LAB REPORT

Fundamentals of Electrical and Electronics Engineering Lab

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INDEX

EXPERIMENTS

Experiment 1

ANALYSIS OF RESISTANCE USING COLOR CODING

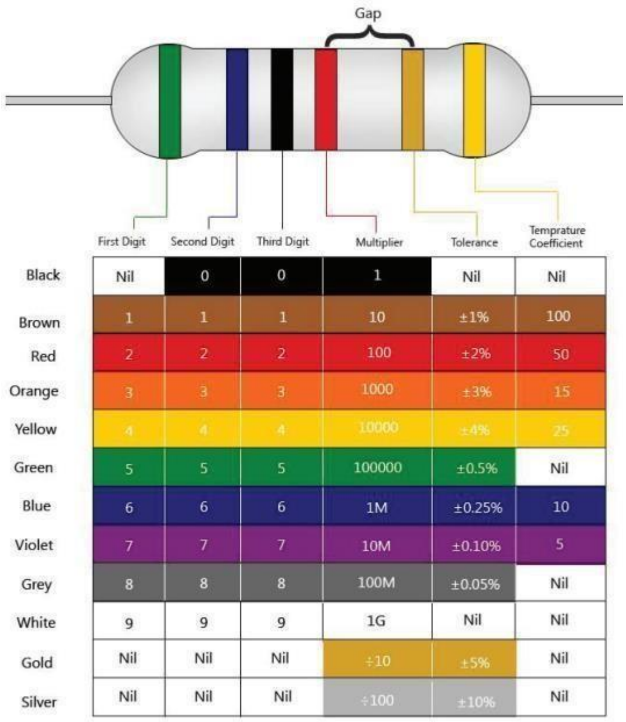
Objectives :

1. To learn Resistor color code
2. To determine the stated value of a resistor by interpreting the colour code indicated on the resistor.

Software Used : Ni Multisim 14.0

Theory : The resistors used in laboratory are carbon composition resistors, consisting of graphite or some other type of carbon embedded in a filler material. Graphite is a moderately good conductor, so by varying the graphite-filler mix, a large range of resistance values can be obtained (the less graphite, the higher the resistance). Carbon resistors are cheap and reliable, however, their tolerances (5 to 20% deviation from nominal values) indicate that larger errors can be expected. Other types of resistors include wire wound, metal film, and carbon film. The nominal value and tolerance of a carbon resistor can be determined from the color-coded stripes that appear on the resistor. The first three bands represent the two significant figures of the resistance, while the fourth band indicated the number of zeros that follow. If there are only three bands, the resistor has a 20% tolerance. If the three color bands are followed by a silver band, the resistor has a 10% tolerance. A gold band following the three color bands indicates a 5% tolerance, a red band indicates a 2% tolerance, and a brown band indicates a 1% tolerance.

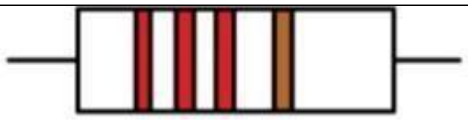
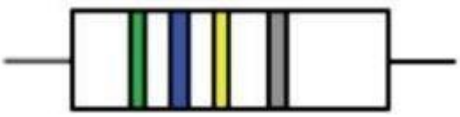
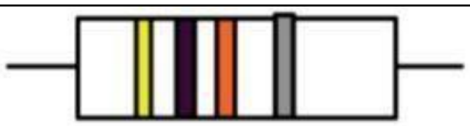
Circuit Diagram :



	First Digit	Second Digit	Third Digit	Multiplier	Tolerance	Temprature Coefficient
Black	Nil	0	0	1	Nil	Nil
Brown	1	1	1	10	±1%	100
Red	2	2	2	100	±2%	50
Orange	3	3	3	1000	±3%	15
Yellow	4	4	4	10000	±4%	25
Green	5	5	5	100000	±0.5%	Nil
Blue	6	6	6	1M	±0.25%	10
Violet	7	7	7	10M	±0.10%	5
Grey	8	8	8	100M	±0.05%	Nil
White	9	9	9	1G	Nil	Nil
Gold	Nil	Nil	Nil	÷10	±5%	Nil
Silver	Nil	Nil	Nil	÷100	±10%	Nil

Figure 1: Colour code for a resistor.

Result & Observation :

	Resistance Value	Tolerance
	22 x $10^2\Omega$	±5%
	56 x 10^4 Ω	±10%
	47 x 10^3 Ω	±10%
	10 x 10^1 Ω	±5%

EXPERIMENT 2

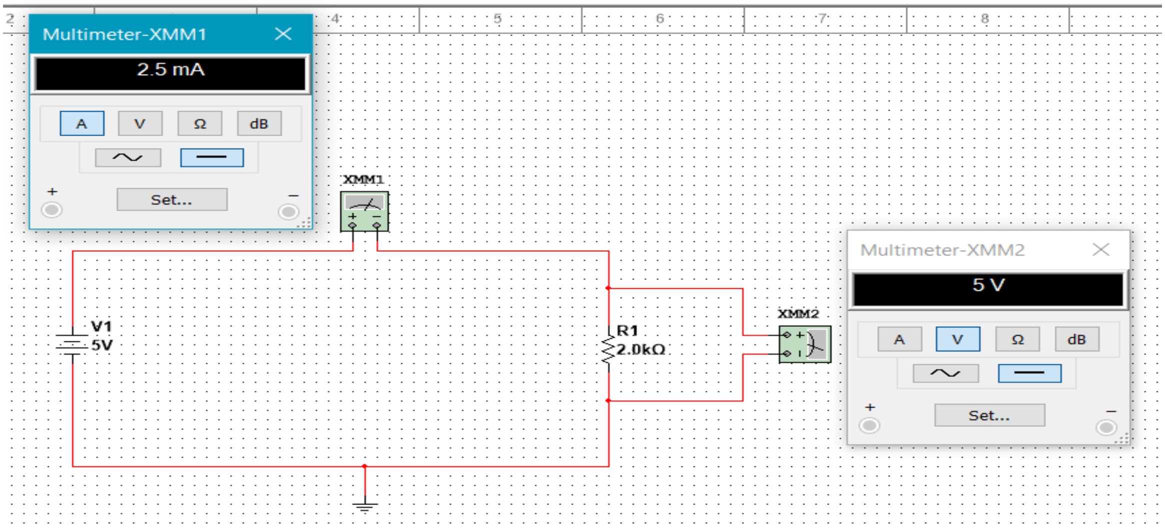
VERIFICATION OF OHM'S LAW

Objective: To verify Ohm's Law

Software Used: NI Multisim 14.0

Theory: Ohm's law states that the voltage or potential difference between two points is directly proportional to the current or electricity passing through the resistance, and directly proportional to the resistance of the circuit. The formula for Ohm's law is **V=IR**. This relationship between current, voltage, and relationship was discovered by German scientist Georg Simon Ohm. Let us learn more about Ohms Law, Resistance, and its applications.

Circuit Diagram:



Result & Observations :

			Theoretical		Experimental	
S. No.	Source Voltage (V)	Resistance kΩ	Current (A)	Voltage Out(V)	Current	Voltage Out(V)
1	5	1	5×10^{-3}	5	5mA	5
2	5	2	2.5×10^{-3}	5	2.5mA	5
3	5	3	0.1×10^{-3}	3	1mA	3
4	5	4	0.5×10^{-3}	2	500μA	2
5	5	5	0.4×10^{-3}	2	400μA	2

Hence we can see the values of theoretical and experimental are matched we can say ohms law is verified.

EXPERIMENT 3

Objective: To verify Kirchhoff's current law(kcl) in the circuit

Software used: **NI MULTISIM 14.0.**

THEORY:

1. Kirchhoff's Current Law or KCL, states that the "total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node ". In other words, the algebraic sum of ALL the currents entering and leaving a node must be equal to zero, I(exiting) + I(entering) = 0. This idea by Kirchhoff is commonly known as the Conservation of Charge.

