VAISHNO COLLEGE OF ENGINEERING

Affliated to HPTU, Hamirpur and approved by AICTE

Basic Electrical Engineering
Lab Manual
EE-111P

Department of Electrical Engineering
VillThapkour, PO Bhardoya, Tehsil Indora,Distt. Kangra (HP)-176403
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Vision of Institute

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical managerial and practical competence.

Mission of Institute

M1 To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a cultural of research and innovation among faculty members and students.

M2 To encourage long term interaction between academia and industry through the involvement of industry for hands on implementation of the curriculum.

M3 To strengthen and molding students in professional ethical, social and environmental dimensions by encouraging participation in co-curricular extracurricular and CSR activities.

Vision of the Department

To emerge as a department of eminence in electrical engineering in serving the industry and the nation by empowering students with high degree of technical and practical competence.

Mission of the department

M1 To strengthen the theoretical and practical aspects of learning process by strongly encouraging a culture of research, innovation and hands on learning in electrical engineering.
M2 To encourage a long term interaction between the department and industry through the involvement of industry for hands on implementation of course curriculum.
M3 To widen the awareness of students in professional, ethical, social and environmental dimensions by encouraging their participation in co-curricular, extra-curricular and CSR activities.

Program Educational Objectives (PEOs) of the department

PEO 1: Engage in successful careers in industry, academia, and public service, by applying the acquired knowledge of Science, Mathematics and Engineering, providing technical leadership for their business, profession and community

PEO 2: Establish themselves as entrepreneur, work in research and development organization and pursue higher education

PEO 3: Exhibit commitment and engage in lifelong learning for enhancing their professional and personal capabilities.

PROGRAM OUTCOMES

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

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

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

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

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

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

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

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

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

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

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

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSOs)

PSO1: Apply knowledge of mathematics, engineering sciences and multidisciplinary knowledgeto the solution of electrical engineering problems.

PSO2: Apply research-based knowledge, appropriate techniques, IT tools to complex electrical
engineering problems including design, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.

PSO3: Apply ethical principles engineering profession and recognize the need of independent and lifelong learning for professional development and personnel growth.

EE-111P Basic Electrical Engineering Lab

Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Examination	Total	
0	0	2	1	Maximum Marks: 30	Maximum Marks: 20	50	2 Hours
				Minimum Marks: 12	Minimum Marks: 8	20	

Following is the list of experiments/ jobs. Minimum 08 number of practicals are to be performed from following list. The additional experiments may be performed by the respective institution depending on the infrastructure available.

List of Experiments:

1. To verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)
2. To study the V-I characteristics of an incandescent lamp.
3. Verification of Thevenin's theorem
4. Verification of Norton theorem
5. Verification of superposition and Maximum power theorem
6. To study series LCR circuit
7. To study parallel LCR circuit
8. Power consumption of a fluorescent lamp
9. Measurement of power and power factor by two wattmeter method.
10. To perform short circuit test on a single-phase transformer to calculate copper loss of the transformer.
11. To measure the single-phase power in a single phase a.c. circuit by using three ammeters.
12. To measure the single-phase power in a single phase a.c. circuit by using three voltmeters.

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H.P. Technical University
Hamirpur - 177 001, HP

LIST OF EXPERIMENTS

BASIC ELECTRICAL ENGINEERING

1. **To verify KCL and KVL**
2. **To study the V-I characteristics of an incandescent lamp.**
3. **To measure single phase power by using three ammeter method.**
4. **To measure the single phase power by using three voltmeter method.**
5. **To perform short circuit test on a single phase transformer.**
6. **To perform open circuit test on a single phase transformer.**
7. **To measure three phase power by using two wattmeter method.**
8. **To verify Thevenin’s theorem.**
9. **To verify Superposition theorem.**
10. **To verify Maximum power transfer theorem.**
11. **To verify Norton theorem.**

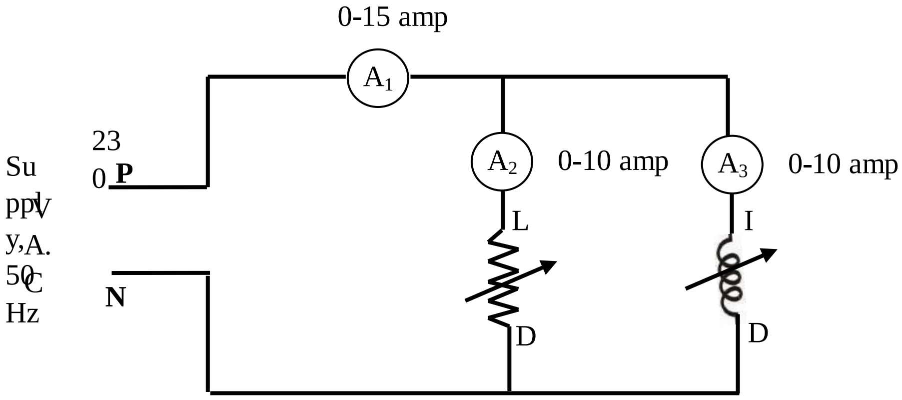
EXPERIMENT NO. 1 T.N. 11

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

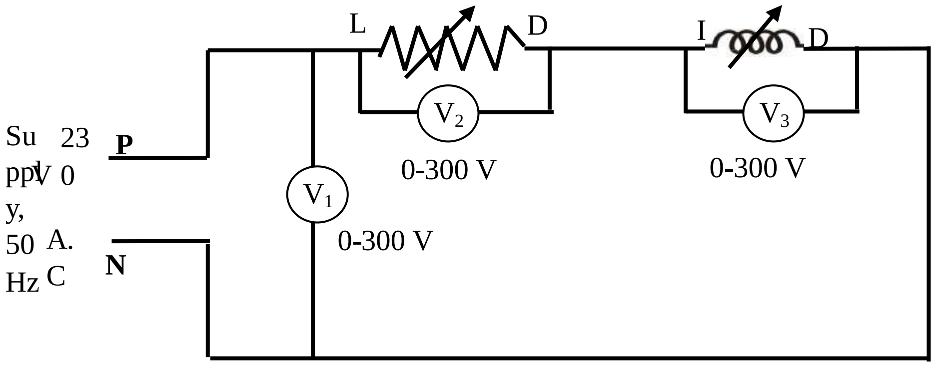
Apparatus Required:

1. A.C. Ammeter- 3 nos. (0-10 amp)
2. A.C Voltmeter - 3 nos. (0-300 V)
3. Rheostat
4. Inductive Load
5. Connecting wires **Circuit Diagram:**

KCL



KVL



Theory:

Procedure:

KCL:

1. First measure the least count of all ammeters A_1, A_2, and A_3 and all voltmeters V_1, V_2 and V_3.
2. Connect the circuit as shown in the diagram.
3. Now, vary both the resistive and inductive load to obtain different readings of ammeters A_1, A_2 and A_3 and voltmeters V_1, V_2 and V_3.
4. Repeat the same procedure for different observations.
5. Calculate percentage error.

