RCC INSTITUTE OF INFORMATION TECHNOLOGY

(UNDER W.B.UNIVERSITY OF TECHNOLOGY)

ELECTRICAL ENGINEERING LABORATORY

__________ SEMESTER ________ YEAR

NAME: ______________________________ ROLL NO. ______

CLASS ____________ GROUP __________ SUB GROUP ________

DATE OF EXPERIMENT ________ DATE OF SUBMITION __________

EXPERIMENT NO. __________

TITLE: ____

OBJECT: ____

CO-WORKERS

NAME	ROLL NO
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GRADE OBTAINED

TEACHER'S SIGNATURE ______________

EXAMINER'S SIGNATURE ______________

Basic Electrical Engineering Laboratory-I

ES 191

Credits: 2

Syllabus

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. (a) Verification of Thevenin's theorem.

   (b) Verification of Norton's theorems.
4. Verification of Maximum power theorem.
5. Verification of Superposition theorem
6. Study of R-L-C Series circuit
7. Study of R-L-C parallel circuit

Title: Characteristics of Fluorescent Lamp. Experiment No. 1

Objectives:

- To study the connection of fluorescent lamp.
- To measure the striking and extinguishing voltages.
- To measure the power consumption of lamp at different voltages.

Theory:

A fluorescent lamp is a low pressure mercury discharge lamp with internal surface coated with a suitable fluorescent material. This lamp consists of a glass tube provided with caps having two pins at both ends of the tube and oxide coated tungsten filaments. The tube consists of an inert gas like argon or krypton to facilitate starting with small quantity of mercury of low pressure. The fluorescent material, when subjected to electromagnetic radiations of particular wavelength produces by the discharge through the mercury vapor, gets excited and in turn gives out radiation which falls under the visible spectrum. Thus the secondary radiation from the fluorescent powder increases the efficiency of the lamp.

When switch is on, full supply voltage from Variac appear across the stator electrodes *P* and *Q* which are enclosed in a glass bulb filled with argon gas. This voltage causes discharge in the argon gas with consequent heating of the electrodes. Due to this heating, the electrode *V* which is made of bimetallic strip bends and closes contact of the starter. At this stage, the chock, the filaments M_1 and M_2 of the tube *T* and the starter become connected in series across the supply. A current flows through filaments M_1 and M_2 and heats them. Meanwhile the argon discharge in the starter tube disappears and after a cooling time, the electrodes *P* and *Q* causes a sudden break in the circuit. This causes a high value of induced emf in the chock. The induced emf in the chock is applied across the tube electrodes M_1 and M_2 and is responsible for initiating a gaseous discharge because initial heating has already created good number of free electrons in the vicinity of electrodes. Thus the tube light starts giving light output. Once the discharge through the tube is established, a much lower voltage is required to maintain it. The capacitor connected across the starter terminals *P* and *Q* is use to suppress the electromagnetic waves generated at the gap due to sparking; thereby reducing the disturbances caused to the nearby radio and TV receivers.

Power factor of the lamp is low and is about 0.5 lagging due to inclusion of the chock. A condenser, if connected across the supply, may improve the power factor to about 0.95 lagging. The light output of the lamp is a function of its supply voltage. At reduced supply voltage, the lamp may click a start but may fail to hold because of non availability of required holding voltage across the tube. Higher voltage reduces the useful life of the tube light to a very great extent.

Device under test:

Name of device	Quantity	Type	Rating	Maker's name	Sl. No.
Fluorescent Lamp					

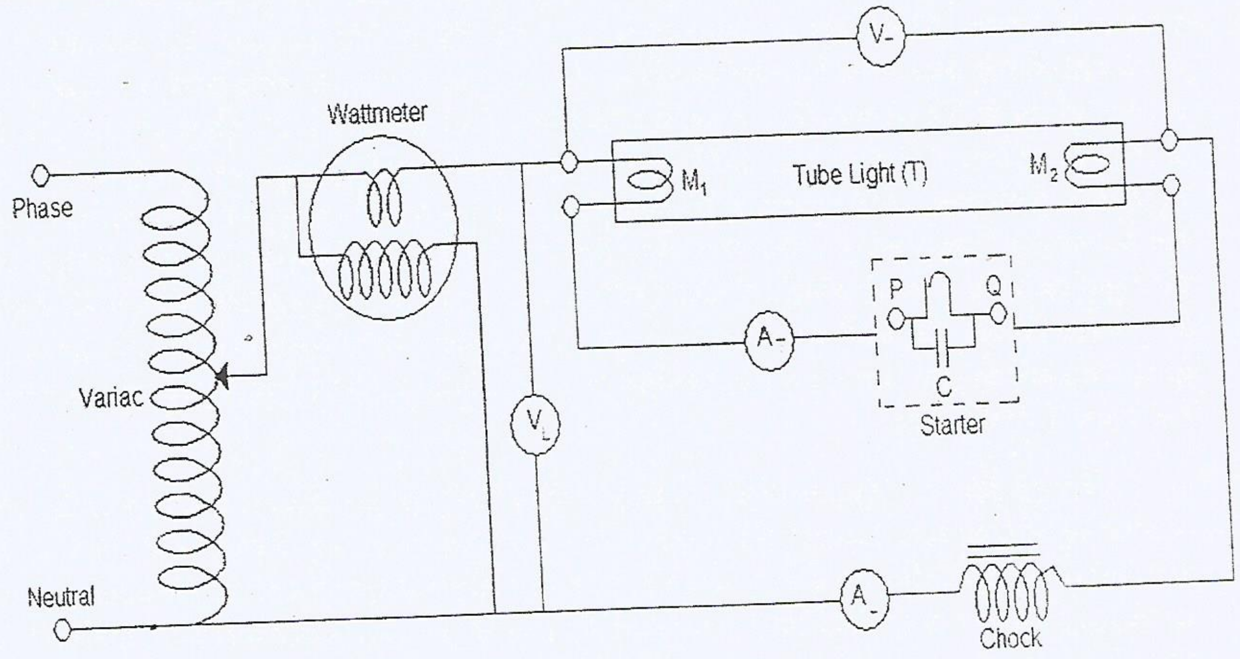
Auxiliary devices:

