D Y PATIL INTERNATIONAL UNIVERSITY

SCHOOL OF COMPUTER SCIENCE ENGINEERING AND APPLICATIONS

Program Name: B.Tech (CSE)

Academic Year 2025-26

First Year B.Tech (CSE), Sem Ist

LAB MANUAL

Subject Code: (CSE1002)

(Basic Electrical & Electronics Engineering)

Course Instructor: Dr. Dipti

Lab Instructor: Ms. Tisha Nimje

Submitted By: A Y U S H Y E N U G W A R

PRN: 20250802802

Department of Computer Science, Engineering and Applications

D. Y. Patil International University, Akurdi, Pune - 411035

D Y PATIL
INTERNATIONAL
UNIVERSITY
AKURDI PUNE

SCHOOL OF COMPUTER SCIENCE ENGINEERING AND APPLICATIONS

CERTIFICATE

This is to certify that Mr. AYUSH YENUGWAR , of B. Tech CSE First Year student, Sem Ist , PRN No. 20250802802 , has successfully completed the lab manual for the course “Basic Electrical & Electronics Engineering” in partial fulfilment of the requirements for the degree of Bachelor of Technology in Computer Science Engineering for the Academic Year 2025-26 .

Ms. Tisha Nimje	Dr. Dipti
Teaching Associate	Course Instructor

INDEX

Experiment-1

Aim: Verification of Ohm’s Law– Determine the relationship between voltage, current, and resistance using a simple resistive circuit.

Requirement: Resistor, 2 multimeter, Power supply, Breadboard

Theory:

Ohm’s law states that the voltage (V) across a conductor is directly proportional to the current (I) flowing through it, provided all physical conditions and temperatures remain constant.

$$\boldsymbol{V = iR}$$

Where R is the resistance of an element denotes its ability to resist the flow of electric current.

Circuit Diagram:

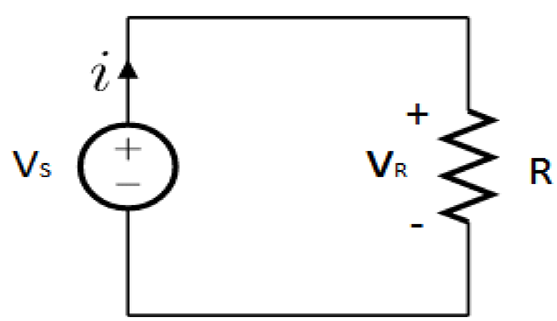


Fig. 1 Circuit diagram

Modified circuit to measure current & voltage across resistor

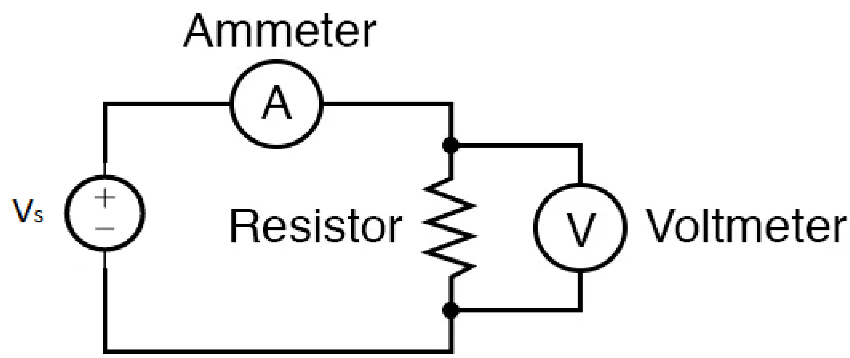


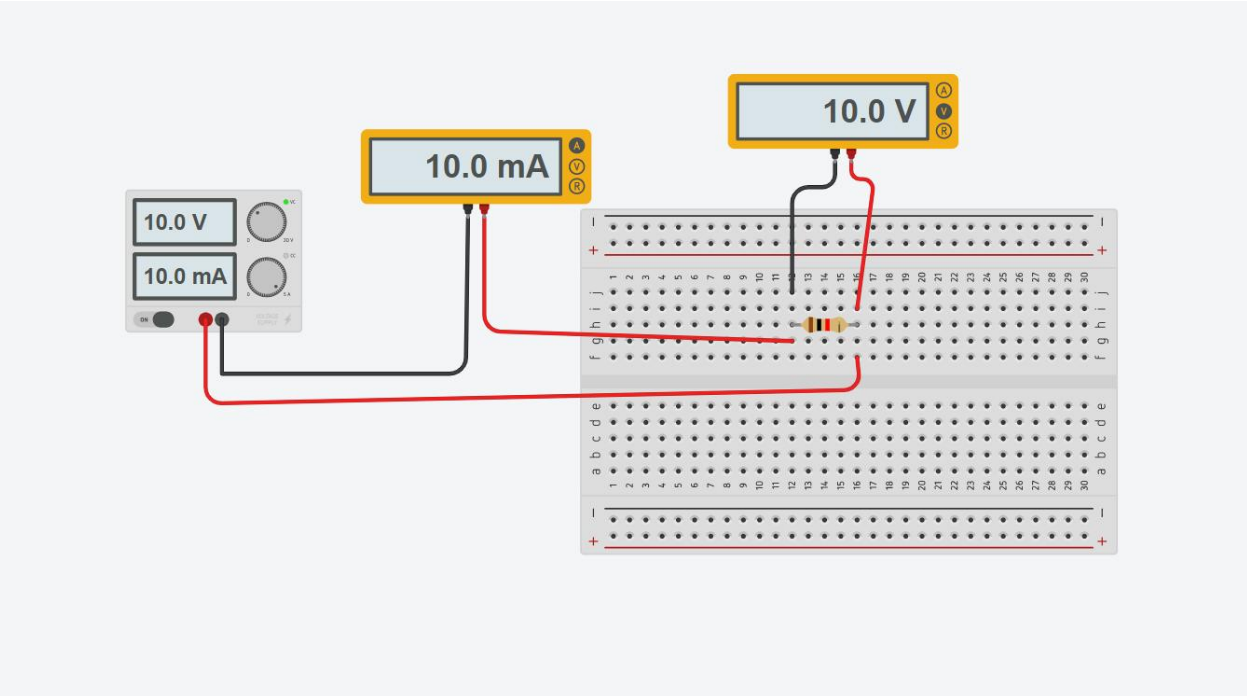
Fig. 2 Modified circuit to measure voltage & current

- Multimeter is used to measure the current and voltage.
- To measure the current through resistor: The multimeter is needed to connect in series with the resistor.
- To measure the voltage across resistor: The multimeter is needed to connect in parallel with the resistor.

Procedure:

1. **Set up the circuit** on the breadboard as shown in the Fig. 2 using the resistor, ammeter, voltmeter, power supply, and connecting wires.
2. **Ensure all connections are tight** and correct. Keep the power supply (V_s) initially at 0 V.
3. **Switch ON** the power supply and gradually increase the voltage (V_s).
4. **Take readings** for each setting of voltage (V_s), note the corresponding current displayed by the ammeter and voltage from the voltmeter.
5. **Repeat** for at least 5 different voltage settings (e.g., 2V, 4V, 6V, 8V, 10V).

Tinkercad Circuit Diagram:



Result:

Observation Table:

V_s	I_R	V_R	R
5V	5.00mA	5V	1kΩ
10V	10.00mA	10V	1kΩ
15V	15.00mA	15V	1kΩ

Precautions:

- Ensure proper connections to avoid short-circuits.
- Avoid overheating the resistor.
- Take multiple readings for accuracy.
- Use appropriate range settings for the ammeter and voltmeter.

Conclusion: After plotting the graph, if the V-I graph is linear and passes through the origin, and R remains constant, Ohm's Law is verified.

Experiment-2

Aim: Verification of Kirchhoff's Laws (KVL & KCL) – Apply KVL in a series circuit and KCL in a parallel circuit, and verify through measurements.

Requirement: Resistors, multimeter, Power supply, Breadboard

Theory:

2.1 Kirchhoff's Voltage Law (KVL)

It states that in a loop, the sum of the voltage drops across all the resistors is equal to the voltage supplied by the source.

