Loop 1:-

Br Bl red → 1k
Br Red Red → 1.2k
Red Red Red → 2.2k

$V_1 \rightarrow 1.5$ V
$V_2 \rightarrow 1.6$ V
$V_3 \rightarrow 1.8$ V

$= 4.9$

$5 \simeq 4.9$ V.

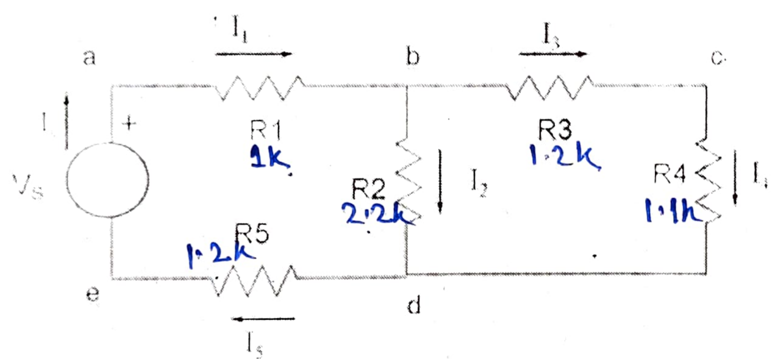
EXPERIMENT No.1

Aim: To verify Kirchhoff Voltage Law and Kirchhoff Current Law using hardware and Proteus **software**

Apparatus required:

S. No.	Items	Specifications	Quantity
1	DC Voltage source	0-20V	01
2	Resistors	1-2 ohms	05
3	Ammeter	Digital type	01
4	Voltmeter	Digital type	01
5	Connecting wires	As per requirements	

1. Kirchhoff's Voltage Law states that the algebraic sum of all the voltages around any closed path (loop or mesh) is zero.



Applying Kirchhoff's voltage law to the first and the second loops in the circuit shown in Figure yields:

Loop 1: $-Vs + V1 + V2 + V5 = 0$ (1a)

Loop 2: $-V2 + V3 + V4 = 0$ (1b)

2. Kirchhoff's Current Law states that the algebraic sum of all the currents at any node is zero.

Applying Kirchhoff's current law to the first four nodes in the circuit shown in Figure yields the following equations;

Node a: $-Is + I1 = 0$ (2a)

Node b: $-I1 + I2 + I3 = 0$ (2b)

Node c: $-I3 + I4 = 0$ (2c)

Node d: $-I2 - I4 + I5 = 0$ (2d)

Procedure:

1. Construct the circuit shown in Figure using the values below:
   R1 = 1 KΩ R2 = 2.4 KΩ R3 = 1.2 KΩ R4 = 1 KΩ R5 = 1.2 KΩ
2. Set the Variable Power Supply (Vs) to 5 Volts.
3. Accurately measure all voltages and currents in the circuit using the Digital Multi-Meter (DMM).
4. Record the measurements in a tabular form containing the measured voltage and current values.
5. Verify KVL for the loops in the circuit using equations 1a and 1b.
6. Verify KCL for the nodes in the circuit using equations 2a, 2b, 2c and 2d.

Precautions:

1. All the connections should be perfectly tight.
2. Always connect ammeter in series and voltmeter in parallel
3. Use safety guards while working on live parts
4. Don't touch the bare conductor when supply is ON.
5. Supply should not be switched ON until and unless the connections are checked by the Faculty/Lab Instructor
6. Use proper wire for connections

Worksheet of the students

Observation and Calculations:

Branch current/voltage	V [volts]	I [mA]	R [KΩ]
V1, I1	1.3 V	1.6	0.8
V2, I2	1.5V	0.81	1.8
V3, I3	0.7 V	0.8	0.8
V4, I4	0.5V	0.7	0.7
V5, I5	1.6V	1.6	1
Vs, Is	5.2V.	5.1	

Results and Discussion:

Learning Outcome (what I have learnt):

To be filled by faculty:

Sr. No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus		20
2	Observations and analysis including learning outcome		20
3	Completion of experiment, discipline and cleanliness		10
	Signature of Faculty	**Total Marks Obtained**	40

Auto transformer = Variac

EXPERIMENT No.2

Aim: To understand the principle of turn ratio of a transformer using both hardware and proteus software

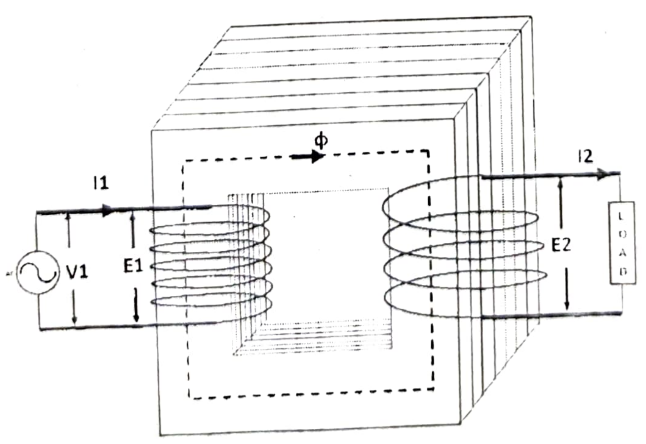
Apparatus Required:-

S. No.	Apparatus Required	Specification	Qty.
1	Transformer	1 Φ,2KVA, 220/220 V	1
2	Auto Transformer	1 Φ,0-270V	1
3	Voltmeter	Digital	1

