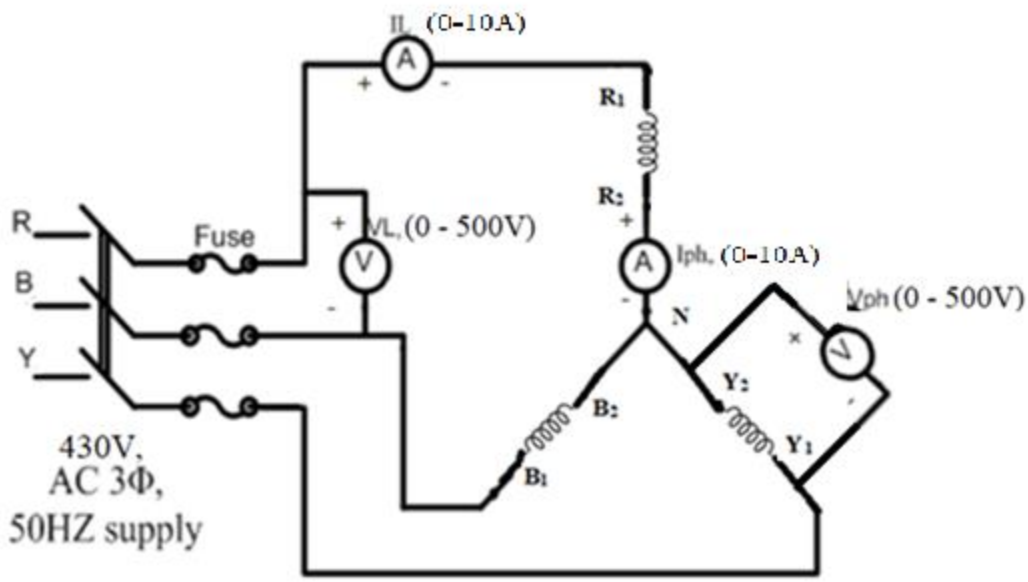
$E_{line} = E_{phase}$

$I_{line} = \sqrt{3}\ I_{phase}$

$P = \sqrt{3} E_L I_L \cos \emptyset$

STAR CONNECTION

Circuit Diagram:



Procedure:

1. Make the connections in the form of star as shown in the circuit.
2. Initially keep the auto transformer at minimum position.
3. Switch ON the MCB.
4. Slowly vary the auto transformer and set the voltage to say 430 Volts.
5. Switch ON load and note down the meter readings V_L,V_{ph} , I_L, I_{ph}
6. Verify if the line voltage is equal to √3 times phase voltage.
7. Repeat the above procedure for different loads.
8. Tabulate the meter readings.
9. Switch off the loads.
10. Bring down the auto transformer voltage to zero.
11. Switch OFF the MCB.

Tabular Column

Sl.No.	I_L Amps	I_{Ph} Amps	V_L Volts	Practical	Theoretical	Power Watts
				V_{Ph} Volts	$V_{Ph}=\frac{V_L}{\sqrt{3}}$ Volts	
01						
02						
03						
04						
05						

Calculations:

