Aim ↬ To plot the VI characteristics of an LED and analyze its behavior in forward and reverse bias conditions.

Equipment Required ↬

Power supply, LED, Resistor, Ammeter, Voltmeter, Breadboard, Connecting wires.

Theory ↬

An LED (Light Emitting Diode) is a semiconductor device that emits light when forward-biased, consisting of a p-n junction where the p-side is rich in holes and the n-side in electrons. When a forward voltage is applied, electrons move from the n-side to the p-side, and holes move in the opposite direction, allowing current flow through the junction.

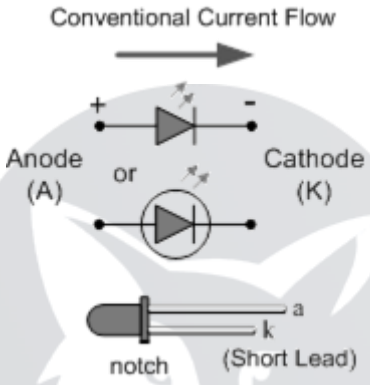

Fig. i) LED representations

Light is emitted when electrons recombine with holes on the p-side, releasing energy as photons through a process called electroluminescence. This light emission depends on the material used and the efficiency of the charge carrier recombination, which also affects the forward voltage drop across the LED, typically between 1.8V to 3.5V.

The color of the LED is determined by the energy bandgap of the semiconductor material, which dictates the wavelength of the emitted light. Different materials like Gallium Phosphide (GaP) for red/green LEDs and Gallium Nitride (GaN) for blue LEDs have specific bandgaps, allowing LEDs to emit a wide range of colors by adjusting material composition and doping.

LEDs efficiently convert electrical energy into light without generating much heat, unlike traditional bulbs. In forward bias, the LED conducts after reaching the threshold voltage, increasing current and light output. In reverse bias, it blocks current, but excessive reverse voltage can damage the LED, highlighting the importance of controlled operation.

