LAB MANUAL

ECUALE3

Basic Electrical Engineering Laboratory

Bachelor of Technology

in

Electronics & Communication Engineering

Department of Electronics & Communication Engineering

School of Studies of Engineering & Technology

Guru GhasidasVishwavidyalaya

Bilaspur-495009 (C. G.)

Website: www.ggu.ac.in

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

(ACENTRALUNIVERSITY)

CBCS-NEWSYLLABUS

B. TECH. THIRD YEAR (ElectronicsandCommunicationEngineering)

Vision and Mission of the Institute

Vision		To be a leading technological institute that imparts transformative education to create globally competent technologists, entrepreneurs, researchers and leaders for a sustainable society
Mission	1	To create an ambience of teaching learning through transformative education for future leaders with professional skills, ethics, and conduct.
	2	To identify and develop sustainable research solutions for the local and global needs.
	3	To build a bridge between the academia, industry and society to promote entrepreneurial skills and spirit

Vision and Mission of the Department

Vision		The Department endeavours for academic excellence in Electronics & Communication Engineering by imparting in depth knowledge to the students, facilitating research activities and cater to the ever-changing industrial demands, global and societal needs with leadership qualities.
Mission	1	To be the epitome of academic rigour, flexible to accommodate every student and faculty for basic, current and future technologies in Electronics and Communication Engineering with professional ethics.
	2	To develop an advanced research centre for local & global needs.
	3	To mitigate the gap between academia, industry & societal needs through entrepreneurial and leadership promotion.

Program Educational Objectives (PEOs)

The graduate of the Electronics and Communication Engineering Program will

PEO1: Have fundamental and progressive knowledge along with research initiatives in the field of Electronics & Communication Engineering.

PEO2: Be capable to contrive solutions for electronic & communication systems for real world applications which are technically achievable and economically feasible leading to academia, industry, government and social benefits.

PEO3: Have performed effectively in a multi-disciplinary environment and have self-learning & self-perceptive skills for higher studies, professional career or entrepreneurial endeavors to be confronted with a number of difficulties.

PEO4: Attain team spirit, communication skills, ethical and professional attitude for lifelong learning.

ProgrammeOutcomes: Graduateswillbe ableto:

PO1:Fundamentals: Applyknowledgeofmathematics,scienceandengineering.

PO2:Problemanalysis:Identify,formulateandsolverealtimeengineeringproblemsusingfirstprinciples.

PO3:Design: Designengineeringsystemscomplyingwithpublichealth,safety,cultural,societalandenvironmentalconsiderations

PO4:Investigation: Investigatecomplexproblemsbyanalysisandinterpretingthedatatosynthesize validsolution.

PO5:Tools: PredictandmodelbyusingcreativetechniquesskillsandITtoolsnecessaryformodernengineeringpractice.

PO6:Society: Applytheknowledgetoassesssocietal,health,safety,legalandculturalissuesforpracticingengineeringprofession.

PO7: Environment: Understand the importance of the environment for sustainable development.

PO8:Ethics: Applyethicalprinciplesandcommittoprofessionalethics,andresponsibilitiesandnormsof theengineering practice.

PO9:Teamwork: Functioneffectivelyasanindividualandasamemberorleaderindiverseteamsandmultidisciplinary settings.

PO10:Communication: Communicateeffectivelybypresentationsandwritingreports.

PO11:Management: Manageprojectsinmultidisciplinaryenvironmentsasmemberorateamleader.

PO12:Life-longlearning: Engageinindependentlifelonglearninginthebroadestcontextoftechnologicalchange.

ProgrammeSpecificOutcomes:

PSO1: Identify, formulateand applyconcepts acquired through Electronics&CommunicationEngineeringcoursestothereal-world applications.

PSO2: Designandimplementproductsusingthecutting-edgesoftwareandhardwaretoolstoattainskillsforanalyzinganddevelopingsubsystem/processes.

PSO3: Abilitytoadaptandcomprehendthetechnologyadvancementinresearchandcontemporaryindustry demands with demonstration of leadership qualities and betterment of organization,environment andsociety.

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
ECUALE3	-	-	2	2 Hours	25	25	50	1

BASIC ELECTRICAL ENGINEERING LABORATORY

Course Objectives:

To understand basic instruments and safety measures.

- To practically provide the concept of different theorems.
- To understand the concept of RLC circuits.
- To understand the working of transformers.
- To understand the concept of DC and AC machines.

Course Outcomes:

At the end of the course, the students will able to:

CO1 Acquire knowledge about different types of meters and construct circuits and measure different electrical quantities.

CO2 Analyse the DC circuits.

CO3 Analyse Single Phase and Three phase AC Circuits, the representation of alternating quantities and determining the power in these circuits.

CO4 Work on machines like transformers.

CO5 Understand the construction of DC and AC machines.

CourseOutcomesandtheirmappingwithProgramOutcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3				3			3	3	2	2
CO2	3	2	2	2	3				3			3	3	2	2
CO3	3	2	2	2	3				3			3	3	3	2
CO4	3	2	2	2	3				3			3	3	3	3
CO5	3	2	2	2	3				3			3	3	3	3

BASIC ELECTRICAL ENGINEERING LABORATORY

EXPERIMENT NO. 1

Objective: To verify Ohm's law.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range /Remark
1	D.C. Supply	1	**(……..) V, (…….)A**
2	D.C Voltmeter	1	**(…….) V**
3	DC Ammeter	1	**(…….) mA**
4	Resistance box	1	**R=……………**
5	Multimeter	--	**To Measure Resistance**
6	Connecting wires	--	

Circuit Diagram:

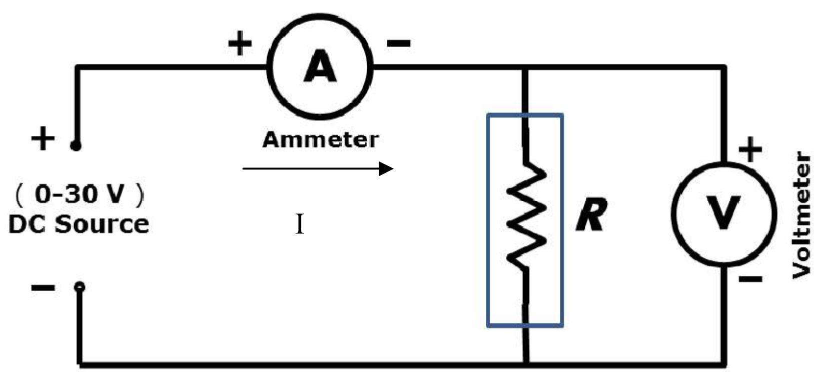


Fig 1 – Ohm's Law Circuit Diagram

Observation Table: Standard Resistance Ro=…………. (Resistance box value as measured by Multimeter)

S.N.	Applied voltage(V)	I(mA)	R=V/I(Ω)	Error= $(\frac{Ro-R}{Ro})$x100

Theory:

This law applies to electric-to-electric conduction through good conductors and may be stated as follows:

The ratio of potential difference (V) between any two points on a conductor to the current (I)flowing between them, is constant, provided the temperature of the conductor does not change.