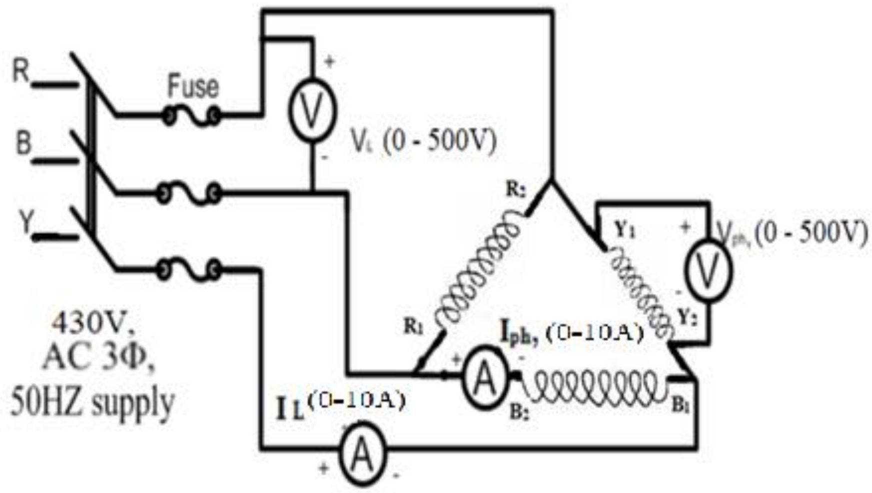
$V_{Ph}=\frac{V_L}{\sqrt{3}}$

$P = \sqrt{3} V_L I_L \cos\emptyset$

$\cos\emptyset = 1$ (As the load is Resistive)

<u>**DELTA CONNECTION**</u>

Circuit Diagram:



Procedure:

1. Make the connections in the form of delta as shown in the circuit.
2. Initially keep the auto transformer at minimum position.
3. Switch ON the MCB.
4. Slowly vary the auto transformer and set the voltage to say 430 Volts.
5. Switch ON load and note down the meter readings V_L,V_{ph},I_L, I_{ph}.
6. Verify if the line current is equal to √3 times phase current.
7. Repeat the above procedure for different loads.
8. Tabulate the meter readings.
9. Switch off the loads.
10. Bring down the auto transformer voltage to zero.
11. Switch OFF the MCB.

Tabular Column

Sl. No.	V_L Volts	V_{Ph} Volts	I_L Amps	Practical	Theoretical	Power Watts
				I_{Ph} Amps	$I_{Ph}= \frac{I_L}{\sqrt{3}}$ Amps	
01						
02						
03						
04						
05						

Calculations:

$I_{Ph}= \frac{I_L}{\sqrt{3}}$

P = $\sqrt{3}V_L I_L \cos\emptyset$

$\cos\emptyset$ = 1 (As the load is Resistive)

Result:

The values of Phase and line quantities in star and delta connection are tabulated and verified.

EXPERIMENT – 08

MEASUREMENT OF 3 PHASE POWER BY 2 WATTMETER METHOD

Aim: To measure three phase power and power factor in a balanced three phase circuit by using two Single-phase wattmeters.

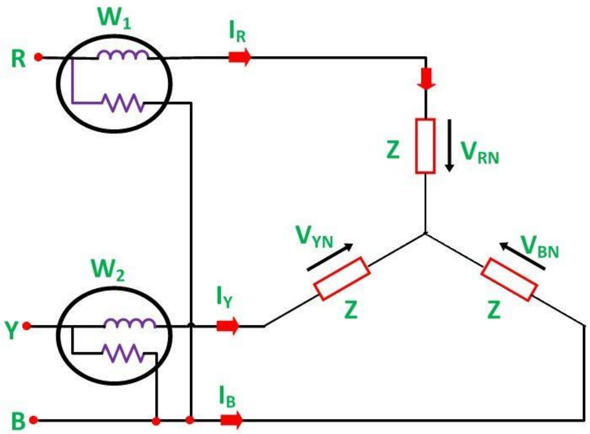
Apparatus:

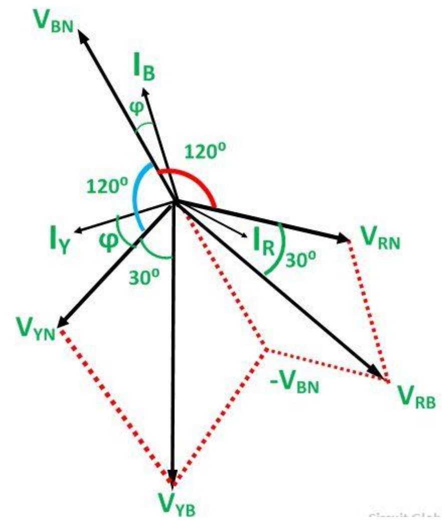
Sl.No	Apparatus	Range	Quantity
1	3 Phase auto transformer	440V, 10A	1 No
3	3 phase Resistive Load	5A in 5 Steps	1 No
3	AC Voltmeter	0-600V	1Nos
4	AC Ammeter	0-10A	1Nos
5	AC Wattmeter	600V,10A, UPF	2Nos