Circuit Diagram ↬

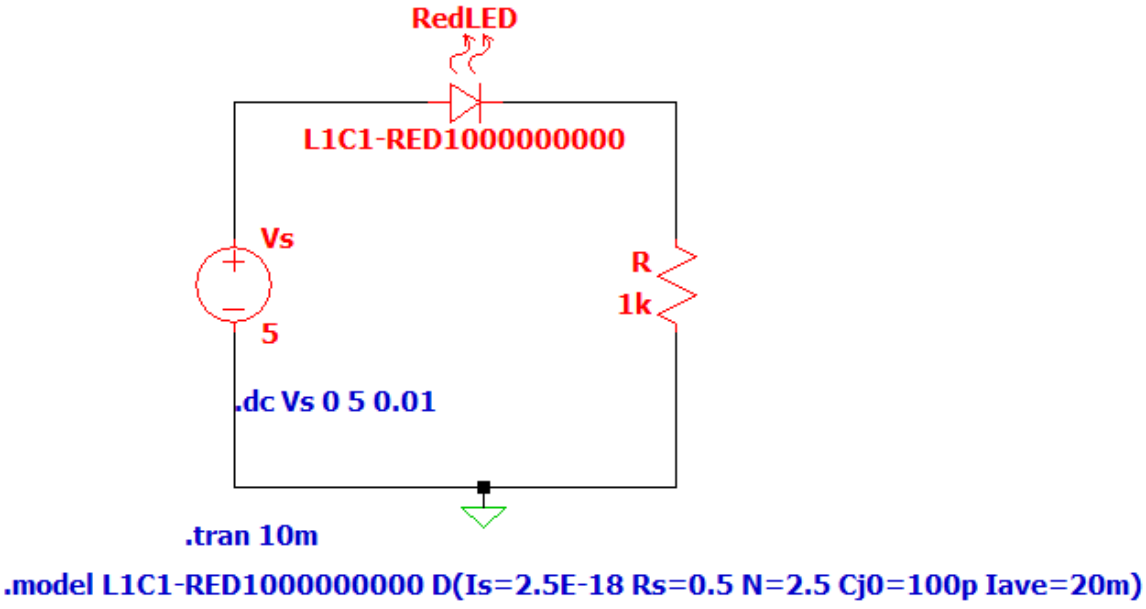

Fig. ii) Circuit in LTSpice

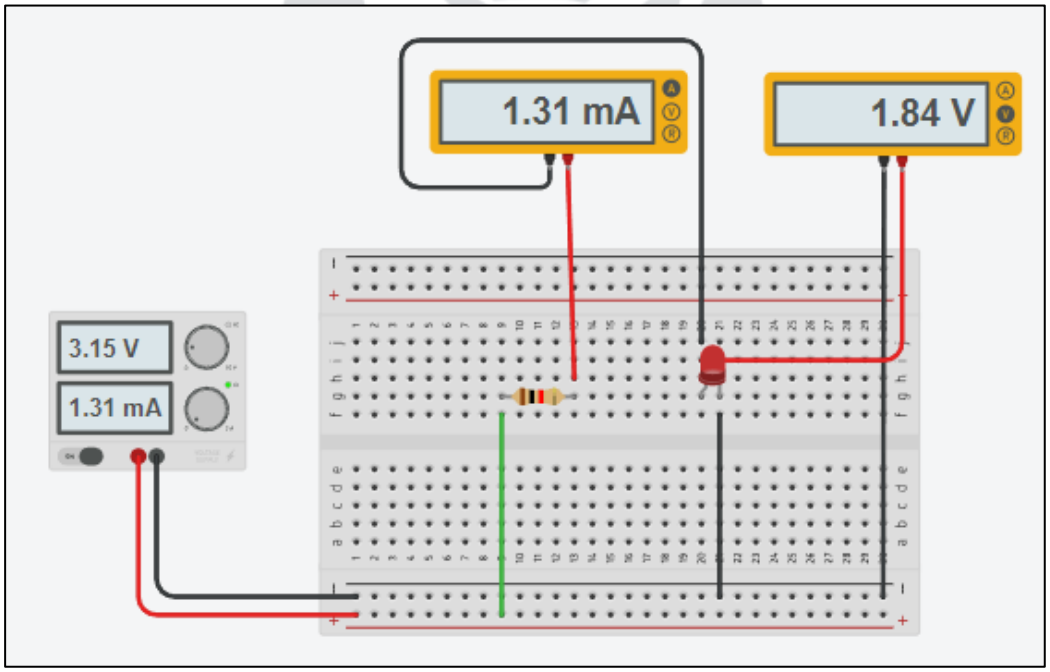

Fig. ii) Circuit in TinkerCad

Observation Table ↬

- Forward Bias ↪

S.No.	Supply Voltage Vs(V)	Output Voltage V_D(V)	Output Current I_D(μA)
1	0	0	0
2	1.5	0	0
3	1.7	0.002	0.6
4	1.8	0.003	2.93
5	2.0	0.038	37.75
6	2.2	0.15	149
7	2.5	0.38	387
8	2.7	0.56	563
9	3.0	0.84	837
10	3.5	1.30	1308
11	4.0	1.79	1787
12	4.5	2.27	2272
13	5.0	2.76	2760

- Reverse Bias ↪

S.No.	Supply Voltage Vs(V)	Output Voltage V_D(nV)	Output Current I_D(pA)
1	0	0	0
2	0.2	0.2	0
3	0.5	0.5	0
4	0.7	0.7	0
5	1	1	0
6	1.5	1.5	0
7	2	2	0
8	3	3	0
9	4	4	0
10	5	5	0