Consider the circuit below:

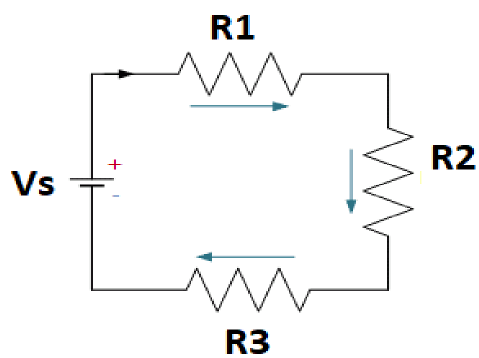


Fig. 1 Circuit for KVL

Applying KVL for figure 1

$$V = V_1 + V_2 + V_3$$

OR

$$V = I\,(R1 + R2 + R3)$$

Procedure to verify KVL:

1. **Set up the circuit** on the breadboard as shown in the Fig. 1 using the resistors, power supply, and connecting wires.
2. Switch ON the power supply and adjust to a reasonable voltage.
3. Connect multimeter across each resistor to measure individual voltage drops: V_{R1}, V_{R2}, V_{R3}.
4. Measure supplied voltage at the input by using multimeter.
5. Verify KVL

$$V_s = V_{R1} + V_{R2} + V_{R3}$$

2.2 Kirchhoff's Current Law (KCL)

The sum of currents entering the node is equal to the sum of currents leaving the node.

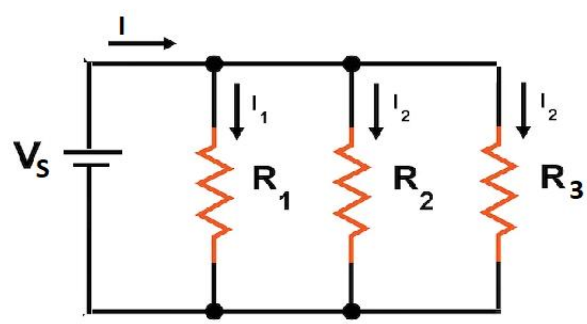


Fig. 2 Circuit for KCL

$$I = I_1 + I_2 + I_3$$

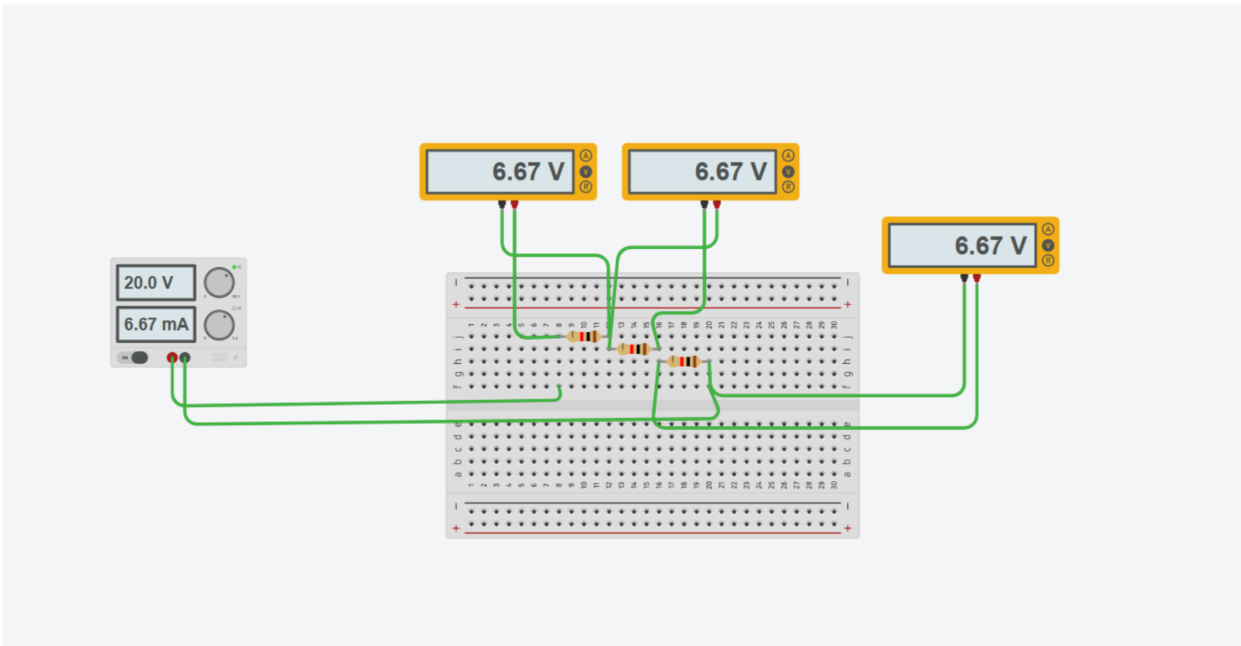
Procedure to verify KCL:

1. **Set up the circuit** on the breadboard as shown in the Fig. 2 using the resistors, power supply, and connecting wires.
2. Switch ON the power supply and adjust to a reasonable voltage.
3. Connect multimeter to measure the individual currents through all the resistors (R_1, R_2 & R_3): I_1, I_2, I_3.

4. Measure total current "I" by using multimeter.
5. Verify KCL

$$I = I_1 + I_2 + I_3$$

Tinkercad Circuit Diagram:

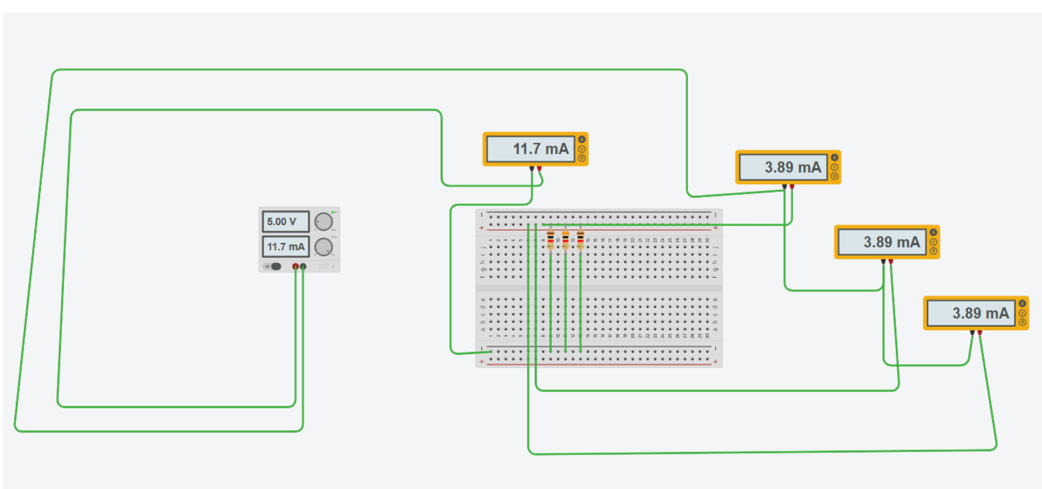


Result:

Observation Table (KVL):

V_s	V_{R1}	V_{R2}	V_{R3}	Verify KVL $V_s = (V_{R1} + V_{R2} + V_{R3})$ Yes/ No
9	3	3	3	9=3+3+3 (yes)
15	5	5	5	15=5+5+5 (yes)
25	8.33	8.33	8.33	25=8.33+8.33+8.33(yes)
30	10	10	10	30=10+10+10 (yes)
20	6.67	6.67	6.67	20=6.67+6.67+6.67 yes

Tinkercad Circuit Diagram:



Observation Table (KCL):

V_s	I	I_1	I_2	I_3	Verify KCL $I = (I_1 + I_2 + I_3)$ Yes/ No
9	18	6	6	6	18=6+6+6 (yes)
15	39	13	13	13	39=13+13+13(yes)
25	54	18	18	18	54=18+18+18(yes)
30	63	21	21	21	63=21+21+21(yes)
20	69	23	23	23	69=23+23+23(yes)

Precautions:

- Ensure all connections are tight.
- Use appropriate range settings on meters.
- Avoid overheating resistors by limiting the supply voltage.
- Take multiple readings for accuracy.

Conclusion:

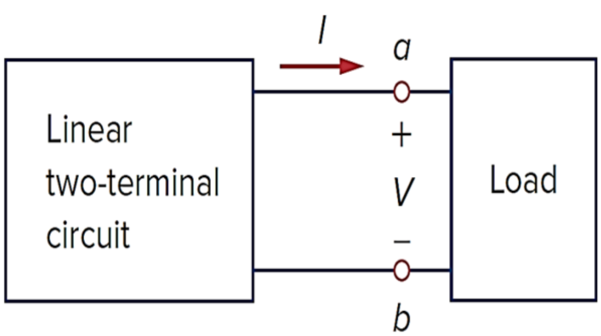
If the total voltage equals the sum of voltage drops in series, and the total current equals the sum of branch currents in parallel, **Kirchhoff's Laws are verified successfully**.