Theory:

Power in an AC circuit is measured with the help of a Wattmeter. A Wattmeter is an instrument which consists of two coils called **Current coil** and **Potential coil.** The current coil having low resistance is connected in series with the load so that it carries the load current. The potential coil having the resistance is connected across the load and carries the current proportional to the potential difference.

The **Two Wattmeter Method** is explained, taking an example of a balanced load. In this, we can prove that the power measured by the Two Wattmeters i.e. the sum of the two wattmeter readings is equal to $\sqrt{3}V_LI_L \, Cos\phi$ which is the actual power consumed in a 3 phase balanced load.The connection diagram of a 3 phase balanced load connected as Star Connection is shown below.





The three phase voltages V_{RN}, V_{YN} and V_{BN}, are displaced by an angle of 120 degrees electrical as shown in the phasor diagram. The phase current lags behind their respective phase voltages by an angle ϕ.

Now, the current flowing through the current coil of the Wattmeter, W_1 will be given as

$$W_1 = I_R$$

Potential difference across the pressure or potential coil of the Wattmeter, W_1 will be

$$W_1 = \overline{V_{RB}} = \overline{V_{RN}} - \overline{V_{BN}}$$

To obtain the value of V_{YB}, reverse the phasor V_{BN} and add it to the phasor V_{YN} as shown in the phasor diagram above. The phase difference between V_{RB} and I_R is $(30^o – \phi)$

Therefore, the power measured by the Wattmeter, W_1 is

$$W_1 = V_{RB} I_R \cos\,(30^\circ - \varphi)$$

Current through the current coil of the Wattmeter, W_2 is given as

$$W_2 = I_Y$$

Potential difference across the Wattmeter, W_2 is

$$W_2 = \overline{V_{YB}} = \overline{V_{RN}} - \overline{V_{BN}}$$

The phase difference V_{YB} and I_Y is $(30^o + \phi)$.

Therefore, the power measured by the Wattmeter, W_2 is given by the equation shown below.

$$W_2 = V_{YB} I_Y \cos(30^\circ + \varphi)$$

Since, the load is in balanced condition, hence,

$$I_R = I_Y = I_B = I_L \text{ and}$$

$$V_{RY} = V_{YB} = V_{BR} = V_L$$

Therefore, the wattmeter readings will be

$$W_1 = V_L I_L \cos(30^\circ - \varphi) \text{ and}$$

$$W_2 = V_L I_L \cos(30^\circ + \varphi)$$

Now, the sum of two Wattmeter readings will be given as

$$W_1 + W_2 = V_L I_L \cos(30^\circ - \varphi) + V_L I_L \cos(30^\circ + \varphi)$$

$$W_1 + W_2 = V_L I_L [\cos(30^\circ - \varphi) + \cos(30^\circ + \varphi)] \quad \text{or}$$

$$W_1 + W_2 = V_L I_L [\cos 30^\circ \cos\varphi + \sin 30^\circ \sin\varphi + \cos 30^\circ \cos\varphi - \sin 30^\circ \sin\varphi] \text{ or}$$