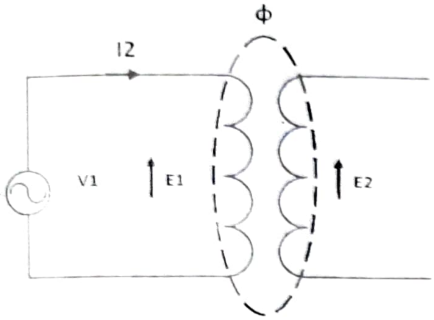
Theory:

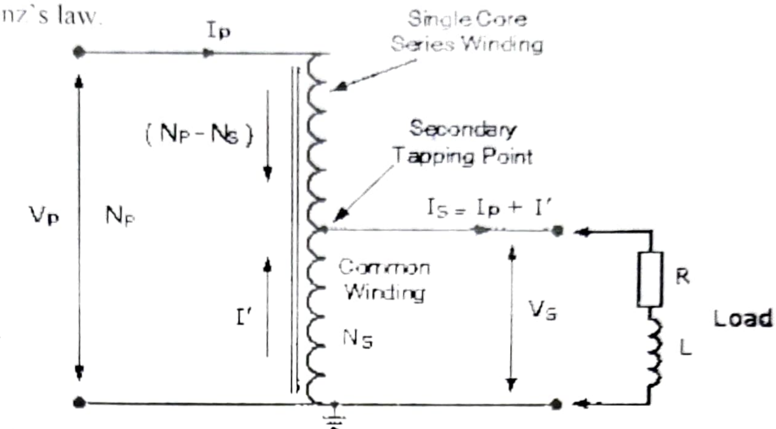
A transformer is a static device which transfers electrical energy from one circuit to another with no direct electrical connection between the two but they are magnetically coupled. It transforms power from one circuit to another without changing its frequency and KVA. A transformer can increase or decrease the voltage with corresponding decrease or increase in current. It helps in providing isolation of the secondary side from the primary side and hence provides safety for the person handling it on the load side.

Working Principle: The basic principle on which the transformer works is **Faraday's Law of Electromagnetic Induction** or **mutual induction** between the two coils. The working of the transformer is explained below.



It consists of two separate windings placed over laminated silicon steel core. The winding to which AC supply is connected is called primary winding and to which load is connected is called secondary winding. It works on the alternating current only because an alternating flux is required for mutual induction between the two windings. When the AC supply is given to the primary winding with a voltage of V_1, an alternating flux ϕ sets up in the core of the transformer, which links with the secondary winding and as a result of it, an emf is induced in it called Mutually Induced emf. The direction of this induced emf is opposite to the applied voltage V_1, this is because of the Lenz's law.





The induced emf in the primary and secondary windings depends upon the rate of change of flux linkage that is ($N\, d\phi/dt$) where, $d\phi/dt$ is the change of flux and is same for both the primary and secondary windings. The induced emf $E_1 \infty N_1$. Similarly $E_2 \propto N_2$.

Turns Ratio:

It is defined as the ratio of primary to secondary turns.

Turns Ratio = N_1 / N_2

If $N_2 > N_1$ the transformer is called Step up transformer

If $N_2 < N_1$ the transformer is called Step down transformer

If $N_2 = N_1$ the transformer is called Isolation transformer

Transformation Ratio

The transformation ratio is defined as the ratio of the secondary voltage to the primary voltage. It is denoted by K.