Name of device	Quantity	Type	Rating	Maker's name	Sl. No.
Starter					
Chock					

Equipment / Instruments required:

Name of device	Quantity	Type	Rating	Maker's name	Sl. No.
Voltmeter					
Ammeter					
Wattmeter					
Variac					

Circuit Diagram:



Procedure:

1. The connection are made as shown in the circuit diagram.
2. With the zero voltage position of the Variac, the AC supply is switches on.
3. The applied voltage is gradually increased till the lamp strikes. It is observed that the current through the starter decreases to zero value immediately after striking. The readings of striking voltage and the current through the starter before and after striking are noted.
4. The applied voltage is increased to the rated value and readings of applied voltage, voltage across the lamp and line current are noted.
5. The applied voltage is decreased in steps till the lamp extinguishes and in step readings are taken as in step 4. The extinguishing voltage is also noted.

Observation Table:

Striking Voltage	Extinguishing Voltage	Current through starter	
		During Striking	After Striking

Multiplying factor of the Wattmeter =

Power = reading of the Wattmeter × multiplying factor

Obs No.	Applied voltage increasing				Obs No.	Applied voltage decreasing			
	Applied voltage	Lamp voltage	Line current	Power input		Applied voltage	Lamp voltage	Line current	Power input
	V_L	V_T	A_L	W		V_L	V_T	A_L	W
1.					11.				
2.					12.				
3.					13.				
4.					14.				
5.					15.				
6.					16.				
7.					17.				
8.					18.				
9.					19.				
10.					20.				

Prepared by: Teacher's Signature:

Roll No: Date:

Remarks:

- The graph of power (Y axis) vs. Supply voltage (X axis) for the lamp are drawn on graph paper.
- The graph of lamp potential (Y axis) vs. line current (X axis) are drawn on the graph paper.

Questions:

1. What is the function of starter?
2. What is the function of chock?
3. Does the tube glow without starter? If yes how?
4. Does the tube glow without chock? If yes how?
5. Can we use a fluorescent lamp in DC? What modification in connection is necessary?
6. What are the gases used in fluorescent lamp?
7. Can we comment on the power factor of the lamp from the observation table? If yes what is power factor of the lamp?
8. Discuss advantages of fluorescent lamp over incandescent lamp.

Experiment No. 2

Title: Characteristics of Tungsten & Carbon Filament Lamps.

Objectives: To study the volt-ampere, resistance-voltage and voltage-power characteristics of Tungsten and Carbon filament lamps.

Theory:

Resistance of any material varies with temperature. The electrical resistance of any conductor is dependent on collisional processes within the wire. The resistance could be expected to increase with temperature since there will be more collisional.

For temperature range that is not too great, this variation can be represented approximately as a linear function.

$$R_T = R_0\left(1+\alpha(T-T_0)\right)$$

Where R_T and R_0 are the values of the resistance at temperature T and T_0 respectively. T_0 is often taken to be either room temperature of 0^0 C. α is the temperature coefficient of resistivity. Pure metal have a small positive value of α, which means that their resistance increases with increasing temperature. Carbon has negative value of α. Therefore resistance of carbon decreases with increase of temperature.

The temperature coefficient of Tungsten and Carbon are 0.0045 and -0.0005 respectively.

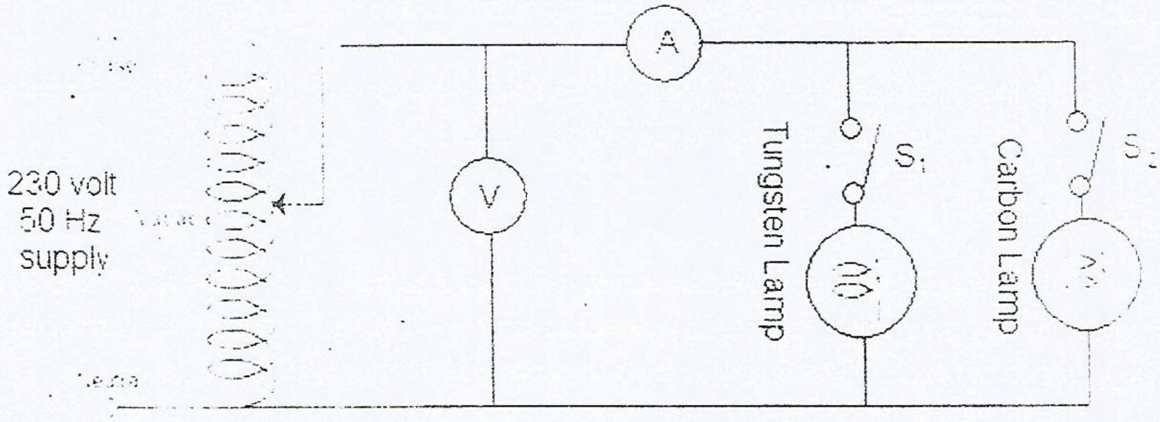
Device under test:

Name of device	Quantity	Type	Rating	Maker's name	Sl. No.
Tungsten filament lamp					
Carbon filament lamp					

Equipment / Instruments required:

Name of device	Quantity	Type	Rating	Maker's name	Sl. No.
Voltmeter					
Ammeter					
Variac					

~~Circuit Diagram:~~



Procedure:

1. The initial resistance of the filament in cold condition is measured by multimeter or by ammeter-voltmeter method.
2. The circuit is made as shown in the circuit diagram.
3. With the tungsten lamp in the circuit and the variac in zero voltage position, the AC supply is switched on.
4. The applied voltage is varied using the variac and corresponding value of of voltage and current are noted.
5. The change of the glow of the lamp with variation of voltage is observed.
6. The readings for various voltages are tabulated till the rated voltage of the lamp is reached.
7. The steps above ((3 to 6) are repeated replacing the tungsten lamp by a carbon lamp.
8. The applied voltage is decreased in steps till the lamp extinguishes and in step readings are taken as in step 4. The extinguishing voltage is also noted.