Experiment-3

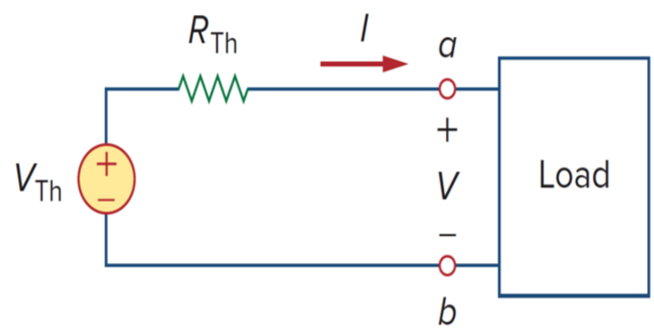
Aim: Verification of Thevenin's Theorem– Reduce a given network into its Thevenin's equivalent circuit and compare measured vs calculated values

Requirement: Resistors, multimeter, Power supply, Breadboard, Connecting wires

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



(a) Original Circuit



(b) Thevenin equivalent circuit

Step by step procedure to solve Thevenin's theorem

1. Identify the element for which the current or voltage is to be found and consider it as load resistor (RL).

2. Open the load resistor and measure the voltage across the terminals by any of the network simplification methods. This voltage is called as Thevenin's voltage (Vth).

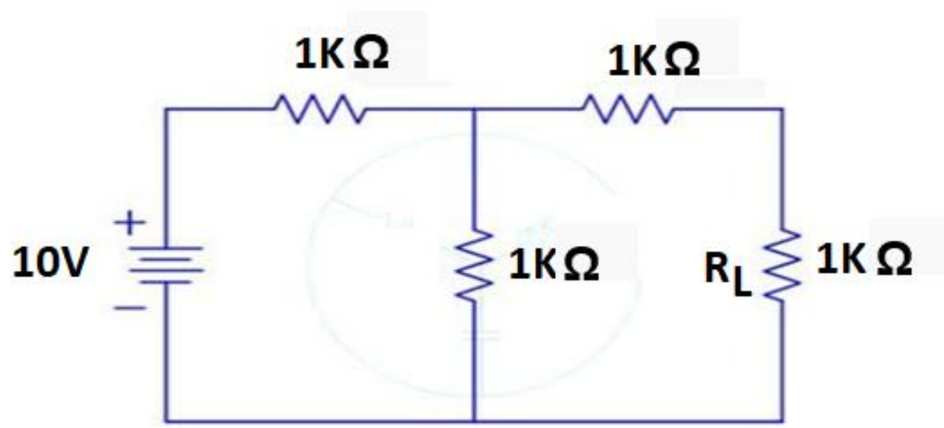
3. Remove the load resistor. Replace all voltage and current sources by their internal resistance. Then measure the equivalent resistance as viewed from the open- circuited terminals. This is the Thevenin's resistance (Rth).

4. Draw the Thevenin's equivalent circuit with Thevenin's voltage source in series with Thevenin's resistance followed by the load resistor.

5. Now find the current (I_L) through load resistor.

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

Circuit:

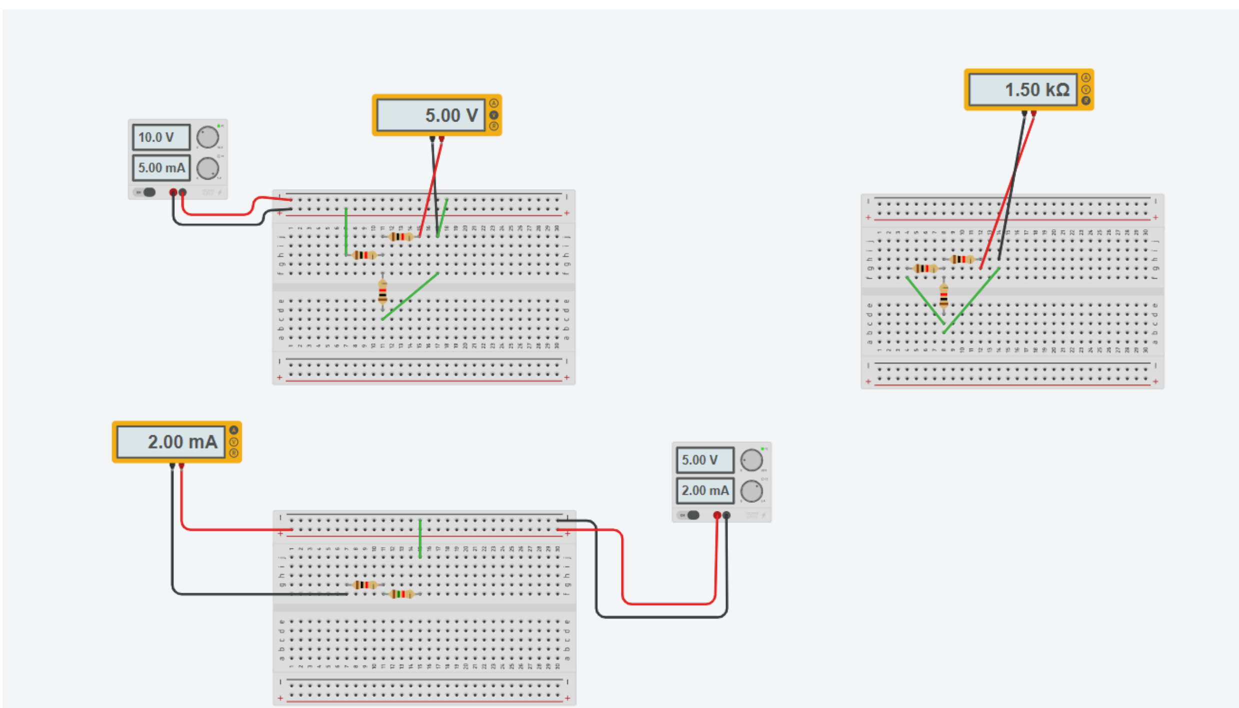


Procedure to verify Thevenin theorem:

1. Complete circuit connections
2. **To measure V_{TH}** : Remove Load resistor and measure the open circuit voltage or Thevenin voltage (V_{TH}) by using multimeter

3. **To measure R_{TH}** : Replace independent voltage source by short circuit & replace independent current source by open circuit (if any) and measure equivalent resistance by using multimeter.
4. Reconstruct the circuit to design Thevenin's equivalent circuit with V_{th}, R_{th} & R_L
5. Measure load current I_L by using multimeter.
6. Compare this with the value measured in the original circuit.

Tinkercad Circuit:



Result:

OBSERVATION TABLE:-

Parameters	Theoretical Value	Practical Value
I_L	2mA	2mA
R_N	1.5KΩ	1.5KΩ
V_{TH}	5v	5v

Precautions:

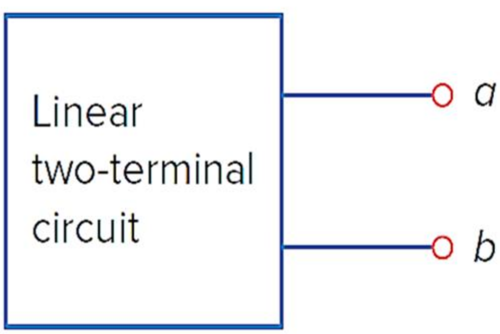
- Ensure all connections are tight.
- Use appropriate range settings on meters.
- Avoid overheating resistors by limiting the supply voltage.

Experiment-4

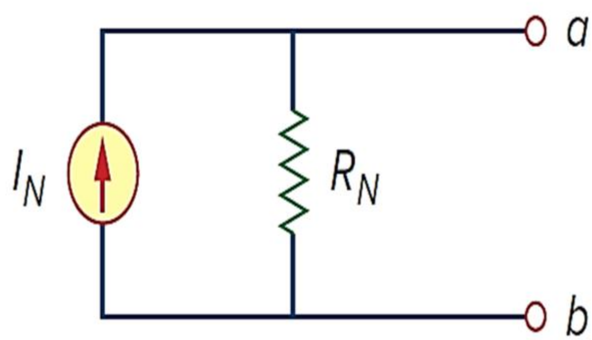
Aim: Verification of Norton's Theorem – Reduce a given network into its Norton's equivalent and validate using experimental setup.

Requirement: Resistors, Multimeter, Power supply, Breadboard, Connecting wires

Theory: A linear two-terminal circuit can be replaced by an equivalent circuit consisting of a current source I_N in parallel with a resistor R_N, where I_N is the short-circuit current through the terminals and R_N is the input or equivalent resistance at the terminals when the independent sources are turned off.