KVL:

1. Connect the circuit as shown in the diagram.
2. Now, adjust both the rheostat and inductive load to obtain different values of then take V_1, V_2 and V_3.
3. Repeat the same procedure for different observations.
4. Calculate percentage error.

Observation Table:

KVL

Sl.No.	V_1 in (Volts)	V_2 in (Volts)	V_3 in (Volts)	V V V$_1\sqrt{\square\ 22\ \square\ 32}$	% Error
1					
2					
3					

KCL

Sl.No.	A_1 in (Volts)	A_2 in (Volts)	A_3 in (Volts)	A A A$_1\sqrt{\square\ 22\ \square\ 32}$	% Error
1					
2					
3					

Calculations:

KCL

% Error = $\left|\frac{A_1' - A_1}{A_1}\right| \times 100$

KVL

% Error = $\left|\frac{V_1' - V_1}{V_1}\right| \times 100$

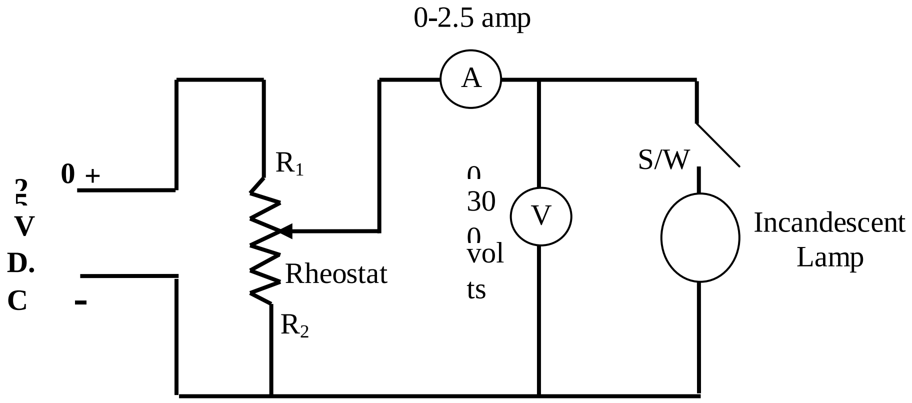
Precautions:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly.
3. Remove insulations from the connecting wire so as the current will flow properly.
4. Avoid loose connections and don't touch wire with wet hand.

Aim of the Experiment: To study the V-I characteristics of an incandescent lamp.

Apparatus Required:

1. Incandescent lamp - 1 no.- (200 Watt)
2. Rheostat – 1 no.- (128 Ohm, 2.3 A)
3. D.C Voltmeter - 1 nos. (0- 300 V)
4. D.C Ammeter - 1 nos. (0-2.5 A)
5. Connecting wires
6. Supply: 250 V D.C **Circuit Diagram:**



Theory:

Procedure:

1. Connect the circuit as shown in the diagram with the switch (S/W) is in off position. .
2. Switch on D.C supply, close the switch and vary the rheostat to obtain different voltage and current values. Note the voltage and corresponding current values. Record the Calculate percentage error.
3. Switch of supply then open the switch. **Observation Table:**

Sl.No.	*V* in (Volts)	*I* in (Amps)	R=V/I
1			
2			
3			

Plot the V-I characteristics of incandescent lamp.

Remarks: The characteristic is non-linear.

Precautions:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly.
3. Remove insulations from the connecting wire so as the current will flow properly.

Questions:

1. Why V-I characteristics of incandescent lamp is nonlinear.

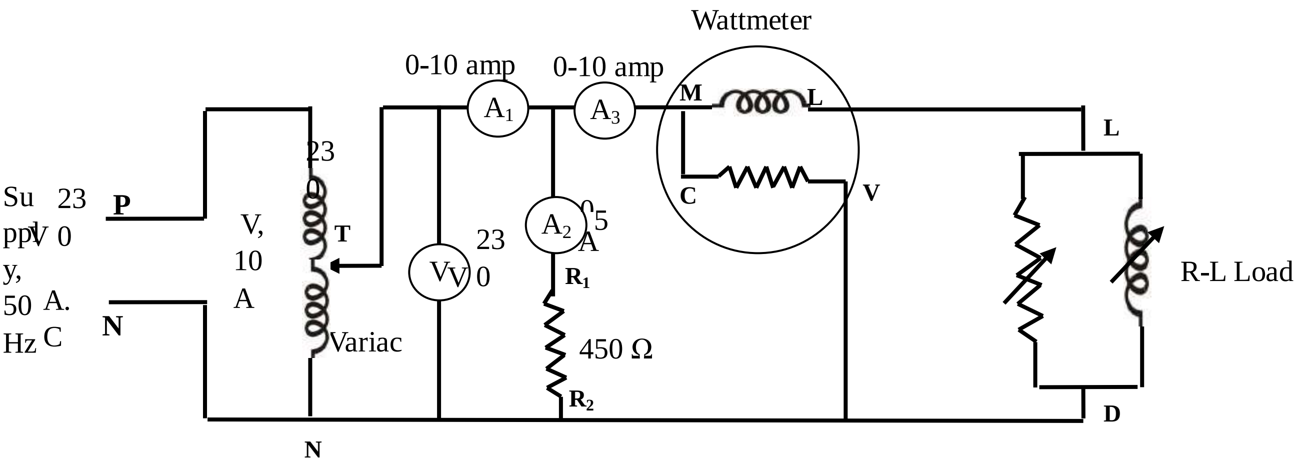
EXPERIMENT NO. 3 T.N. 2 B

Aim of the Experiment: To measure the single phase power in a single phase a.c. circuit by using three ammeters.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 250 V, 0- amp)
2. A.C Ammeter - 1 nos. (0-10 A)
3. A.C Ammeter - 2 nos. (0-5 A)
4. A.C Voltmeter - 1 nos. (0-300 V)
5. Variac: 230 V, 10 A, 50 Hz, 1-Phase
6. Resistor: 450 ohm
7. R-L Load Box
8. Connecting wires

Circuit Diagram



Theory:

Power consumed by load= $P=VI_3 \cos Ø$ (1)

From the phasor diagram we can write,

$I_1^2=I_2^2+I_3^2+2.I_2.I_3 \cos Ø$ (2)

Power factor, $\cos Ø= (I_1^2-I_2^2-I_3^2)/ 2.I_2.I_3$ (3)

$I_2=V/R$ (Here R= 450 Ohm)

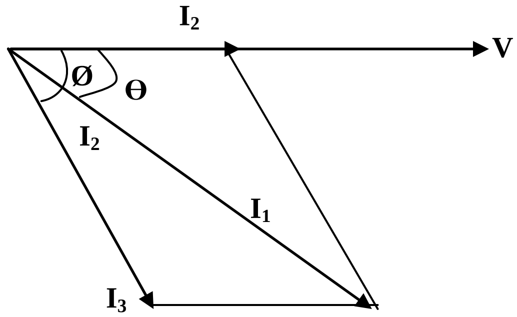
Now,

$P_{calculated} =VI_3 \cos Ø= I_2R I_3 \cos Ø$

$= R I_2 I_3 ((I_1^2-I_2^2-I_3^2)/ 2.I_2.I_3) = (R/2) * (I_1^2-I_2^2-I_3^2)$ (4)

From the above equation it can observed that, the power and power factor in an a.c circuit can be measured by using 3-single phase ammeters, instead of a wattmeter.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading



Phasor diagram of the above circuit.