Precaution:

1. The voltage rating of the lamps should not be exceeded.
2. The reading to be taken with increase of voltage. Reverse should not be done.
3. The connection of ammeter and voltmeter should be done in proper manner.
4. The circuit to be done with power switch in off condition.

Observation Table:

For Tungsten:

Sl. No.	Voltage (V)	Current (A)	Power ($W=V\times I$)	Resistance $R=(W/I^2)$	Remarks

For Carbon:

Sl. No.	Voltage (V)	Current (A)	Power ($W=V\times I$)	Resistance $R=(W/I^2)$	Remarks

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Roll No:

Teacher's Signature:
Date:

Remarks:

- The graphs of voltage (Y-axis) vs. current (X-axis) for both the lamps are drawn on the same graph paper.
- The graphs of power (Y-axis) vs. voltage (X-axis) for both the lamps are drawn on the same graph paper.
- The graphs of voltage (Y-axis) vs. resistance (X-axis) for both the lamps are drawn on the same graph paper.
-

Questions:

1. What is the slope of the voltage vs. resistance characteristics of both the lamps and why the slops are so?
2. Can you comment on the efficiency of an incandescent lamp and fluorescent lamp?

Title: ~~Verification of Thevenin's~~ Theorem. ~~Experiment No. 3(a)~~

Objectives: Verify the Thevenin's Theorem practically.

Theory:

Statement of the Theorem: "The Thevenin's theorem states that in any bilateral network the current through any resistance connecting across any two points of an active network, can be obtained by dividing the potential difference between the two points with the load resistance disconnected (equivalent Thevenin's source V_{th}) by the sum of load resistance and the resistance of the network measured between these points with load resistance disconnected and source of emf replaced by their internal resistances (equivalent Thevenin's resistance)."

Explanation:

To find a current *IL* through the load resistance R_L (as shown in fig. 1(a)) using Thevenin's theorem, the following steps are followed:

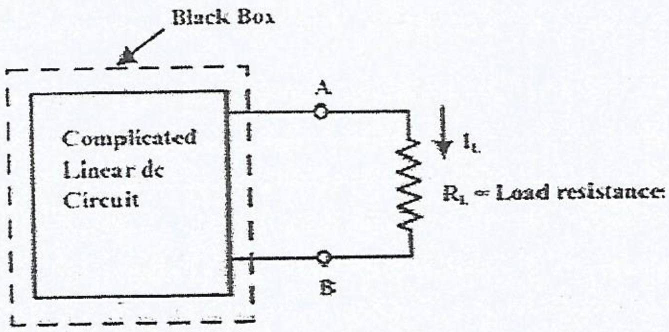


Figure 1(a): Explanation of Thevenin's Theorem

Step-1: Disconnect the load resistance (R_L) from the circuit, as indicated in fig. 1(b).

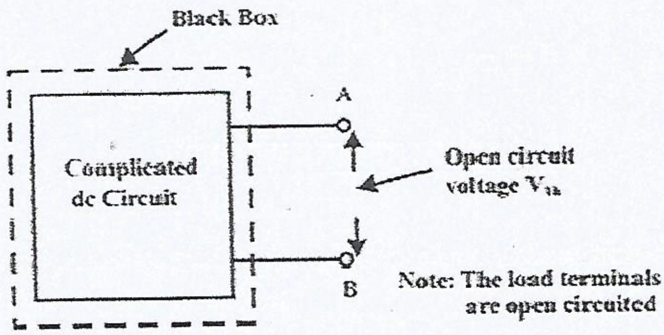


Figure 1(b): Load is disconnected from the circuit

Step-2: ~~Calculate the open-circuit voltage~~ V_{Th} ~~(shown in fig.1(b)) at the load terminals~~ $(A\&B)$ after disconnecting the load resistance (R_L). In general, one can apply any of the techniques (mesh-current, node-voltage and superposition method) to compute V_{Th} (experimentally just measure the voltage across the load terminals using a voltmeter).

Step-3: Redraw the circuit (fig. 1(b)) with each practical source replaced by its internal resistance as shown in fig. 1(c). (note, voltage sources should be short-circuited (just remove them and replace with plain wire) and current sources should be open-circuited (just removed).

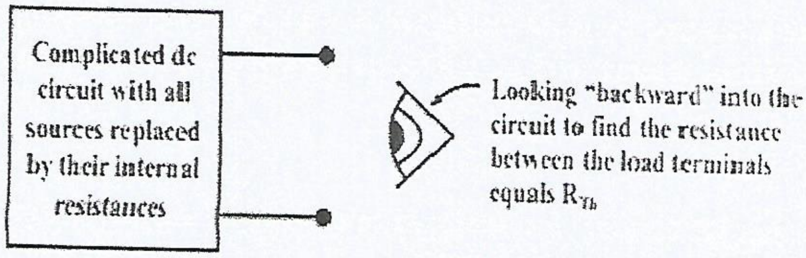


Figure 1(c): Procedure to find out the Thevenin's Resistance R_{Th}.

Step-4: Look backward into the resulting circuit from the load terminals $(A\&B)$, as suggested by the eye in fig. 1(c). Calculate the resistance that would exist between the load terminals (or equivalently one can think as if a voltage source is applied across the load terminals and then trace the current distribution through the circuit (fig. 1(c)) in order to calculate the resistance across the load terminals.) The resistance R_{Th} is described in the statement of Thevenin's theorem. Once again, calculating this resistance may be a difficult task but one can try to use the standard circuit reduction technique or $Y-\Delta$ *or* $\Delta - Y$ transformation techniques.