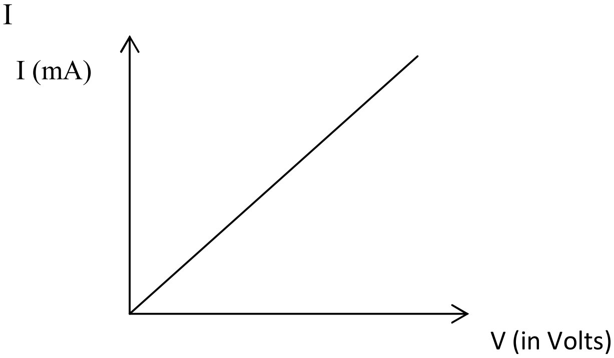
In other words,

$$\frac{V}{I} = \text{ constant or } \frac{V}{I} = R$$

Where, R is the resistance of the conductor between the two points considered.Put in another way, it simply means that provided R is kept constant, current is directly proportionalto the potential difference across the ends of a conductor. However, this linear relationshipbetween V and I do not apply to all non-metallic conductors.

Model graph:

Graph in between V and I



Result: Ohm’s law has been correctly verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don’t touch wire with wet hand.

EXPERIMENT NO. 2.a

Objective: To verify Kirchhoff's Current Law (KCL)

Apparatus Required:

S/N	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	1	(………..) V, (………) A
2	D.C Voltmeter	-	-
3	DC Ammeter	3	(…….)A, (……..)mA, (…….)mA
4	Rheostat	2	R_1=……………, R_2=…………
5	Multimeter	1	To Measure Resistance
6	Connecting wires	--	--

Circuit Diagram:

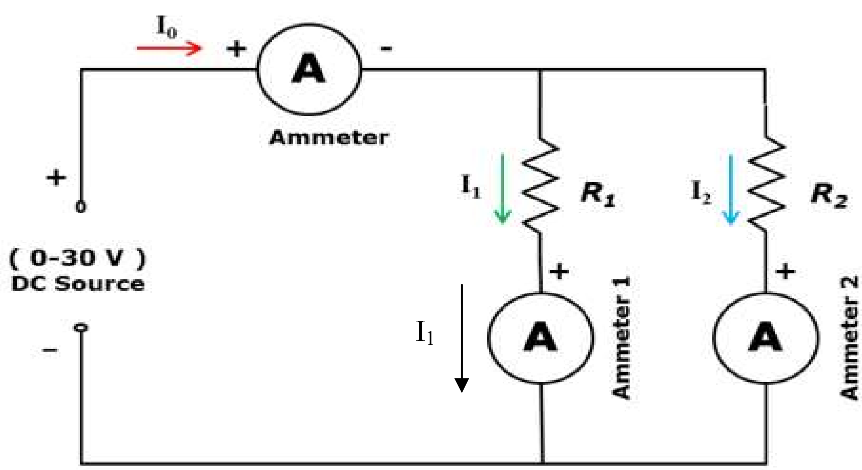


Fig.1 -Kirchhoff's Current Law (KCL) Circuit Diagram

Observation Table:

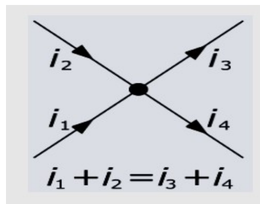
S/N	Current (A/ mA)			I'= I_1+I_2	%Error= $(\frac{I-I'}{I})$x100
	I (A)	I_1 (mA)	I_2(mA)		
1					
2					
3					
4					
5					

Theory:

It states that "in any electrical network, algebraic sum of the currents meeting a point is zero".

In another way, it simply means that the total current leaving a junction is equalto the total current entering that junction. It is obviously true because there is noaccumulation or depletion of current at any junction of the network.

Consider the case of a few conductors meeting at a node as in fig.



Some conductors have currents leading to node whereas some have currents leadingaway from node. Assuming the incoming currents to be positive and the outgoing currentsnegative, applying KCL at node we have,

$$I_1+I_2=I_3+I_4$$

Procedure:

1. Connect the circuit as shown in the diagram.
2. Switch On the DC power supply
3. By varying the voltage supply, take the reading of I_1, I_2& I
4. Repeat the same procedure for different observations.
5. Measure the values of R_1 and R_2 using multimeter
6. Calculate percentage error.

Result: The KCL has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 2.b

Objective: To verify Kirchhoff's Voltage Law (KVL)

Apparatus Required:

S/N	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	1	**(……..) V, (……..)A**
2	D.C Voltmeter	3	**Power Supply Voltmeter, (……..)V, (……..)V**
3	DC Ammeter	-	--
4	Rheostat	2	**R_1=……………, R_2=…………**
5	Multimeter	1	**To Measure Resistance**
6	Connecting wires	--	--

Circuit Diagram:

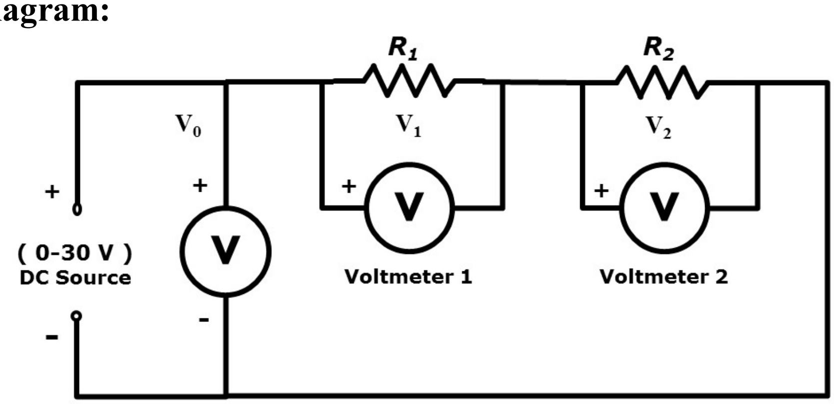


Fig. 1 - Kirchhoff's Voltage Law (KVL) Circuit Diagram

Observation Table:

S/N	Voltage (V)			V'= V_1+V_2 (volts)	%Error= $(\frac{V-V'}{V}) * 100$
	V_0(volts)	V_1 (volts)	V_2(volts)		
1					
2					
3					
4					
5					

Theory:

It states that “the algebraic sum of products of currents and resistances in each of theconductors in any closed path in a network plus the algebraic sum of the e.m.fs in thatpath is zero”.

In other words, $\sum IR + \sum e.m.f. = 0$

It should be noted that algebraic sum is the sum which takes into account the polaritiesof the voltage drops

Procedure:

1. Connect the circuit as shown in the diagram.
2. Switch On the DC power supply
3. By varying the voltage supply, take the reading of V_1, V_2 & V
4. Repeat the same procedure for different observations.
5. Measure the values of R_1 and R_2 using multimeter
6. Calculate percentage error.

Result: The KVL has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don’t touch wire with wet hand.

EXPERIMENT NO. 3

Objective: To verify Superposition Theorem.