$$\text{Turns Ratio} = \frac{N_1}{N_2}$$

Procedure

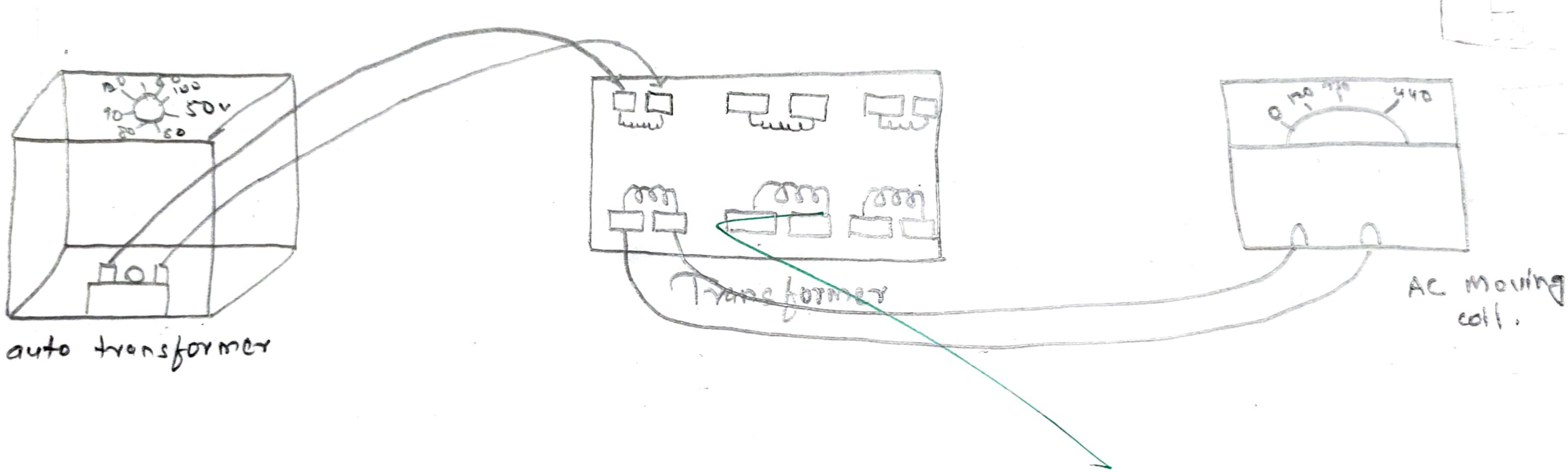
1) Connect the primary side of the transformer with the auto transformer.
2) Turn on the supply
3) Measure the voltage on the secondary side using multimeter.

(NOTE: For step up transformer the percentage take tapping on the primary side should be less than the secondary side while for step down transformer it should be more than that of secondary.)

4) Calculate the value of turns ratio.

Precautions:

1. All the connections should be perfectly tight.
2. Always connect ammeter in series and voltmeter in parallel
3. Use safety guards while working on live parts
4. Don't touch the bare conductor when supply is ON.
5. Supply should not be switched ON until and unless the connections are checked by


50v
auto transformer
Transformer
440
AC moving coil.

Worksheet of the students

Observation and Calculations:

S.No.	V1	V2	N1 %	N2 %	Turns ratio
1.	50	50	50	50	1:1
2.	50	50	100	100	1:1
3.	50	57	87	100	57:100
4.	50	100	50	100	1:2
5.	50	25	100	50	2:1
6	50	44	100	87	100:87.

Result and Discussion:

supply conducted to auto transformer is primary.
supply conducted to voltmeter is secondary
V_1 was kept constant (50 V) and V_2 values
were obtained by changing N_1 and N_2
Finally turn ratio was calculated by using $\left(\frac{N_1}{N_2}\right)$.

Learning Outcome (what I have learnt):

For N1 = N1 = Isolation transformer
For N1 < N2 = Step up transformer
For N1 > N2 = Step down transformer

To be filled by faculty:

Sr. No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus	16	20
2	Observations and analysis including learning outcome	16	20
3	Completion of experiment, discipline and cleanliness	6	10
	Signature of Faculty	Total Marks Obtained	38

EXPERIMENT No.3

Aim: To learn the use of electrical fuse, MCB, energy meter, house wiring and connection of switches.

Apparatus required:

S. No.	Items	Specifications	Quantity
1	Kit Kat Fuse	0-10A	02
2	MCB	0-10A	01
3	ELCB	0-230V	01
4	Switch	0-10A	01
5	Ammeter	Digital type	01
6	Voltmeter	Digital type	01
7	Variac	1-phase, 230V	01
8	Resistive load	200-2000W	01 Set
9	Connecting wires	As per requirements	

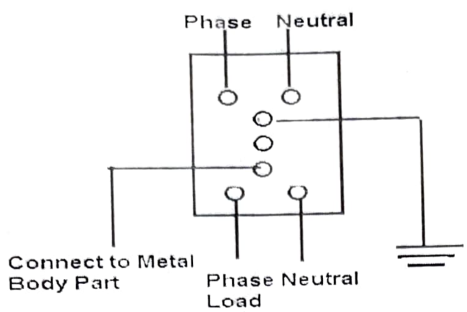
Theory: Over current protection devices are essential in electrical systems to limit threats tohuman life and property damage. Short circuits, overloading, mismatched loads, or device failure are the prime reasons for excessive current. So we need devices to prevent safety hazards to the end user. The various protecting devices used for domestic purposes are,

a. Kit Kat Fuse
b. Miniature Circuit breaker (MCB)
c. Earth Leakage Circuit breaker (ELCB)