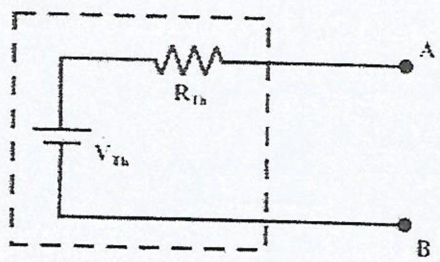


Figure 1(d): Dash-portion of the circuit (fig. 1(a)) is equivalently replaced by a practical voltage source

Step-5: Place R_{Th} in series with V_{Th} to form the Thevenin's equivalent circuit (replacing the imaginary fencing portion or fixed part of the circuit with an equivalent practical voltage source) as shown in fig. 1(d).

Step-6: Reconnect the original load to the Thevenin voltage circuit as shown in fig. 1(e); the load's voltage, current and power may be calculated by a simple arithmetic operation only.

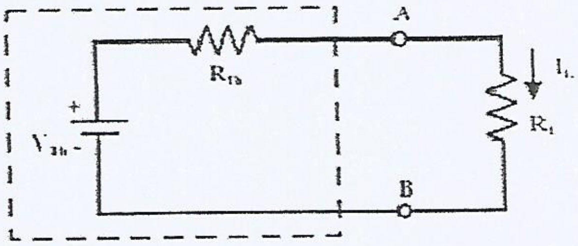


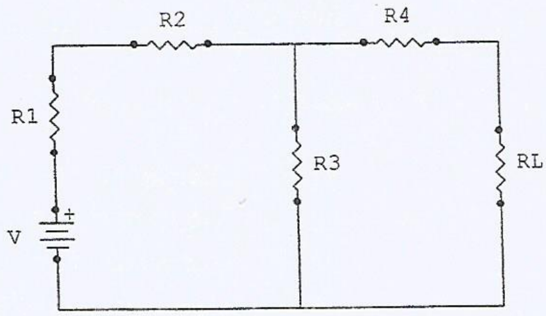
Figure 1(e): Thevenin's equivalent circuit

Load current = $I_L = \dfrac{V_{Th}}{R_{Th} + R_L}$

Voltage across the load $V_L = \dfrac{V_{Th}}{R_{Th} + R_L} \times R_L = I_L \times R_L$

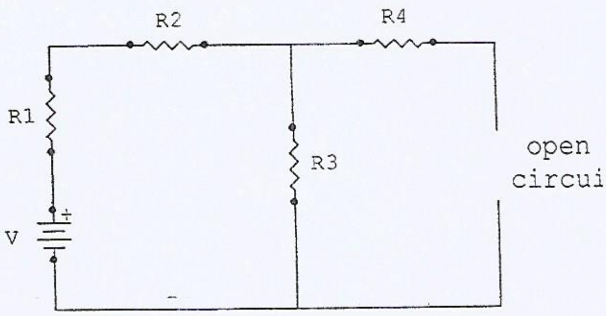
Power absorbed by the load $P_L = I_L^2 \times R_L$

Experimental Circuit:



The circuit contains one voltage source (V) and five resistors of resistances R_1, R_2, R_3, R_4 and R_L. Using Thevenin's theorem you have to find the current flowing through the load resistor R_L.

Step 1 At first disconnect (remove) the load resistance. Next find the open circuit voltage across the load terminals. This voltage is designated as "Thevenin's Equivalent Voltage Source (V_{Th}).

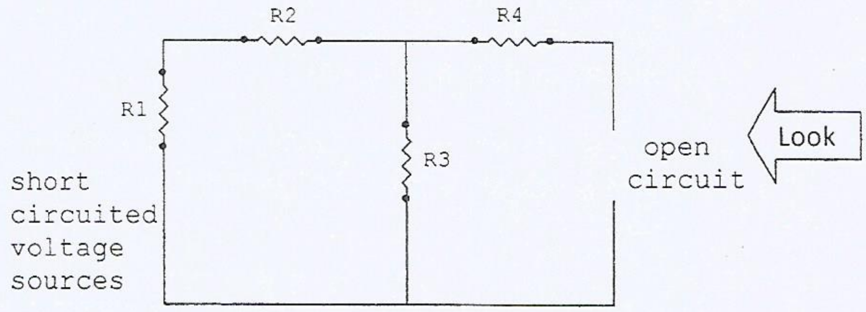


V_{Th} = voltage across the resistance R_3 (since no current will flow through the resistance R_4)

$$V_{Th} = \frac{V}{R_1 + R_2 + R_3} \times R_3$$

Step 2 Next remove all the sources from the circuit leaving their internal resistances (if any). Look backward into the circuit from the open circuited load terminals to find the Thevenin's resistance (R_{Th}).

$$R_{Th} = \frac{(R_1 + R_2)R_3}{R_1 + R_2 + R_3} + R_4$$



Step 3 Now draw the Thevenin's Equivalent Circuit and connect the load resistance to the circuit again. Find the load current (I_L) using the formula

$$\text{Load current} = I_L = \frac{V_{Th}}{R_{Th} + R_L}$$

Apparatus required: Network theorem test set.

Name of the apparatus	Quantity	Type	Range	Maker's Name	Serial No.
Voltmeter					
Ammeter					
Network Theorem Trainer					
Multimeter					

Procedure:

1. Measure all the resistances by a multimeter.
2. Measure the voltage source (V).
3. Complete the circuit as per the diagram by connecting wires.
4. Open circuit the load resistance and measure V_{Th}.
5. Short circuit the voltage source and measure R_{Th} experimentally.
6. Connect a dc ammeter in series with the load resistance to measure the load current (I_L).