Apparatus Required:

S/N	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	2	**(……..) V, (…….)A and (…….) V, (……)A**
2	D.C Voltmeter	2	**Power Supply Voltmeter-2 ,**
3	DC Ammeter	1	**(………)mA**
4	Rheostate	3	**R1=……………, R2=…………., R3=……….**
5	Multimeter	1	**To Measure Resistance**
6	Connecting wires	--	--

Circuit Diagram:

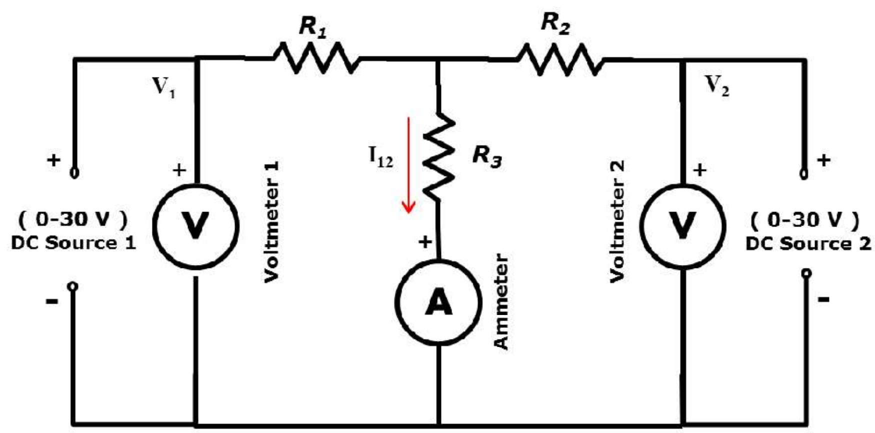


Fig. 1 - Superposition Theorem

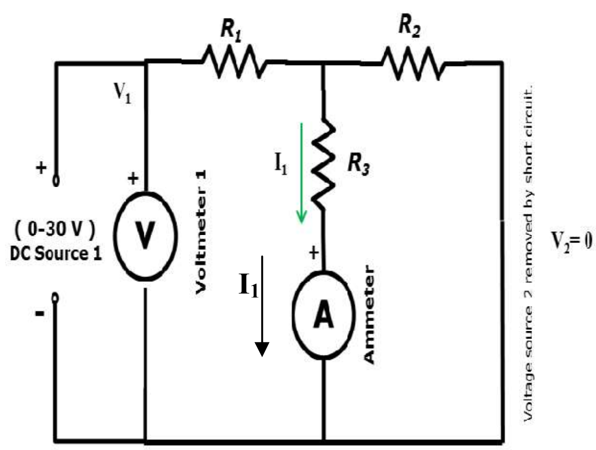


Fig 2 – Superposition Theorem

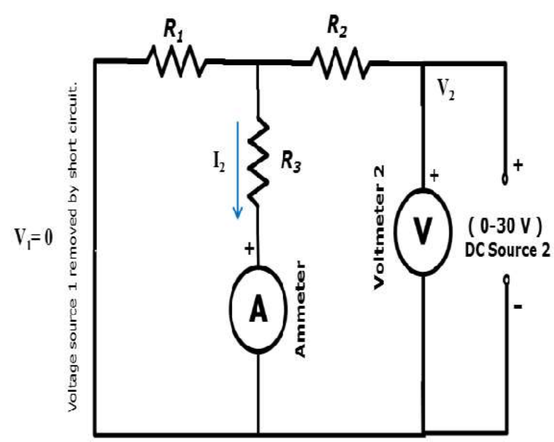


Fig 3 – Superposition Theorem

Observation Table:

$R_1 =$ _____Ω, R_2=_________Ω, $R_3 =$ _______Ω

Sr.No.	V_1 (Volts)	V_2 (Volts)	I_{12} (mA)	I_1 (mA)	I_2 (mA)	I_1+I_2 (mA)	%Error=$\left\|\frac{I_{12}-(I_1+I_2)}{I_{12}}\right\| \times 100$

Theory: According to superposition Theorem: 'In a network of linear resistances containing more than one generator, the current which flows at any point is the sum of all the current which would flow at that point if the each generator were considered separately and all the other generators replaced for the time being by resistance equal to their internal resistances'

$$I = I_1+I_2 \text{ mA}$$

I_1 = Current due to one source, mA

I_2 = Current due to one source, mA

I = Total current at that point, mA

Procedure:

1. Connect the circuit as shown in the circuit diagram Fig.1.
2. Switch On the DC power supply
3. By varying the voltage supply V_1&V_2 in steps of 5 and record the corresponding reading of I
4. Now connect the circuit according to Fig2 and record the values of I1 for the corresponding values of V_1
5. Repeat the step 3 as per Fig3 and take the reading of I_2 by varying V_2
6. Measure the values of R_1 ,R_2 and R_3 using multimeter
7. Calculate percentage error.

Result: The Super position Theorem has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 4.a

Objective: To verify Thevenin's Theorem.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	1	**(……..) V, (…….)A**
2	D.C Voltmeter	2	**Power Supply Voltmeter-1,(………)V**
3	DC Ammeter	1	**(………)mA**
4	Rheostate	3	**R1=……………, R2=…………., R3=……….**
5	Multimeter	1	**To Measure Resistance**
6	Connecting wires	--	--

Circuit Diagram:

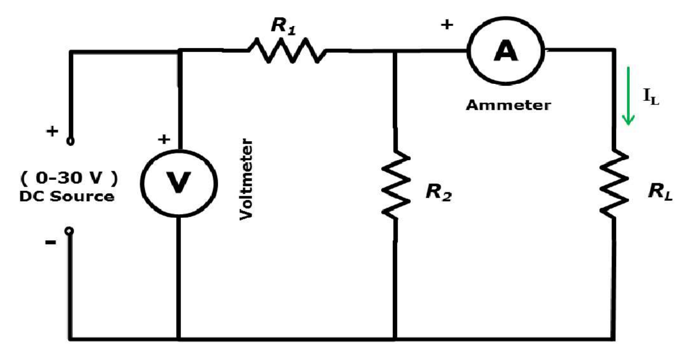
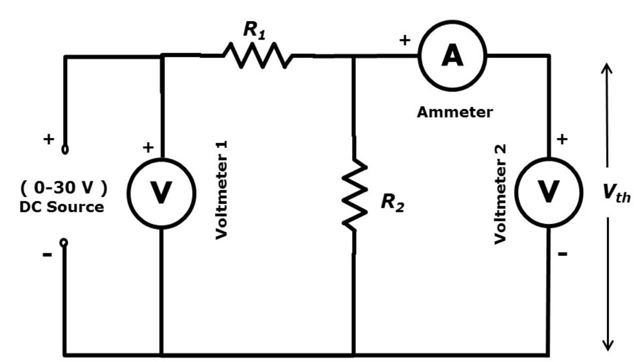