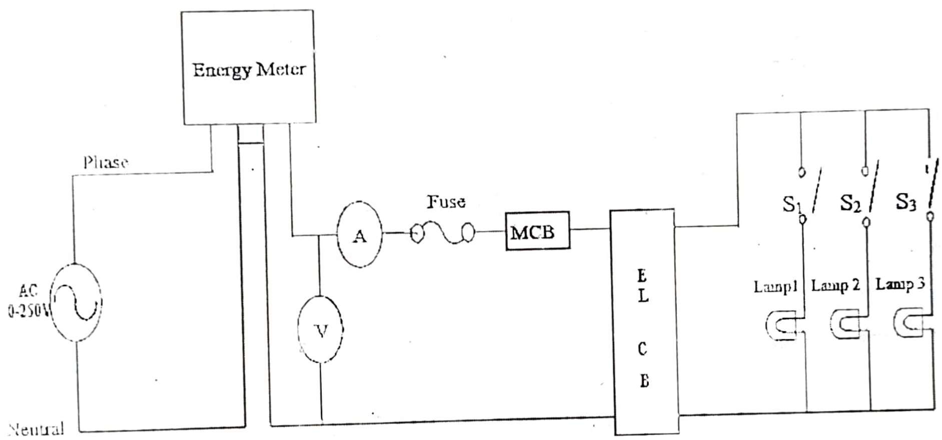
Fuse: It interrupts excessive current so that further damage by overheating or fire isprevented. It is a short length of wire, having low resistance designed to melt and separate in the event of excessive current and provide protection of either the load or source circuit.

MCB: It is abbreviated for miniature circuit breaker (MCB). It also interrupts the excessivecurrent in the circuit due to over loading, short circuiting and when live conductor comes in contact with earth surface.

Earth leakage circuit breaker (ELCB): It is a safety device used in electrical installationswith high earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected.
The ELCB detects fault currents from live to the earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other earthed body.



Circuit Diagram:

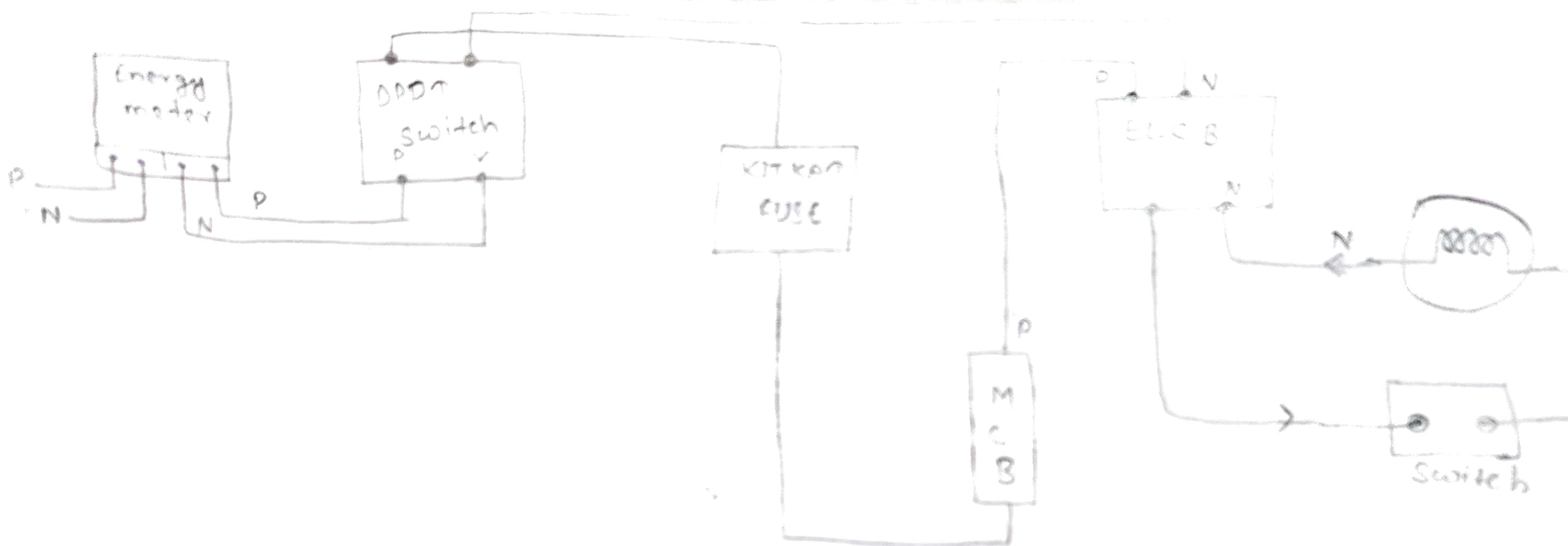


Procedure:

1. Connect the energy meter just after the supply terminals of variac.
2. Connect MCB/FUSE/ELCB in the circuit as shown in diagram.
3. Connect the load across the supply after protecting devices as per diagram.
4. Now gradually vary the supply in the circuit, so that current flowing through the circuit increases.
5. With different size of fuse wire, connect the full load across the system and note down the value of current/voltage at which Fuse burns/MCB trips/ELCB operates independently.
6. Connect the ammeter and voltmeter as shown in circuit diagram.
7. Connect the variable resistive load and vary the load as per requirement.

