Laboratory Report

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Study Level: UG/PG	UG	**Year &Term:** I
Subject Name	Engineering Physics – 1	**Location:** A101
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Name of the experiment	Light emitting diode	
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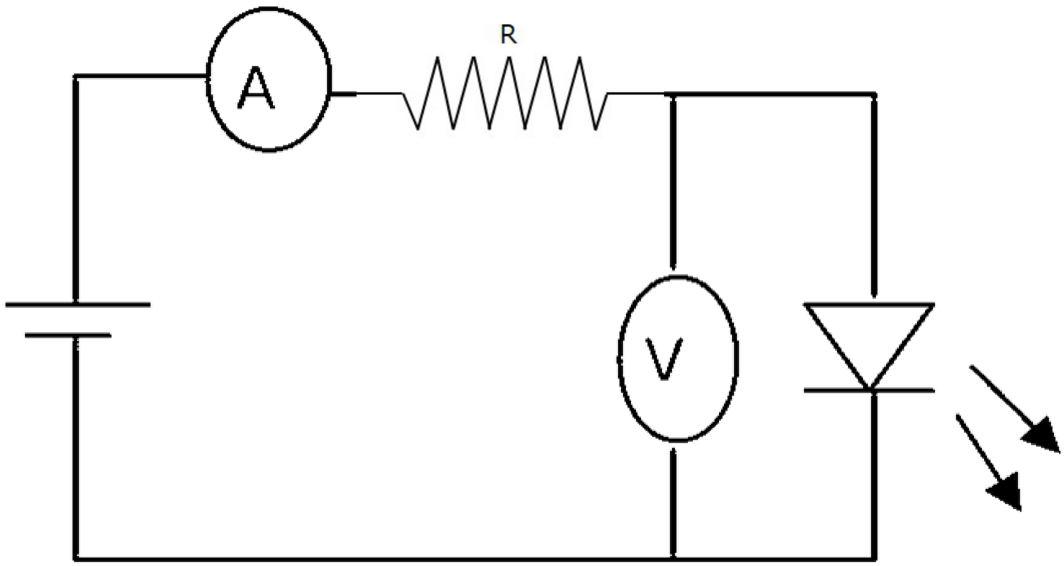
Objective:
To study the V-I characteristics of Light emitting diode under forward bias condition and determine its threshold voltage.

Experimental Setup:

Apparatus: Light emitting diode, Resistor, Power supply, Voltmeter and ammeter

Circuit Diagram:



Note: Connect the circuit in the kit as per the circuit diagram given above.
Take a picture of it and paste it below.

Procedure:

1. The main component of the apparatus is the circuit board containing LEDs, each with a different emission wavelength. A particular LED is connected to the circuit as shown in the figure.
2. The voltage is varied with the help of power supply which is externally connected.
3. Turn the power supply on and very slowly increase the voltage until the LED just starts to glow.
4. Continuously monitor the current as function of voltage across the LED.
5. Plot the graph ·with voltage on X-axis and current on Y-axis, which gives the current voltage characteristics of LED.
6. The graph is as shown in figure indicating the exponential nature of the current voltage relationship. The threshold voltage (V0) is the voltage when the current reaches 0.01 mA. Extrapolate I-V curves to where they cross 0.01 mA current and that is the working value of Vo.

Results and Observations:

For Red,

S.NO	V(mv)	I(mA)
1.	0.25	0
2.	0.75	0
3.	1.0	0
4.	1.5	0
5.	1.67	0.1
6.	1.74	0.2
7.	1.77	0.3
8.	1.82	0.4
9.	1.87	0.5
10.	1.90	0.6
11.	1.93	0.7
12.	1.99	0.8
13.	2.03	0.9
14.	2.06	1.0