Fig 1: Circuit Diagram for Load Current



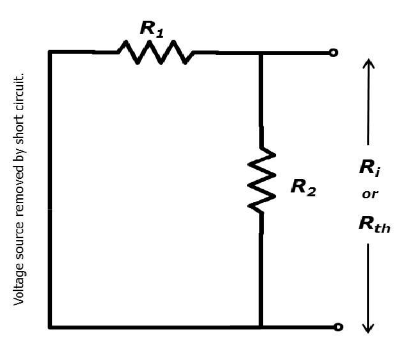


Fig 2: Circuit Diagram for Thevenin Voltage V_{th} Fig 3: Circuit Diagram for R_{th}

Observation Table:

$\boldsymbol{R_1}$=…..Ω, $\boldsymbol{R_2}$=......Ω, Load resistance $\boldsymbol{R_L}$=…….Ω, Thevenin resistance $\boldsymbol{R_{th}}$=…….Ω

S.N.	V (volts)	I_L (mA)	V_{th}(volt)	R_{TH}(Ω)	R_L (Ω)	$I'_L = \frac{V_{TH}}{R_{TH}+R_L}$	Error= $\frac{I_L - I'_L}{I_L}$*100

Theory: The current flowing through a load resistance R_L connected across any two terminal A and B of a linear bilateral network is given by

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

Where Vth is the open circuit voltage (i.e. voltage across two terminals from where R_L is removed)

R_{TH} is the internal resistance of the network as the viewed back into open circuited network from terminal A and B with all voltage source replaced by their internal (if any) and current source by infinite resistance.

Procedure:

1. Connect the circuit as shown in the circuit diagram Fig.1.
2. Switch On the DC power supply.
3. Record the current I_L for varying supply voltage V in steps.
4. Replace the R_L with the voltmeter and record its valueas V_{th} by connecting the circuit as per fig.2
5. Give the supply voltage in steps of 5 and record the corresponding reading in V_{th} voltmeter
6. Short the supply (considering it an ideal voltage source) and record the resistance across A and B using multimeter as shown in Fig.3
7. Measure the values of R1,R2 and R3 using multimeter.
8. Calculate percentage error.

Result: The Thevenin's Theorem has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 4.b

Objective: **To verify Norton's Theorem.**

Apparatus Required:

S/N.	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	1	**(……..) V, (…….)A**
2	D.C Voltmeter	1	**Power Supply Voltmeter-1,(………)V**
3	DC Ammeter	1	**(………)mA**
4	Rheostat	3	**R1=……………, R2=…………., R3=……….**
5	Multimeter	1	**To Measure Resistance**
6	Connecting wires	--	--

Circuit Diagram:

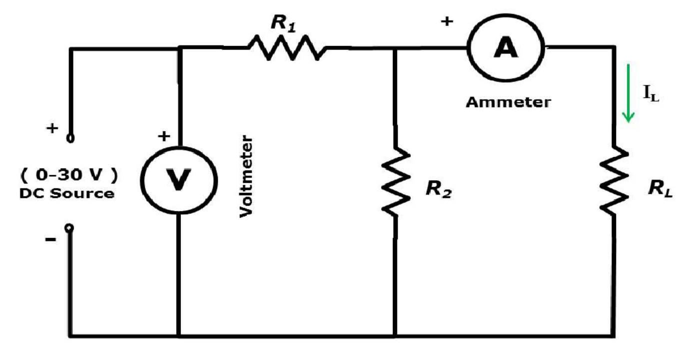
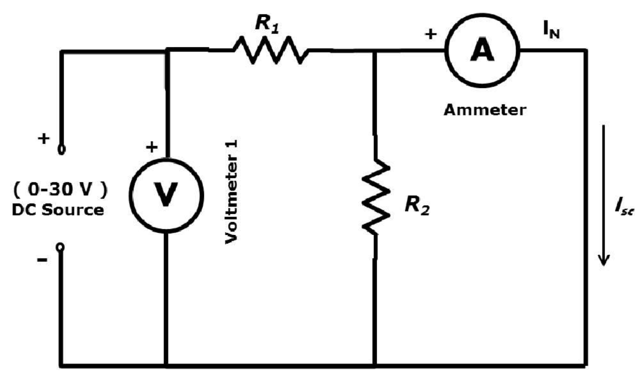


Fig 1: Circuit Diagram for Load Current I_N



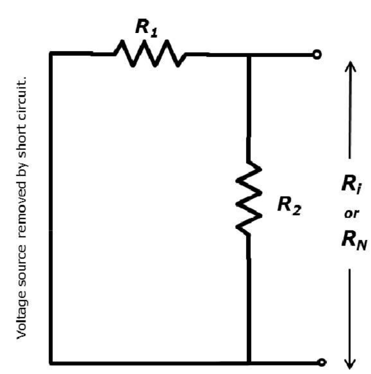


Fig 2: For Norton Current I_{SC} or I_N

Fig3: For Norton resistanceR_N or R_i

Circuit Diagram for Norton Theorem

Observation Table:

$\boldsymbol{R_1}$=…..Ω, $\boldsymbol{R_2}$=......Ω, Load resistance $\boldsymbol{R_L}$=…….Ω, Norton resistance $\boldsymbol{R_N}$ ***or*** $\boldsymbol{R_i}$=…….Ω

S.N.	V (volts)	I_L (mA)	I_N(A)	R_i (Ω)	R_L (Ω)	$I'_L = \frac{I_N * R_i}{R_i+R_L}$	Error= $\frac{I_L - I'_L}{I_L} * 100$

Theory: According to Norton's Theorem "Any two terminal active, linear network containingvoltage source and resistance when viewed from its output terminal is equivalent to a constant current source and a parallel resistance. The constant current is equal to the current which wouldflow in a short circuit placed across the terminals and parallel resistance is the resistance of thenetwork when viewed from these open circuited terminals after all voltage and current sources hasbeen replaced by their internal resistances". The load current

$$I'_L = \frac{I_N * R_i}{R_i + R_L}$$

Where I_N = Norton current, R_i= Norton's Resistance (Ω), R_L= Load Resistance (Ω)

Procedure:

1. Connect the circuit as shown in the circuit diagram Fig.1.
2. Switch On the DC power supply
3. Record the current I_L for varying supply voltage V in steps.
4. Replace the R_L with short circuit as per fig.2 and by varying supply voltage V in steps and take reading of I_N
5. Give the supply voltage in steps and record the corresponding reading of voltmeter as $V_{th.}$
6. Short the supply (considering it an ideal voltage source) and record the resistance across A and B using multimeter as shown in Fig.3
7. Measure the values of R_1,R_2 and R_3 using multimeter.
8. Calculate percentage error.