Precautions:

1. All the connections should be perfectly tight.
2. Always connect ammeter in series and voltmeter in parallel
3. Use safety guards while working on live parts
4. Don't touch the bare conductor when supply is ON.
5. Supply should not be switched ON until and unless the connections are checked by the Faculty/Lab Instructor
6. Use proper wire for connections.



→ CIRCUIT CHARGE DISTRIBUTION

Worksheet of the students

Observation and Calculations:

First we connect the wire to the energy meter and check the phase and neutral side, usually phase is an outer side then we connect the phase to DPST and then MCB. After the neutral and phase went the bulb through switch and neutral directly.

Results and Discussion:

Every component were in order and DPST was also working so switch on all ~~battery~~ botton and bulb

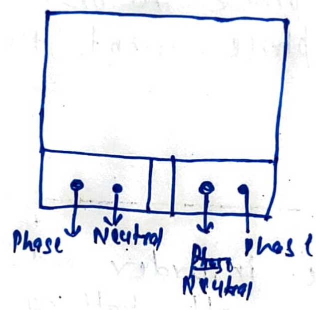
Learning Outcome (what I have learnt):

I Learnt how to connect,

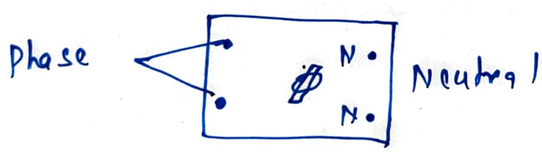
To be filled by faculty:

Sr. No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus		20
2	Observations and analysis including learning outcome		20
3	Completion of experiment, discipline and cleanliness		10
	Signature of Faculty	Total Marks Obtained	30

Electric Meter



Earth Leakage circuit breaker



EXPERIMENT 4 and 5

Aim :- To compare incandescent lamps, fluorescent lamps, CFL, and LED-based light sources for its efficiency.
Switching control of a single lamp by using four 2-way switches.

Apparatus Required:-

. No.	Apparatus Required	Specification	Qty.
1	Incandescent Lamp(Bulb)	230V,40W	1
2	Fluorescent Lamp	230V,40W	1
3	CFL	230V,40W	1
4	LED	230V,40W	1
5	Luxmeter	Digital	1
6	SPDT Switch	230V,10A	2
7	Bulb	230V,60W	I
8	Wires	As per requirement	

Theory: There are various light sources used at home such as Incandescent lamp,fluorescent lamp, CFL and LED . Out of all these LED is the greenest option available in all forms of lighting. And that is because:

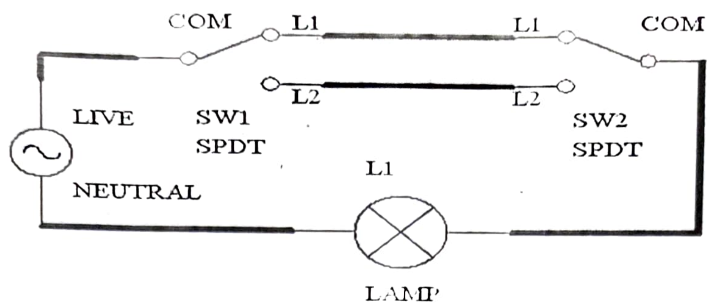
- It does not contain any mercury, which is harmful for environment unlike the fluorescent bulbs and lights.
- It lasts much longer (about 10-20 years) and thus their disposal is less of a concern.

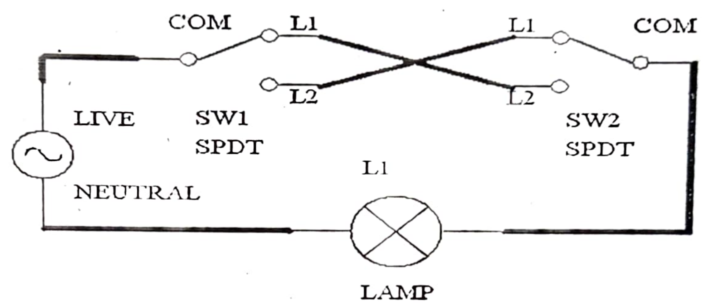
Fluorescent lights and CFLs on the other hand contain mercury that is harmful for environment and their disposal is a concern.
Most fluorescent bulbs/tubes may not last more than 3-4 years (10000-15000 hrs of usage). But LEDs last much longer (upto 25000-50000 hrs of usage).

Lumens or brightness of the light:LEDs are always marketed as lighting options that givemore brightness per watt of electricity. The claim is true if LEDs are used for spotlighting. LEDs are unidirectional source of light and thus they are excellent for spot lighting. LED luminaires that are available for general-purpose lighting have inbuilt reflectors that spread the light in all directions. And the use of reflectors causes decrease in brightness per watt. This results in their efficiency come down to as low as that of fluorescent lights.