For Green,

S.NO	V(mv)	I(mA)
1.	0.25	0
2.	0.75	0
3.	1.0	0
4.	1.5	0
5.	1.78	0.1
6.	1.85	0.2
7.	1.88	0.3
8.	1.92	0.4
9.	1.95	0.5
10.	1.99	0.6
11.	2.04	0.7
12.	2.06	0.8
13.	2.10	0.9
14.	2.20	1.2

For Yellow,

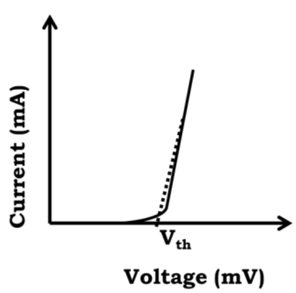
S.NO	V(mv)	I(mA)
1.	0.25	0
2.	0.75	0
3.	1.0	0
4.	1.5	0
5.	1.78	0.1
6.	1.79	0.2
7.	1.84	0.3
8.	1.89	0.4
9.	1.95	0.5
10.	1.99	0.6
11.	2.00	0.7
12.	2.05	0.8
13.	2.10	0.9
14.	2.19	1.2

For Laser Diode Characteristics,

S.NO	V(mv)	I(mA)
1.	0.25	0

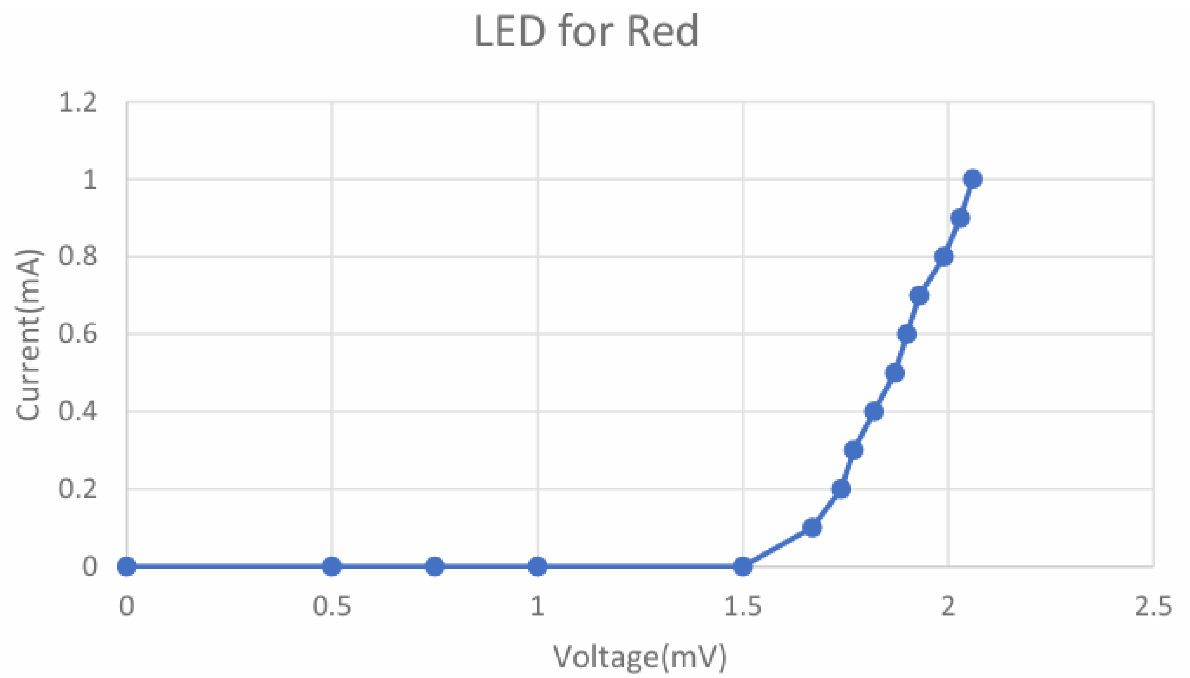
2.	**0.50**	**0**
3.	**0.6**	**0**
4.	**0.64**	**0.1**
5.	**1.78**	**0.2**
6.	**1.21**	**0.3**
7.	**1.81**	**0.4**
8.	**1.84**	**0.5**
9.	**1.87**	**0.6**
10.	**1.89**	**0.7**
11.	**1.90**	**0.8**
12.	**1.91**	**0.9**
13.	**1.93**	**1.0**