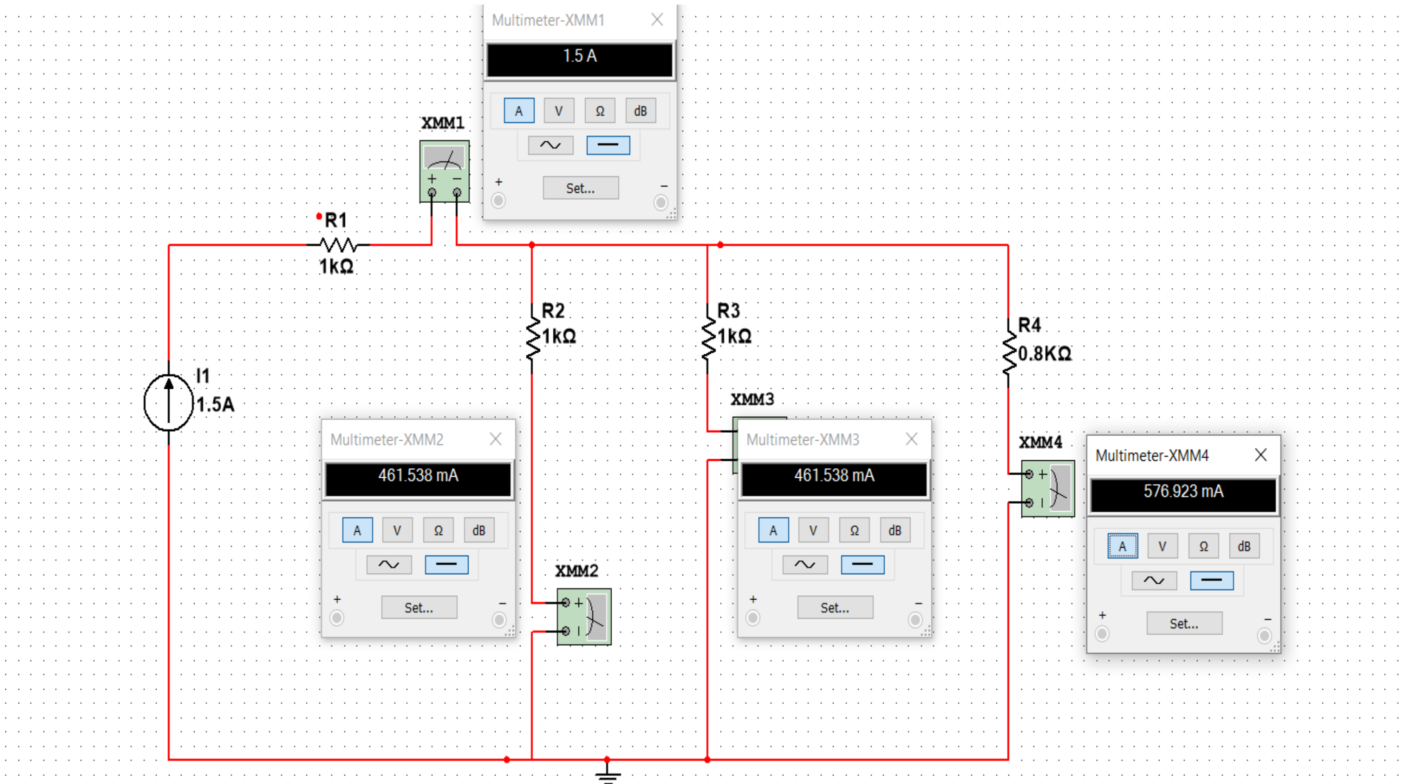
2. Here, the three currents entering the node, I1, I2, I3 are all positive in value and the two currents leaving the node, I4 and I5 are negative in value. Then this means we can also rewrite the equation as;

3. $I1 + I2 + I3 - I4 - I5 = 0$
4. The term Node in an electrical circuit generally refers to a connection or junction of two or more current carrying paths or elements such as cables and components. Also, for current to flow either in or out of a node a closed-circuit path must exist. We can use Kirchhoff's current law when analyzing parallel circuits

Circuit 1: Connect three resistors in parallel and one resistor in series and connect the multimeter for each of the resistor to note down values of individual resistor

.

Circuit diagram:



Observation:

Current through the resistors R1, R2, R3, R4 are 1.5A,461.538 mA, 461.538 mA, 576.923 mA respectively.

Significance:

The law states that at any circuit junction, the sum of the currents flowing into and out of that junction are equal. In simple terms, what KCL really says is that, the sum of all currents entering a node is equal to the sum of all currents leaving the node.

Result:

1. The sum of currents entering and leaving are equal at thenode
2. In circuit I = I1 + I2 +I3
3. Hence the values are known for the equation I = I1 + I2 + I3
   1.5A= 461.538mA+461.538mA+576.923mA
4. Now the Kirchhoff currentlaw has been verified

Objective: To verify Kirchhoff's voltage law(kvl) in the circuit

Software used: **NI MULTISIM 14.0** **Theory:**

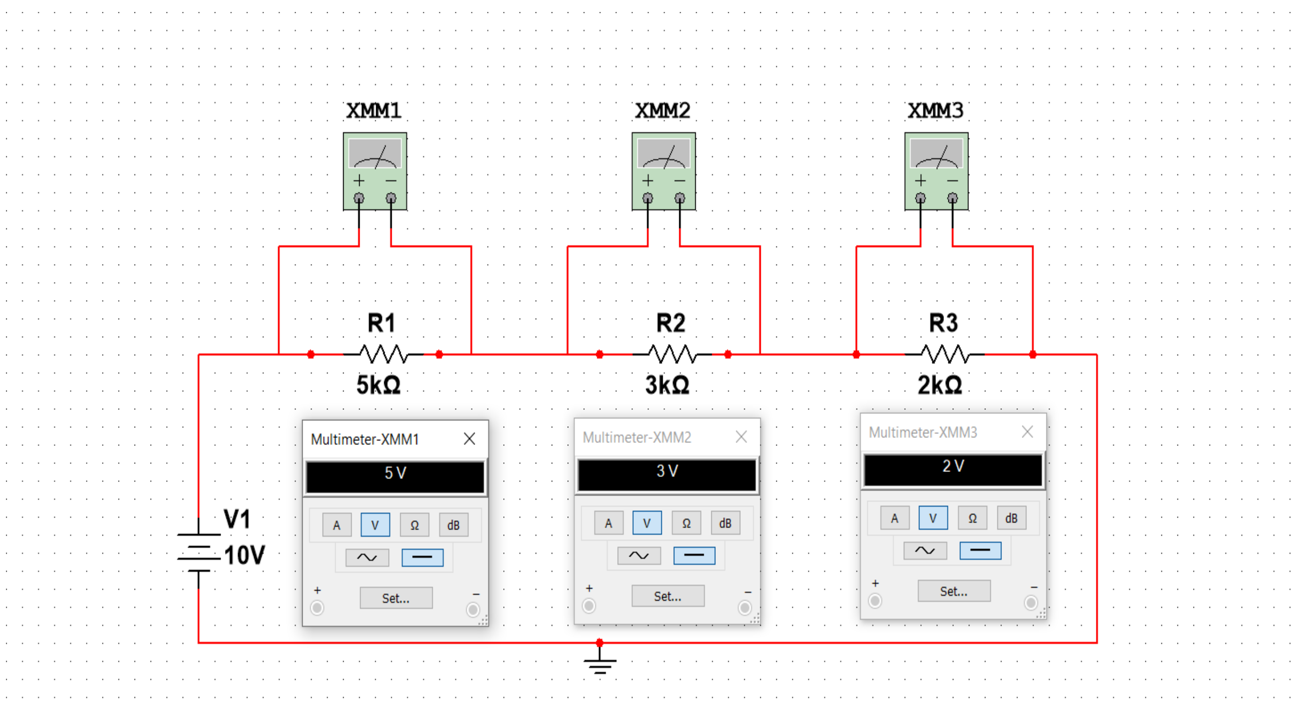
1. Gustav Kirchhoff's Voltage Law is the second of his fundamental laws we can use for circuit analysis. His voltage law states that for a closed loop series path the algebraic sum of all the voltages around any closed loop in a circuit is equal to zero. This is because a circuit loop is a closed conducting path so no energy is lost
2. In other words, the algebraic sum of ALL the potential differences around the loop must be equal to zero as: ΣV = 0. Note here that the term "algebraic sum" means to take into account the polarities and signs of the sources and voltage drops around the loop.
3. This idea by Kirchhoff is commonly known as the Conservation of Energy, as moving around a closed loop, or circuit, you will end up back to where you started in the circuit and therefore back to the same initial potential with no loss of voltage around the loop. Hence any voltage drops around the loop must be equal to any voltage sources met along theway

Circuit 2:

Connect three resistors in series and connect the multimeter parallel to each of the resister to note the individual voltage value

- Connect three resistors in parallel and multimeters to it in parallel
- And connect a voltage V1 = 10v and give the resistor values as follow
- R1 = 5v, R2 = 3v, R3 =2v

Circuit diagram:



Observation:

Voltage across the resistors R1, R2, R3 are 5v,3v,2v respectively

Voltage given is 10v so that sum of voltages of their respective voltages should be equal

V = V1 +V2 + V3

5v+3v+2v = 10v

Significance:

Kirchhoff's loop rule (otherwise known as Kirchhoff's voltage law (KVL), Kirchhoff's mesh rule, Kirchhoff's second law, or Kirchhoff's second rule) is a rule pertaining to circuits, and is based on the principle of conservation of energy.

Result:

The algebraic sum of all voltages around any closed loop in a circuit is zero

Now Kirchhoff's voltage law hasbeen verified

EXPERIMENT 4

VERIFICATION OF CURRENT AND VOLTAGE DIVISION RULE

Objective: To verify current and voltage division rule

Software Used: NI Multisim 14.0

Theory:

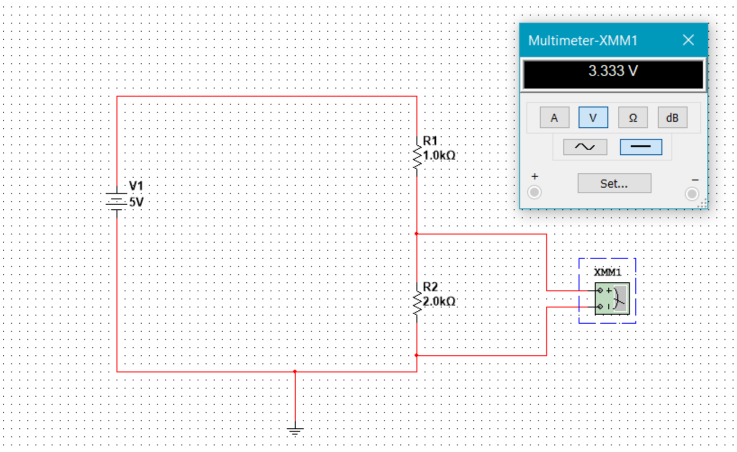
Voltage Division Rule: The **voltage** across any resistor in a series connection of resistors shall be equal to the ratio of the value of the resistor divided by the equivalent resistance of the circuit. This is called **Voltage division rule**. **Vout = (Vs * R2) / (R1 + R2)**

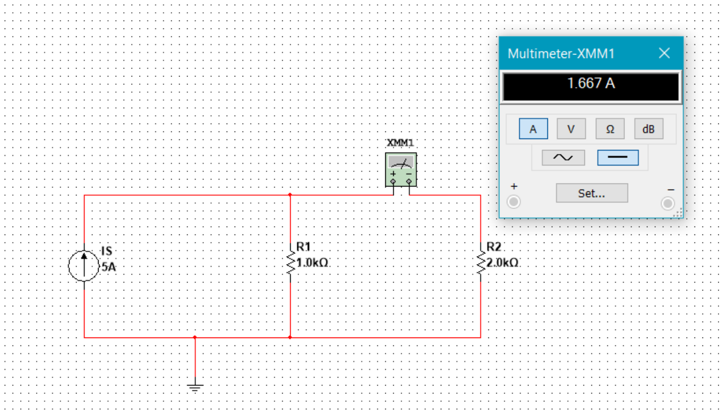
Current Division Rule: Parallel circuits in which the source or supply current divides into a number of parallel paths. In a parallel connected circuit, all the components have their terminals connected together sharing the same two end nodes. This results in different paths and branches for the current to flow or pass along. However, the currents can have different values through each component.