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac set the voltmeter reading as supply voltage.
5. Vary the RL load to obtain different readings of ammeters, and wattmeter.
6. Repeat step 5 for different observations.
7. Set the variac at zero position and switch of supply.

Tabulation:

Sl.No.	A1 in (amp)	A2 in (amp)	A3 in (amp)	$P_{calculated}$	Wattmeter Reading*M.F	cos Ø
1						
2						
3						
4						

Calculation:

Calculate the value of P, cos Ø.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading

Precautions:

1. All connection should be proper and tight.
2. The zero setting of all the meters should be checked before connecting them in the circuit.
3. The current through ammeter should never be allowed to exceed the current rating of variac and load used.

Questions:

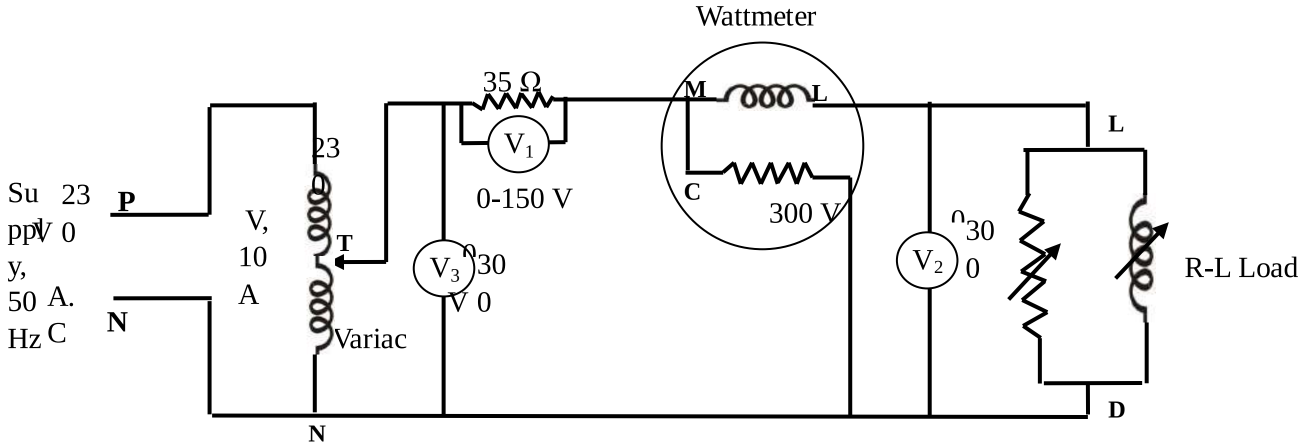
1. In an a.c. circuit which power is more apparent or real and why?
2. What is the basic difference between an inductive load and purely inductive load?
3. The practical loads are purely inductive or inductive?

Aim of the Experiment: To measure the single phase power in a single phase a.c. circuit by using three voltmeters.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 300 V, 10- amp)
2. A.C Voltmeter - 1 nos. (0-180 V)
3. A.C Voltmeter - 1 nos. (0-300 V)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Resistor: 35 Ω
6. R-L Load Box
7. Connecting wires

Circuit Diagram



Theory:

Power consumed by load= $P=V_2 I \cos \varnothing$ (1)

From the phasor diagram we can write,

$V_3^2=V_1^2+V_2^2+2.\ V_1.\ V_2 \cos \varnothing$ (2)

Power factor, $\cos \varnothing= (V_3^2-V_1^2-V_2^2)/\ 2.\ V_1.\ V_2$ (3)

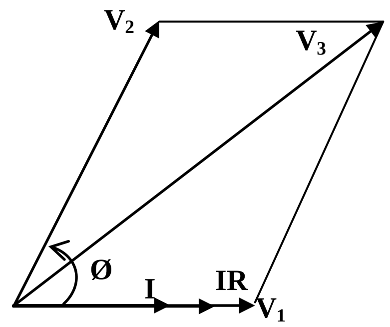
$I=V_1/R$ (Here R= 35 Ohm)

Now,

$P_{calculated} = V_2\, I \cos \varnothing = V_2\, (V_1/R) \cos \varnothing$

$= (V_1\, V_2/R)\, ((V_3^2-V_1^2-V_2^2)/\ 2.\ V_1.\ V_2) = (1/2R) * (V_3^2-V_1^2-V_2^2)$ (4)

From the above equation it can observed that, the power and power factor in an a.c circuit can be measured by using 3-single phase voltmeters, instead of a wattmeter. Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading



Phasor diagram of the above circuit.

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac set the voltmeter reading as supply voltage.
5. Vary the RL load to obtain different readings of voltmeters, and wattmeter.
6. Repeat step 5 for different observations.
7. Set the variac at zero position and switch of supply.

Tabulation:

Sl.No.	V_1 in (volts)	V_2 in (volts)	V_3 in (volts)	$P_{calculated}$	Wattmeter Reading*M.F	cos Ø
1						
2						
3						
4						

Calculation:

Calculate the value of P, cos Ø.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading

Precautions:

1. All connection should be proper and tight.
2. The zero setting of all the meters should be checked before connecting them in the circuit.
3. The current through ammeter should never be allowed to exceed the current rating of variac and load used.

Questions:

1. Why current is taken as a reference?

EXPERIMENT NO. 5 T.N. 1 A

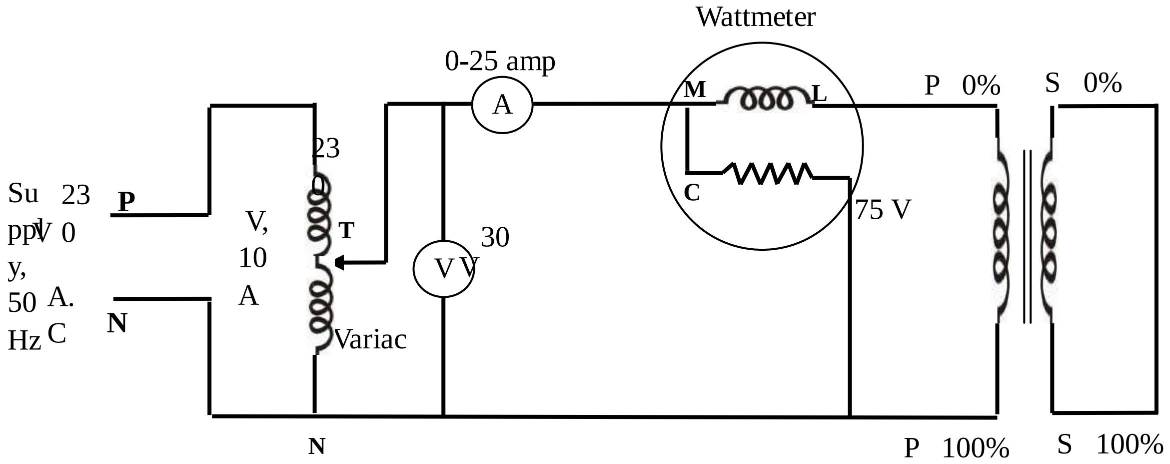
Aim of the Experiment: To perform short circuit test on a single phase transformer to calculate:

1. The copper loss of the transformer.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 75 W)
2. A.C Voltmeter - 1 nos. (0-300 V)
3. A.C ammeter - 1 nos. (0-25 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz)
6. Connecting wires

Circuit Diagram



Theory:

$$R_{01} = \frac{W_{sc}}{I_{sc}^2}$$

$$Z_{01} = \frac{V_{sc}}{I_{sc}}$$

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

Procedure:

1. Make the connections as per the circuit diagram.
2. Make sure that the secondary side of transformer is shorted.
3. Keep the variac at zero position before switch on the supply.
4. Switch on A.C supply.
5. By varying the variac apply full load current to the transformer and note the reading of voltmeter, wattmeter and ammeter.
6. Keep the variac at zero position and switch of supply.

Tabulation:

Sl.No.	Voltmeter Reading (V)	Ammeter Reading (A)	Wattmeter Reading (W)
1			

Calculation:

Calculate the multiplying factor (M.F) of the wattermeter.

M.F= ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin)

Copper loss = W_{sc} (in Watts) = Wattmeter Reading*M.F

Short circuit current=Ammeter reading= I_{sc}

Voltmeter Reading = V_{sc}

Copper loss = Wattmeter Reading =W_{sc}

Calculate the values of R_{01}, X_{01}, Z_{01}.

Precautions:

1. All the connections should be tight and clean.
2. Special care should be taken while selecting the ranges of the meters for conducting short-circuit test.
3. While conducting the short-circuit test, the voltage applied should be initially set at zero, and then increase slowly. If a little higher voltage than the required voltage be applied (by mistake), there is a danger of transformer being damaged.

Questions:

1. Why transformer rating is in KVA?
2. What type of losses occur in the primary and secondary windings of a transformer when it is in service?
3. How do copper losses vary with load on the transformer?
4. Which parameters of the equivalent circuit of a transformer can be found through short-circuit test ?

EXPERIMENT NO. 6 **N. 2 A**

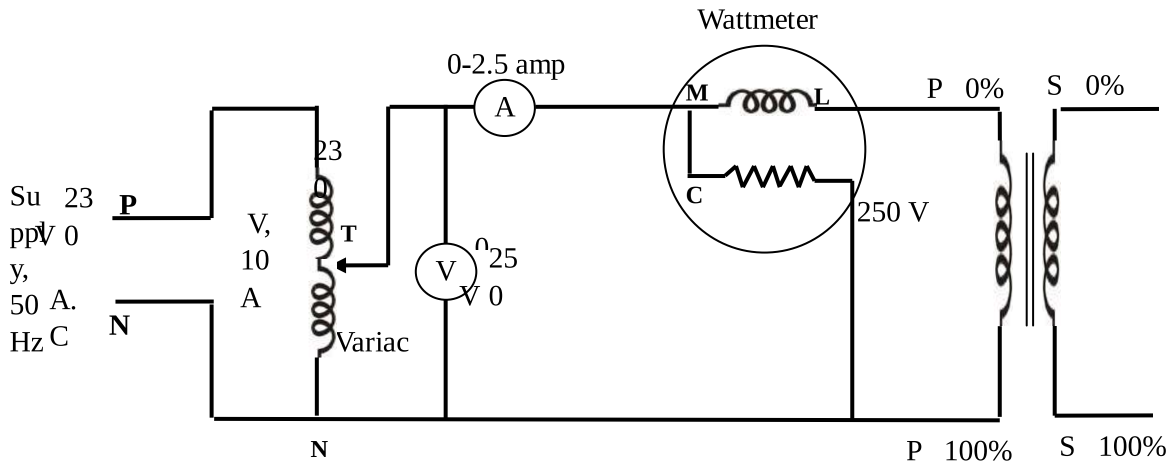
Aim of the Experiment: To perform open circuit test on a single phase transformer to calculate:

2. The equivalent circuit parameters with respect to primary side of the transformer.
3. The open circuit loss or core loss/iron loss of the transformer.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 250 W)
2. A.C Voltmeter - 1 nos. (0-250 V)
3. A.C ammeter - 1 nos. (0-2.5 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz)
6. Connecting wires

Circuit Diagram



Theory:

$W = V_1 I_0 \cos\phi_0$ $\cos\phi_0 = W/(V_1 I_0)$

$I_\mu = I_0 \sin\phi_0, I_W = I_0 \cos\phi_0$

$R_0 = \frac{V_1}{I_W}, X_0 = \frac{V_1}{I_\mu}$

$W = V_1^2 G_0, G_0 = \frac{W}{V_1^2}$

$I_0 = V_1 Y_0, Y_0 = \frac{I_0}{V_1}$

$B_0 = \sqrt{Y_0^2 - G_0^2}$

Procedure:

1. Make the connections as per the circuit diagram.
2. Make sure that the secondary side of transformer is open.
3. Keep the variac at zero position before switch on the supply.
4. Switch on A.C supply.

5. By varying the variac apply full supply voltage i.e. 230V to the primary of the transformer and note the reading of voltmeter, wattmeter and ammeter.
6. Keep the variac at zero position and switch of supply.

Tabulation:

Sl.No.	Voltmeter Reading (V)	Ammeter Reading (A)	Wattmeter Reading (W)
1			

Calculation:

Calculate the multiplying factor (M.F) of the wattermeter.
M.F= ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin)
Iron loss = W (in Watts) = Wattmeter Reading*M.F
No load current=Ammeter reading= I_0
Supply Voltage =Voltmeter Reading = V_1

Precautions:

1. All the connections should be tight and clean.
2. Special care should be taken while selecting the ranges of the meters for conducting open-circuit test.

Questions:

1. When a transformer is energised what types of losses occur in the magnetic frame of the transformer?
2. What information can be obtained from open circuit test of a transformer?
3. Why in open circuit test HV side is always kept open?
4. What is the power factor of a transformer under no load test situation?
5. What is the magnitude of no load current as compared to full load current?