$$W_1 + W_2 = V_L I_L (2 \cos 30^\circ \cos\varphi) \quad \text{or}$$

$$W_1 + W_2 = V_L I_L \left(2 \frac{\sqrt{3}}{2} \cos\varphi\right)$$

$$W_1 + W_2 = \sqrt{3} V_L I_L \cos\varphi$$

$$W_1 + W_2 = P \text{ ... . } (1)$$

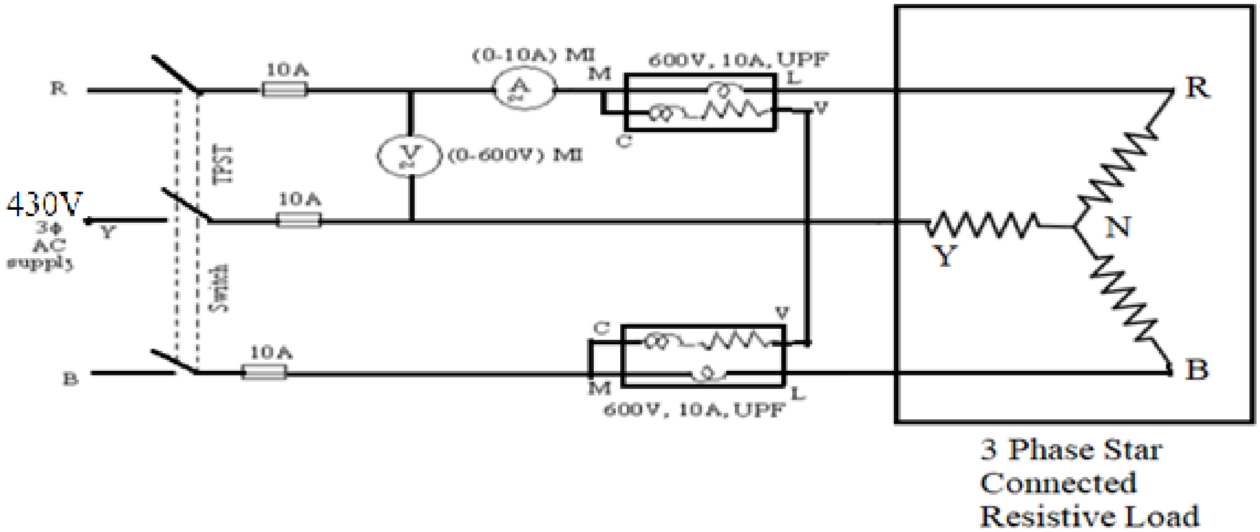
And ,

$$\cos \emptyset = \cos[\tan^{-1}(\frac{\sqrt{3}(w_1 - w_2)}{w_1 + w_2})]$$

The above equation (1) gives the total power absorbed by a 3 phase balanced load.

Thus, the sum of the readings of the two Wattmeters is equal to the power absorbed in a 3 phase balanced load.

Circuit Diagram:



Procedure:

1. Make the connections as shown in the circuit diagram.
2. Ensure that autotransformer knob to be at minimum position.
3. Switch on the 3- phase supply.
4. Slowly vary the autotransformer knob and apply the rated voltage.
5. Apply the load in steps for different load currents and note down all the meter readings.
6. Repeat the above step for different load currents.
7. Switch off the load and bring the auto transformer to zero position and switch off the supply.

Tabular Column

Sl.No	V_L Volts	I_L Amps	W_1 Watt	W_2 Watt	Power in Watts		Power factor $\cos\emptyset = \cos[\tan^{-1}(\frac{\sqrt{3}(w_1 - w_2)}{w_1 + w_2})]$
					Practical $W=W_1+W_2$	Theoretical $W=\sqrt{3}\,V_L I_L \cos\emptyset$	
01							
02							
03							
04							
05							

Calculations:

Total Power P = $(\mathbf{W_1} + \mathbf{W_2})$Watts.

Power Factor $\cos\emptyset = \cos[\tan^{-1}(\frac{\sqrt{3}(w_1 - w_2)}{w_1 + w_2})]$

Result:

The three – phase power and power factor of a given 3Ø star connected Resistive load was measured using Two – Wattmeter method.

Viva questions

Experiment 1 – Verification of KCL and KVL for DC circuits

1. State KCL for DC circuits.
2. State KCL for AC circuits.
3. State KVL for DC circuits.
4. State KVL for AC circuits.
5. What is a loop in circuit?
6. State Ohms law? State its limitations.Is this law applicable to High voltage circuits?
7. What is current?
8. What is voltage?
9. What is resistance?