Original circuit



Norton equivalent circuit

Step by step procedure to solve Norton's theorem

6. Identify the element for which the current or voltage is to be found and consider it as load resistor (RL).

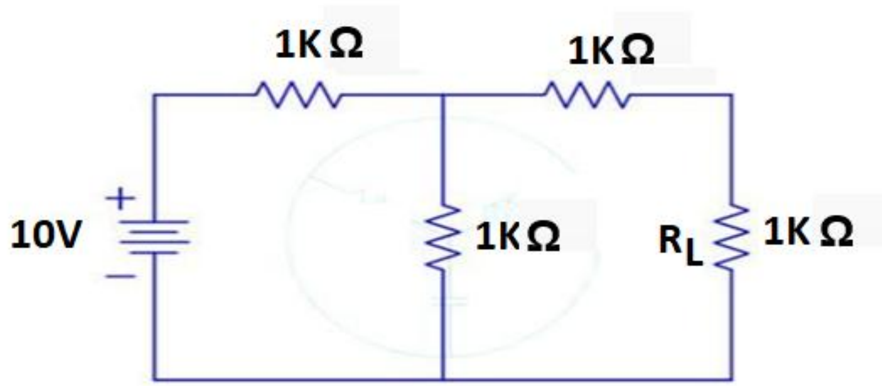
7. **To find I_N:** Short the branch that has load resistor and measure the short circuit current by any of the network simplification methods. This current is called as Norton Current (I_N).

8. **To find R_N:** Replace all independent voltage source by short circuit and

independent current sources by open circuit. Then measure the equivalent resistance. This is the Thevenin's resistance (R_N).

9. Draw the Norton equivalent circuit with Norton current source in parallel with Norton resistance parallel with load resistor.

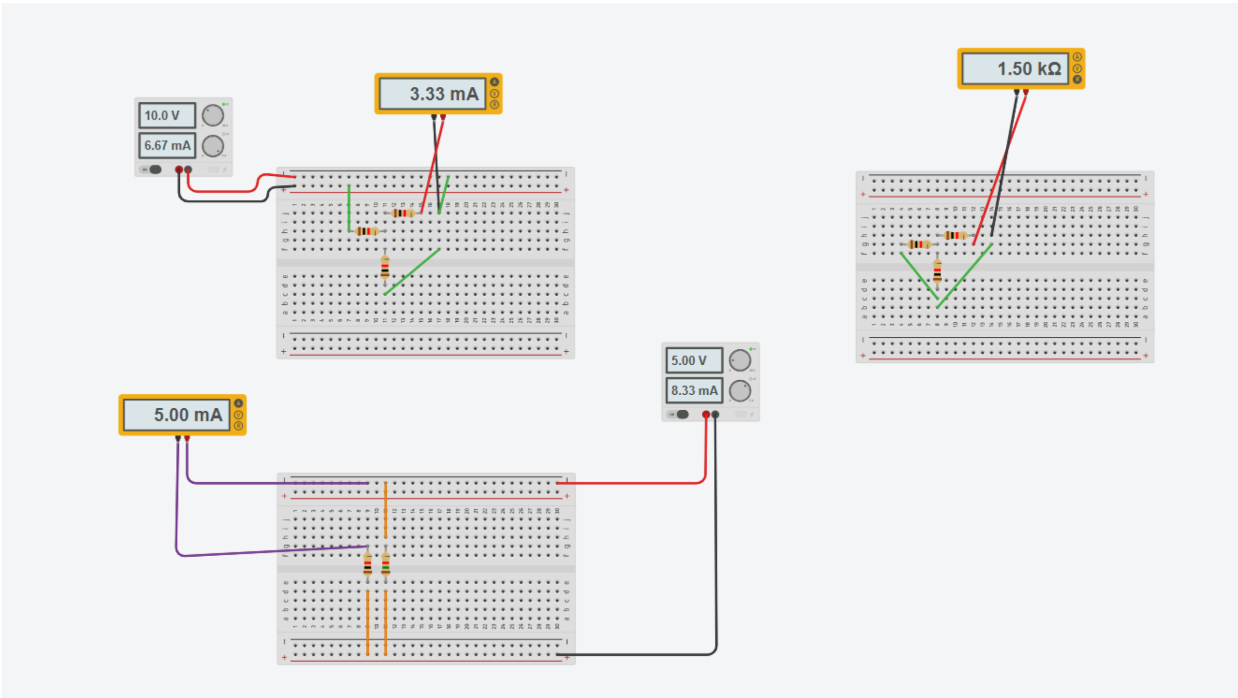
Circuit:



Procedure to verify norton's theorem:

1. Complete circuit connections
2. **To measure I_N** : Replace the Load resistor by short circuit branch and measure the short circuit current or Norton current (I_N) by using multimeter
3. **To measure R_N** : Replace independent voltage source by short circuit & replace independent current source by open circuit (if any) and measure equivalent resistance by using multimeter.
4. Reconstruct the circuit to design Thevenin's equivalent circuit with I_N, R_N & R_L
5. Compare this with the value measured in the original circuit.

Tinkercad Circuit Diagram:



Result: Observation Table:

Parameters	Theoretical Value	Practical Value
I_N	3.33mA	3.33mA
R_N	1.5KΩ	1.5KΩ
I_L	2mA	2mA

Precautions:

- Ensure all connections are tight.
- Use appropriate range settings on meters.
- Avoid overheating resistors by limiting the supply voltage.

Experiment-5

Aim:

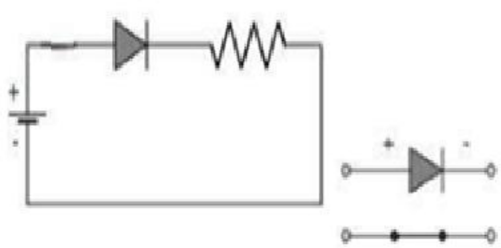
To plot IV Characteristics of PN Diode in forward & Reverse Bias

Requirement: Resistors, Multimeter, Power supply, Breadboard, Connecting wires, Diode, CRO, Function Generator

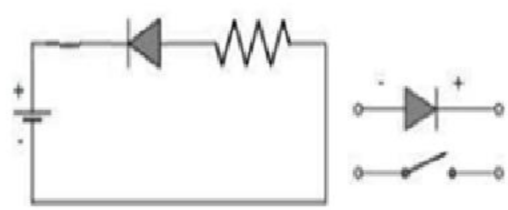
Theory:

A PN diode (also known as rectifier diode) is a two-terminal device, having two active electrodes between which the signal of interest may flow, and most are used for their unidirectional current property. It allows an electric current to pass in one direction (called the forward biased condition) and to block it in the opposite direction (the reverse biased condition).

Circuit Diagram:



Forward Biased



Reverse Biased

Procedure:

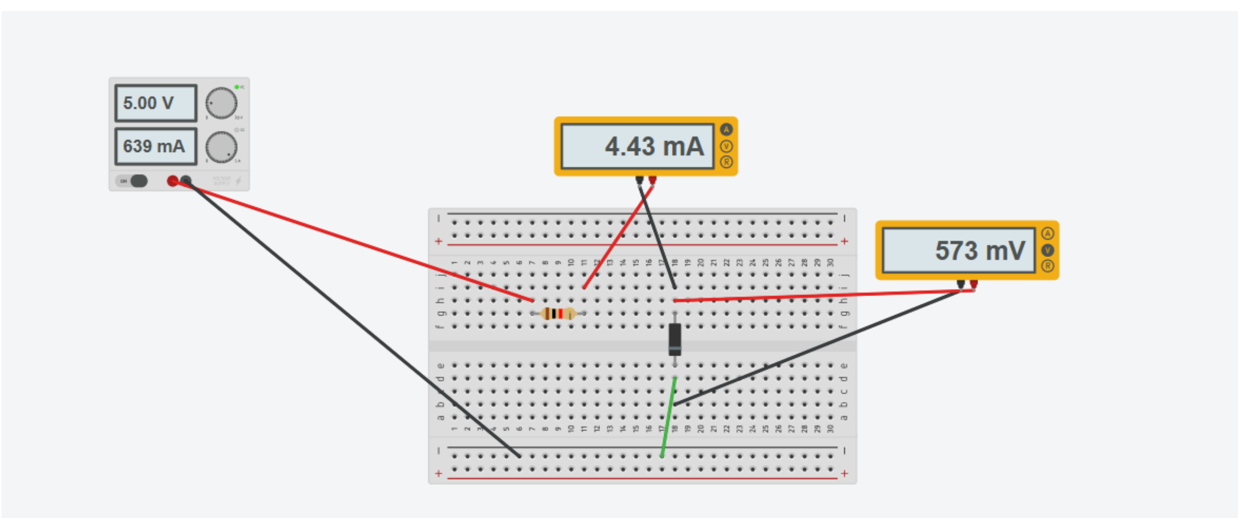
(A) FORWARD CHARACTERISTICS OF DIODE:

1. Make the connections as shown in the figure.
2. Vary the D.C. Supply voltage so that the diode voltage will vary and connect Multimeters to measure the voltage (V_D) & current (I_D) of the diode
3. Note down the corresponding V_D & I_D readings.
4. Plot the graph of voltage (on X-axis) vs. current (on Y-axis).

