LED – Light Emitting Diode (16 Marks Answer)

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1. Introduction

- **LED** stands for **Light Emitting Diode**.
- It is a **semiconductor device** that emits **light** when **electric current** passes through it.
- Works on the principle of **electroluminescence** – emission of light due to electron-hole recombination.

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2. Construction

- Made using **PN junction diode** with:
    - **P-type and N-type semiconductors**.
    - Enclosed in a **transparent plastic body** for light emission.
    - **Metal leads** for connecting to circuits.
- Materials used: **Gallium arsenide (GaAs), Gallium phosphide (GaP), Gallium nitride (GaN)**.

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3. Working Principle

1. When **forward biased**, current flows from P to N side.
2. Electrons from N-side and holes from P-side **combine at the junction**.
3. This recombination releases **energy in the form of photons (light)**.
4. The **color of light** depends on the **bandgap energy** of the material.

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4. Diagram Description

Simple LED diagram:

- Arrows showing current from + to –
- PN junction in center
- Light emission shown outward
- Label: P-type, N-type, anode, cathode

Caption: *"Light emission in LED under forward bias."*

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5. Properties / Characteristics

- Emits **visible or infrared light**.
- Operates at **low voltage and current**.
- Has **no filament** – solid-state device.
- **Fast switching** and long life.

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6. Applications

- **Display systems** (TVs, calculators, digital clocks)
- **Indicator lights** in electronics.
- **Street lights, home lighting** (LED bulbs).
- **Traffic signals**.
- **Automotive lighting**.
- **Medical devices and remote controls**.

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7. Advantages

- **Low power consumption**.
- **Long life** (up to 50,000 hours).
- **Compact and lightweight**.
- **No heat or UV radiation**.
- **Eco-friendly** – no mercury or toxic materials.

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8. Disadvantages

- **More expensive** than traditional bulbs initially.
- **Sensitive to voltage fluctuations**.
- Limited in **light spread** without reflectors or diffusers.
- Efficiency drops at **high temperatures**.

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10. Summary

- LED is a **modern light source** based on a **PN junction**.
- Converts electrical energy to light using **electron-hole recombination**.
- Offers **efficiency, long life, and eco-friendliness**.
- Widely used in **lighting, display, and electronics**.