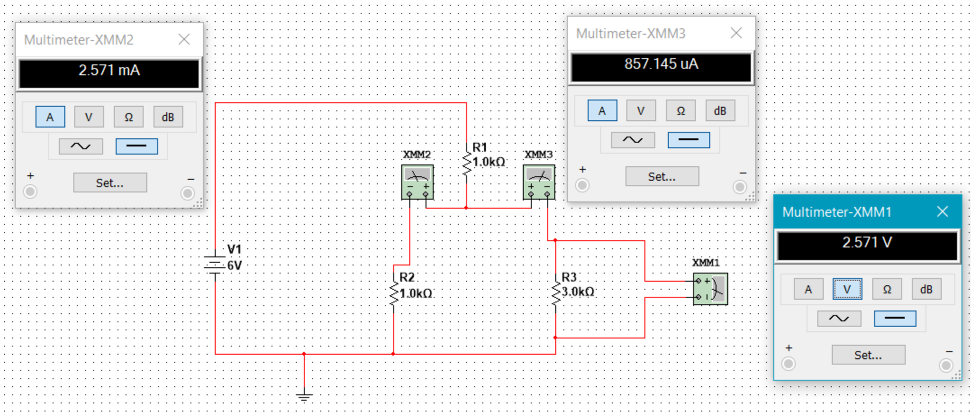
The main characteristic of parallel circuits is that while they may produce different currents flowing through different branches, the voltage is common to all the connected paths. That is VR1 = VR2 = VR3 ... etc. Therefore, the need to find the individual resistor voltages is eliminated allowing branch currents to be easily found with Kirchhoff's Current Law, (KCL) and of course Ohm's Law.

I2 = IS * R2 / R1 + R2

Circuit Diagram:







Result & Observations:

- **Voltage DivisionRule:**

S No.	Source Voltage (V)	Resistance 1 kΩ	Resistance 2 kΩ	Theoretical Voltage Out (V)	Experimental Voltage Out (V)
1	5	1	2	3.33	3.33
2	5	2	3	3	3
3	5	2.5	3.1	2.76	2.76
4	5	2.6	3.2	2.75	2.75
5	5	3	5.25	3.18	3.18

- **Current Division Rule:**

S No.	Source Voltage (V)	Resistance 1 kΩ	Resistance 2 kΩ	Theoretical Voltage Out (V)	Experimental Voltage Out (V)
1	5	1	2	1.66	1.66
2	5	2	3	2	2
3	5	2.5	3.1	2.23	2.23
4	5	2.6	3.2	2.24	2.24
5	5	3	5.25	1.81	1.81

				Theoretical	Experimental
S No.	**Source Voltage (V)**	**Current I1 (A)**	**Current I2 (A)**	**Voltage Out (V)**	**Voltage Out (V)**
1	**5**	**2.1×10^{-3}**	**0.714×10^{-3}**	**2.142**	**2.143**
2	**6**	**2.55×10^{-3}**	**0.857×10^{-3}**	**2.571**	**2.571**
3	**7**	**3×10^{-3}**	**1×10^{-3}**	**3**	**3**

Hence theoretical and experimental values are matched we can say voltage and current division ruleis verified

EXPERIMENT-5

VERIFICATION OF VOLTAGE CURR ENT POWER RELATIONS FOR STAR AND DELTA CONNECTED LOADS

Objective: To verify the voltage, current, power relations for star and delta connected loads

Software Used: NI MULTISIM 14.0

Theory:

Voltages and currents in Y-connection:

- The voltage induced in each winding is called the phase voltage and current in each winding is likewise known as phase current.
- However, the voltage available between any pair of terminals is called line voltage (VL) and the current flowing in each line is called line current (IL).

Line voltage and phase voltage:

- The conductors between a voltage source and a load are called lines, and the voltage between any two lines is called line voltage.
- The voltage measured between any line and neutral is called phase voltage.
- The p.d. between line 1 and 2 is VRY = ER – EY.
- Hence, VRY is found by compounding ER and EY reversed.
- Obviously, the angle between ER and EY reversed is 60°. Hence if ER = EY = EB = say,
- Eph – the phase e.m.f.,
- Then VRY = 2 × Eph×cos (60°/2) =√3Eph similarly, VYB= EY– EB =√3Eph and VBR = EB– ER = √3Eph
- Now VRY = VYB = VBR = line voltage, say VL. Hence, in star connection VL= √3Eph

Line currents and phase currents:

- Line current in each line is the same as the current in the phase winding to which the line is connected.
- Current in line 1 = IR; Current in line 2 = IY;
- Current in line 3 = IB Since IR = IY = IB = say,

- Iph - the phase current
- Line current IL= Iph.

Power:

- The total active or true power in the circuit is the sum of the three phase powers.
- Total active power = 3 × phase power or P= 3 × Vph Iph cosφ P=√3VL IL cosφ

Delta (Δ) or Mesh Connection:

- If the system is balanced then sum of the three voltages round the closed mesh is zero.
- This type of connection is also referred to as 3-phase, 3-wire system.

Line Voltages and Phase Voltages: The voltage between lines 1 and 2 as VRY and that between lines 2 and 3 as VYB, we find that VRY lead VYB by 120°. Similarly, VYB leads VBR by 120°. Let VRY= VYB= VBR = line voltage VL. Then, it is seen that VL= Vph

Line Currents and Phase Currents: Current in each line is the vector difference of the two phase currents flowing through that line. Current in line No. 1 is found by compounding IR and IB reversed I1= 2 × Iph× cos (60º/2) =√3Iph