EXPERIMENT NO. 7 **T.N. 3**

Aim of the Experiment: To measure:

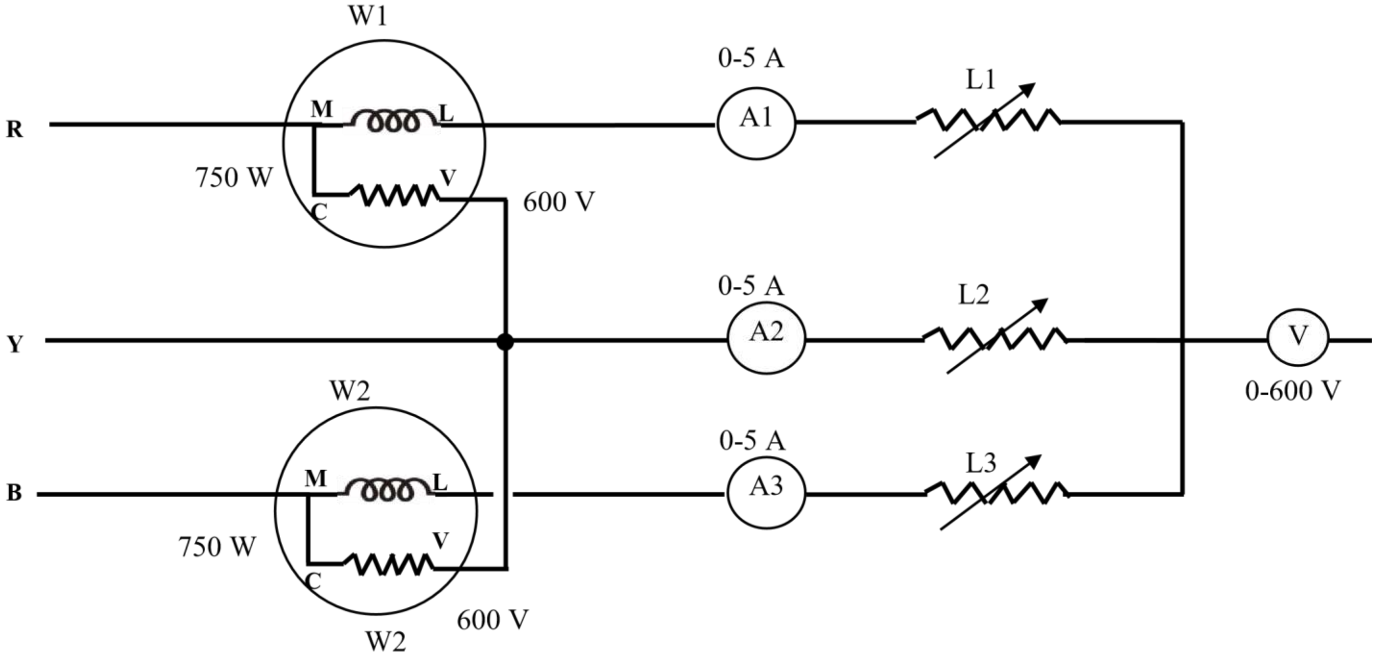
(i) three phase power and power factor in a balanced three phase circuit by using two single-phase wattmeter.

(ii) Calculate the three phase power for unbalance load condition.

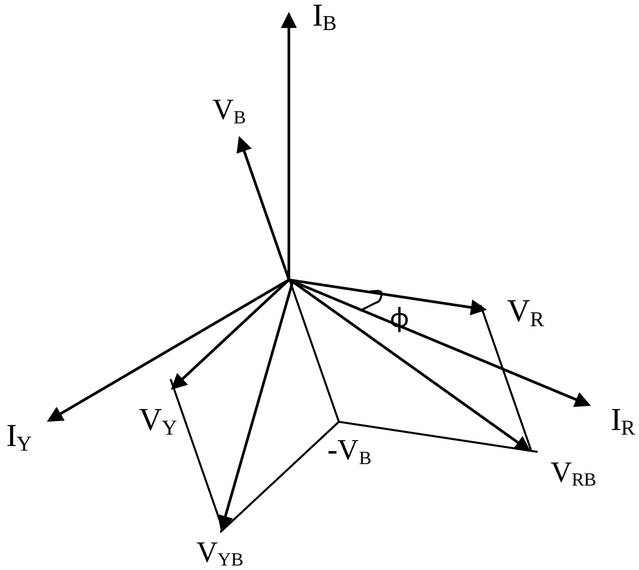
Apparatus Required:

1. A.C Wattmeter - 2 nos. (0- 600 V, 750 W)
2. A.C Voltmeter - 1 nos. (0-600 V)
3. A.C ammeter - 3 nos. (0-5 A)
4. Load Box

Circuit Diagram



Theory: For Balance Load Condition:



Phasor Diagram

$$P_M = W_1 + W_2 \qquad (1)$$

$$P_C = 3\, V_{ph}\, I_{ph} \cos\phi \qquad (2)$$

As it is a balance load condition, $V_a = V_b = V_c$ = Phase Voltage

$I_a = I_b = I_c$ = Phase Current

For resistive load $\cos\phi = 1$. So, $P_C = 3\, V_{ph}\, I_{ph}$

$$W_1 = V_{RB}\, I_R \cos(30^0 - \phi) = \sqrt{3}\, V_{ph}\, I_{ph} \cos(30^0 - \phi) \qquad (3)$$

$$W_2 = V_{YB}\, I_Y \cos(30^0 + \phi) = \sqrt{3}\, V_{ph}\, I_{ph} \cos(30^0 + \phi) \qquad (4)$$

$$W_1 + W_2 = \sqrt{3}\, V_{ph}\, I_{ph} [2\cos 30^0 \cos\phi] = 3\, V_{ph}\, I_{ph} \cos\phi = \sqrt{3}\, V_L\, I_L \cos\phi \qquad (5)$$

The above equation shows that the sum of the two wattmeter readings gives the total power consumed in the three-phase balanced system. We can also calculate the load power factor angle from the measurement of W_1 and W_2.

$$\frac{W_1}{W_2} = \frac{\cos(30^0 - \phi)}{\cos(30^0 + \phi)}$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{\cos(30^0 - \phi) - \cos(30^0 + \phi)}{\cos(30^0 - \phi) + \cos(30^0 + \phi)} = \frac{2\sin 30^0 \sin\phi}{2\cos 30^0 \cos\phi} = \tan 30^0 \tan\phi$$

$$\tan\phi = \sqrt{3}\left[\frac{W_1 - W_2}{W_1 + W_2}\right] \qquad (7)$$

For Unbalance Load Condition:

$P_M = W_1 + W_2$

$P_C = V_a I_a + V_b I_b + V_c I_c$, % Error $= \frac{P_C - P_M}{P_C} \times 100$

Procedure:

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.
3. For balanced load condition measured the values of wattmeters, ammeters and voltmeter.
4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

Tabulation:

Sl. No.	Condition	I_R	I_Y	I_B	V_R	V_Y	V_B	M.F.	W_1	W_2
1	Balanced Load									
2	Unbalanced Load									

Calculation:

Calculate P_M, Pc and % Error.

Precautions:

1. All the connections should be tight and clean.
2. The readings in ammeters should not exceed the current ratings of wattmeters.
3. With negative deflection in wattmeter the connection should be reversed.

Questions:

1. Is it possible to measure reactive power in a three phase circuit using this method?
2. What would be the readings of two wattmeters in this experiment, if the load is purely resistive?
3. What would be the readings of two wattmeters in this experiment, if the load is purely inductive?
4. If one of the wattmeter reads zero, what is the power factor of the load?