(B) REVERSE CHARACTERISTICS OF DIODE:

1. Make the connections as shown in the figure.
2. Vary the D.C. Supply voltage so that the diode voltage will vary and connect Multimeters to measure the voltage & current of the diode in reverse bias
3. Note down the corresponding voltage and current readings.
4. Plot the graph of voltage (on X-axis) vs. current (on Y-axis).

Tinkercad Circuit Diagram:



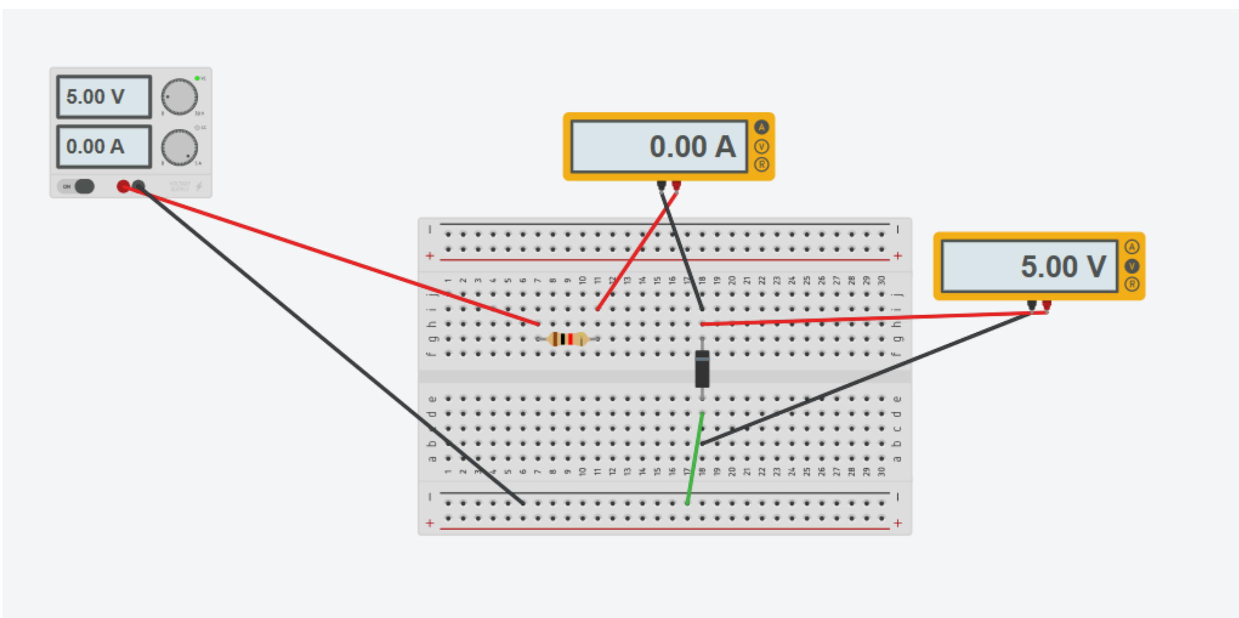
forwardbias

Observation Table:

Forward Bias

S. No	V_{in}	V_D	I_D
1	5V	573mV	4.43 mA
2	10V	592 mV	9.41 mA
3	15V	603 mV	14.4 mA
4	20V	611 mV	19.4 mA
5	25V	617 mV	24.4 mA

Tinkercad Circuit Diagram:



Reverse Bias

S. No	V_{in}	V_D	I_D
1	**5V**	**5V**	**0 mA**
2	**10V**	**10V**	**0 mA**
3	**15V**	**15V**	**0 mA**
4	**20V**	**20V**	**0 mA**
5	**25V**	**25V**	**0 mA**

Result:

1. Plot the IV Characteristics of PN Diode in forward & reverse bias.
2. Determine Knee voltage or Cut-in voltage of the Diode

Experiment-6

Aim: To implement the Diode as Rectifier (Half wave Rectifier & Full wave Rectifier)

Requirement: Resistors, Multimeter, Power supply, Breadboard, Connecting wires, Diode, CRO, Function Generator

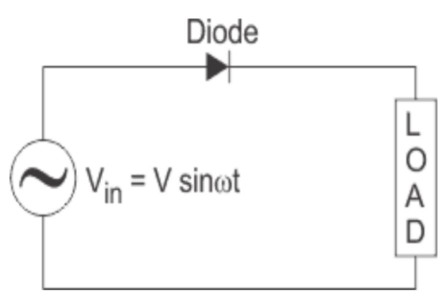
Theory:

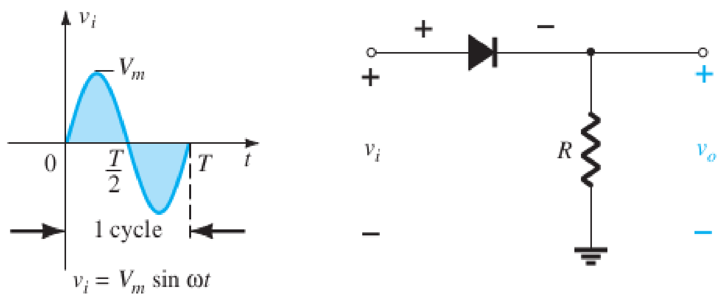
Half-wave rectifier:

Half-wave rectifiers transform AC voltage to DC voltage. A halfwave rectifier circuit uses only one diode for the transformation. A halfwave rectifier is defined as a type of rectifier that allows only one-half cycle of an AC voltage waveform to pass while blocking the other half cycle.

During the **positive half-cycle**, the diode becomes forward-biased and allows current through the load, producing output voltage. During the **negative half-cycle**, the diode is reverse-biased and blocks current flow, so the output voltage is zero.

Circuit Diagram:

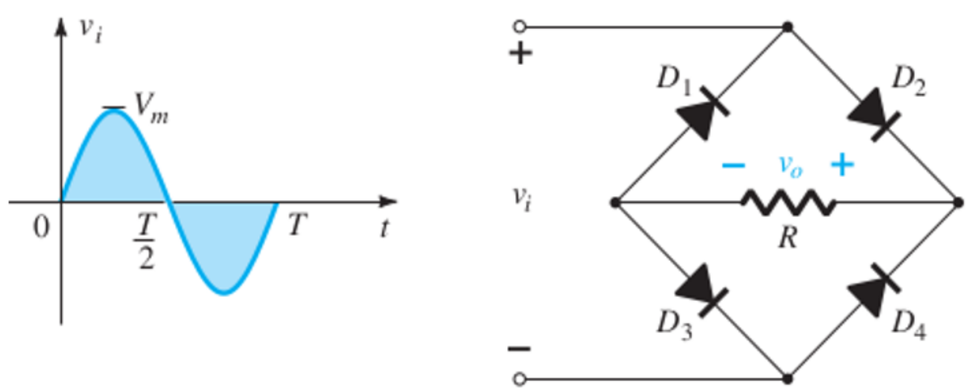


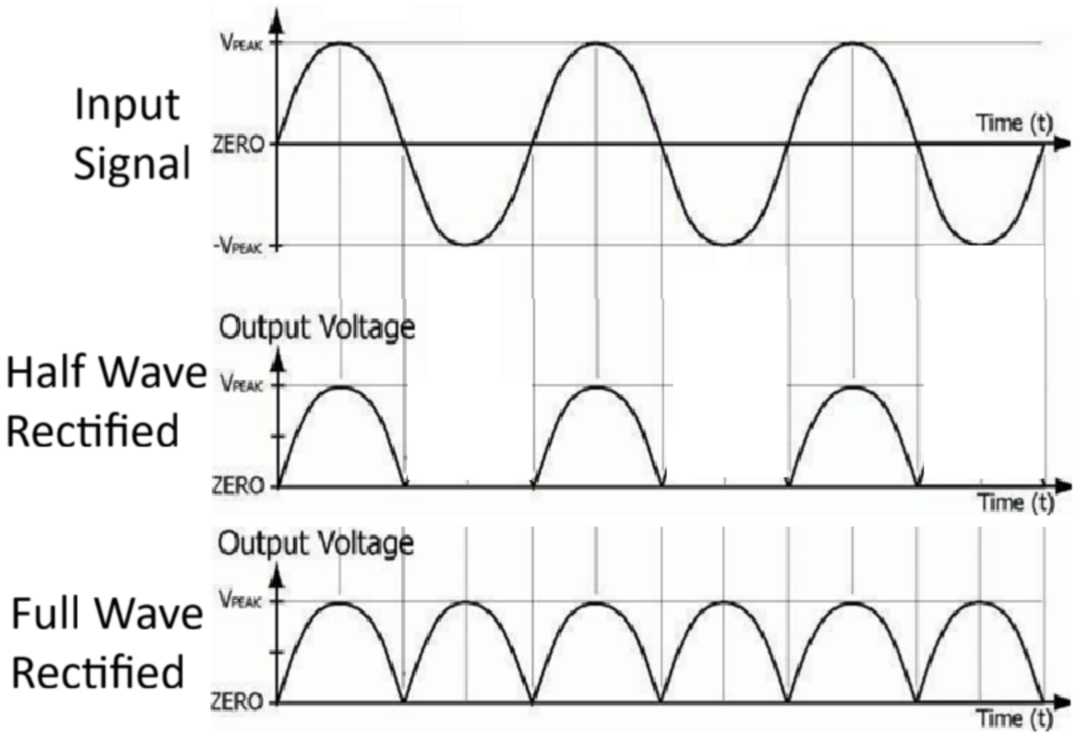


Full Wave Rectifier:

A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC. Unlike half wave rectifiers that utilize only the half wave of the input AC cycle, full wave rectifiers utilize the full cycle.

Circuit Diagram:





PROCEDURE:

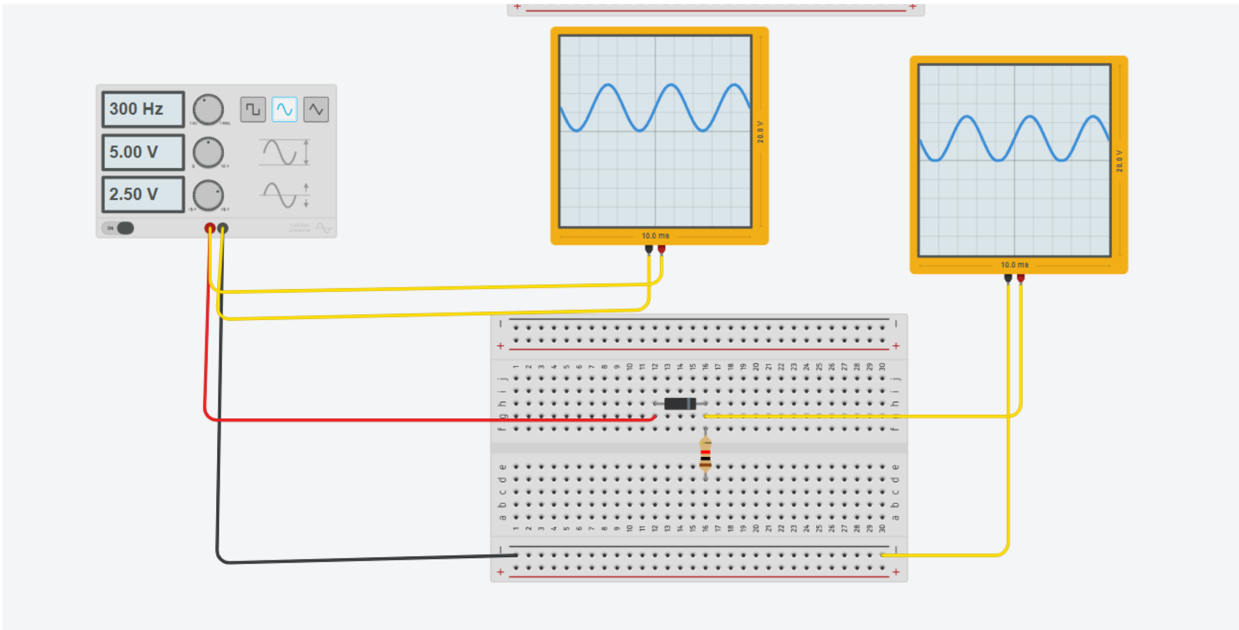
Half wave rectifier

- Make connections as shown in the figures for half wave rectifier circuits on breadboard.
- Apply an input signal of 1 KHz and 20 V, using function generator & check the input on CRO.
- Connect CRO probes to output and observe the output waveform.

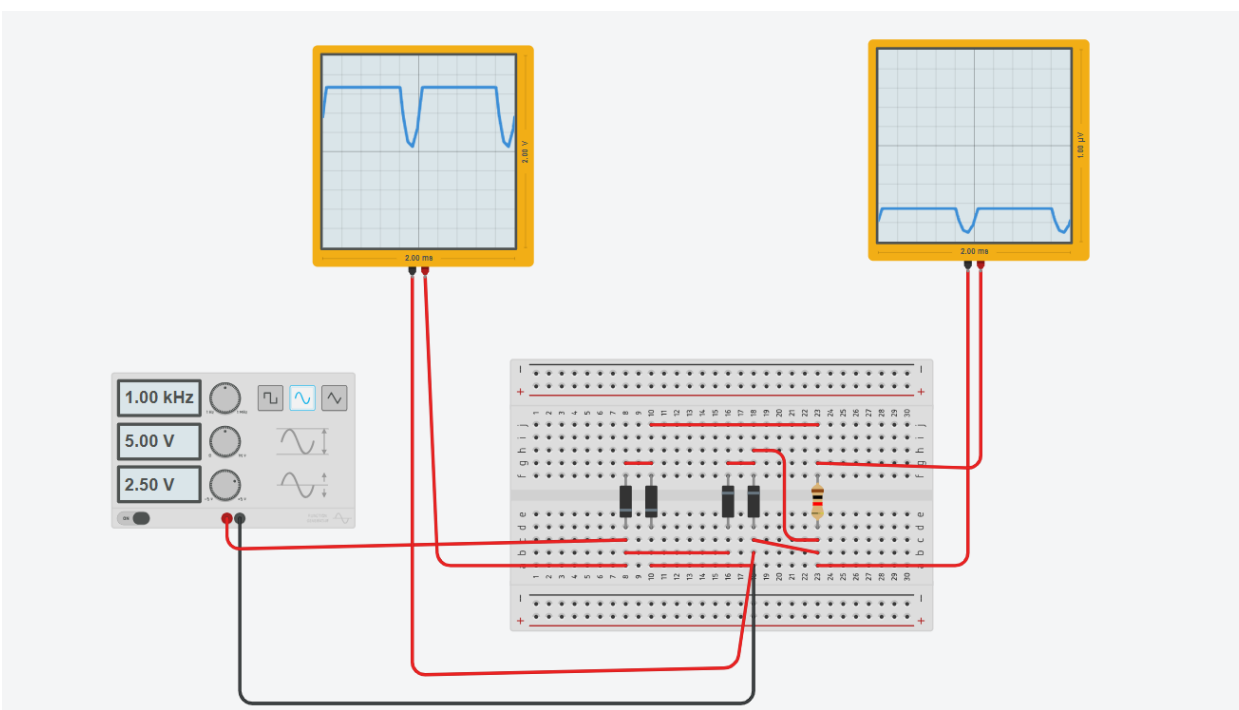
Full wave rectifier

- Make connections as shown in the figures for A full wave rectifier circuits on the bread board.
- Apply on input signal of 1 KHz & 20 V using function generator & check the input on CRO.
- Connect CRO probes to output and observe the output waveform.

Tinkercad Circuit Diagram: (halfwave-rectifier)



Tinkercad Circuit Diagram: (fullwave-rectifier)



Result

- Plot the input and Output waveforms of Half wave rectifier
- Plot the input and Output waveforms of Full wave rectifier

Procedure

- Before switch ON the power supply, make sure connections are proper
- Ensure all connections are tight.

Experiment-7

Aim:

Input-Output Characteristics of BJT (Common Emitter configuration) – Study transistor characteristics.

Requirement: Resistors, Multimeter, Power supply, Breadboard, Connecting wires, Transistor.