Result: The Norton's Theorem has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 5

Objective: To verify the Maximum power transfer theorem Theorem.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	D.C. Supply	1	**(……..) V, (…….)A**
2	D.C Voltmeter	3	**Power Supply Voltmeter-1,(………)V. (……..) V**
3	DC Ammeter	1	**(………)mA**
4	Rheostate	3	**Rs=……………, RL=…………**
5	Multimeter	1	**To Measure Resistance**
6	Connecting wires	--	--

Circuit Diagram:

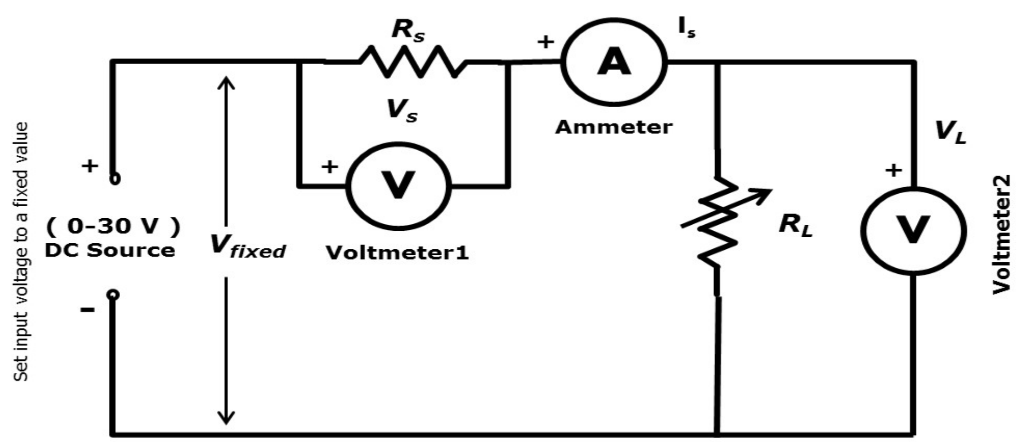


Fig 1- Circuit diagram for Maximum power transfer theorem

Observation Table:

S.N.	V (volts)	V_S (volt)	V_L(volt)	I (mA)	$R_S = \frac{V_S}{I}$	$R_L = \frac{V_L}{I}$	Pmax= V_L(volt) I (mA)
1							
2							
3							
4							
5							
6							
7							

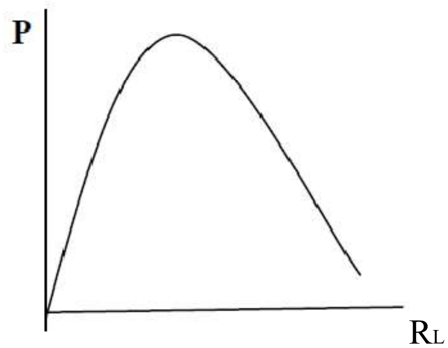
Theory:

According to maximum power transfer theorem "maximum power is transferred from source to load when load resistance is made equal to internal resistance of the source" The value of maximum power transfer is given by:

$$Pmax = \left(\frac{V_{TH}^{2}}{4 * R_L}\right) = V_L * I$$

Where V_L is load voltage, I = load current and R_L = load resistance.

Model Graph:



Procedure:

1. Connect the circuit as shown in the diagram.
2. Switch On the DC power supply
3. Keeping the V fixed and varying the value of R_L note down the value of V_S, V_L and I
4. Calculate Rs and $R_L$using formula and show the maximum power position

Result: When $R_S = R_L$ ……Ω maximum power is obtained and therefore maximum power transfer theorem has been verified successfully.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 6

Objective: To Draw V-I characteristics of an Incandescent lamp.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	Incandescent lamp	**1**	(220V , 60W)
2	Variac	**1**	(i/p-230V,o/p-0-270V,15A)
3	A.C. Voltmeter	**1**	**(………)V**
4	A.C. Ammeter	**1**	**(………)mA**
5	Multimeter	**1**	**To Measure Resistance**
6	Connecting wires	**--**	**--**

Circuit Diagram:

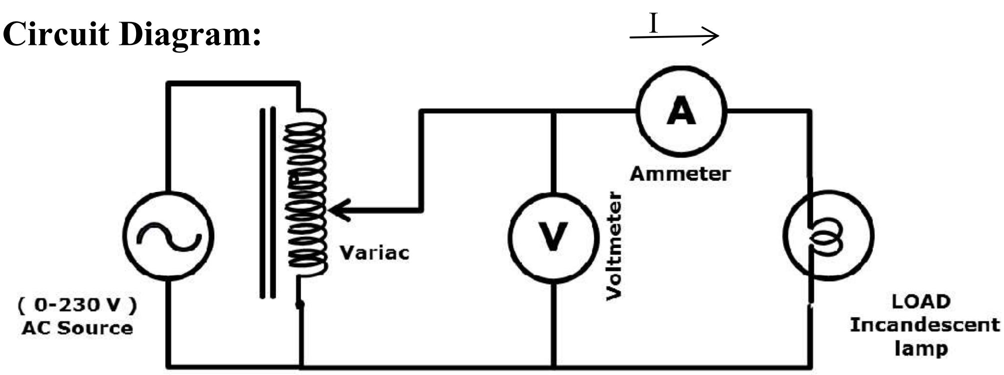


Fig 1 – Circuit Diagram to Draw V-I characteristics of an Incandescent lamp.

Observation Table:

S.N.	V (volts)	I (A)	Rs = $\frac{V\ (volts)}{I\ (A)}$
1			
2			
3			
4			
5			
6			
7			
8			

Theory:

The purpose of this experiment is to study the effect of temperature variation in resistance. Since the temperature is directly proportional to the voltage applied across the resistance, the effect of voltage variation on resistance would be similar to the effect of temperature variation on resistance. The resistance of a material changes as its temperature changes. A rise in temperature increases the molecular movement within the material. As a result, the drift of free electron through the material is increased, in other words the resistance of the material increases. Most of conductors shows these characteristics for a moderate range of temperature, the change in resistance is usually proportional to the change in temperature. The ratio of the change in resistance per degree change in temperature to the resistance at some definite temperature adopted as standard is termed as the temperature coefficient of resistance. It is represented by Greek letter α .

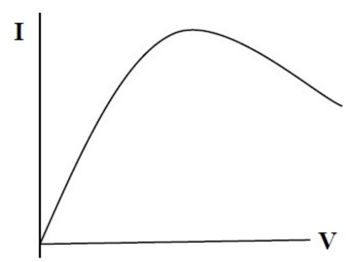
Assuming that the resistance of a conductor at a standard temperature To (0^oC) be Ro and at temperature T1 be R1, Ro & R_1 are related as follows:

$$R_1 = Ro + \alpha o\ (T_1 - To)\ Ro$$

Where α0 is the temperature coefficient of resistance of given material at 0^oC

Tungsten has positive temperature coefficient of resistance and hence its resistance increases with temperature.

Model Graph:



Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Vary the supply voltage and note the ammeter reading
3. Repeat the above steps to take different values of voltage

Result:

The V-I characteristics of an Incandescent lamp on AC supply 0-230 V has been successfully Verified. It does not follow the ohm's law.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax.
3. Avoid loose connections and don't touch wire with wet hand.