Costs: It's commonly known that LED luminaires are expensive. They cost at least 3-4 times more than T5 fluorescent lights. However their life is also much longer as compared to fluorescent lights.

Circuit Diagram:-





Procedure:

1) Connect the Incandescent bulb in series to the power supply.
2) Connect voltmeter in parallel and ammeter in series to the incandescent bulb
3) Place the lux meter at some specific distance from incandescent bulb. If required, take help of scale for this purpose.
4) Note down the lumens and fix this lumens as reference for rest of the bulbs.
5) Note down the reading of voltmeter and ammeter.
6) Repeat steps 1 to 5 for the fluorescent lamp, CFL and LED bulbs.

Precautions:

2. All the connections should be perfectly tight.
3. Use safety guards while working on live parts.
4. Don't touch the bare conductor when supply is ON.
5. Supply should not be switched ON until and unless the connections are checked by the Faculty/Lab Instructor.

Worksheet of the students

Observation and Calculations:

Sr. No	Type of Bulb	Voltage(V)	Current(A)	Power Input(W) P=VI	Power Outage Rating(W) Conversion Factor 1Lumen=0.00147W	Percentage Efficiency (%)
1.	Incandescent Lamp	220V	—	60 W	—	—
2.	CFL	220V	0.085 A	25 W	1450	8.60 %.
3.	Fluorescent Lamp	220 V.	0.012 A	18 W	1000	8.1 %.
4.	LED	220 V.	0.014 A	14 W	1250	13.12 %.

Truth table for Switching control:

S_1	S_2	Cross
ON	OFF	ON
OFF	OFF	OFF
OFF	ON	ON
ON	ON	OFF

S_1	S_2	Parallel
ON	ON	ON
OFF	OFF	ON
ON	OFF	OFF
OFF	ON	OFF

Results and Discussion:

Learning Outcome (what I have learnt):

To be filled by faculty:

S.No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus		20
2	Observations and analysis including learning outcome		20
3	Completion of experiment, Discipline and Cleanliness		10
	Signature of Faculty	Total Marks Obtained	30

ORANGE	ORANGE	BLACK	–	$330\,\Omega$
BROWN	BLACK	RED	–	$1k\Omega$
RED	RED	BROWN	–	$220\,\Omega$

EXPERIMENT No. 6

Aim: To verify Thevenin's and Norton's theorems in DC circuits along with simulation on P-spice.

Experiment No. 3.1: Verification of Thevenin's theorem.

Apparatus required:

Sl.No.	Apparatus	Range	Quantity
1	RPS (regulated power supply)	(0-30V)	2
2	Ammeter	(0-10mA)	1
3	Resistors	1Kohm, 330ohm	3,1
4	Bread Board	--	Required
5	DRB	--	1

Statement:

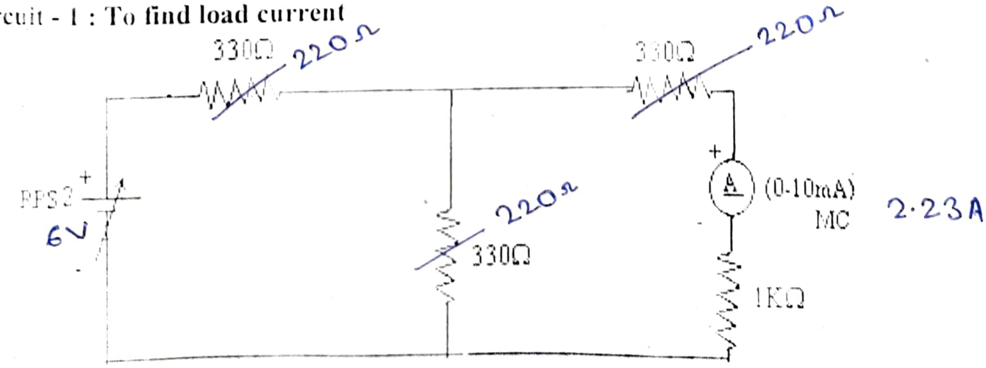
Any linear bilateral, active two terminal network can be replaced by a equivalent voltage source (V_{TH}). Thevenin's voltage or V_{OC} in series with looking back resistance R_{TH}.