Observation Table:

$R_1 =$ Ω $R_4 =$ Ω $V =$ *volt*

$R_2 =$ Ω $R_L =$ Ω

$R_3 =$ Ω

Thevenin's Equivalent Voltage	Thevenin's Equivalent Resistance	Load Current
V_{Th} (observed) (volt)	**R_{Th} (observed) (Ω)**	**I_L (observed) (amp)**

Thevenin's Equivalent Voltage	Thevenin's Equivalent Resistance	Load Current
V_{Th} (analytically) (volt)	**R_{Th} (analytically) (Ω)**	**I_L (analytically) (amp)**

Prepared by: Teacher's Signature:

Roll No: Date:

Remarks:

- Show all the calculations to find out the parameters (V_{Th}, R_{Th} and I_L) analytically.
- Draw the Thevenin's Equivalent Network.

Questions:

1. Can we apply Thevenin's Theorem in circuit having multisource?
2. What is a bilateral network?
3. 'Thevenin's Theorem is a dual of Norton's Theorem' explain.
4. A resistor placed directly in parallel with a source voltage does not affect R_{Th}, why?

Title: Verification of Norton's Theorem. Experiment No. 3(b)

Objectives: Verify the Norton's Theorem practically.

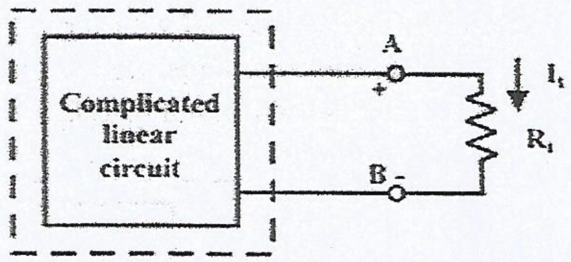
Theory:

Statement of the Theorem: "The Norton's Theorem state that any two terminal active network containing energy sources and resistances only when viewed from its output terminals, is equivalent to a constant current sources and a parallel resistance. The constant current is equal to the current which would flow if a short circuit is placed across the load terminals (**Norton's Equivalent Current Source (I_N)**) and parallel resistance is the resistance of the network when viewed from the open circuited load terminals (**Norton's Equivalent Resistance (R_N)**) after all voltage and current sources have been removed and replaced by their internal resistances."

Explanation:

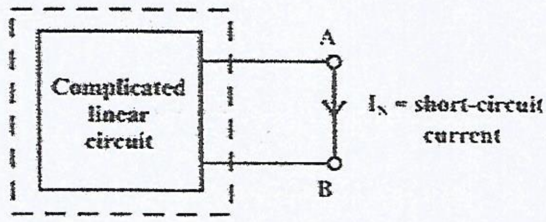
Any linear dc circuit, no matter how complicated, can also be replaced by an equivalent circuit consisting of one dc current source in parallel with one resistance. Precisely, Norton's theorem is a dual of Thevenin's theorem. To find a current I_L through the load resistance R_L (as shown in fig. 1(a)) using Norton's theorem, the following steps are followed:

Figure 1(a): Explanation of Norton's Theorem



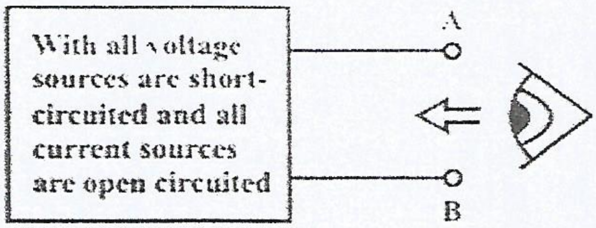
Step-1: Short the output terminal after disconnecting the load resistance (R_L) from the terminals A&B and then calculate the short circuit current I_N (as shown in fig. 1(b)). In general, one can apply any of the techniques (mesh-current, node-voltage and superposition method) to compute I_N (experimentally just measure the short-circuit current using an ammeter).

Figure 1(b): Load is short circuited in the circuit



Step-2: Redraw the circuit with each practical sources replaced by its internal resistance while the short–circuit across the output terminals removed (note: voltage sources should be short-circuited (just replace with plain wire) and current sources should be open-circuited (just removed)). Look backward into the resulting circuit from the load terminals (&*AB*), as suggested by the eye in fig. 1(c).

Figure 1(c): Procedure to find out the Norton's equivalent resistance



Step-3: Calculate the resistance that would exist between the load terminals A&B (or equivalently one can think as if a voltage source is applied across the load terminals and then trace the current distribution through the circuit (fig. 1(c)) in order to calculate the resistance across the load terminals). This resistance is denoted as R_N, is shown in fig. 1 (d). Once again, calculating this resistance may be a difficult task but one can try to use the standard circuit reduction technique or $Y-\Delta$ or $\Delta-Y$ transformation techniques. It may be noted that the value of Norton's resistance R_N is truly same as that of Thevenin's resistance R_{Th} in a circuit.

Step-4: Place R_N in parallel with current I_N to form the Norton's equivalent circuit (replacing the imaginary fencing portion or fixed part of the circuit with an equivalent practical current source) as shown in fig. 1(d).