I2 = IB - IY =

√3Iph I3 =

IB - IY =

√3Iph

Since all the line currents are equal in magnitude

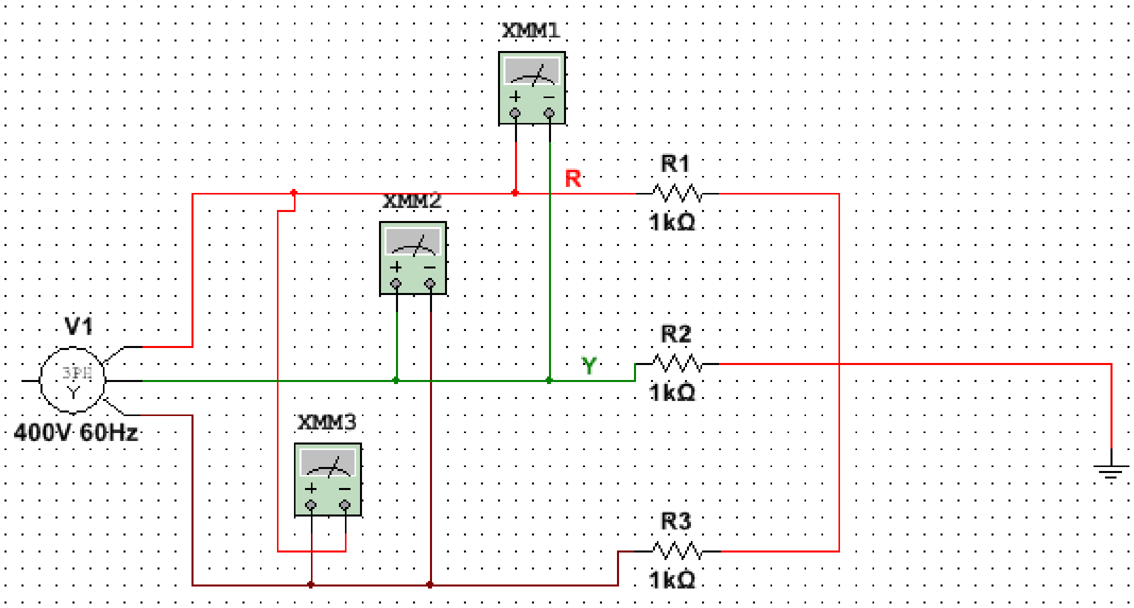
i.e. I1 = I2 = I3 = IL

IL= √3Iph

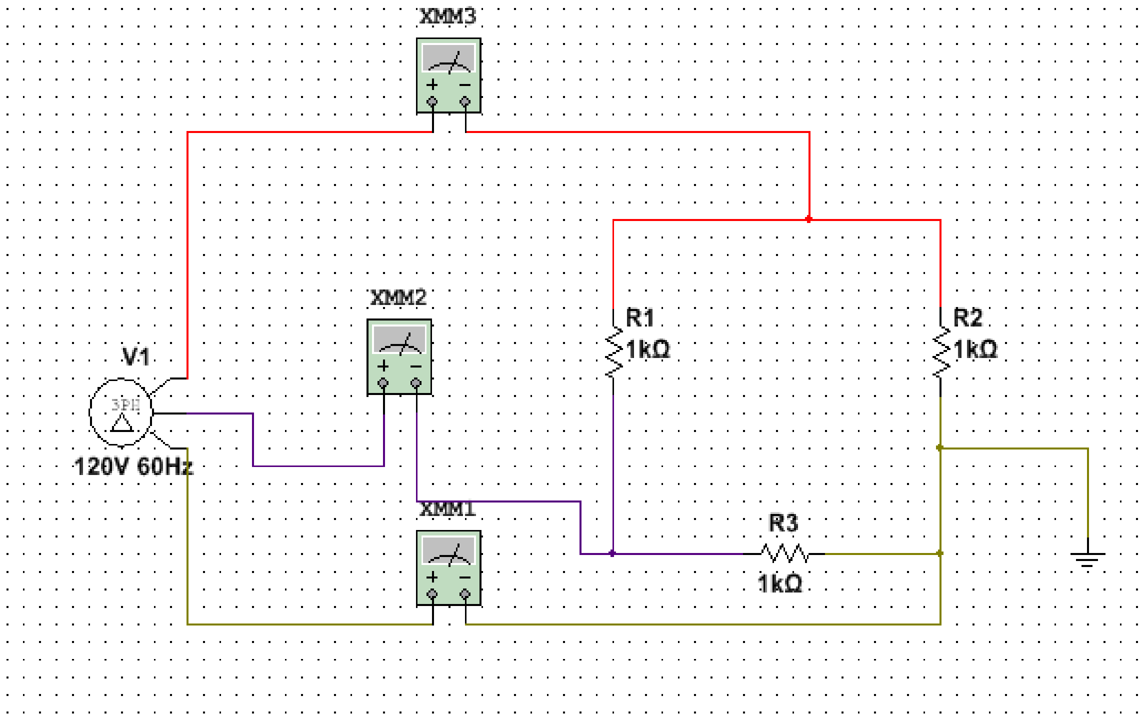
Power:

Total power = 3 × Vph Iph cosφ

Star connected load:



Delta connected load:



Result and observation:

Star connected load:

	MULTISIM VALUE	THEORITICAL VALUE
VRY	692.872V	692.8V
VYB	692.872V	692.8V
VBR	692.872V	692.8V
IR	400.03mA	400 mA
IY	400.016 mA	400mA
Ib	400.023 mA	400mA
P1	240.037W	240 W
P2	240.037W	240 W
P = p1+p2	480.074W	480.07W

Delta connected load:

	MULTISIM VALUE	THEORITICAL VALUE
VRY	400V	400V
VYB	400V	400V
VBR	400V	400V
IR	692.861mA	692.8mA
IY	692.872mA	692.8mA
Ib	692.848mA	692.8mA
P1	240.037W	
P2	240.037W	
P = p1+p2	480.074W	480W

As we can see both theoretical values are same therefore the values are verified

Experiment- 6

CALCULATION OF TWO PORT NETWORK PARAMETERS

Objective :

- To understand the analysis of a two-port network.
- To understand the behavior of a two-port network using parametric analysis.
- To learn the conditions and procedure for two-port analysis.measurement

Software Used : NI Multisim 14.0

Theory : The electrical network with two pairs of terminals is a two-port network. The network can contain resistors, inductors, capacitors, transformers, transistors and in general any linear circuit device, including depending devices but no independent sources are allowed. The behavior of a linear two-port network is described by impedance (Z), admittance (Y), transmission (ABCD), or hybrid (h) parameter.

Z Parameter :

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

Parameter	Condition	Name
Z11=V1/I1	I2=0	Input impedance
Z21=V2/I1	I2=0	Transfer impedance
Z12=V1/I2	I1=0	Transfer impedance
Z22=V2/I2	I1=0	Output impedance

Y Parameter :

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

Parameter	Condition	Name
Y11=I1/V1	V2=0	Input admittance
Y21=I2/V1	V2=0	Transfer admittance
Y12=I1/V2	V1=0	Transfer admittance
Y22=I2/V2	V1=0	Output admittance

H Parameter :

$$V_1 = h_{11} I_1 + h_{12} V_2$$

$$I_2 = h_{21} I_1 + h_{22} V_2$$

Parameter	Condition	Name
h11=V1/I1	V2=0	SS input admittance
h21=I2/I1	V2=0	SS forward current gain
h12=V1/V2	I1=0	OS reverse voltagegain
h22=I2/V2	I1=0	OS output admittance

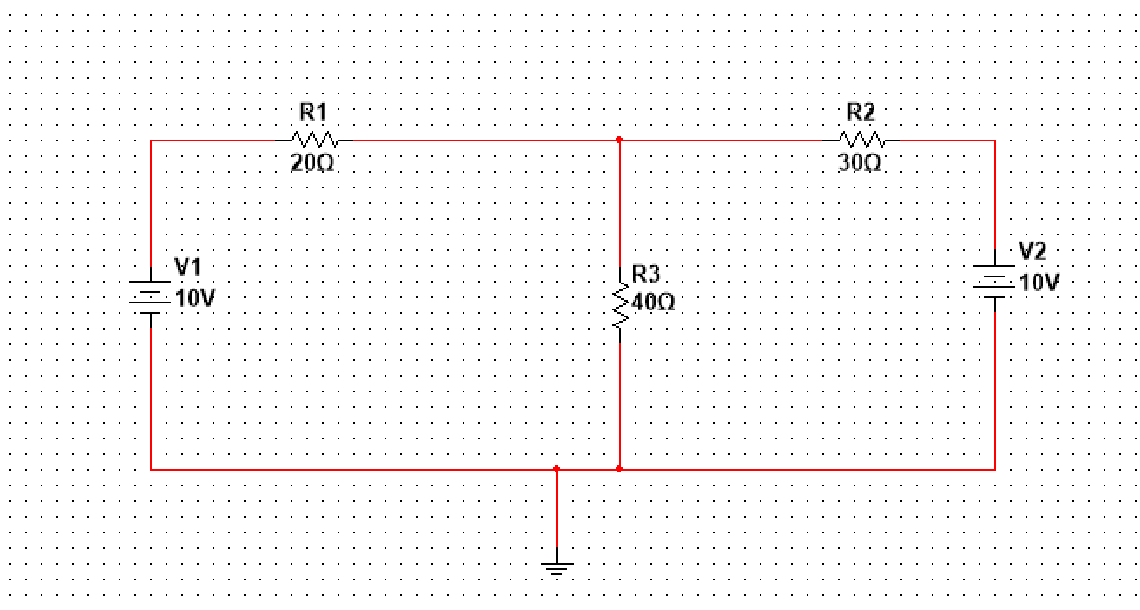
ABCD Parameter :

$$V_1 = A\ V_2 - B\ I_2$$

$$I_1 = C\ V_2 - D\ I_2$$

Paramete r	Condition	Name
A=V1/V2	I2=0	OC voltage ratio
B=V1/-I2	V2=0	OC transfer admittance
C=I1/V2	I2=0	-SC transfer impedance
D=I1/-I2	V2=0	-SC current ratio

Circuit Diagram :



Result & Observations :

Parameter	Calculated Value	Average value
Z_{11}	60	59.998
Z_{21}	40	40.001
Z_{12}	40	39.998
Z_{22}	70	70
Y_{11}	0.0269	0.0269
Y_{21}	0.0153	0.01538
Y_{12}	0.0153	0.01538
Y_{22}	0.023	0.023
h_{11}	37.142	37.14
h_{21}	0.571	0.57
h_{12}	0.571	0.571
h_{22}	0.0142	0.0142
A	1.5	1.499
B	-65	-65
C	0.025	0.0249
D	-1.75	-1.75

Hence we can see that the calculated and experimental values match. Therefore all parameters of two port networks have been verified.

EXPERIMENT-7

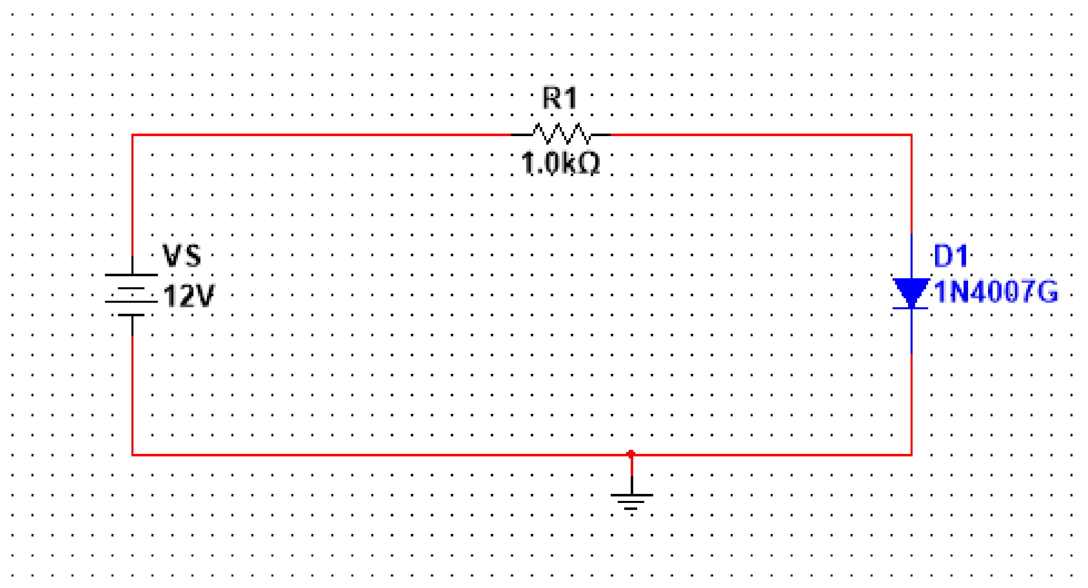
Objective: studying input and output characteristics of semiconductor diodes