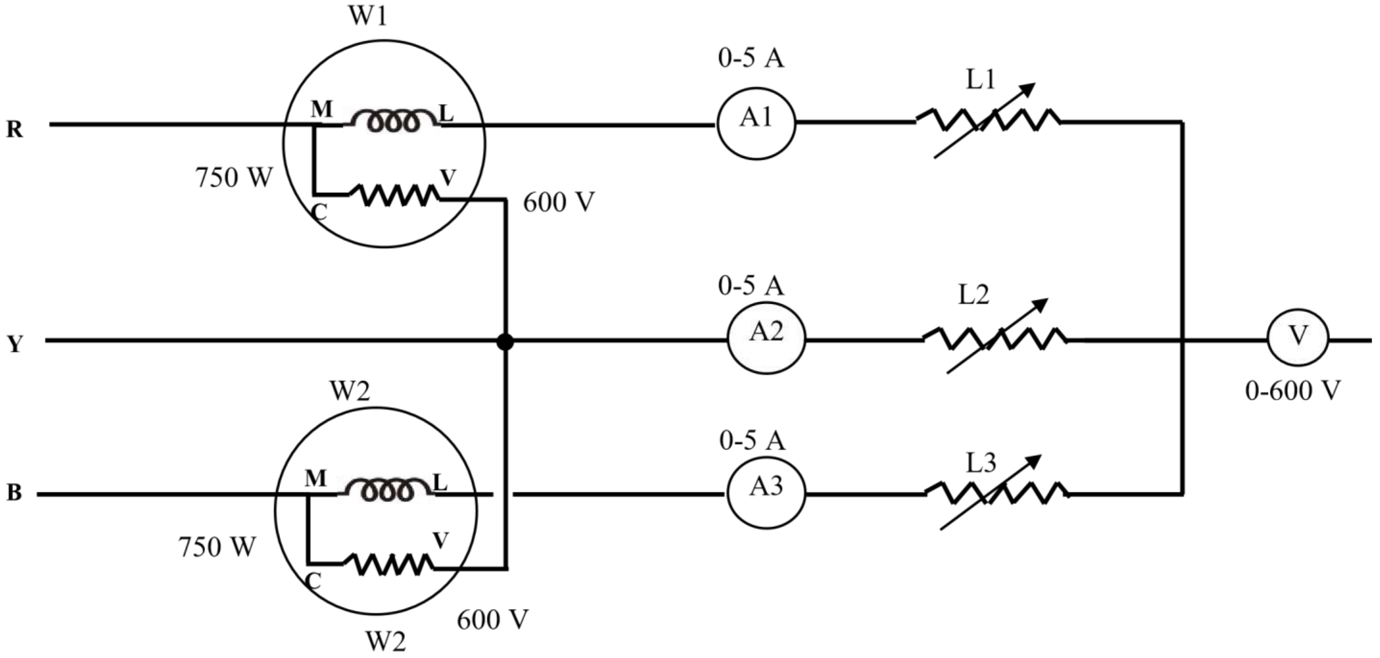
EXPERIMENT NO. 7 T.N. 3

Aim of the Experiment: To measure three phase power using two wattmeter method during balanced and unbalance load condition.

Apparatus Required:

1. A.C Wattmeter - 2 nos. (0- 600 V, 750 W)
2. A.C Voltmeter - 1 nos. (0-600 V)
3. A.C ammeter - 3 nos. (0-5 A)
4. Load Box

Circuit Diagram



Theory:

$$P_M = W_1 + W_2 \quad (1)$$

$$P_C = V_R I_R + V_Y I_Y + V_B I_B \quad (2)$$

For balance load condition, $V_R = V_Y = V_B$ = Phase Voltage

$I_R = I_Y = I_B$ = Phase Current

$$\% \text{ Error} = \frac{P_C - P_M}{P_C} \times 100$$

$$\tan\phi = \sqrt{3}\left[\frac{W_1 - W_2}{W_1 + W_2}\right] \quad (3)$$

$$\cos\phi = ?$$

Procedure:

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.
3. For balanced load condition measured the values of wattmeters, ammeters and voltmeter.

4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

Tabulation:

Sl. No.	Condition	I_R	I_Y	I_B	V_R	V_Y	V_B	M.F.	W_1	W_2	$\cos\phi$
1	Balanced Load										
2	Unbalanced Load										

Calculation:

Calculate P_M, Pc and % Error.

Precautions:

1. All the connections should be tight and clean.
2. The readings in ammeters should not exceed the current ratings of wattmeters.
3. With negative deflection in wattmeter the connection should be reversed.

Questions:

1. Is it possible to measure reactive power in a three phase circuit using this method?
2. What would be the readings of two wattmeters in this experiment, if the load is purely resistive?
3. What would be the readings of two wattmeters in this experiment, if the load is purely inductive?
4. If one of the wattmeter reads zero, what is the power factor of the load?

EXPERIMENT NO. 8

VERIFICATION OF THEVENIN'S THEOREM

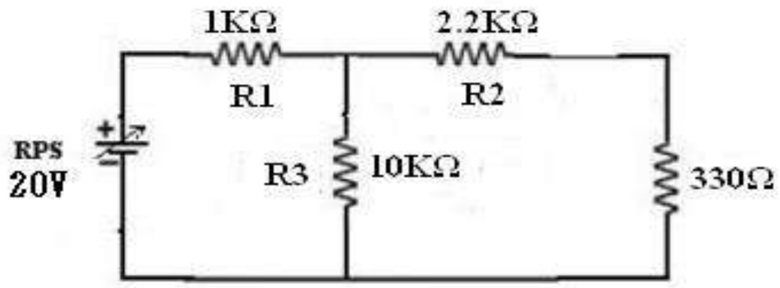
AIM: To verify Theremin's theorem for the given circuit.

APPARATUS REQUIRED:

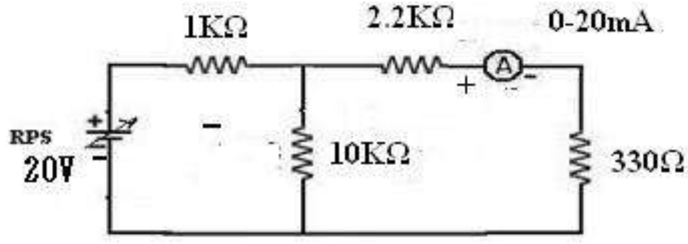
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:

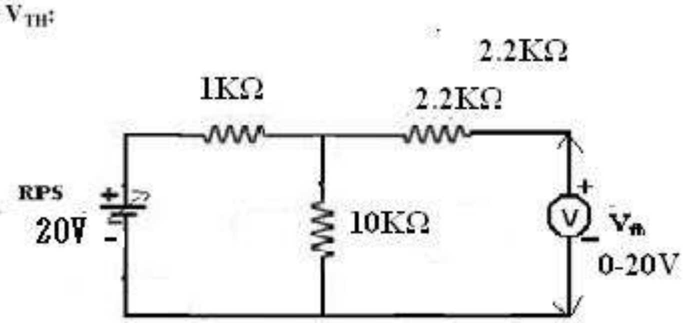


PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



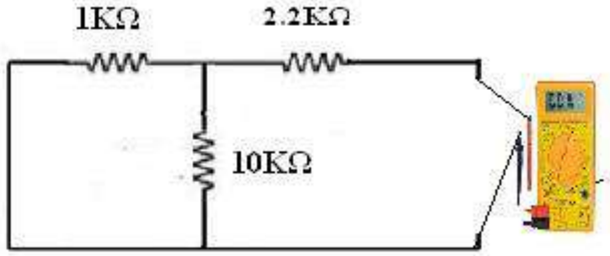
FIG(1)

TO FIND V_{TH}:



FIG(2)

TO FIND R_{th}:



fig(3)

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.

