Aim ↬ Study of Characteristics of Light Emitting Diode (LED) in Forward bias & Reverse bias.

Equipment Required ↬

Diode characteristics trainer kit, patch cords, power supply, etc.

Theory ↬

An LED, or Light Emitting Diode, is a semiconductor device that emits light when forward-biased. It consists 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 from the n-side move toward the p-side, and holes move in the opposite direction, allowing current to flow through the junction. This recombination of electrons and holes on the p-side releases energy in the form of photons, a process known as electroluminescence, which results in light emission.

The emitted light's wavelength, and consequently its color, is determined by the energy bandgap of the semiconductor material used in the LED. Different materials such as Gallium Phosphide (GaP) for red or green LEDs and Gallium Nitride (GaN) for blue LEDs have specific bandgaps. By adjusting the material composition and doping, LEDs can emit a variety of colors. The forward voltage required for an LED to emit light typically ranges from 1.8V to 3.5V, depending on the material and color of the LED.

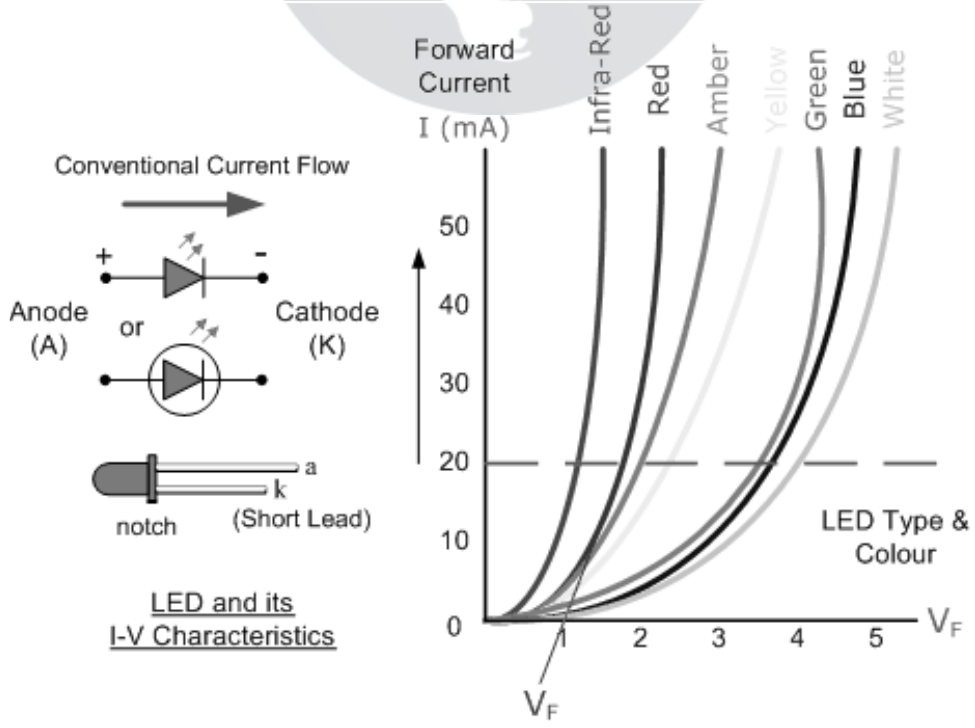

Fig. i) I-V characteristics of LED with various colors

In forward bias, once the threshold voltage is reached, the LED begins to conduct, and the intensity of light emitted increases with the current. LEDs efficiently convert electrical energy into light, producing minimal heat compared to traditional bulbs. However, when reverse-biased, the LED blocks current flow, acting like a regular diode. Exceeding the reverse breakdown voltage can damage the LED, highlighting the importance of maintaining proper voltage and current conditions during operation.

To ensure safe operation, a current-limiting resistor is often added to LED circuits to prevent excessive current flow. This is crucial because LEDs are sensitive to overcurrent, which can lead to overheating and permanent damage. As the forward current increases, the brightness of the LED also increases, but staying within the manufacturer's recommended current limits is vital to avoid reduced efficiency and longevity of the LED.