Expected Graph:

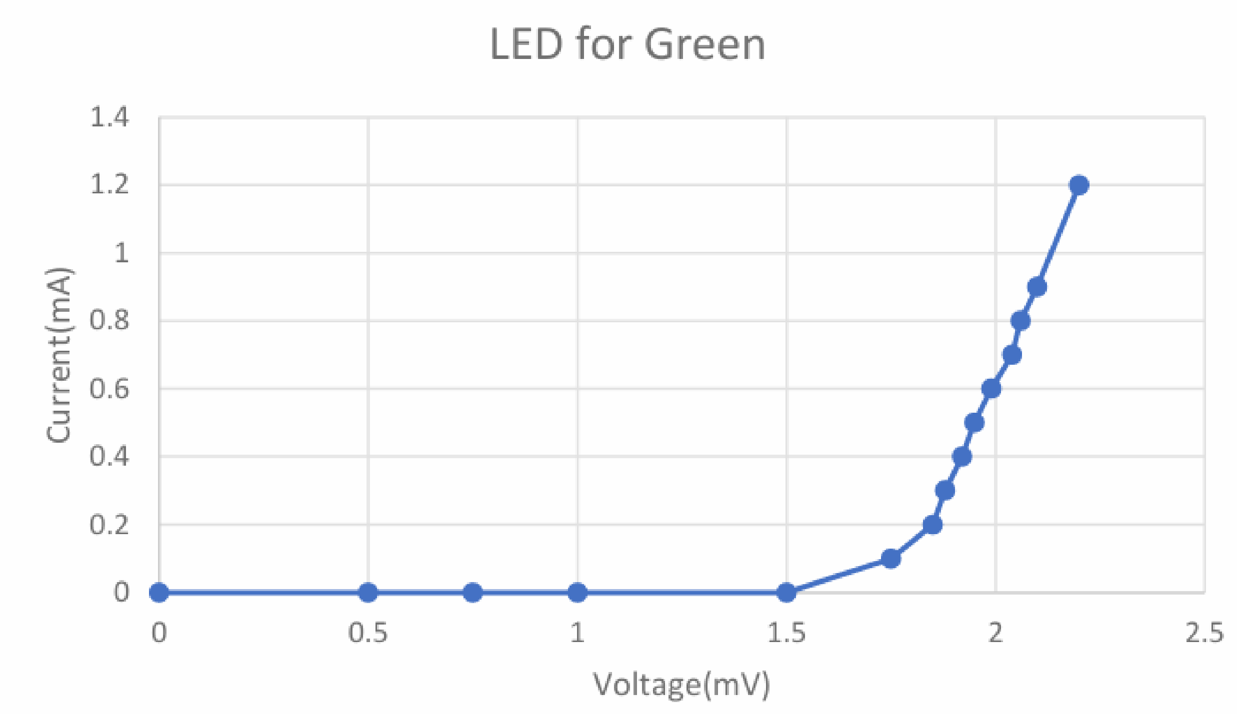


Note: Paste your graph here after calculations

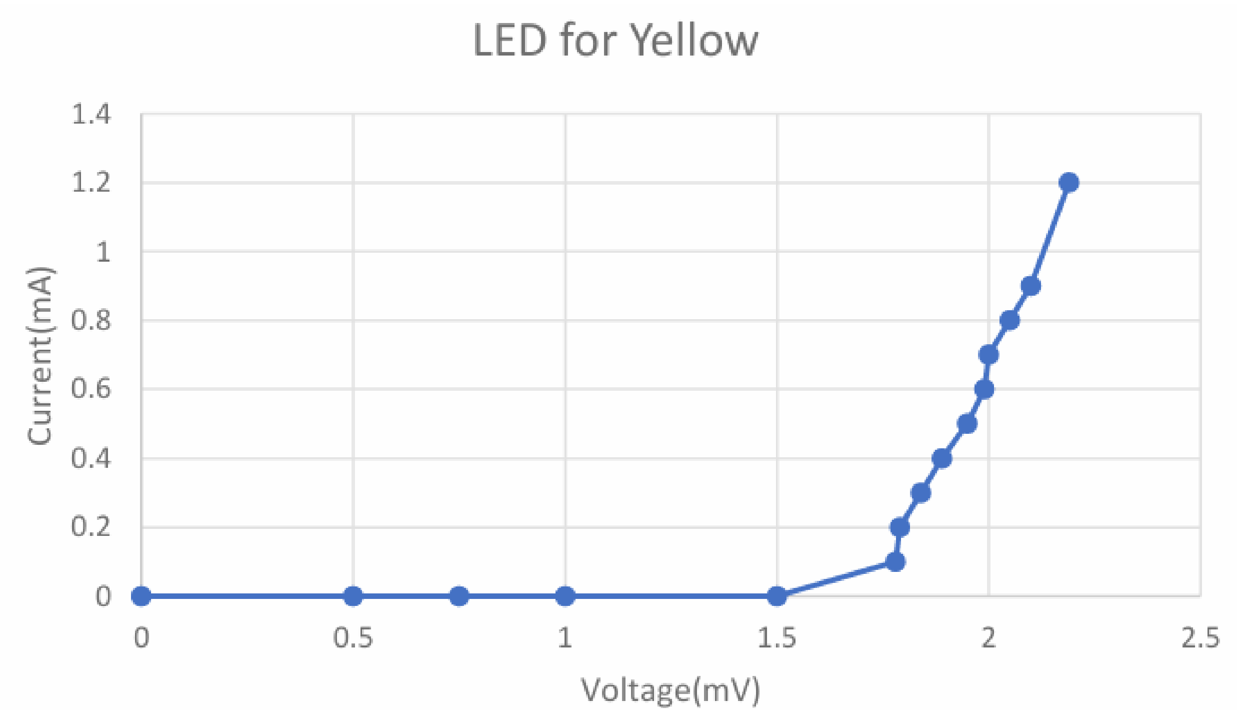
For Red,



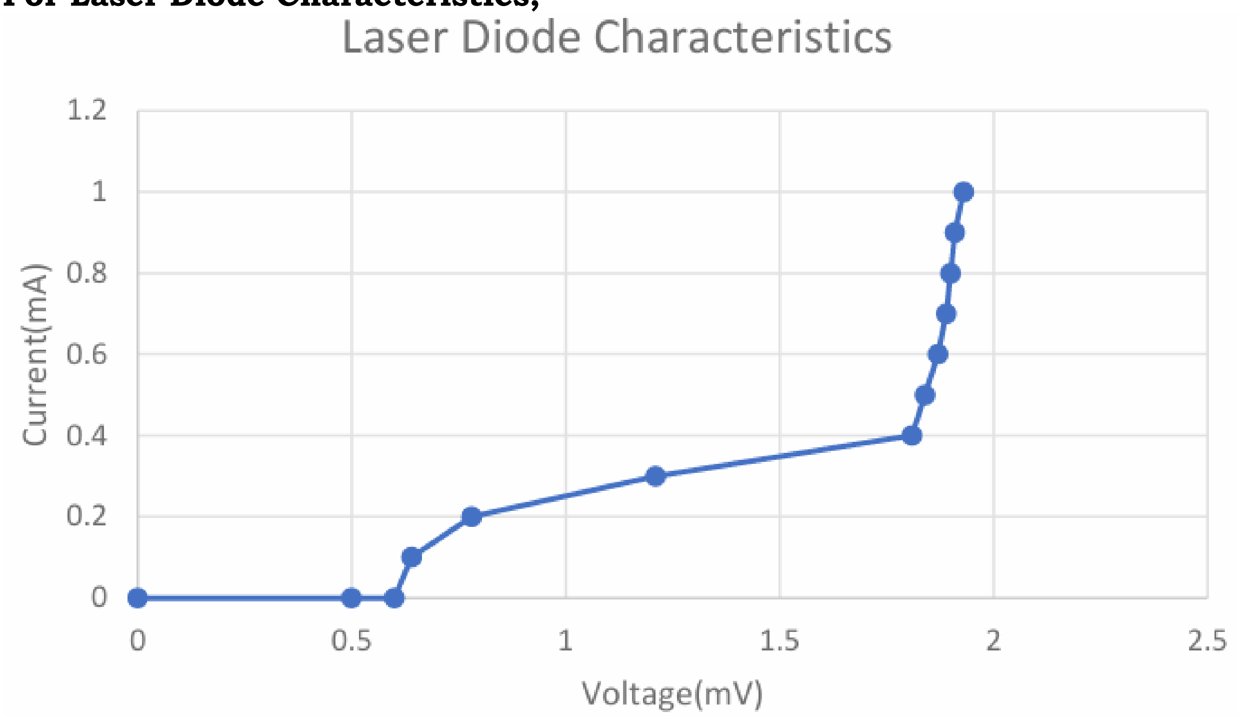
For Green,



For Yellow,



For Laser Diode Characteristics,



Discussion:

LED Operation:
1 1.5 Voltage(mV) 2 2.5
➢ LEDs are semiconductor devices that emit light when an electric current is passed through them.
➢ They rely on the principle of electroluminescence, where electrons and holes recombine within the semiconductor material, releasing energy in the form of photons.
➢ The colour of the emitted light depends on the bandgap energy of the semiconductor material.
LED Characteristics:
Forward Bias:
➢ LEDs exhibit a characteristic forward voltage drop (Vf) before significant current flows.
➢ Beyond Vf, the current increases rapidly with a small increase in voltage.
Reverse Bias:
➢ LEDs have a high reverse breakdown voltage, making them suitable for various applications.

Conclusion:

The Light Emitting Diode (LED) stands as a brilliant example of how innovative semiconductor technology can transform our world. LEDs are renowned for th eir efficiency, longevity, and versatility, making them essential components in a myriad of applicationsfrom simple indicator lights to sophisticated display sy stems and energy-efficient lighting solutions.
By leveraging the principles of electroluminescence, LEDs convert electrical en ergy directly into light, offering significant advantages over traditional incandes cent and fluorescent lighting. Their development has paved the way for advanc ements in technology, environmental sustainability, and even healthcare, with applications in medical devices and plant growth.

Result: The I-V characteristic of a given LED is studied and threshold value of voltage is

For Red, Threshold Voltage is 1.67 mV.

For Green, Threshold Voltage is 1.75 mV.

For Yellow, Threshold Voltage is 1.78 mV.

For Laser Diode Characteristics, Threshold Voltage is 0.64 mV.

Viva Questions

1. **What is the working Principle of LED?**
   ANS:
   An LED operates on the principle of electroluminescence, where a materi al emits light in response to an electric current passing through it. Here' s how it works:

1. Semiconductor Material: LEDs are made from semiconductor materials, t ypically gallium arsenide (GaAs) or gallium nitride (GaN).
2. PN Junction: They have a PN junction, similar to regular diodes, with p-type and n-type materials.
3. Forward Bias: When a forward voltage is applied, electrons from the n-type material recombine with holes in the p-type material.
4. Energy Release: During recombination, energy is released in the form of photons (light).

5. Wavelength/Color: The energy released, and thus the color of the emitted light, depends on the semiconductor material's energy gap.
   The efficiency and color of LEDs make them essential in various applications, from indicator lights to advanced displays and general lighting.