Graphs ↬

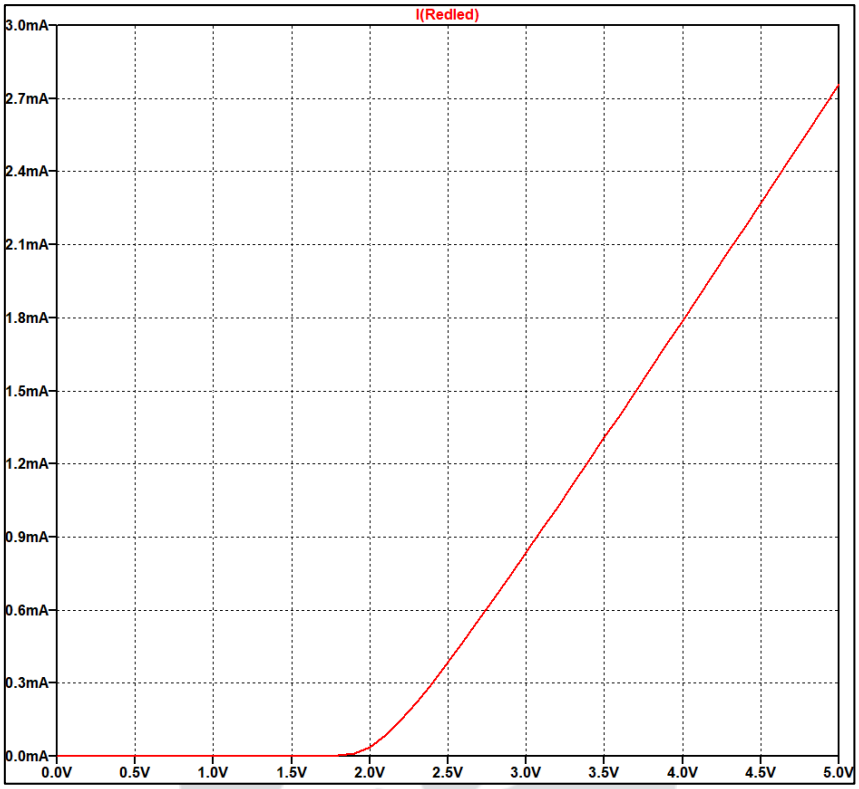

Fig. iii) Forward Bias

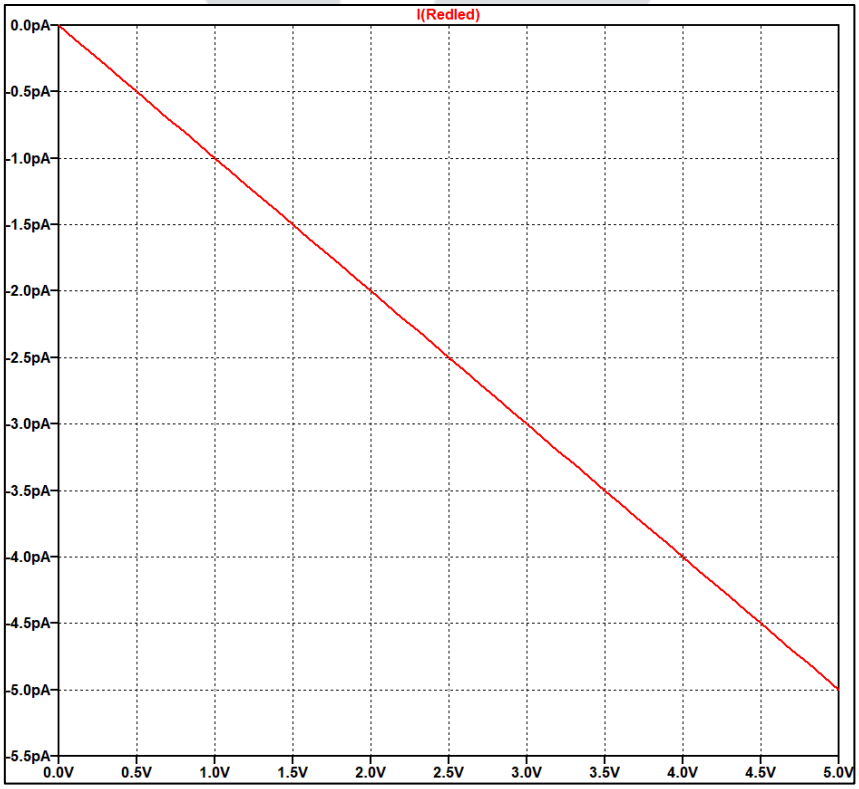

Fig. iv) Reverse Bias

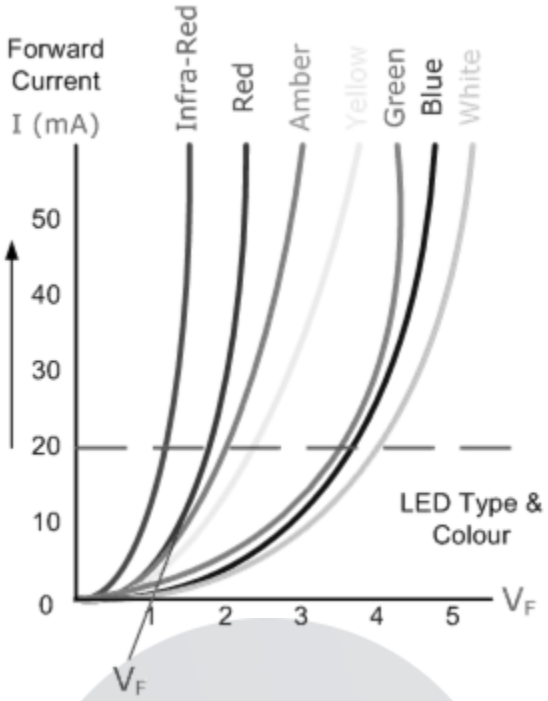

Fig. v) Ideal Characteristic Curve

Result ↬

The VI characteristics of the LED demonstrate that it conducts significantly in forward bias after the threshold voltage is reached, emitting light, while in reverse bias, it blocks current, preventing conduction. The observed forward voltage drop and reverse leakage current are within typical ranges for standard LEDs.

Conclusion ↬

Successfully performed the experiment and observed the LED's behavior in forward and reverse bias, validating its VI characteristics through practical measurements.

Precautions ↬

- Ensure the polarity of the LED is correct before applying voltage.
- Do not exceed the recommended forward current rating to prevent damage to the LED.
- Avoid reverse bias voltages near or exceeding the breakdown voltage to protect the LED.
- Use appropriate resistors to limit the current in both forward and reverse bias tests.