SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution
Coimbatore-35

Department of Artificial Intelligence and Data Science

23EET103 Electric Circuits and Electron Devices

I B.TECH CSE-IOT/ II SEMESTER

UNIT IV : ELECTRONIC DEVICES AND APPLICATIONS

Topic : -LED, LCD,OLED & QLED

Dr INDU NAIR. V
ASP/AIDS

Let's Recall!!

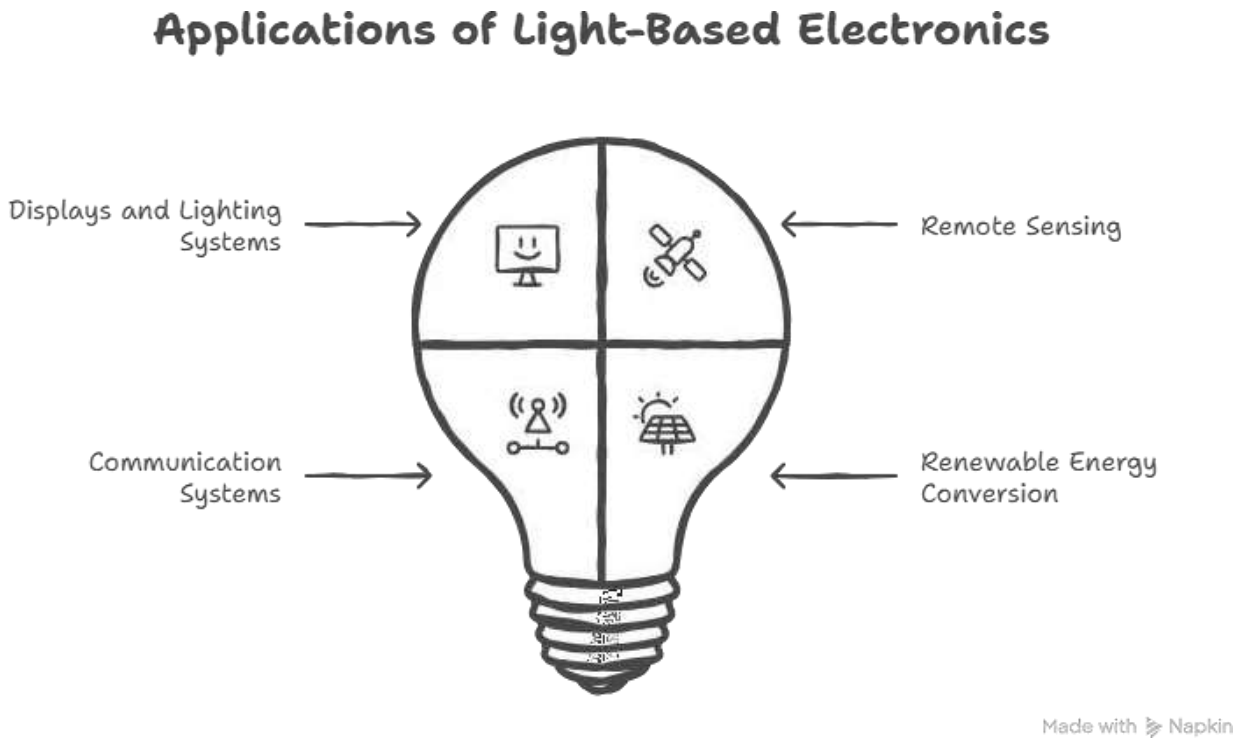
- Optoelectronic devices convert **electrical energy ↔ light energy**.
- These devices are based on PN junctions operating under **forward or reverse bias** depending on application.
- Examples include **LEDs, LCD, OLED**,QLED etc.

Topics for discussion

- How does an LED produce light?
- What happens when a PN junction is exposed to light?
- What is a Liquid Crystal Display (LCD) ?
- How does an LCD operate?
- Applications of LED, LCD, and OLED

Why Study Optoelectronic Devices?