Software used: NI Multisim 14.0

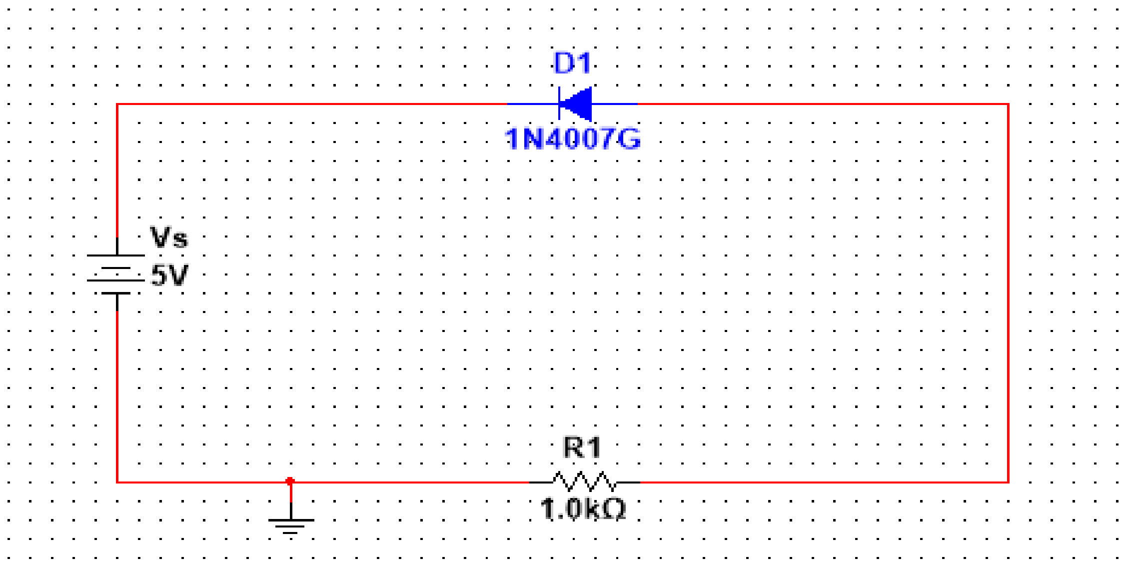
Theory: A semiconductor diode is a combination of p and n type semiconductors which in forward bias conducts current only above a certain voltage known as cutting voltage. After achieving cutting voltage, the increase in current is almost exponential. A diode in reverse bias conducts negligible amount of current in the order of micro amperes.

Circuit diagrams:

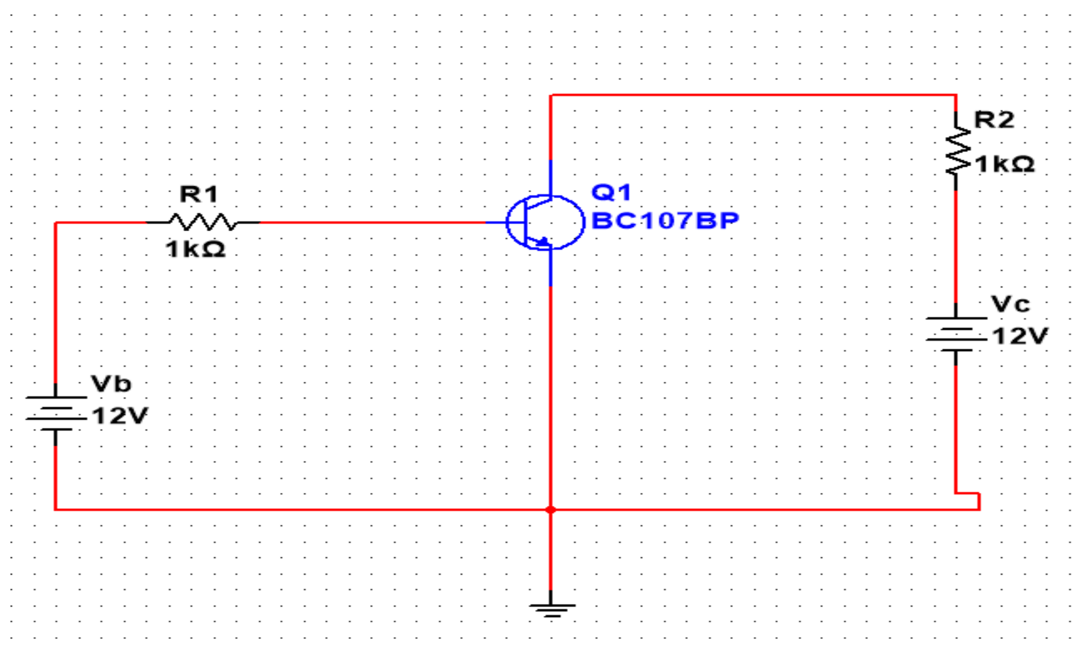
- **Forward bias diode**



- **Reverse bias diode**

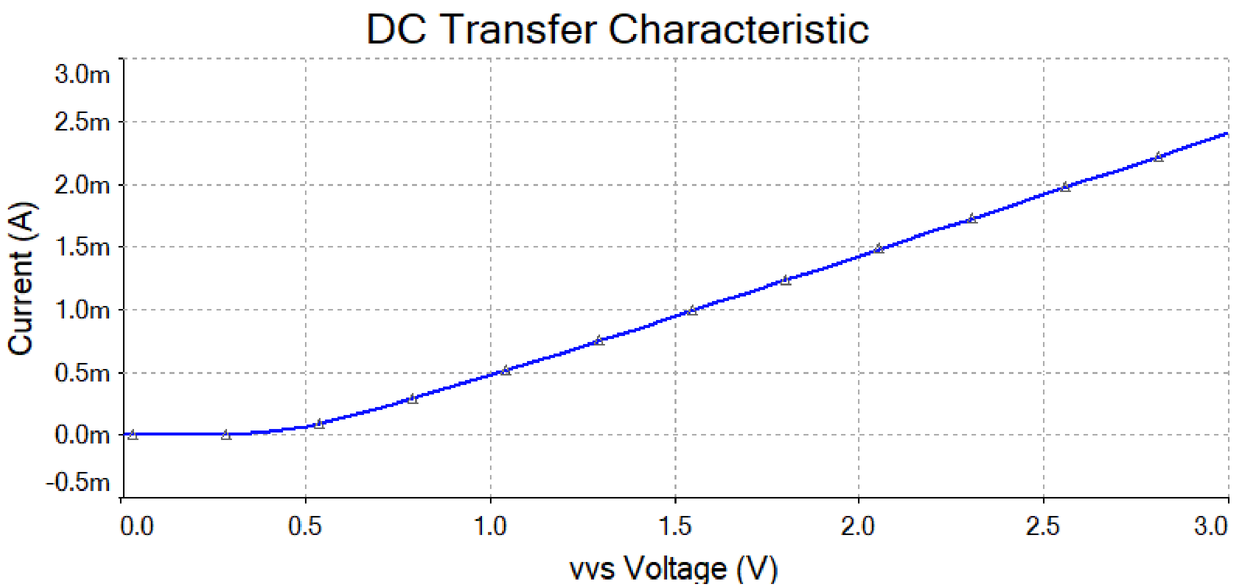


- Common emitter configuration



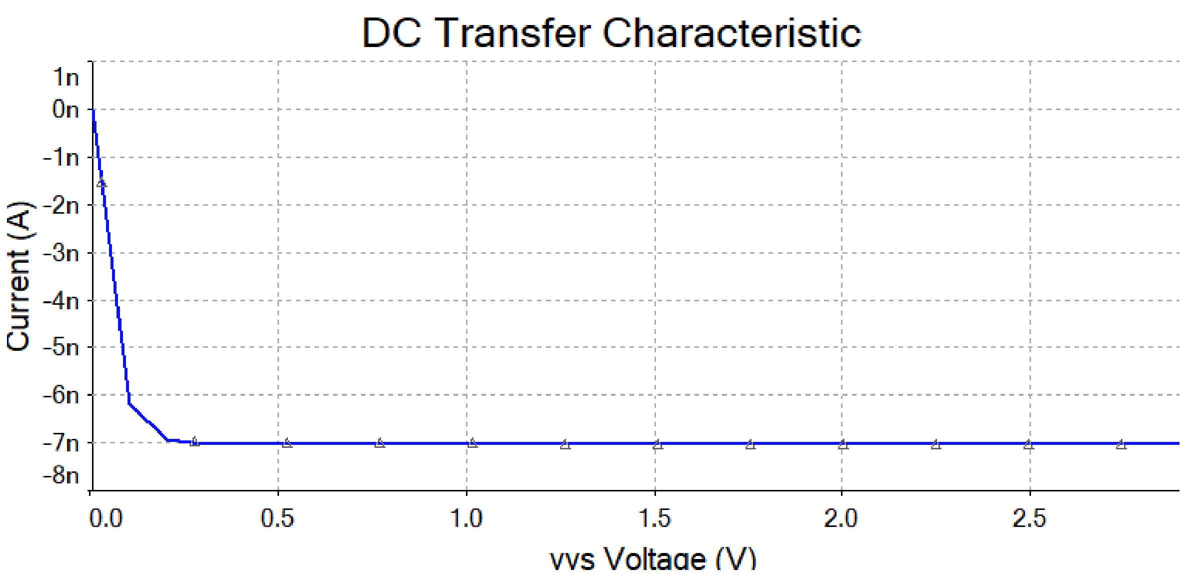
Result and observation:

- Forward bias graph



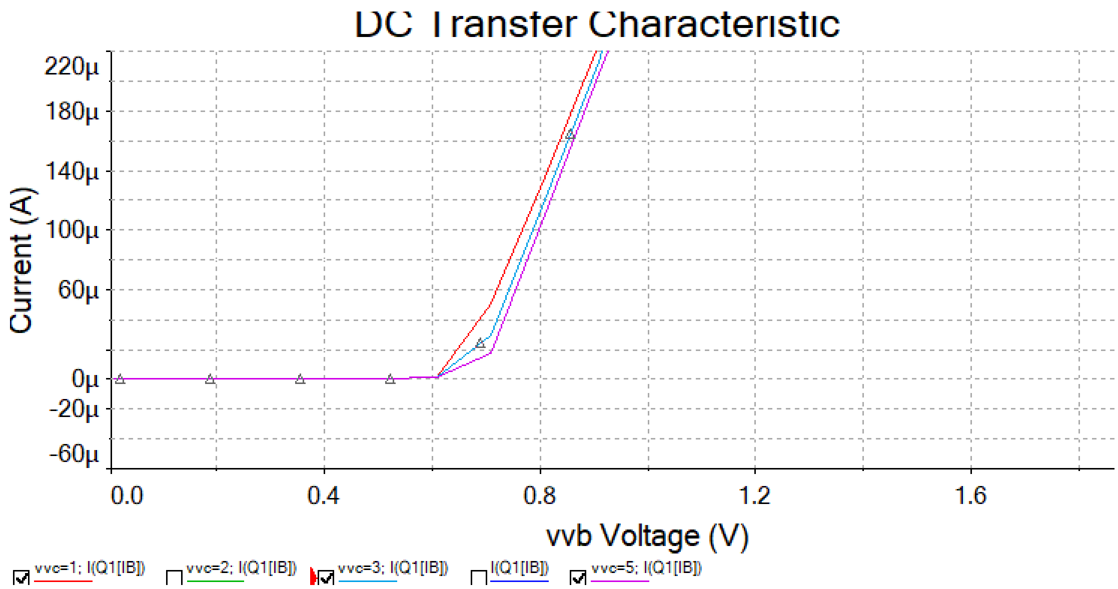
Cutting voltage for forward bias graph is 0.3V. Hence it is germanium diode

- Reverse bias graph



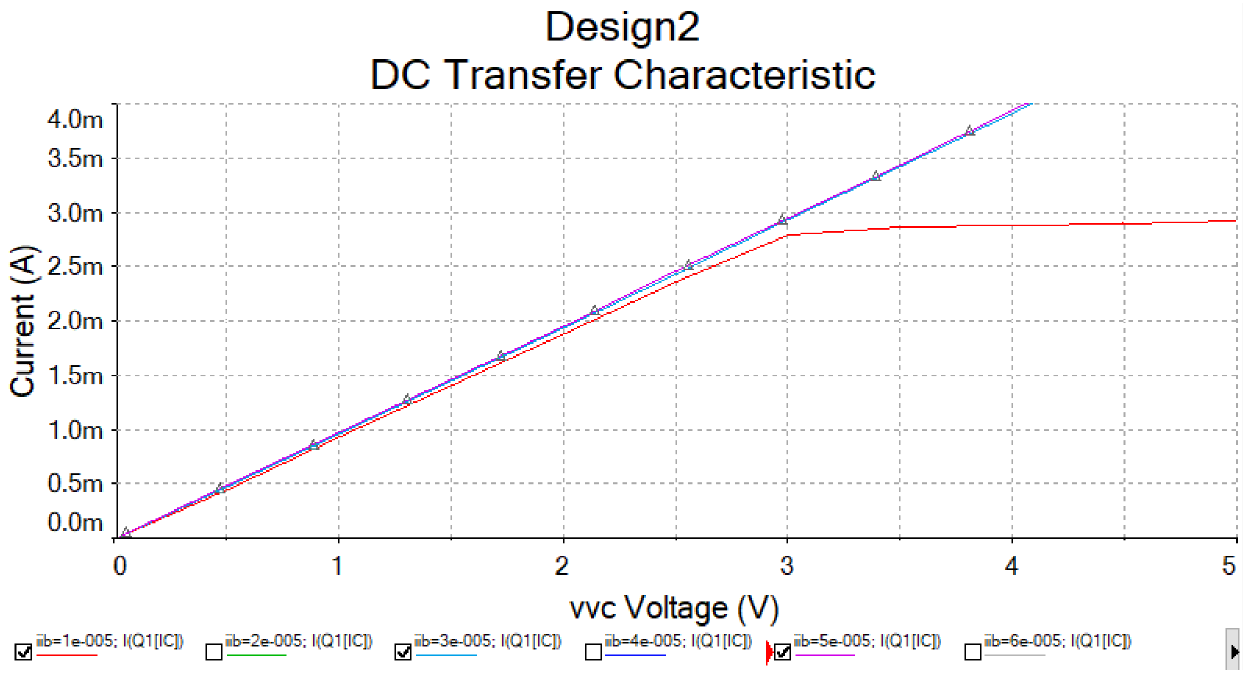
The leakage current is zero or negligible

- Common emitter input characteristics



	Voltage(vc)		
	1V	3V	5V
Cutting voltage (V_γ)	0.500V	0.506V	0.510V

➢ Common emitter output characteristics



	Base current(Ib)		
	10µA	30µA	50µA
Collector voltage (Ic)	**2.77mA**	**8.74mA**	**14.46mA**

Experiment 8

Objective: To design and simulate various rectifier circuits.

Software used: Ni Multisim 14.0

Theory: A rectifier is a device that converts an oscillating two-directional alternating current (AC) into a single-directional direct current (DC). Rectifiers can take a wide variety of physical forms, from vacuum tube diodes and crystal radio receivers to modern silicon-based designs

There are two types of rectifier

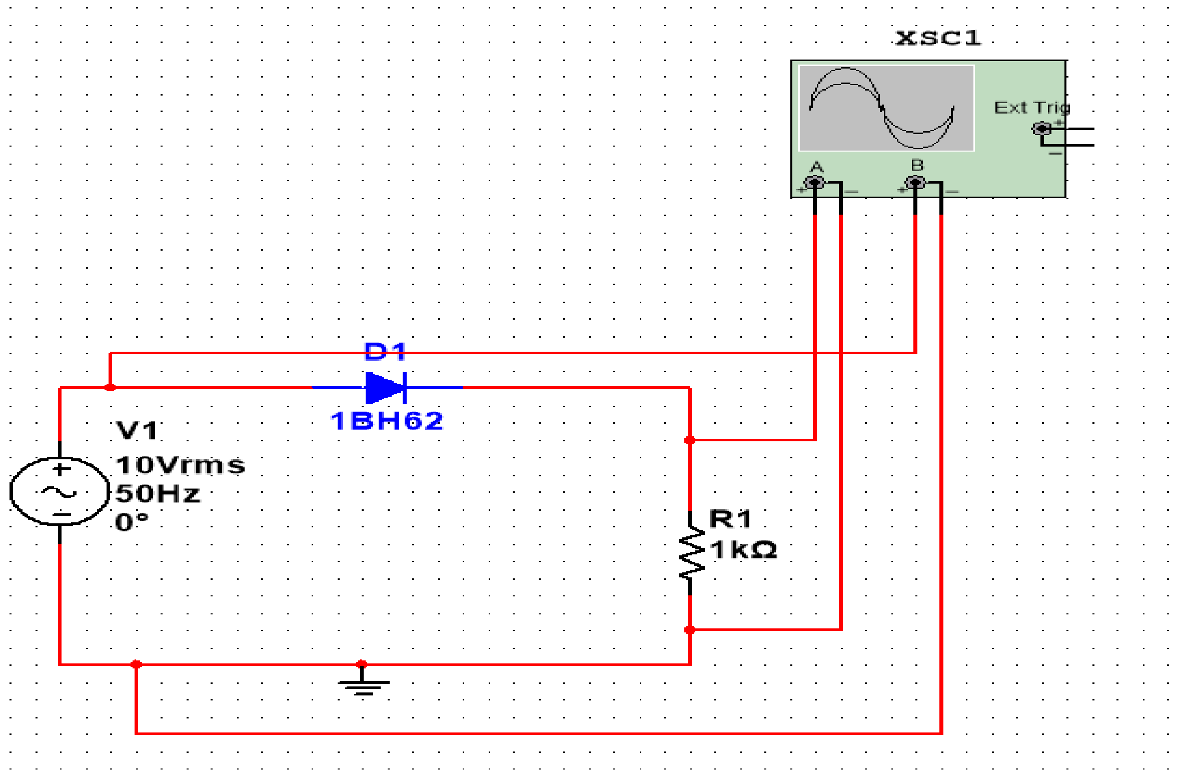
- Half wave rectifier
- Full wave rectifier