Theory:

In this configuration, we make the emitter terminal common to the input and output, the E-B junction is forward biased and the C-B junction is reverse biased. In CE configuration, I_B and V_{BE} are the input variables. The output variables are I_C and V_{CE}. The output current I_C, to the voltage between collector and emitter, V_{CE}, for various values of input current, I_B. A CE amplifier is one of three basic single-stage BJT amplifier topologies, typically used as a voltage amplifier. In this circuit the base terminal of the transistor serves as the input, the collector is the output, and the emitter is common to both, hence its name.

Circuit Diagram:

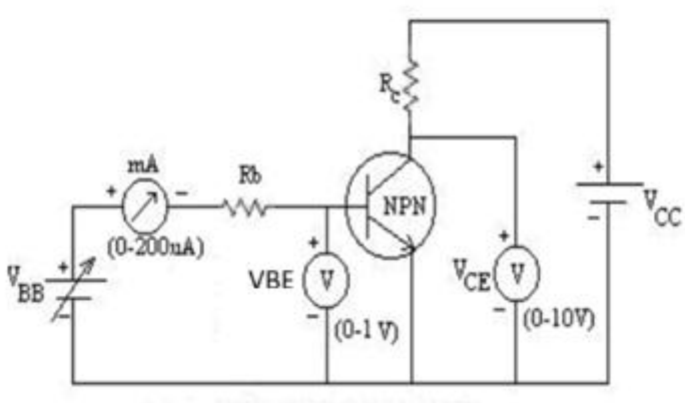


Fig: CE Circuit for Input Characteristics

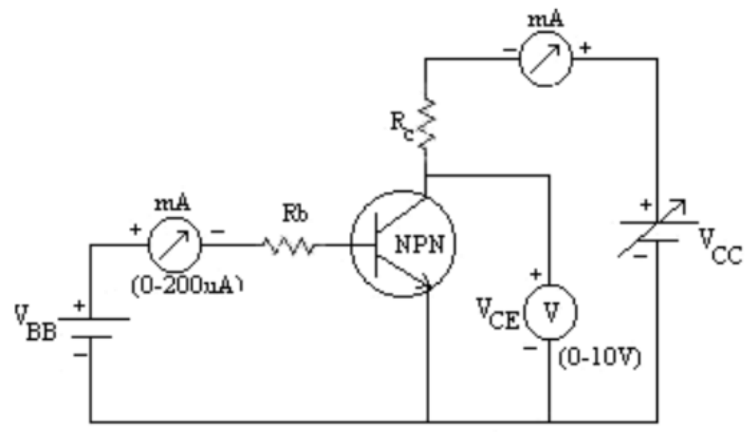
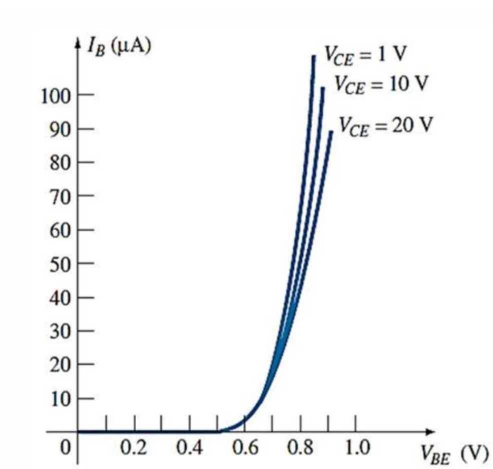


Fig: CE Circuit for Output Characteristics



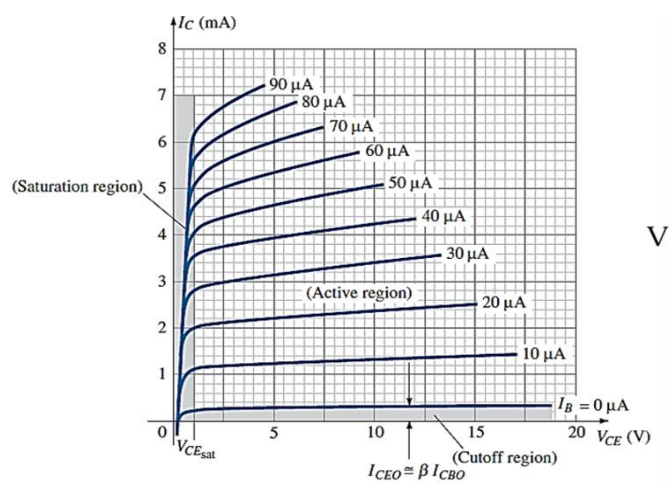


Fig: CE Input Characteristics

Fig: CE Output Characteristics

Procedure:

(A) Input characteristics of transistor in common emitter mode:

1. Make connections as shown in figure for n-p-n transistor.

2. Apply a constant dc voltage between collector and emitter V_{CE}.

3. Vary input voltage VBE in steps of 0.1V and note down corresponding V_{BE} and I_B readings.

4. Repeat above steps, by keeping different constant voltage V_{CE}.

5. Plot the graph of I_B v/s V_{BE} for different constant V_{CE}.

(B) Output Characteristics of Transistor in Common Emitter Mode:

1. Make connections as shown in figure for n-p-n transistor

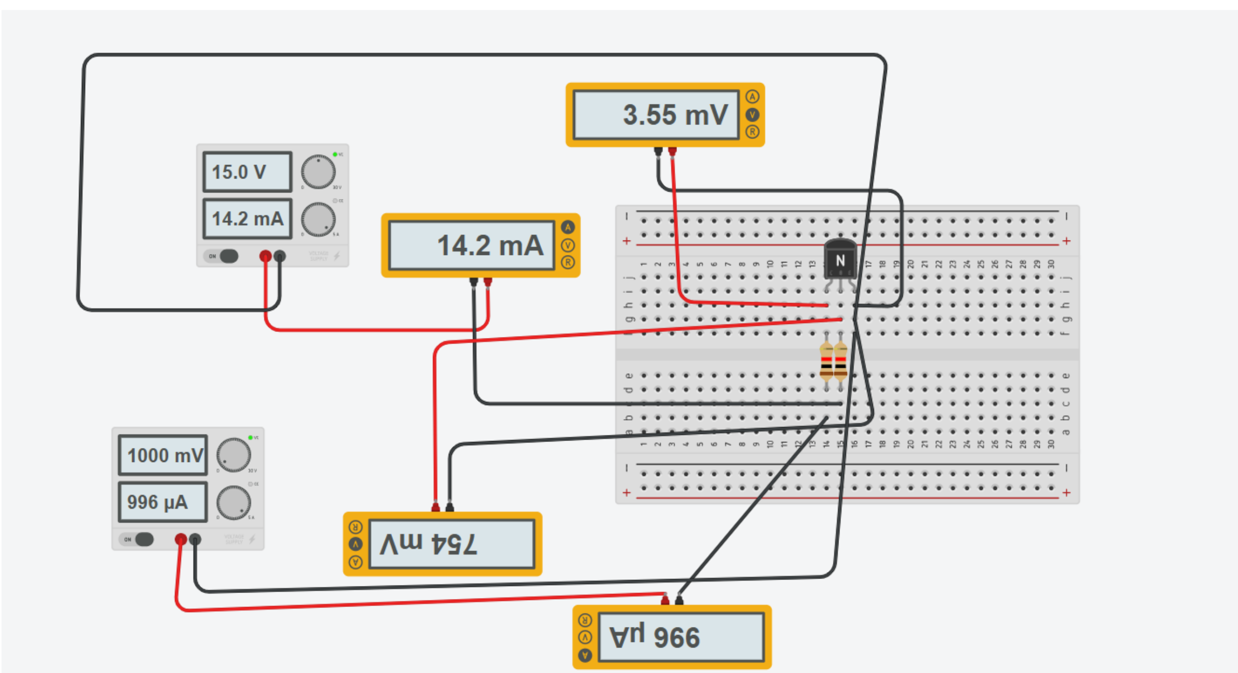
2. Apply a constant input current IB for the first set of readings.

3. Vary output voltage V_{CE} in steps of 1V and note down corresponding V_{CE} and I_C readings.

4. Repeat above steps, by keeping base current I_B constant to different values.

5. Plot the graph of I_C v/s V_{CE} for different constant I_B.

Tinkercad Circuit Diagram:



Observation Table:

(A) Input characteristics

S.no	V_{bb}	V_{cc}	V_{ce}	I_{be}	V_{be}
1	3V	1V	4.68mV	2.29mA	708mV
2	10V	1V	3.67mV	9.26mA	743mV
3	15V	1V	3.55mV	14.2mA	754mV
4	17V	1V	3.52mV	16.2mA	757mV
5	19V	1V	3.50mV	18.2mA	760mV

(B) Output characteristics

S.no	V_{bb}	V_{cc}	V_{ce}	I_{be}	V_{be}
1	1V	5V	32mV	317μA	683mV
2	1V	10V	47.5mV	304 μA	696 mV
3	1V	15V	58.6mV	296 μA	704 mV
4	1V	17V	62.4mV	293 μA	707 mV
5	1V	20V	67.7mV	289 μA	711 mV

Result:

Plot a graph between voltage and current readings for:

(a) Input Characteristics CE transistor (I_B v/s V_{BE}).