2. Do all Diodes emit light during their conduction? Why? Explain.
ANS:

No, not all diodes emit light during their conduction.
Explanation:

1. **Types of Diodes**:
   - **Standard PN Junction Diodes**: These are designed primarily for allowing current to flow in one direction and blocking it in the reverse. They do not emit visible light during conduction because the energy released during electron-hole recombination is not in the form of visible photons but rather heat or infrared light.
   - **Light Emitting Diodes (LEDs)**: These are specifically designed to emit light when an electric current passes through them. The semiconductor material and the construction of LEDs are optimized so that electron-hole recombination releases energy in the form of visible photons.
2. **Energy Band Gap**:
   - **PN Junction Diodes**: The materials used in standard diodes have energy band gaps that result in the emission of non-visible light (infrared) or generate heat.
   - **LEDs**: The semiconductor materials used in LEDs have band gaps specifically engineered to emit light in the visible spectrum.
3. **Construction and Material**:

- **Standard Diodes**: Typically made from silicon or germanium, which are not optimized for light emission.
- **LEDs**: Made from compound semiconductor materials like gallium arsenide (GaAs), gallium phosphide (GaP), and gallium nitride (GaN), which are selected for their ability to emit visible light.

In essence, the difference lies in the materials and design. Standard diodes focus on electrical characteristics, whereas LEDs are engineered for light emission, utilizing materials that convert electrical energy directly into visible photons.

3. Differentiate between Direct and Indirect band gap semiconductors.
ANS:

Direct Band Gap Semiconductors:

- **Electron Transition:** Electrons can directly recombine with holes, releasing energy in the form of photons (light).
- **Efficiency:** More efficient for light emission due to the direct transition, making them ideal for LEDs and laser diodes.
- **Examples:** Gallium arsenide (GaAs), gallium nitride (GaN).

Indirect Band Gap Semiconductors:

- **Electron Transition:** Electrons need to pass through an intermediate state (usually involving phonons) to recombine with holes, making the process less direct.
- **Efficiency:** Less efficient for light emission because energy is lost in the form of heat rather than light.
- **Examples:** Silicon (Si), germanium (Ge).

4. What are the advantages and disadvantages of LED?
ANS:

Advantages:

1. **Energy Efficiency:**
   - LEDs convert more electricity into light, consuming significantly less power compared to traditional incandescent and fluorescent lights.
2. **Longevity:**
   - LEDs have a long lifespan, often lasting tens of thousands of hours, which reduces the need for frequent replacements.
3. **Durability:**
   - LEDs are solid-state devices, making them more resistant to shock, vibration, and external impacts.
4. **Instant On:**
   - LEDs light up instantly without any warm-up time, providing immediate full brightness.
5. **Environmental Benefits:**
   - They contain no harmful substances like mercury and are fully recyclable, making them environmentally friendly.
6. **Versatility:**
   - Available in a variety of colors and sizes, LEDs can be used in a wide range of applications, from indicator lights to large-scale displays.

Disadvantages:

1. **Initial Cost:**
   - The upfront cost of LEDs is higher compared to traditional lighting solutions, although this is offset by their longer lifespan and energy savings.
2. **Temperature Sensitivity:**
   - LEDs can be sensitive to high temperatures, which may affect their performance and lifespan if not properly managed.
3. **Directional Lighting:**

- LEDs emit light in a specific direction, which can be advantageous for focused lighting but may require additional fixtures for ambien t lighting.

4. **Voltage Sensitivity:**
    - LEDs require a consistent current and voltage to operate efficiently , necessitating appropriate drivers or circuits.
5. **Potential for Light Pollution:**
    - Bright, improperly shielded LED lights can contribute to light pollu tion, affecting night-time environments and wildlife.

Understanding these pros and cons helps in making informed decisions abo ut where and how to use LEDs most effectively. They're clearly a step forwar d in lighting technology but come with their own set of considerations.