EXPERIMENT NO. 7

Objective: To find the power factor and circuit constant in R-L-C series circuit.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	Single phase AC supply	1	**(……..) V**
2	Variac (i/p-230V,o/p-0-270V,15A)	1	
3	AC Voltmeter	4	**(……)V, (…..) V, (……)V , (…...)V**
4	AC Ammeter	1	**(………)A**
5	wattmeter	1	**(………)W, …..V, …..A**
6	Rheostat	1	**……..Ω**
7	capacitor	1	**--**
8	inductor	1	**--**
9	Connecting wires	**--**	**--**

Circuit Diagram:

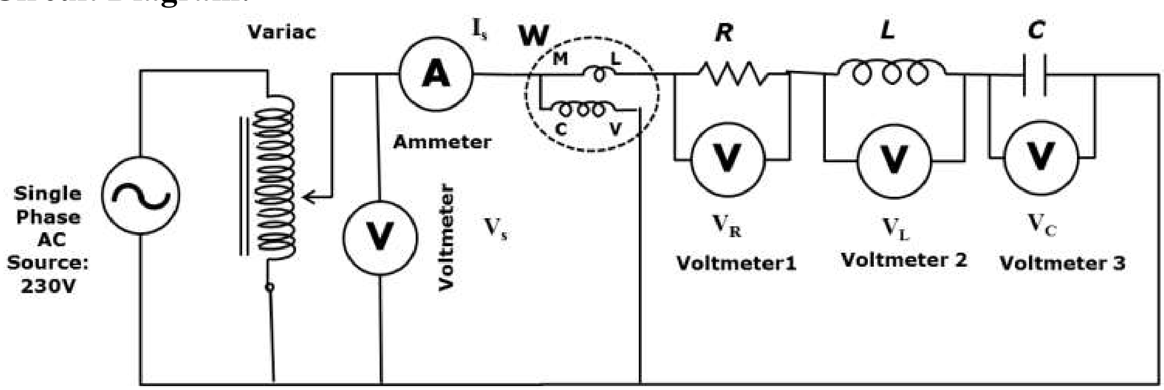


Fig 1 – R-L-C Series Circuit

Observation Table:

S. N.	Observed value							Calculated value				θ	L	C
	V (v)	I (A)	V_R (v)	V_L (v)	V_C (v)	P (Watt)	R (V_R/I)	X_L V_L/I	X_c V_C/I	Cosθ = P/VI	Z= $\frac{V}{I}$			

Theory:

A series R-L-C circuit is shown in Fig.1 from KVL

$$V = V_R + V_L + V_C$$

$$V = IR + I(jwL) + I(\frac{1}{jwc})$$

$$V = I[R + j(wL - \frac{1}{wc})]$$

$$V = IZ, \text{ where } Z = \text{impedance}$$

$Z = [R + j(wL - \frac{1}{wc})]$

$\Theta = \tan^{-1}[(wL - \frac{1}{wC})/R]$

Power factor $\cos(\theta) = \frac{P}{VI}$, $R = \frac{VR}{I}$, $X_L = \frac{VL}{I}$, $X_C = \frac{VC}{I}$, $L = X_L/w$, $C = 1/wX_C$

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Switch On the AC supply
3. Set the variac to zero value
4. Vary the variac to a suitable value and note down the reading of V, V_R, V_L, V_C, I and W.
5. Repeat step 4 and take more reading.

Result:

Value of power factor and circuit constant (R,L,C) have been obtained successfully.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax
3. Avoid loose connections and don't touch wire with wet hand.
4. Before connecting all instruments check their zero reading.

EXPERIMENT NO. 8

Objective: To find the polarity and turns ratio of a single-phase transformer.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	Single phase AC supply	**1**	**(……..) V**
2	Variac (i/p-230V,o/p-0-270V,15A)	**1**	
3	AC Voltmeter	**3**	**(……)V, (…....) V, (……)V**
4	Single phase transformer	**1**	(2KVA ,i/p: 230-199-115V, o/p: 0-230V,Rated current 8.7A)
5	Connecting wires	**--**	**--**

Circuit Diagram:

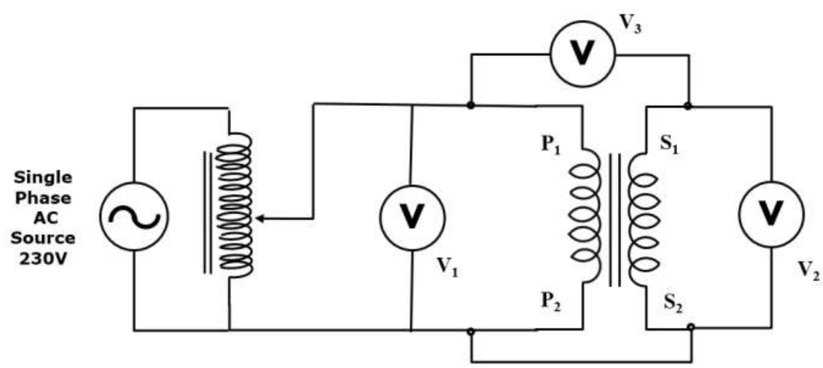


Fig 1 – Circuit Diagram for Single Phase Transformer

Observation Table:

S.N.	V_1 (volts)	V_2 (volt)	$V_3 = V_1 - V_2$ or $V_3 = V_1 + V_2$	Turns Ratio $= \frac{V_2}{V_1}$

Theory:

It is essential to know the relative polarity at any instant of primary and secondary terminal for making correct connection, when two transformers are to be connected in parallel to share the load on the system. When voltage $V_3 = V_1 - V_2$, such a polarity is termed as a additive polarity. The standard practice is to have additive polarity because it reduces the voltage stress between adjacent load. In case $V_3 = V_1 + V_2$ the EMF induces in primary and secondary have a subtractive relation in transformer and is said to have subtractive polarity.

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Switch On the AC supply.
3. Record the voltages V1, V2 and V3 of voltmeter
4. If $\mathbf{V_3 = V_1 - V_2}$ then mark S_1 as a additive polarity or positive polarity
5. If $\mathbf{V_3 = V_1 + V_2}$ then mark S_1 as a subtractive polarity or negative polarity.

Result:

The polarity of primary and secondary winding of single phase transformer has been marked and turns ratio found out.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters properly avoid parallax
3. Avoid loose connections and don’t touch wire with wet hand.
4. Before connecting all instruments check their zero reading.

EXPERIMENT NO. 9

Objective: To perform Open circuit (OC) and Short circuit (SC) Test on single phase transformer.