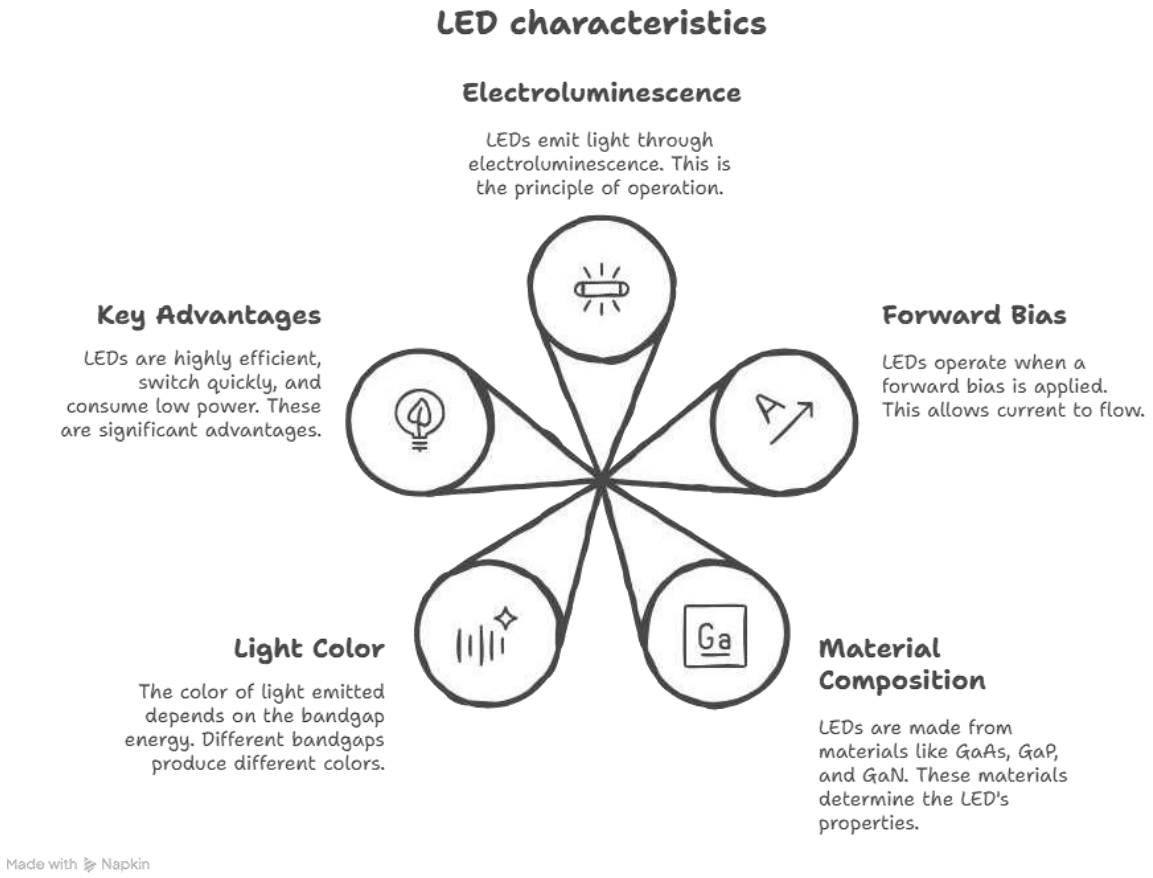
DT-Empathize



These devices are used in:

- Displays and lighting systems
- Remote sensing
- Communication systems (fiber optics)
- Renewable energy conversion
- Understanding them helps design energy-efficient and light-based electronic systems.

Light Emitting Diode (LED) – Principle



DT-DEFINE

- LED works on the principle of **electroluminescence**

Key Features

- Operates under forward bias
- Made from materials like GaAs, GaP, GaN
- Color of light depends on bandgap energy
- Highly efficient, fast switching, low power consumption

LCD – Principle

DT-DEFINE

- LCD is a type of flat panel display technology used in various electronic devices like televisions, computer monitors, smartphones, and calculators.