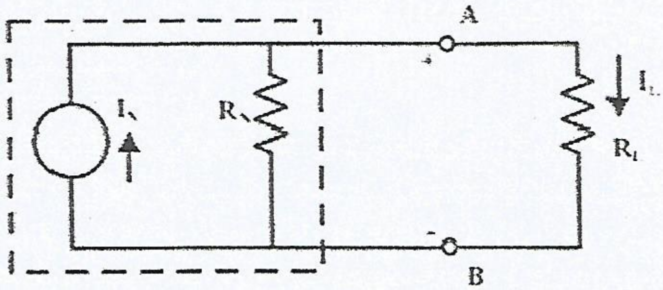


Figure 1(d): Norton's Equivalent Circuit of the original Network

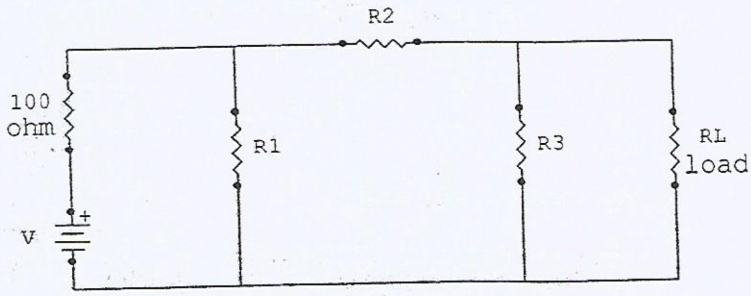
Load current $I_L = \dfrac{R_N}{R_N + R_L} \times I_N$

Voltage across the load $V_L = I_L \times R_L$

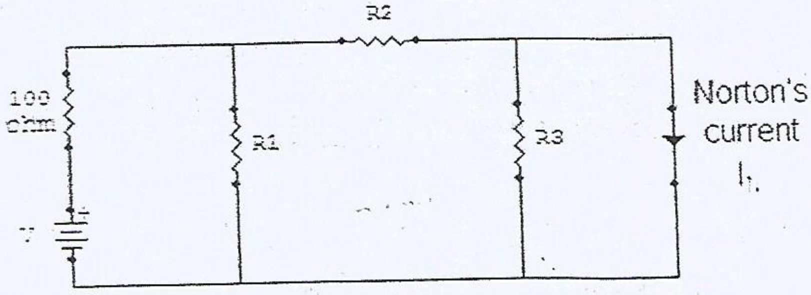
Power absorbed by the load $P_L = I_L^2 \times R_L$

Experimental Circuit:

The circuit contains one voltage source (V) and four resistors of resistances viz R_1, R_2, R_3 and R_L. Using Norton's theorem you have to find the current flowing through the load resistor R_L.



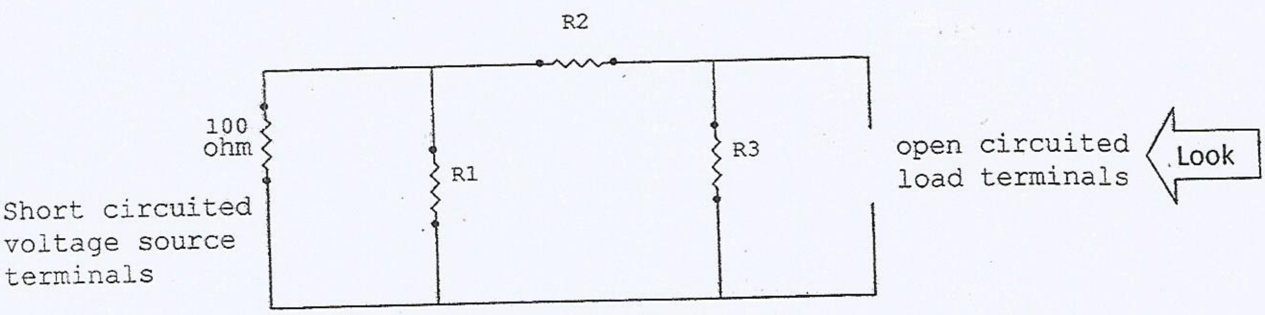
Step 1 At first short circuited the load resistance. Next find the short circuit current through the load terminals. This current is designated as "Norton's Equivalent Current Source (I_N).



I_N = Current through the resistance R_2

$$I_N = \frac{V}{100 + \frac{R_1 R_2}{R_1 + R_2}} \times \frac{R_1}{R_1 + R_2}$$

Step 2 Next remove all the sources from the circuit leaving their internal resistances (if any). Look backward into the circuit from the open circuited load terminals to find the Norton's resistance (R_N).



$$R_N = [(R_1 \parallel 100) + R_2] \parallel R_3 = \frac{\left(\frac{100R_1}{100+R_1} + R_2\right) R_3}{\left(\frac{100R_1}{100+R_1} + R_2\right) + R_3}$$

Step 3 Now draw the Norton's Equivalent Circuit and connect the load resistance to the circuit again. Find the load current (I_L) using the formula

$$\text{Load current} = I_L = \frac{R_N}{R_N + R_L} \times I_N$$

Apparatus required:

Name of the apparatus	Quantity	Type	Range	Maker's Name	Serial No.
Voltmeter					
Ammeter					
Network Theorem Trainer					
Multimeter					

Procedure:

1. Measure all the resistances by a multimeter.
2. Set the voltage source to 10 volt.
3. Choose the suitable resistances.
4. Complete the circuit as per the diagram by connecting wires.
5. Short circuit the load resistance and measure I_N.
6. Short circuit the voltage source and measure R_N experimentally.
7. Connect a dc ammeter in series with the load resistance to measure the load current (I_L).

Observation Table:

$R_1 =$ Ω $\quad$ $R_L =$ Ω

$R_2 =$ Ω $\quad$ $V =$ volt

$R_3 =$ Ω

Norton's Equivalent Current	Norton's Equivalent Resistance	Load Current
I_N (observed) (amp)	**R_N (observed) (Ω)**	**I_L (observed) (amp)**

Norton's Equivalent Current	Norton's Equivalent Resistance	Load Current
I_N (analytically) (amp)	**R_{Th} (analytically) (Ω)**	**I_L (analytically) (amp)**

Prepared by:

Roll No:

Teacher's Signature:

Date:

Remarks:

- Show all the calculations to find out the parameters (I_N, R_N *and* I_L) analytically.
- Draw the Norton's Equivalent Circuit.