Procedure:

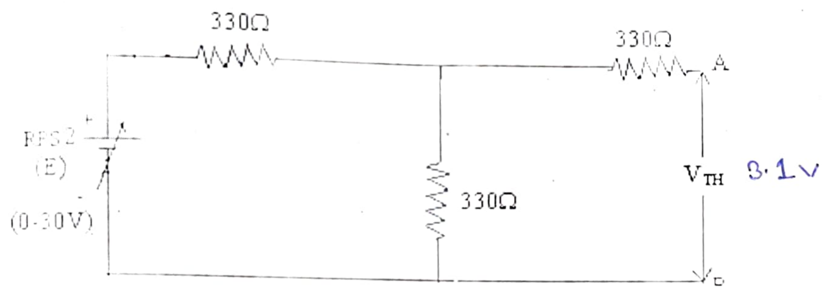
1. Connections are given as per the circuit diagram.
2. Set a particular value of voltage using RPS and note down the corresponding ammeter readings.
3. To find V_{TH} : Remove the load resistance and measure the open circuit voltage using multimeter (V_{TH}).
4. To find R_{TH} : Remove the RPS and short circuit it and find the R_{TH} using multimeter.
5. Give the connections for equivalent circuit and set V_{TH} and R_{TH} and note the corresponding ammeter reading.
6. Verify Thevenins theorem.

Circuit Diagrams:

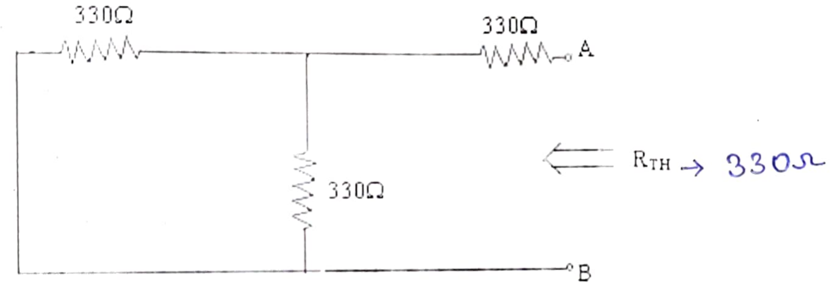
Circuit - 1 : To find load current



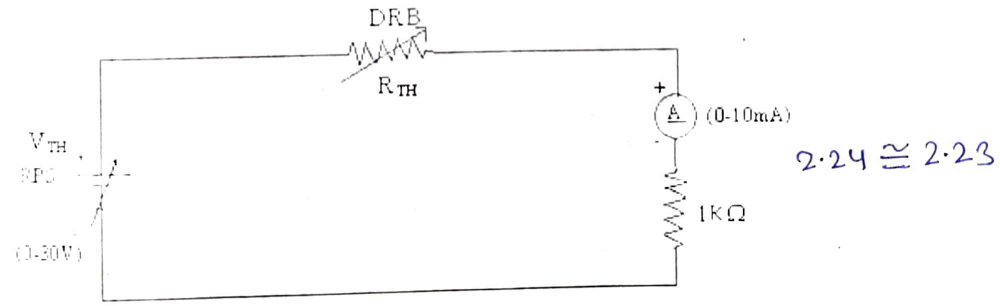
Circuit 2: To find V_{TH}



Circuit 3 : To find R_{TH}



Thevenin's Equivalent Circuit:



Precautions:

1. Voltage control knob of RPS should be kept at minimum position.
2. Current control knob of RPS should be kept at maximum position

Worksheet of the student

Date of Performance: Registration Number:

Observation Table:

Load current from Circuit 1	V_{TH} from Circuit 2	R_{TH} from Circuit 3	V_{TH} / R_{TH}
2.23mA	2.8v	330Ω	$\frac{2.8V}{330\Omega} = 0.008$

Calculations:

In circuit 3: $R_{th} = 220 + (220 \| 220) = 330\Omega$

~~current in~~ Step ~~circuit~~ 2 = 2.16A

~~Current in~~ Step ~~circuit~~ 3 = 2.28A

~~find Rth~~

step IV ⇒ Thevinens theorem verified

Now find $\frac{V_{th}}{R_{th}} = \frac{2.8}{330} = 0.008$

Results and Discussion:

In circuit 1 ≅ current in circuit 4.

2.16 A ≅ 2.28 A

Learning Outcomes (what I have learnt):

I have learnt to prove thevénins theorem in the given circuit

Thévenin's Verified.

To be filled by faculty:

S.No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus	14	20
2	Observations and analysis including learning outcome	14	20
3	Completion of experiment, Discipline and Cleanliness	2	10
	Signature of Faculty	Total Marks Obtained	30

Experiment No. 3.2: Verification of Norton's theorem.