(b) Output Characteristics CE transistor (I_C v/s V_{CE}).

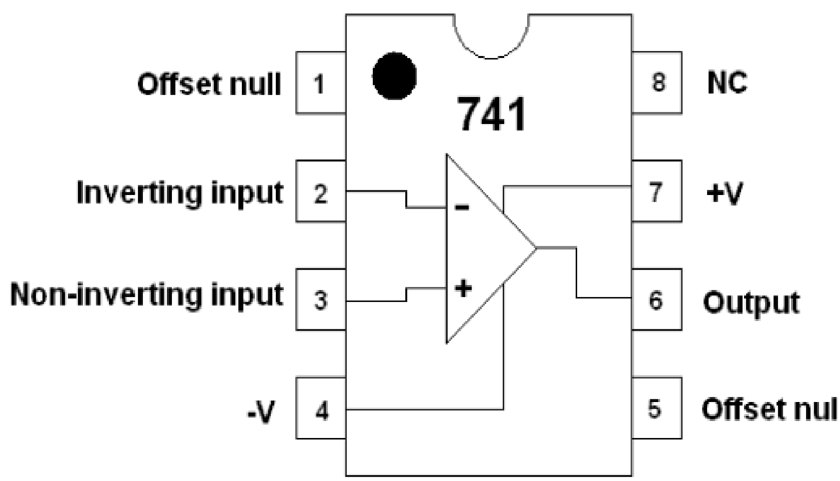
Experiment-8

Aim: To design and verify the operation of a **Non-Inverting Amplifier** using a 741 operational amplifier and calculate its voltage gain.

Apparatus Required: Op-amp IC 741, Dual DC power supply (±12V), Resistors, Function generator, Breadboard, Connecting wires, Multimeter, CRO.

Theory:

IC 741 Pin Configuration:

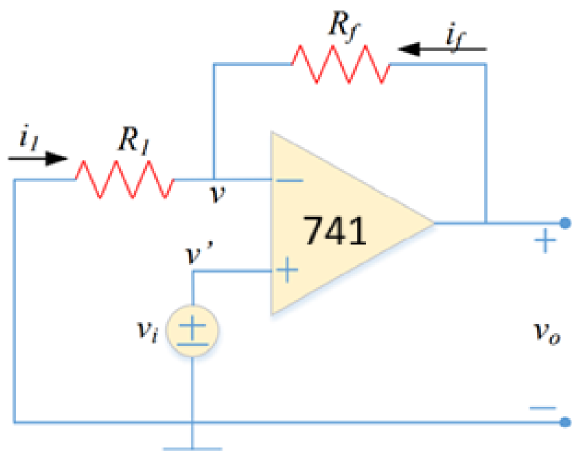


S. No	Pin Name	Description
1	Offset Null	Used for adjusting the offset voltage.
2	Inverting Input (-)	Input terminal where the signal is inverted.
3	Non-Inverting Input (+)	Input terminal where the signal is not inverted.
4	Negative Voltage Supply (V-)	Provides negative voltage supply (VCC).
5	Offset Null	Used for adjusting the offset voltage.
6	Output	Output terminal for the voltage.
7	Positive Voltage Supply (+VCC)	Provides positive voltage supply.
8	Not Connected (NC)	This pin has no connection.

Non- Inverting Amplifier:

A non-inverting amplifier provides a positive voltage gain without phase reversal between input and output.

Circuit Diagram:



Voltage Gain

$$A_v = 1 + \frac{R_f}{R_1}$$

R1 is resistor connected from inverting input to ground

Rf is feedback resistor from output to inverting input

Procedure:

1. Connect the circuit as per the circuit diagram on a breadboard.
2. Connect resistances (R_1 = 1Kohm & R_f = 10 Kohm)
3. Apply a small input signal (e.g., 1 V peak-to-peak sine wave at 1 kHz).
4. Power the op-amp with ±12V supply.
5. Observe the output waveform on CRO.
6. Measure the V_{in} and V_{out} using CRO.

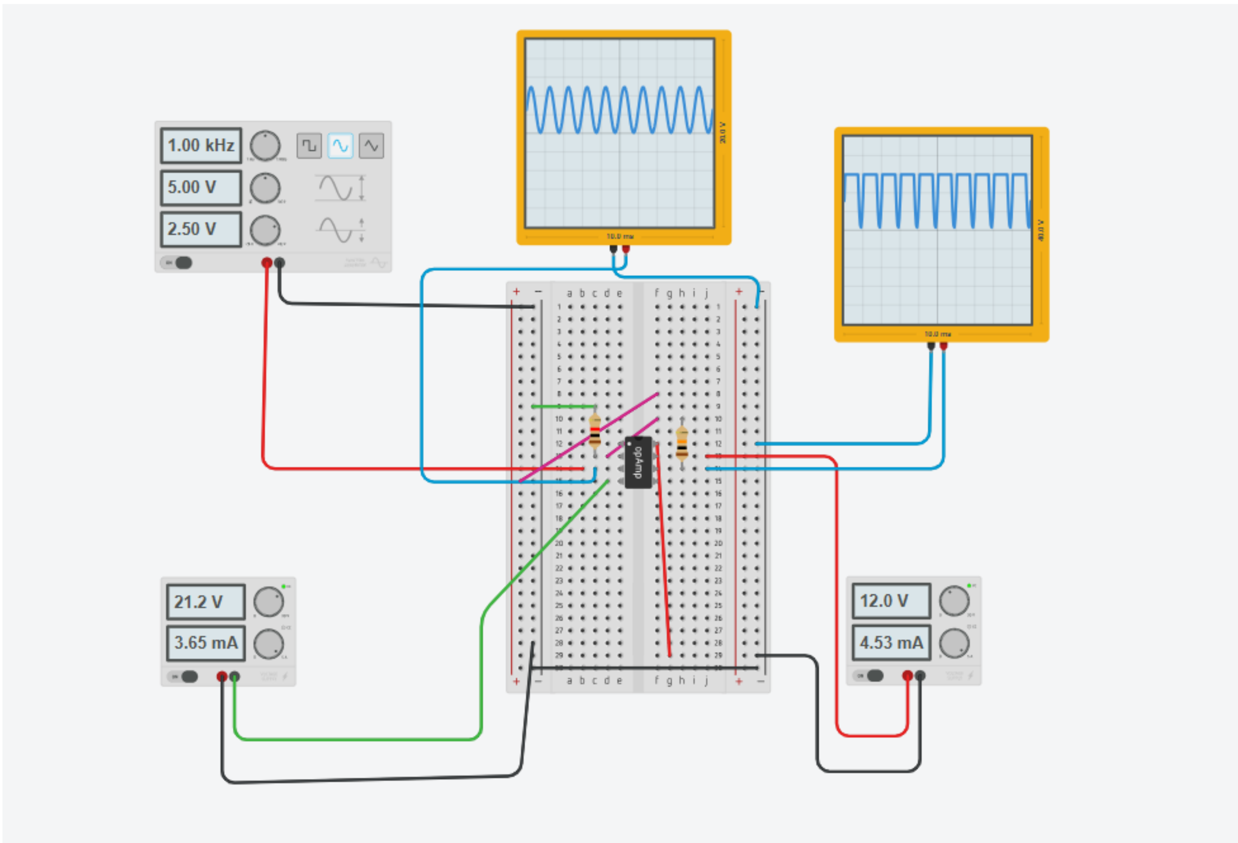
7. Calculate practical gain:

$$A_v(exp) = \frac{V_{out}}{V_{in}}$$

8. Verify the results with the theoretical gain.

$$A_v = 1 + \frac{R_f}{R_1}$$

Tinkercad Circuit Diagram:



Observation Table:

S. No	Vin	Vout	Practical Gain $A_v = (V_{out} / V_{in})$
1	0.1	1.095	10.95
2	0.5	5.450	10.90

Result:

The non-inverting amplifier was successfully designed and implemented using a 741 op-amp. The observed gain closely matches the theoretical gain.