Questions:

1. Can we apply Norton's Theorem in circuit having multisource?
2. What is a linear network?
3. What is the relation between Thevenin's equivalent resistance (R_{Th}) and Norton's equivalent resistance (R_N)?
4. A resistor placed directly in parallel with a source voltage does not affect R_N, why?

Title: Verification of Superposition Theorem. Experiment No. 5

Objectives: Verify the Superposition Theorem practically.

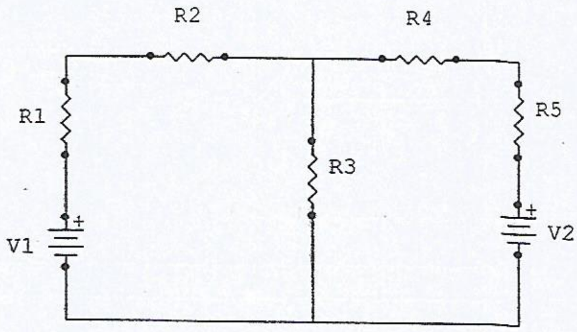
Theory:

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

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

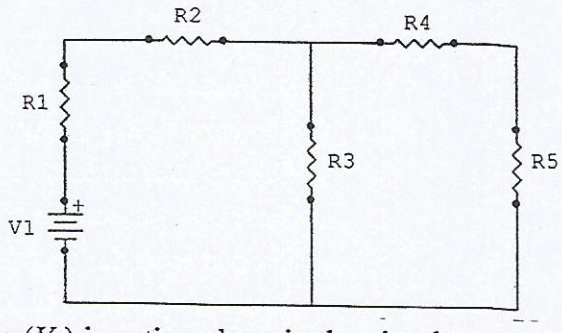
1. Replacing all other independent voltage sources with a short circuit (thereby eliminating difference of potential. i.e. V=0, internal impedance of ideal voltage source is ZERO (short circuit)).
2. Replacing all other independent current sources with an open circuit (thereby eliminating current. i.e.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

Consider the following circuit:



The circuit contains two voltage sources (V_1 and V_2) and five resistors of resistances R_1, R_2, R_3, R_4 and R_5. Using superposition theorem you have to find the current flowing through the resistor R_3.

Step 1 Rebuild the circuit with one voltage source (any one) acting alone at a time. Let us consider that V_1 is acting alone in the circuit. Based on the rule mentioned above the other voltage source (V_2) must be replaced with its internal resistance. For an ideal voltage source the internal resistance is zero (i.e. short circuit). So V_2 will be replaced by short circuit.

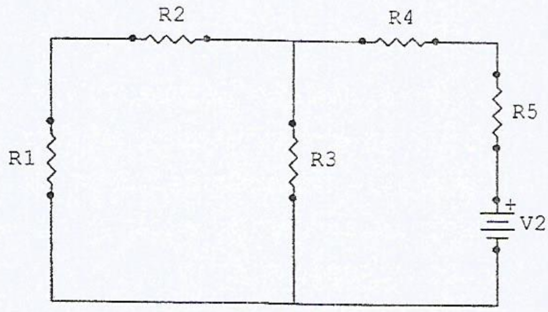


Current through R_3 is

$$I_1 = \frac{V_1}{\frac{(R_4+R_5)R_3}{R_3+R_4+R_5} + R_1 + R_2} \times \frac{R_4+R_5}{R_3+R_4+R_5} \quad (amp)$$

Note that I_1 is the current through R_3 due to voltage source (V_1) is acting alone in the circuit.

Step 2 Next rebuild the circuit with voltage source (V_2) is acting alone in the circuit. Based on the rule mentioned above the voltage source (V_1) must be replaced with its internal resistance. For an ideal voltage source the internal resistance is zero (i.e. short circuit). So V_1 will be replaced by short circuit.



Current through R_3 is

$$I_2 = \frac{V_2}{\frac{(R_1+R_2)R_3}{R_1+R_2+R_3}+R_4+R_5} \times \frac{R_1+R_2}{R_1+R_2+R_3} \quad (amp)$$

Note that I_2 is the current through R_3 due to voltage source (V_2) is acting alone in the circuit.

Step 3 Now when two sources (V_1 and V_2) acting simultaneously in the circuit then the total current flowing through R_3 is the algebraic sum of the currents caused by each independent source acting alone.

Total current $I_T = I_1 + I_2$

$$= \left(\frac{V_1}{\frac{(R_4+R_5)R_3}{R_3+R_4+R_5}+R_1+R_2} \times \frac{R_4+R_5}{R_3+R_4+R_5} \right) + \left(\frac{V_2}{\frac{(R_1+R_2)R_3}{R_1+R_2+R_3}+R_4+R_5} \times \frac{R_1+R_2}{R_1+R_2+R_3} \right) \quad (amp)$$

Apparatus required:

Name of the apparatus	Quantity	Type	Range	Maker's Name	Serial No.
Voltmeter					
Ammeter					
Network Theorem Trainer					
Multimeter					

Procedure:

1. Measure all the resistances by a multimeter.
2. Measure voltage source V_1 and V_2 .
3. Complete the circuit as per the diagram by connecting wires.
4. Connect a dc ammeter in series with the resistor R_3.
5. Short circuit the voltage source V_1 terminals and measure I_1.
6. Short circuit the voltage source V_2 terminals and measure I_2.
7. Connect all the sources in the circuit and measure the total current (I_T).

Observation Table:

$R_1 =$ Ω $R_4 =$ Ω $V_1 =$ *volt*
$R_2 =$ Ω $R_5 =$ Ω $V_2 =$ *volt*
$R_3 =$ Ω

Voltage source (V_1) is acting alone	Voltage source (V_2) is acting alone	Both the sources are acting simultaneously
I_1 (observed) (amp)	**I_2 (observed) (amp)**	**I_T (observed) (amp)**

Voltage source (V_1) is acting alone	Voltage source (V_2) is acting alone	Both the sources are acting simultaneously
I_1 (analytical) (amp)	**I_2 (analytical) (amp)**	**I_T (analytical) (amp)**

Prepared by: Teacher's Signature:

Roll No: Date:

Remarks:

- Show all the calculations to find out the current analytically.