Experiment 2 – Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, and LED lamp.

1. What is the function of choke in the circuit of a fluorescent lamp?
2. What is the function of the starter in the circuit of a fluorescent lamp?
3. Explain the functioning of starter.
4. If once the lamp is on can I remove the starter? Will the lamp still glow?
5. Briefly explain the working of fluorescent lamp.
6. The fluorescent lamp works at what type of power factor? Lagging or Leading.
7. Define real power, reactive power and apparent power.
8. State the definition of power factor.
9. Draw the power triangle and explain.
10. Tell the disadvantages of lower power factor.
11. What do you mean by lagging and leading p.f.

Experiment 3 - Measurement of resistance and inductance of a choke coil using 3 voltmeter method

1. Define resistance, inductance. What are the units for them?
2. Define Henry, the unit of inductance.
3. Define inductive reactance.
4. What is choke coil and where it is used?
5. Define power factor in three different ways.
6. Draw the voltage triangle of the choke coil and convert it into impedance triangle and power triangle.
7. Mention the advantages of high-power factor.
8. Differentiate between real and reactive power
9. Why Current is lagging In Inductor?
10. Why Inductance is not consuming power?
11. What are the parameters of a choke coil?
12. Give the equation to calculate power factor interms of 3 voltmeter readings. Can you derive it?

Experiment 4 - Determination of phase and line quantities in three phase star and delta connected loads

1. Differentiate between three phase three wire system and three phase four wire system
2. What you mean by a balanced three phase system.
3. What is phase sequence?
4. Compare star connected system to delta connected system.
5. What is the relationship between phase current and line current in a three-phase star connected system?
6. What is the relationship between phase voltage and line voltage in a three-phase star connected system?
7. What is the relationship between phase current and line current in a three-phase delta connected system?
8. What is the relationship between phase voltage and line voltage in a three-phase delta connected system?
9. What is the equation to calculate the 3 phase power?
10. What are the advantages of a three phase system compared to single phase system?
11. What is the angle between phase and line voltages in a delta connected system?
12. What is the angle between phase and line currents in a star connected system?
13. What doyou mean by phase voltage and line voltage?

Experiment 5 - Measurement of three phase power using two wattmeter method

1. Differentiate between three phase three wire system and three phase four wire system
2. What you mean by a balanced three phase system
3. What is phase sequence?
4. Compare star connected system to delta connected system
5. What is the expression for real power in terms of wattmeter readings?
6. What is the power factor for which both watt meters read equal?
7. For what power factor one of the wattmeters reads zero?
8. What is the expression for the power factor of the circuit in terms of wattmeter readings?
9. Can you suggest any other methods for measurement of power in three phase circuits?
10. Explain the effect of p.f. on wattmeter reading.
11. When will one of the wattmeters read negative and how will you read it?
12. Give the expression for 3phase reactive and apparent powers.

Experiment 6 – Two way and three-way control of lamp and formation of truth table

1. State the application of two-way switch.
2. Why is three-way switch required?
3. Do you have two way or three-way control of lamps at home? How do you find it convenient in operating the lamp?
4. List some more applications of such control observed by you.
5. Can you explain the working of the 3 way and two way control ckt.?

Experiment 7 – Study of effect of open circuit and short circuit in simple circuit

1. What is open circuit? Give one example.
2. What is short circuit? Give one example
3. What are the effects of open circuit?
4. What are the effects of short circuit?
5. What is current in an open circuit and why?
6. What is the voltage in a short circuit and why?

Experiment 8 – Study of effect of open circuit and short circuit in simple circuit

1. What is earthing? Explain the necessity of earthing.
2. What is the importance of earthing?
3. What is the range of earth resistance?
4. What are the types of earthing?
5. Why is charcoal and salt arrangement used in earthing?
6. What do mean by earth resistance measurement? How do you measure it?
7. What is the ideal value of earth resistance?

------------------------------ END -------------------------------