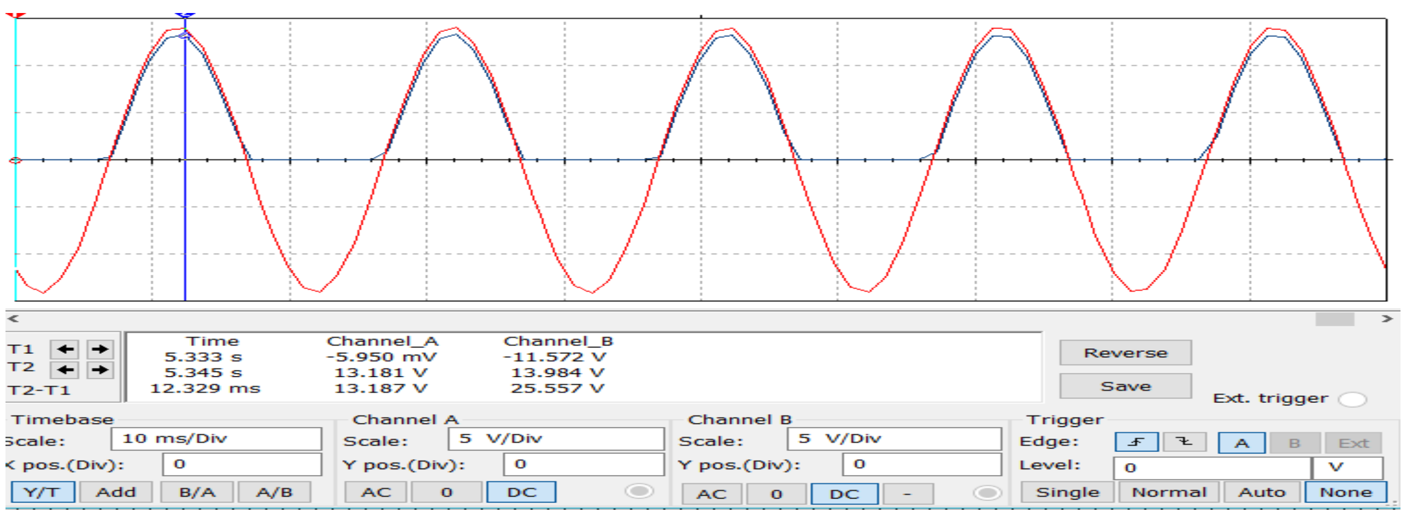
Half wave rectifier: For most power applications, half-wave rectification is insufficient for the task. The harmonic content of the rectifier's output waveform is very large and consequently difficult to filter. Furthermore, the AC power source only supplies power to the load one half every full cycle, meaning that half of its capacity is unused. Half-wave rectification is, however, a very simple way to reduce power to a resistive load. Some two-position lamp dimmer switches apply full AC power to the lamp filament for "full" brightness and then half-wave rectify it for a lesser light output.

Full wave rectifier: if we need to rectify AC power to obtain the full use of both half cycles of the sine wave, a different rectifiers circuit configuration must be used. Such a circuit is called a full-wave rectifier. One kind of full-wave rectifier, called the center-tap design, uses a transformer with a center-tapped secondary winding and two diodes

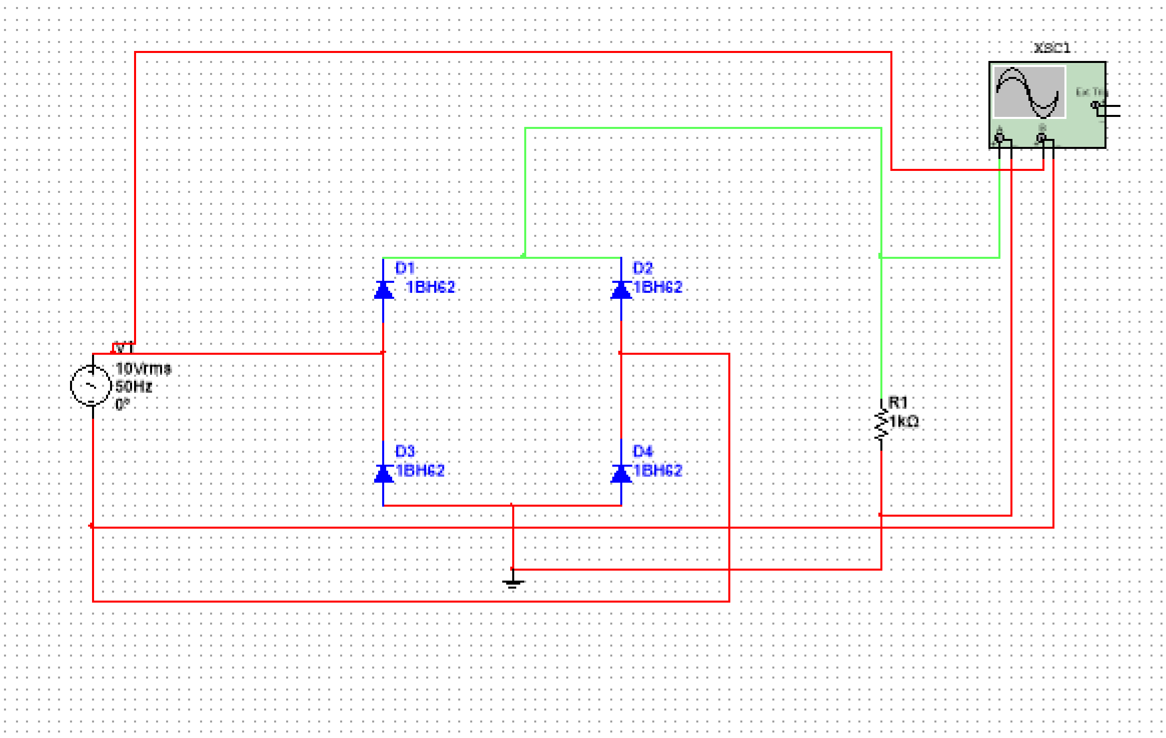
Circuit diagram

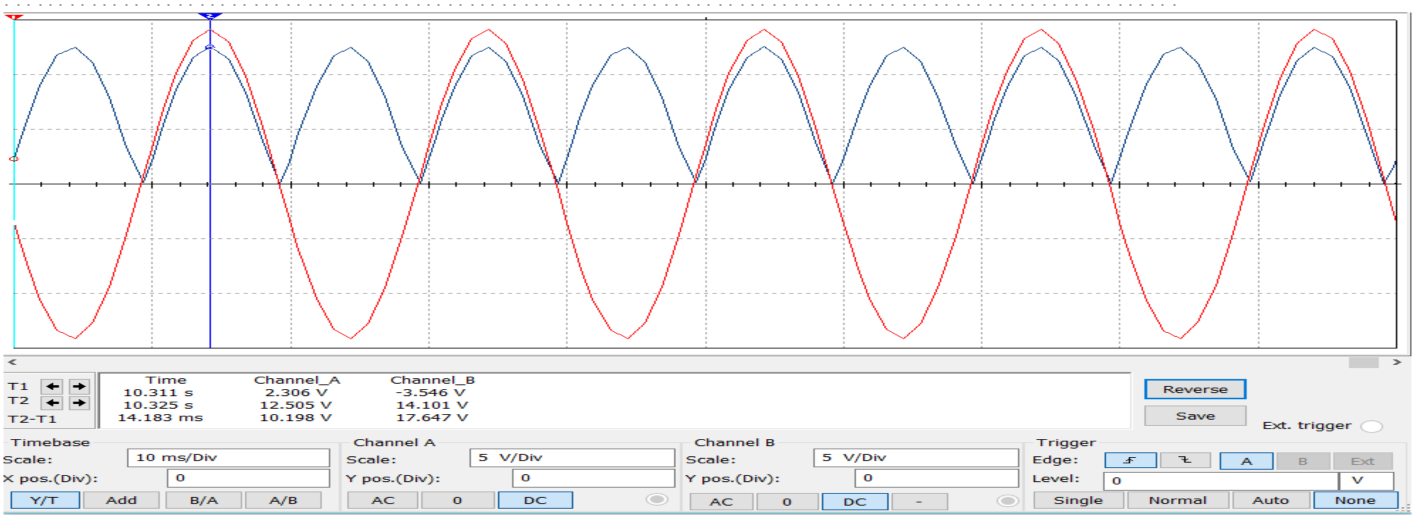
- **Half wave rectifier:**





- **Full wave rectifier:**


XSC1
Ext Trig
A
B
D1
1BH62
D2
1BH62
V1
10Vrms
50Hz
0°
R1
1kΩ
D3
1BH62
D4
1BH62


Time
Channel_A
Channel_B
T1
10.311 s
2.306 V
-3.546 V
T2
10.325 s
12.505 V
14.101 V
T2-T1
14.183 ms
10.198 V
17.647 V
Reverse
Save
Ext. trigger
Timebase
Scale:
10 ms/Div
X pos.(Div):
0
Y/T
Add
B/A
A/B
Channel A
Scale:
5 V/Div
Y pos.(Div):
0
AC
0
DC
Channel B
Scale:
5 V/Div
Y pos.(Div):
0
AC
0
DC
-
Trigger
Edge:
A
B
Ext
Level:
0
V
Single
Normal
Auto
None

Result and observation:

half wave rectifier:

V_M		V_{RMS}		V_{DC}		Ripple factor (γ)	
Theory	Multisim	Theory	Multisim	Theory	Multisim	Theory	Multisim
20	13.181	10	6.590	6.636	4.195	1.2114	1.2115

Full wave rectifier:

V_M		V_{RMS}		V_{DC}		Ripple factor (γ)	
Theory	Multisim	Theory	Multisim	Theory	Multisim	Theory	Multisim
14.14	12.505	10	8.843	9.001	7.960	0.484	0.483

Hence we saw that theoretical and multisim values are same the experiment has proved

EXPERIMENT -9

MOSFET AMPLIFIER

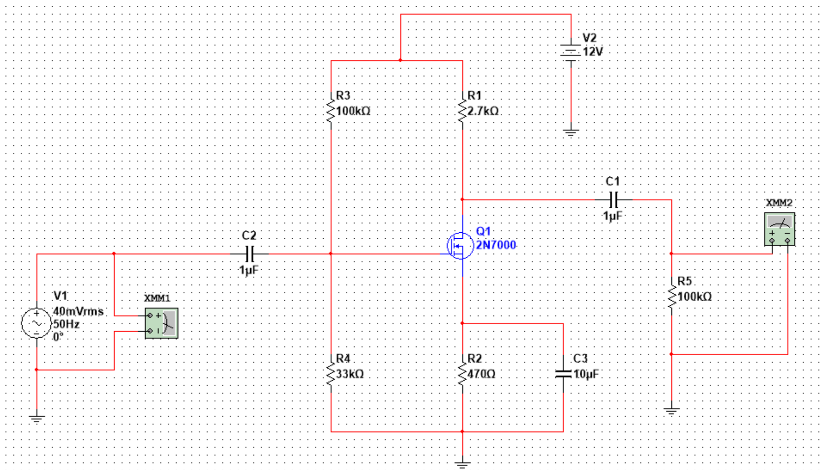
AIM:

To study the MOSFET amplifier working in common source configuration
with given specifications.