Questions:

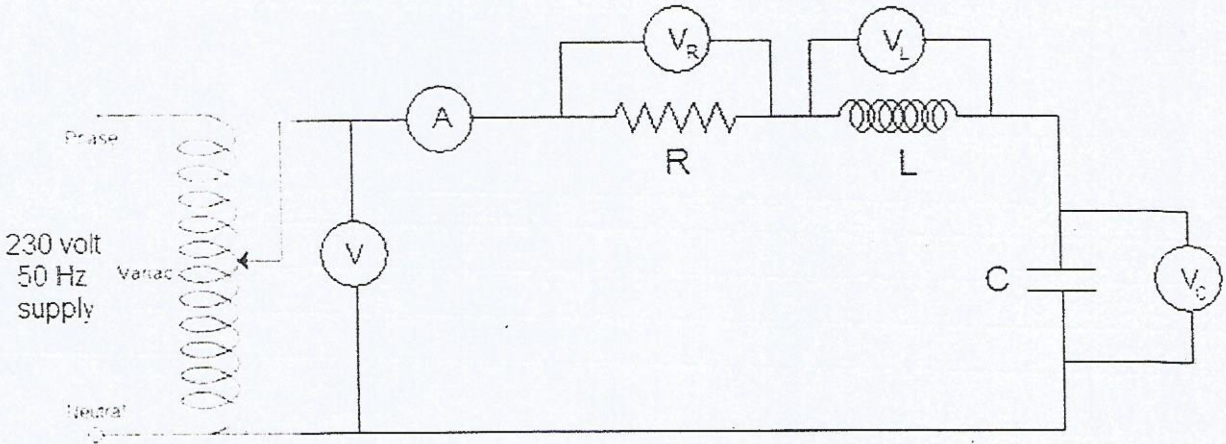
1. Why the analytical values of the currents are slightly greater than the actual (practical) value?
2. What is a bilateral network?
3. Is the superposition theorem applicable to all the networks?
4. If the sources are not ideal then what will be the modification of the procedures?

Title: Study of R-L-C Series Circuit. Experiment No. 6

Objectives:

- To study the behavior of R-L-C Series Circuit.
- To become familiar with the phasor diagram in single phase series R-L-C circuit.

Circuit Diagram:



RLC Series Circuit

Theory:

An A.C. supply voltage of rms value 'V' (volt) when applied to an R-L-C series circuit, an rms current 'I' (amp) flows through it,

$$I = \frac{V}{Z} \text{(Amp)}$$

Where $Z = \sqrt{R^2 + (X_L - X_C)^2}$ (Ω) = Impedance of the series R-L-C circuit.

R = Resistance in the circuit (Ω)

X_L = Inductive reactance in the circuit = ωL (Ω)

X_C = Capacitive reactance in the circuit = $1/\omega C$ (Ω) and

ω = Angular frequency of the supply (rad/sec).

therefore, voltage across the resistance, $V_R = IR$ volt

voltage across the inductance, $V_L = jIX_L$ volt

voltage across the capacitance, $V_C = -jIX_C$ volt

total active power loss, $P = VI \cos\phi = I^2R$ (watt) power factor in the circuit, p.f. = $\cos \phi$

in a coil, the copper loss takes place due to resistance of its own and the core loss takes place in the magnetic core (in case of 'Iron core' inductor). In the capacitor, the loss takes place in the dielectric medium used for making it. The losses in the magnetic core of the inductor and in the dielectric medium of the capacitor are usually ignored. In a series circuit, the copper loss is taken into account when the resistance is connected in series with the inductance, as shown in the circuit diagram.

In this experiment, we are mainly concerned with the measurement of voltage, current and power in different circuit elements and the verification of the relations in the series R-L-C circuit.

Devices under test:

Name of the Device	Quantity	Type	Range	Maker's Name	Serial No.
Resistance (R)					
Capacitance (C)					
Inductance (L)					

Apparatus required:

Name of the apparatus	Quantity	Type	Range	Maker's Name	Serial No.
Variac					
Voltmeter					
Ammeter					

Procedure:

1. Complete the circuit as per the circuit diagram.
2. Adjust the Variac to zero output position and switch on A.C. mains.
3. Apply a suitable voltage from the Variac so that a reasonable current flows through the circuit. Note the output voltage of the Variac and the voltages across R, L and C and also note the circuit current.
4. Take different readings by varying the voltage from the Variac.
5. Note down the readings in the observation table.
6. Draw the phasor diagram from one of the readings for verification.

Observation Table:

Sl. No.	Observations					Calculations						Verification (from phasor diagram)
	Supply Voltage (V) (Volt)	Supply Current (I) (Amp)	V_R (Volt)	V_L (Volt)	V_C (Volt)	$R=\frac{V_R}{I}$ (Ω)	$X_L=\frac{V_L}{I}$ (Ω)	$X_C=\frac{V_C}{I}$ (Ω)	$Z=\frac{V}{I}$ (Ω)	$\cos\phi=\frac{R}{Z}$	Power $P=VI\cos\phi$	ϕ
1.												
2.												
3.												
4.												
5.												

Prepared by: Teacher's Signature:

Roll No: Date:

Remarks:

- Draw the phasor diagram of the series R-L-C circuit.
- Show all the calculations to find out the various parameters analytically.

Questions:

1. What do you mean by *power factor*?
2. What is *lagging* and *leading* power factor in A.C. circuit?
3. What will be the power factor of an *R-L* series circuit when *R* is made zero?