LCD working principle:

- ✓ The fundamental principle of an LCD is that liquid crystals change their molecular alignment when an electrical voltage is applied, thereby modulating the passage of light.
- ✓ **Liquid crystals do not emit light themselves**; they act as "light valves" that block or allow light from the backlight to pass through color filters

https://youtu.be/F0aeFniieB8?si=mpcUd5qLwoJRU8qi

LCD Features

- **Low-voltage and energy efficiency:** Modern LCDs utilizing LED backlights operate on significantly lower voltages (IC circuits) compared to legacy display technologies, making them ideal for battery-operated devices.
- **Ultra-slim profile:** The physical footprint is minimal. Modern panels are often less than 10mm thick, with high-end models achieving widths under 5mm.
- **Non-emissive technology:** Unlike OLEDs or CRTs, LCDs function by modulating light rather than emitting it directly from the liquid crystal layer. This often results in reduced eye strain during prolonged use (flicker-free backlights).

LCD Features-Contd

- **High Pixel Density:** The technology allows for extremely small pixel pitch, enabling high-definition resolutions (4K and 8K) on relatively small screens.
- **Accurate Color Reproduction:** With the integration of IPS (In-Plane Switching) and Quantum Dot technology, modern LCDs cover wide color gamuts (sRGB, DCI-P3).
- **Minimal Radiation:** LCDs produce negligible electromagnetic radiation compared to CRT monitors, ensuring safety for users and security for information sensitive to TEMPEST attacks.
- **Long Lifespan:** LED-backlit LCDs typically offer a lifespan of 30,000 to 60,000 hours before brightness degradation becomes noticeable.

LCD advantages

(1) **Geometric Accuracy:** Historically, CRT displays relied on electromagnetic deflection, which often caused geometric distortion (pincushion effects) at the screen edges. LCDs rely on a fixed pixel grid, ensuring zero geometric distortion and perfect linear alignment across the entire screen area.

(2) **Environmental Safety:** Compared to legacy CRT (which contained lead) and early CCFL-backlit LCDs (which contained mercury), modern LED-backlit LCDs are environmentally friendly. They do not emit X-rays and are generally compliant with modern RoHS (Restriction of Hazardous Substances) standards.

(3) **Power Efficiency:** The most significant advantage of LCD technology is power consumption. A traditional 17-inch CRT monitor could consume over 80W. In contrast, a modern 24-inch LED-backlit LCD typically consumes between 20W and 30W. This drastic reduction in wattage translates to lower thermal output and significant electricity savings in corporate environments.

LCD types

Based on the backlight source technology, LCDs are primarily categorized into two generations:

- **CCFL(Cold Cathode Fluorescent Lamp)-Legacy** and

- **LED (Standard/Modern)**.

OLED

- OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors.
- When electrical current is applied, a bright light is emitted.
- OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

OLED vs LCD

An OLED display have the following advantages over an LCD display:

- Improved image quality - better contrast, higher brightness, fuller viewing angle, a wider color range and much faster refresh rates.
- Lower power consumption.
- Simpler design that enables ultra-thin, flexible, foldable and transparent displays
- Better durability - OLEDs are very durable and can operate in a broader temperature range
- OLEDs have some disadvantages, though: their lifetime is limited, and currently they are more expensive to produce than LCDs.

Ideate: Comparison

DT-IDEATE

Technology	Full Form	Key Idea
LCD	Liquid Crystal Display	Uses liquid crystals + backlight
LED	Light Emitting Diode (LED-LCD)	LCD with LED backlight
OLED	Organic Light Emitting Diode	Self-lighting pixels (no backlight)
QLED	Quantum Dot LED	LED-LCD enhanced with quantum dots

Summary

- **LED**

Improved LCD with LED backlight.

- Brighter, thinner, and more energy-efficient.

Most common today.

- **LCD**

Uses liquid crystals with a fluorescent backlight.

Cheapest, but lower picture quality and weak contrast.

- **OLED**

Self-lighting pixels (no backlight).

Best picture quality with perfect blacks and high contrast, but expensive.

- **QLED**

LED TV enhanced with quantum dots.

- Very bright and colorful, good for bright rooms, but blacks not as perfect as OLED

References

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Thank You