Thevenin's theorem:

The values of VTh and RTh 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. V_{Th} in series with a source resistance R_{Th}

(i) The e.m.f the voltage obtained across the terminals A and B with load, if any removed i.e., it is open circuited voltage between terminals A and B.

(ii) The resistance R_{Th} is the resistance of the network measured between the terminals A and B with load removed and sources of e.m.f replaced by their internal resistances. Ideal voltage sources are replaced with short circuits and ideal current sources are replaced with open circuits.

To find V_{Th}, the load resistor 'RL' is disconnected, then $VTh = \frac{V}{R_1+R_2} X\, R3$

To find R_{Th},

$$R_{Th} = R2 + \frac{R_1 R_3}{R_1 + R_3}$$

Thevenin's theorem is also called as "Helmoltz theorem"

PROCEDURE:

1. Connect the circuit as per fig (1)
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 fig (2).
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 fig (3).
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:

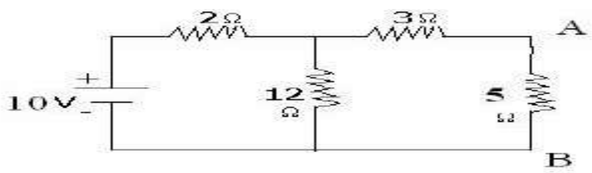
Tabulation for Thevenin's Theorem:

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

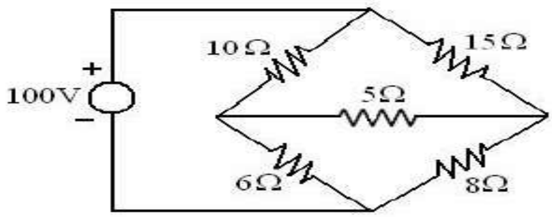
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



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 External Load 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. 9

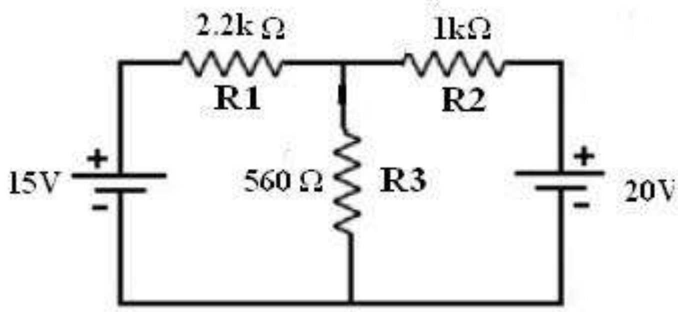
VERIFICATION OF SUPERPOSITION THEOREM

AIM: To verify the superposition theorem for the given circuit.

APPARATUS REQUIRED:

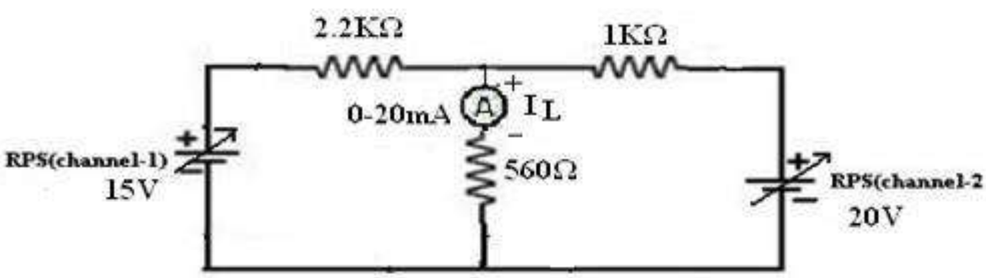
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20) mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	2.2k Ω		1 NO
		1k Ω		1 NO
		560 Ω		1 NO
5	Connecting Wires	-	-	As required

CIRCUIT DIAGRAM:



PRACTICAL CIRCUITS:

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



Fig(1)

When V_1 Source Acting (To Find I_L^I)

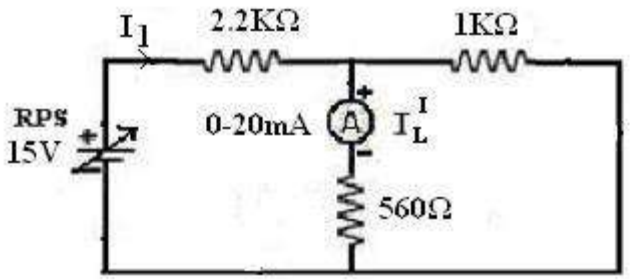


Fig (2)

WhenV$_2$ source acting (To find I_L^{II}):

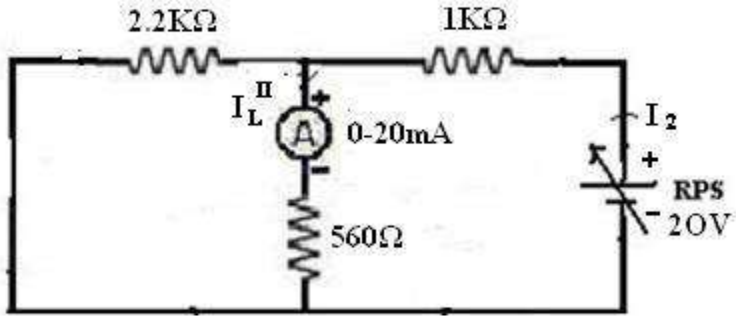


Fig (3)

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 fig (1).
2. Adjust the output voltage of sources X and Y 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 fig (2) and set the source Y (20V) to 0V.
5. Note down the current ($I_L^{1)}$ through 560ohm resistor by using ammeter.
6. Connect the circuit as per fig(3) and set the source X (15V) to 0V and source Y to 20V.
7. Note down the current (I_L^{ll}) through the 560 ohm resistor branch by using ammeter.
8. Reduce the output voltage of the sources X and Y to 0V and switch off the supply.
9. Disconnect the circuit**.**

THEORITICAL CALCULATIONS

From Fig(2)

$$I_1=V_1/(R_1+(R_2//R_3))$$

$$I_L^{1}=I_1*R_2/(R_2+R_3)$$

From Fig(3)

$$I_2=V_2/(R_2+(R_1//R_3)$$

$$I_L^{11}=I_2*R_1/(R_1+R_3)$$

$$I_L = I_L^{1} + I_L^{11}$$

TABULAR COLUMNS:

From Fig(1)

S. No	Applied voltage (V_1) Volt	Applied voltage (V_2) Volt	Current I_L (mA)

From Fig(2)

S. No	Applied voltage (V_1) Volt	Current I_L^{I} (mA)

From Fig(3)

S. No	Applied voltage (V_2) Volt	Current I_L^{II} (mA)

S.No	Load current	Theoretical Values	Practical Values
1	When Both sources are acting, I_L		
2	When only source X is acting, I_L^1		
3	When only source Y is acting, I_L^{II}		

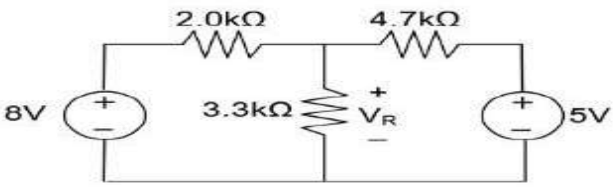
PRECAUTIONS:

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:

EXERCISE QUESTIONS:

1. Using the superposition theorem, determine the voltage drop and current across the resistor 3.3K as shown in figure below.