Apparatus Required:

For OC Test:

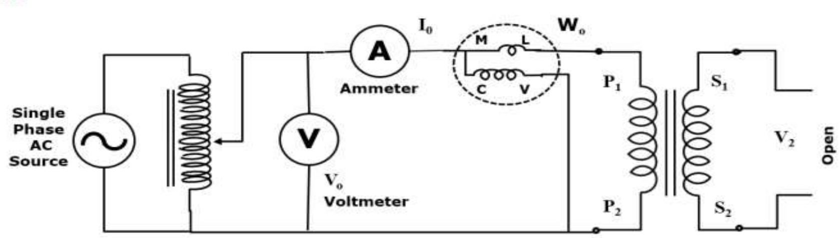
Sr. No.	Apparatus	Quantity	Range/ Remark
1	Single phase AC supply	1	**(……..) V**
2	Variac	1	**(i/p-230V,o/p-0-270V,15A)**
3	Single phase Transformer	1	2KVA,i/p-0-230-119-115V,o/p-0-230V,i/p and o/p-current-8.7A)
4	Wattmeter	1	**(……….)W**
5	AC Voltmeter	1	**(……….)V**
6	AC Ammeter	1	**(………)A**
7	Connecting wires	--	--

For SC Test:

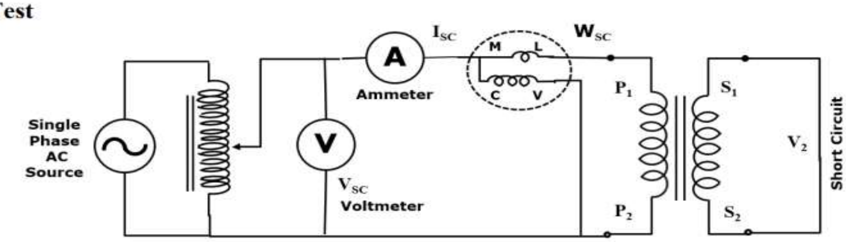
Sr. No.	Apparatus	Quantity	Range/ Remark
1	Single phase AC supply	1	**(……..) V**
2	Variac	1	**(i/p-230V,o/p-0-270V,15A)**
3	Single phase Transformer	1	2KVA,i/p-0-230-119-115V,o/p-0-230V,i/p and o/p-current-8.7A)
4	Wattmeter	1	**(……….)W**
5	AC Voltmeter	1	**(……….)V**
6	AC Ammeter	1	**(………)A**
7	Connecting wires	--	--

Circuit Diagram:

OC Test



SC Test



Observation Table

A. **Open Circuit Test:**

S. No.	V_1 (Volts)	I_0 (A)	W_i (W)	$\cos\phi_0 = \frac{W_i}{V_1 I_0}$	$I_\mu = I_0 \sin\phi_0$	$I_w = I_0 \cos\phi_0$	$R_0 = \frac{V_1}{I_w}$	$X_0 = \frac{V_1}{I_\mu}$

B. **Short Circuit Test:**

S. No.	V_{sc} (Volts)	I_1 (A)	W_{cu} (W)	$Z_{01} = \frac{V_{sc}}{I_1}$ (Ω)	$R_{01} = \frac{W_{sc}}{I_1^2}$	$X_{01} = \sqrt{Z_{01}^2 - R_{01}^2}$

Theory: The performance of a transformer can be calculated on the basis of its equivalent circuit which contains four main parameters, the equivalent resistance R01 as referred to primary (or secondary R02),the equivalent leakage reactance X01 as referred to primary, the core-loss conductance G0 and the magnetizing susceptance B0.These constants or parameters can be easily determined by two test i.e. Open circuit test and Short circuit test.

Open Circuit Test: The purpose of this test is to determine no load loss or core loss and no load circuit paramters X_0 and R_0. One winding of the transformer (usually high voltage winding) is left open and other side (usually low voltage side) is connected to the AC supply with a wattmeter(W), voltmeter(V) and ammeter(A) as shown in figure. With rated voltage applied to the circuit, normal flux will be setup in the present case. With normal voltage applied to the primary, normal flux will be setup in the core, hence normal or rated iron losses will occur which is recorded by the wattmeter. As primary no load current I_0 is small, Copper loss is negligibly small in primary and will in secondary. Hence, the wattmeter reading represents practically the core loss under no load condition.

Let V_1 = Rated voltage, I_0 = no-load current and wattmeter reading W_i = Core loss

$$\cos\phi_0 = W_i / V_1 * I_0$$

$$I_\mu = I_0 \sin\phi_0 \text{ and } I_w = I_0 \cos\phi_0$$

$$X_0 = V / I_\mu \text{ and } R_0 = V / I_w$$

Short Circuit Test: For short circuit test, one winding usually the low voltage winding, is solidly short circuited by a thick conductor (or through an ammeter which may serve the additional purpose of indicating till rated load current) and the other side is connected as shown in the figure. A low voltage (usually 5 to 10% of normal primary voltage) at correct frequency (though for Copper losses it is not essential) is applied to the primary and is cautiously increased till full load or rated current flows in both primary and secondary (as indicated by the respective ammeter). Since, in this test, the applied voltage is small percentage of the normal voltage, the mutual flux produced is also a small percentage of its normal value. Hence, core losses are very small with the result that the wattmeter reading represents the full load Copper loss for the whole transformer i.e., both primary Copper loss and secondary Copper loss.

Let V_{SC} = Short circuit voltage, I_1 = rated current and wattmeter reading W_{cu} = rated Copper loss

$$R_{01} = W_{cu} / I_{SC}^2$$

$$Z_{01} = V_{SC} / I_1$$

$$X_{01} = \sqrt{Z_{01}^2 - R_{01}^2}$$

Procedure:

Open Circuit:

1. Connect the circuit as per fig 1.
2. Switch on the supply .
3. Increase the voltage to rated voltage with the help of variac.
4. Note down the readings of wattmeter, voltmeter, ammeter.

Short Circuit:

5. Connect the circuit as per fig 2 and short circuit the secondary windings.
6. Increase the voltage applied, slowly, so that the current flowing in the transformer winding equals the rated value.
7. Record the readings of the ammeter, voltmeter and wattmeter

Result:

1. For Open Circuit:

a. Iron losses (Wi) =

b. R_0 =

c. X_0 =

2. For Short Circuit:

a. Copper loss (W_{cu}) =

b. Equivalent Resistance (R_{01}) =

c. Equivalent Reactance (X_{01}) =

Precaution:

1. Connection should be tight and proper
2. While performing the short circuit test, the voltage applied should be initially set at zero and then increased slowly.

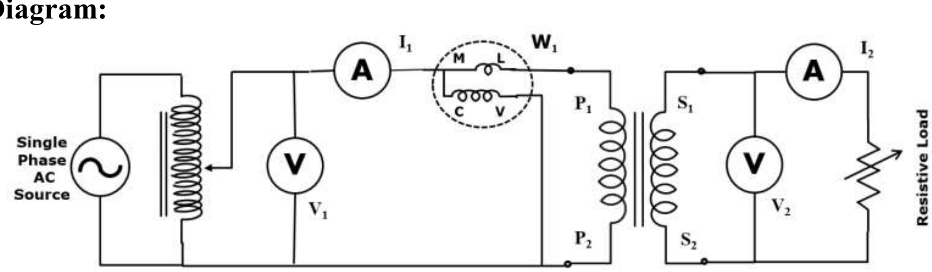
EXPERIMENT NO. 10

Objective: To perform a load test on single transformer and find efficiency and voltage regulation atfull load and unity power factor load.