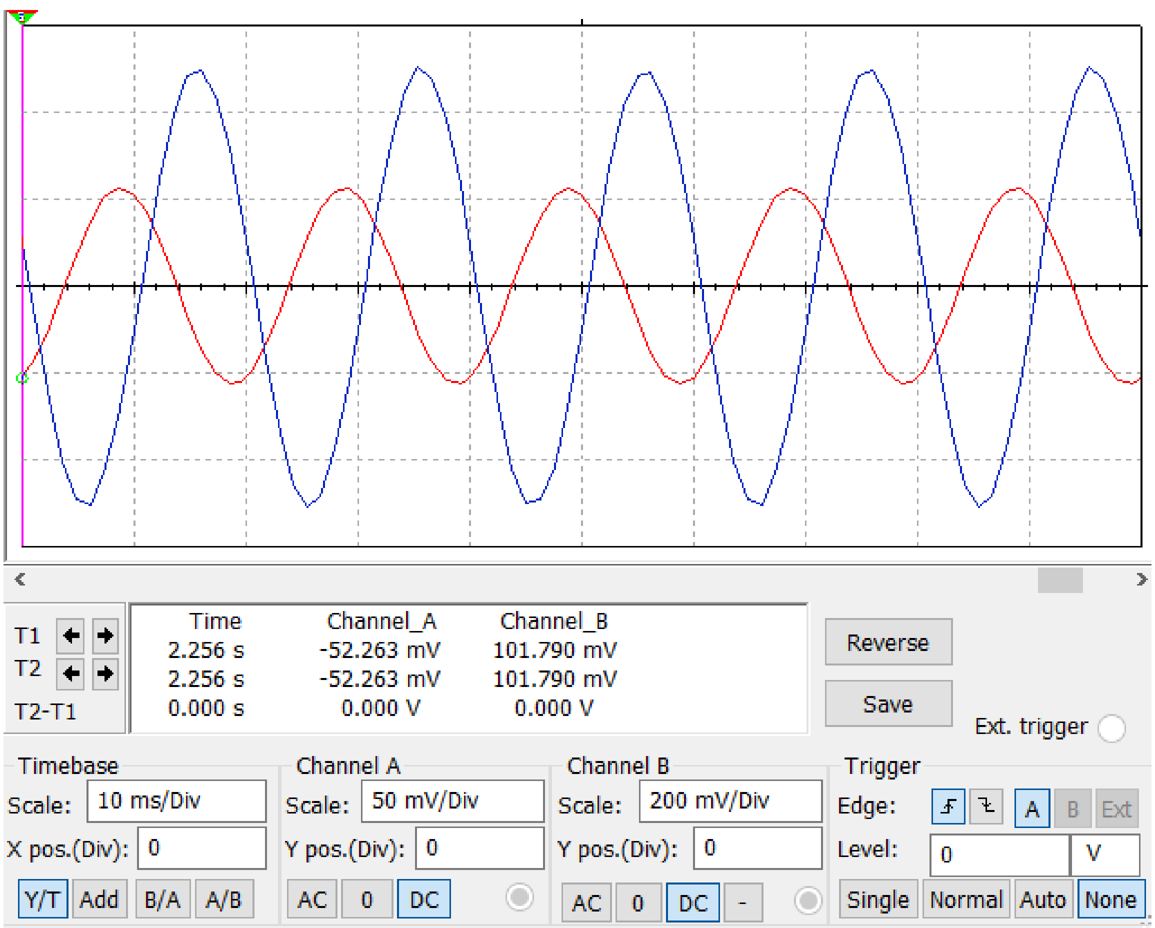
THEORY:

The MOSFET structure has become the most important device structure in the electronics industry. It dominates the integrated circuit technology in Very Large Scale Integrated (VLSI) digital circuits based on n-channel MOSFETs and Complementary n- channel and p-channel MOSFETs (CMOS). The technical importance of the MOSFET results from its low power consumption, simple geometry, and small size, resulting in very high packing densities and compatibility with VLSI manufacturing technology. Two of the most popular configurations of small-signal MOSFET amplifiers are the common source and common drain configurations. The common source circuit is shown below. The common sources, like all MOSFET amplifiers, have the characteristic of high input impedance. High input impedance is desirable to keep the amplifier from loading the signal source. This high input impedance is controlled by the bias resistors R1 and R2). Normally the value of the bias resistors is chosen as high as possible. However, too big a value can cause a significant voltage drop due to the gate leakage current. A large voltage drop is undesirable because it can disturb the bias point. For amplifier operation the MOSFET should be biased in the active region of the characteristics.

CIRCUIT DIAGRAM:



RESULT & OBSERVATION:



INPUT VOLTAGE Vi (mV)	OUTPUT VOLTAGE Vo (mV)	VOLTAGE GAIN Vo/Vi (mV)
40.021	355.734	8.888
50.016	442.937	8.856

Therefore we can see the MOSFET given an voltage gain of 8.8 Such that MOSFET works as an voltage amplifier

Experiment – 10

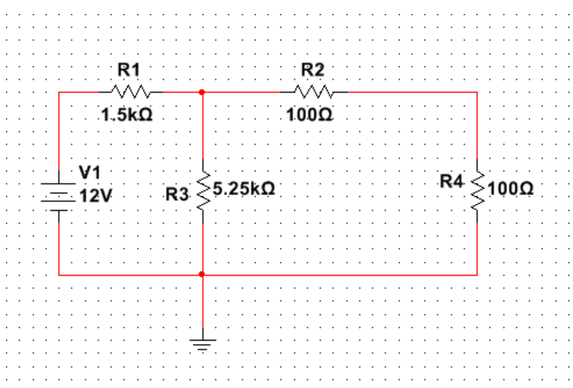
APPLICATION OF THEVENIN'S THEOREM

Objective: To Verify Thevenin's theorem.

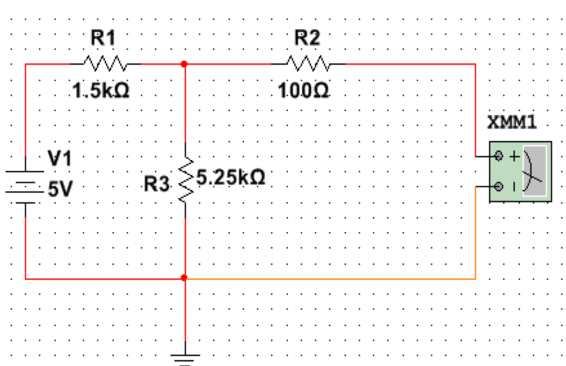
Software Used: NI Multisim 14.0

Circuit diagrams:

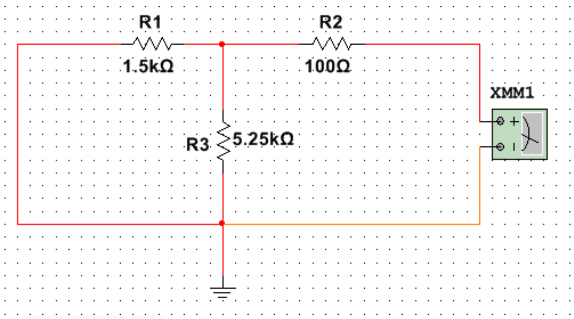
Overall circuit



Circuit for Vth



Circuit for Rth



Theory:

Any linear, bilateral network having a number of voltage, current sources and resistances can be replaced by a simple equivalent circuit consisting of a single voltage source in series with a resistance, where the value of the voltage source is equal to the open circuit voltage and the resistance is the equivalent resistance measured between the open circuit terminals with all energy sources replaced by their ideal internal resistances.

Result & Observations :

				V_{Th}		R_{Th}	
V_S	R_1	R_2	R_3	Theoretical	Multisim	Theoretical	Multisim
5V	1.2kΩ	1 kΩ	1.3k Ω	2.6V	2.6V	1.624k Ω	1.624k Ω
5.2V	3k Ω	1 kΩ	4k Ω	4.571V	4.571V	2.7142k Ω	2.714k Ω
7.6V	7k Ω	5kΩ	4kΩ	2.764V	2.764V	7.5454k Ω	7.545k Ω
10V	9.5k Ω	6.2kΩ	2.4kΩ	2.017V	2.017V	8.116k Ω	8.116k Ω

Hence we can see the match of multisim and theoretical values we can say this experiment is proved

END OF LAB REPORT
THANK YOU

DONE BY

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20BCD7171