Apparatus required:

Sl.No.	Apparatus	Range	Quantity
1	RPS (regulated power supply)	(0-30V)	2
2	Ammeter	(0-10mA)	1
3	Resistors	1Kohm, 330ohm	3,1
4	Bread Board	--	Required
5	DRB	--	1

Statement:

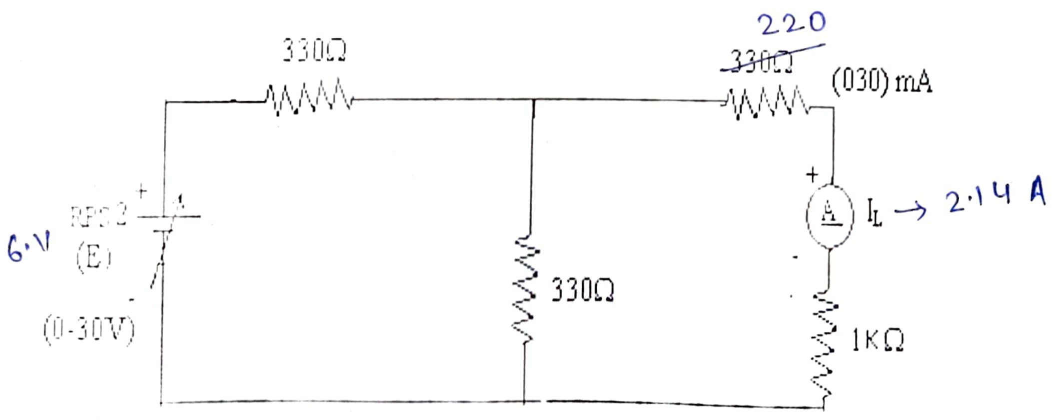
Any linear, bilateral, active two terminal network can be replaced by an equivalent current source (I_N) in parallel with Norton's resistance (R_N)

Procedure:

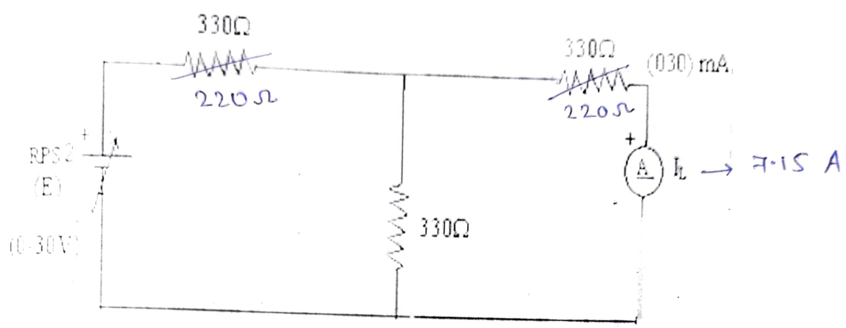
1. Connections are given as per circuit diagram.
2. Set a particular value in RPS and note down the ammeter readings in the original circuit.
3. To Find I_N: Remove the load resistance and short circuit the terminals.
4. For the same RPS voltage note down the ammeter readings.
5. To Find R_N: Remove RPS and short circuit the terminal and remove the load and note down the resistance across the two terminals.
6. Equivalent Circuit: Set I_N and R_N and note down the ammeter readings.
7. Verify Norton's theorem.

Circuit Diagrams:

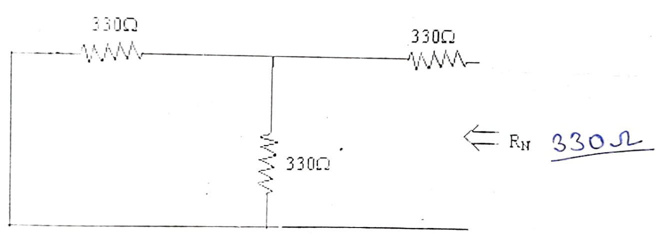
Circuit 1: To find load current



Circuit 2: To find I_N

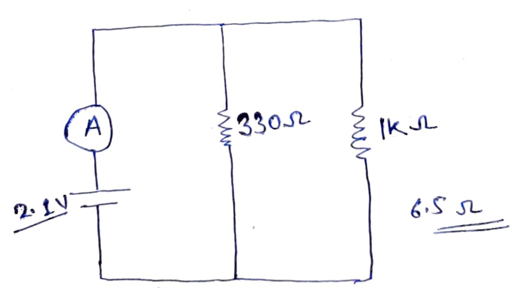


Circuit 3: To find R_N



Precautions:

1. Voltage control knob of RPS should be kept at minimum position.
2. Current control knob of RPS should be kept at maximum position.



Worksheet of the student

Date of Performance: Registration Number:

Observation Table:

Load current from Circuit 1	I_N from Circuit 2	R_N from Circuit 3	Vth / Rth
2.12 mA	7.22 Ω	330 Ω	0.07

Calculations:

$R_n = 220 \; (220 \| 220) = 330\,\Omega$

$\frac{V_{th}}{R_{th}} = 0.07$

Results and Discussion:

In circuit 4.
when voltage source was on 2.1 V
reading of ammetre is 6.43

Learning Outcomes (what I have learnt):

I have learnt to verify the nortons theorem.

To be filled by faculty:

S.No.	Parameters(Scale from 1-10, 1 for very poor and 10 for excellent)	Marks Obtained	Max. Marks
1	Understanding of the student about the procedure/ apparatus	14	20
2	Observations and analysis including learning outcome	14	20
3	Completion of experiment, Discipline and Cleanliness	2	10
	Signature of Faculty	Total Marks Obtained	30