Apparatus Required:

Sr. No.	Apparatus	Quantity	Range/ Remark
1	Single phase AC supply	1	**(……..) V**
2	Variac	1	**(i/p-230V,o/p-0-270V,15A)**
3	Single phase	1	2KVA,i/p-0-230-119-115V,o/p-0-230V,i/p and
4	Wattmeter	1	**(……….)W**
5	AC Voltmeter	2	**(……)V, (……)V**
6	ACAmmeter	2	**(………)A, (………)A**
7	Connecting wires	--	--

Circuit Diagram:



Single Phase Transformer

Observation Table:

Observation Table:

S.N.	W_1 (Input)	V_2 (volt)	I_2 (A)	V_2I_2 (Output)	Efficiency $= \frac{V2I2}{W1}$	Voltage Regulation $= \frac{E-V}{V}$

Theory:

For this experiment, a load resistor is connected at the output terminals of the transformer. The input to the transformer is measured in the Wattmeter connected as W1. The output of transformer is the product of V2 and I2 .As the load is resistive, power factor is unity.

$$\% \text{ efficiency } \eta = \frac{V2I2}{W} x\ 100$$

With the increase in load on the transformer, there is a change in its terminal voltage. The voltage falls if the load power factor is lagging. It increases if the power factor is leading. The change in secondary voltage from full load to no load expressed as a percentage of full-load voltage is called percentage voltage regulation of the transformer.

If E_2 is the no-load terminal voltage and V_2 is the full load terminal voltage,

then % voltage regulation

$$\% \text{ V.R.} = \frac{E_2 - V_2}{E_2} * 100$$

Procedure:

1. Connections are made as per the circuit diagram.
2. Increase the supply voltage with the help of variac till the input voltage V_1 is rated voltage.
3. Now adjust the rheostat so that I_2 reads rated current.
4. Take the reading of W_1, V_2 and I_2.

Result: The load test on single phase transformer has been successfully conducted.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters properly avoid parallax
3. Avoid loose connections and don't touch wire with wet hand.
4. Before connecting all instruments check their zero reading
5. Variac should be in minimum position at start.

EXPERIMENT NO. 11

Objective: To find line, phase quantities and power in three phase star load using two wattmeter method.

Apparatus Required:

S/N	Apparatus	Quantity	Range/ Remark
1	Three phase supply	1	**(0-440) V**
2	Three Phase Variac	1	(i/p-440V,o/p-0-470V,15A)
3	Three bulbs in each	1	(……………..) W Each
4	Wattmeter	2	**(……….)W, (……….)W**
5	AC Voltmeter	2	**(……)V, (……)V**
6	ACAmmeter	1	**(………)A**
7	Connecting wires	--	--

Circuit Diagram:

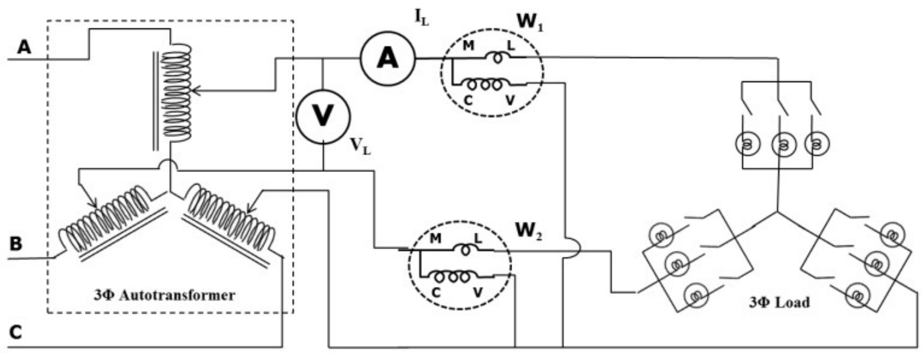


Fig1.

Observation Table:

S.N.	V_l (volt)	V_{ph} (volt)	$I_L = I_{ph}$ (A)	W_1 (Watt)	W_2 (Watts)	$W_1 + W_2$ (Watts)	tanΦ	cosΦ	$W=\sqrt{3}\, V_l I_l \cos\Phi$

Theory:

Measurement of power

The three phase power can be measured by three single Wattmeters having current coils in each line and potential coils connected across the given line and any common junction. Since the common junction is completely arbitrary it may be placed on any one side of the three lines. In which case the wattmeter connected in the line will indicate the zero power because its potential coil has voltage across it. Hence that wattmeter may be dispersed with and the three phase power can measured by means of only two single phase wattmeter having common potential junction on any of the three lines in which there is no current coil. This is known as two wattmeter method, measuring three phase power. In general m phase power can measured by means of m-1 wattmeters. This method is valid for both balanced as well as unbalanced circuits. The total real powers delivered to the load are given by the algebraic sum of the two wattmeter reading.

$$P=W_1+W_2$$

This significance of the algebraic sum will be realized in the paragraph that follow. Two wattmeter can be connected with their current coils in any two lines, while their potential coils are connected to the third, as shown in fig 1.The wattmeter readings are given by

$$W_1=V_{RB}I_R\cos \phi_1$$

Where ϕ_1 is the angle between V_{AB} and I_A and

$W2 = V_{YB}\ I_Y \cos \phi_2$

Where ϕ_2 is the anlge between V_{BY} and I_B

The two wattmeter method when applied to the balanced loads, yield interesting result. Consider either balanced by on delta connected loads, with the aid of the corresponding phase diagram drawn earlier for the phase sequence A-B-C fig 2, it can be seen that the angle between V_{BY} and I_Y is (30°+ ϕ) and that between V_{RB} and IR is (30°- ϕ),where is the load power factor angle associated with the load impedance. Thus,we have

$$W_1=V_L\ I_L\cos(30°+ \phi)$$

Where VL and IL are the magnitude of the line voltage and line current, respectively. Simple manipulation yield

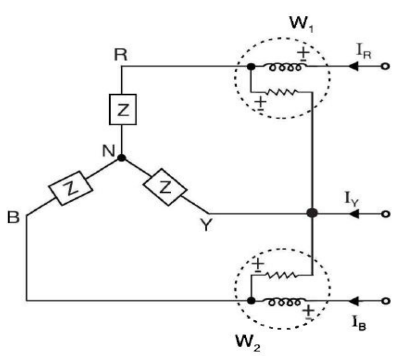
$$W_1+W_2=\sqrt{3}V_L\ I_L\cos(\phi)$$

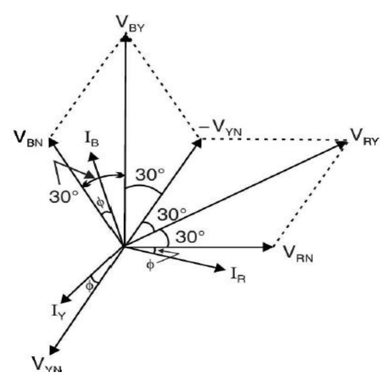
And,

$$W_2-W_1=V_L\ I_L\sin(\phi)$$

From which

$$\tan \phi = \frac{\sqrt{3}(W_2 - W_1)}{(W_2 + W_1)}$$





Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the three phase variac at its zero position.
3. Make sure all the switches are in off position.
4. Switch on the supply and increase the supply voltage to rated voltage.
5. Switch on one bulb each of all the phases and note the reading of all the meters.
6. Repeat step 5 for two bulbs and three bulbs switched on in each phase.

Result: The line voltage is $\sqrt{3}$ times the phase voltage and the two wattmeter method measure three phase power.

Precaution:

1. All connections should be done tightly.
2. Take the readings carefully, avoid parallax.