QUESTIONS:

1) What do you m ean by Unilateral and Bilateral network? Give the limitations of Superposition Theorem ?

2) What are the equivalent internal impedances for an ideal voltage source and for a Current source?

3) Transform a physical voltage source into its equivalent current source.

4) If all the 3 star connected impedance are identical and equal to ZA, then what is the Delta connected resistors

EXPERIMENT NO. 10

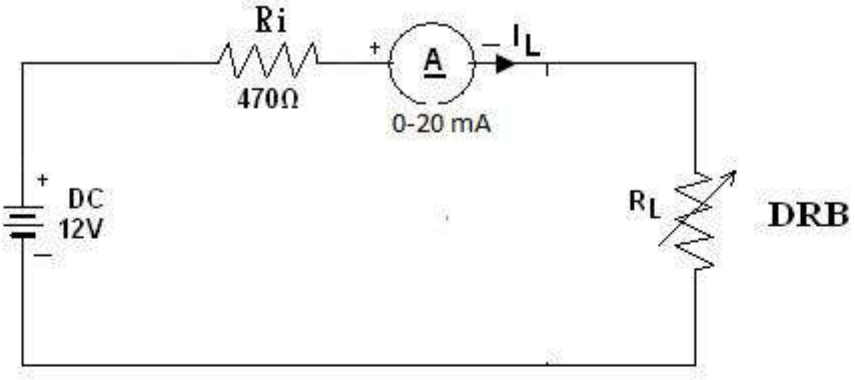
VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

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:



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

$$\boxed{R_L == Ri}$$

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

PROCEDURE:

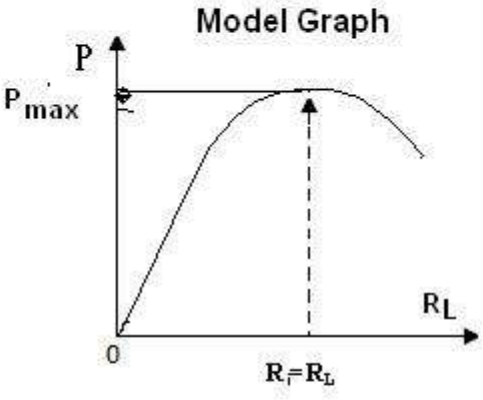
1. Connect the circuit as shown in the above figure.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance (R_L) in steps and note down the corresponding Ammeter Reading

(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			



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?

EXPERIMENT NO. 11

VERIFICATION OF NORTON'S THEOREM

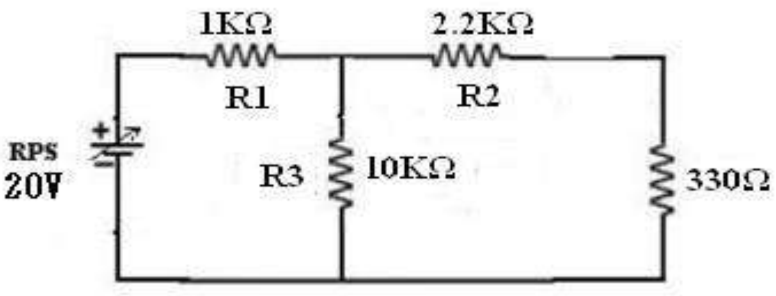
AIM: To verify Norton's theorem for the given circuit.

APPARATUS REQUIRED:

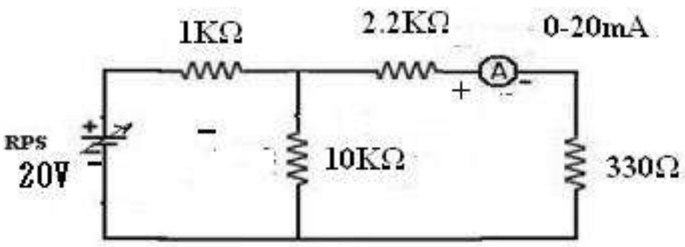
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:



PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



FIG(1)

TO FIND I_N:

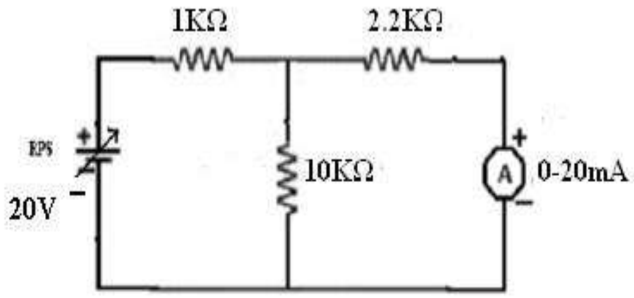
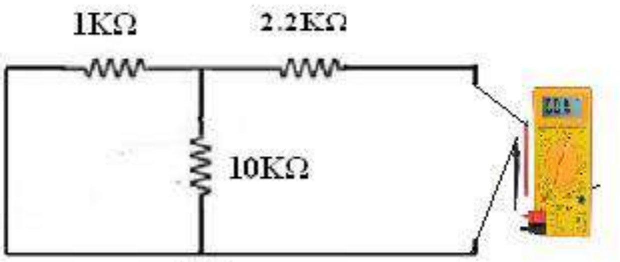


fig (2)

TO FIND R_N:



fig(3)

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 fig (1)
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 fig (2).
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 fig (3).
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Norton's resistance(R_N).

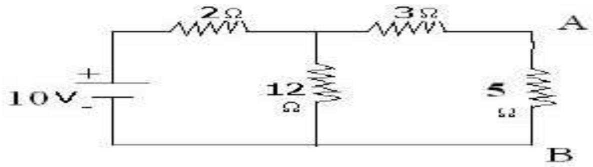
TABULATION FOR NORTON'S THEOREM:

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

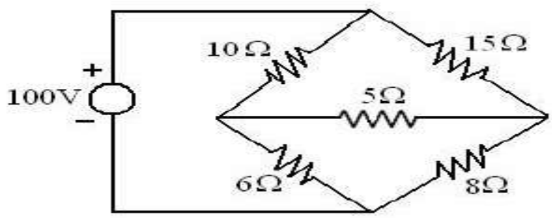
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



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 External Load 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 ?