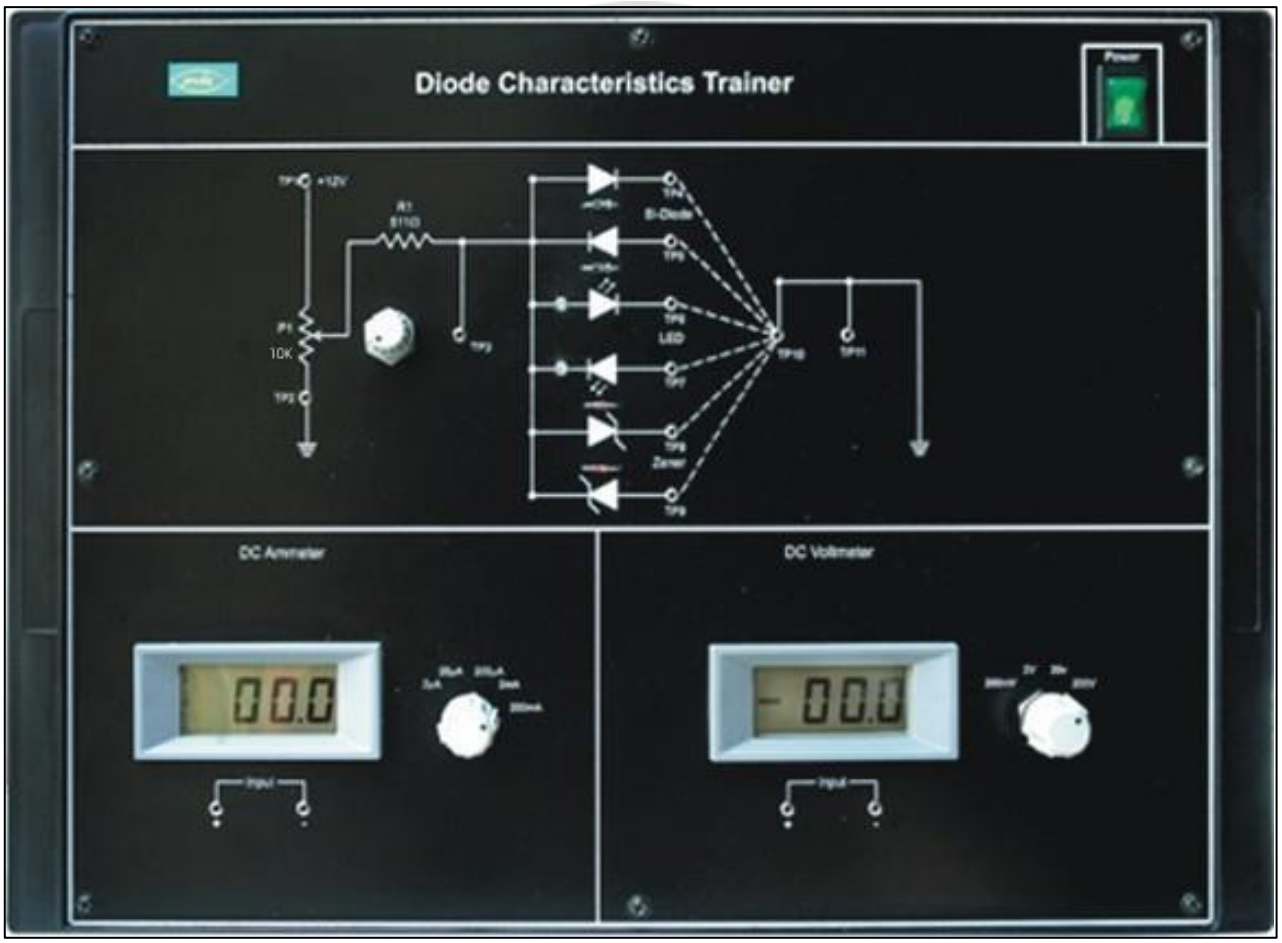

Fig. ii) Diode Characteristics Trainer Kit

Procedure ↬

To plot Forward Characteristics proceed as follows

1. Rotate potentiometer P1 fully in CCW (counterclockwise direction).
2. Connect the Ammeter between TP6 and TP10 to measure the diode current ID (mA) & set the Ammeter at the 2mA / 200mA range.
3. Connect Voltmeter across TP3 and TP11, to measure diode voltage V_D & set Voltmeter at 20V range.
4. Switch 'On' the power supply.
5. Vary the potentiometer P1 so as to increase the value of LED voltage V_D from zero to maximum in steps and measure the corresponding values of LED current I_D.
6. Plot a curve between diode voltage V_D and diode current I_D. This curve is the required Forward Characteristic of a light-emitting diode.
7. Switch 'Off' the supply.

To plot Reverse Characteristics proceed as follows

1. Rotate potentiometer P1 fully in CCW (counter clockwise direction).
2. Connect the Ammeter between TP7 and TP10 to measure the diode current I_D (mA).
3. Connect Voltmeter across TP3 and TP11, to measure diode voltage V_D.
4. Switch 'On' the power supply.
5. Vary the potentiometer P1 so as to increase the value of diode voltage V_D from zero to maximum in steps and measure the corresponding values of diode current I_D.
6. Plot a curve between diode voltage V_D and diode current I_D. This curve is the required Reverse Characteristics of Light Emitting Diode.
7. Switch 'Off' the supply.

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 ↬

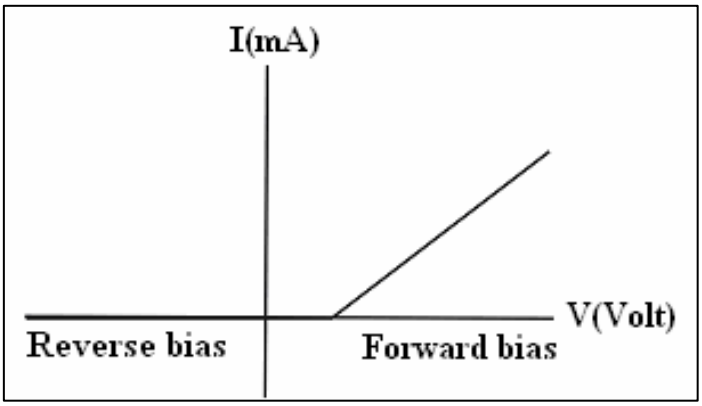

Fig. v) I-V characteristics of LED

Result ↬

The experiment successfully demonstrated the forward and reverse characteristics of the LED. In forward bias, the LED emitted light as current increased with voltage, while in reverse bias, no significant current was observed.

Conclusion ↬

The characteristics of the LED were as expected, with light emission in forward bias and current blockage in reverse bias. This experiment highlighted the role of LEDs in applications such as indicators and signal displays, emphasizing the need for controlled current and voltage conditions.

Precautions ↬

- Ensure all connections are properly secured before powering the circuit.
- Avoid exceeding the LED's voltage and current ratings.
- Verify the polarity of the LED before powering on the circuit.
- Double-check measurement instrument settings for accurate readings.