

# UNIT V

## ALTERNATE ENERGY STORAGE TECHNOLOGIES

### Super-capacitors

A **super-capacitor** is also called an **ultra-capacitor**. It is an energy storage device that stores electrical energy through **electrostatic charge** rather than chemical reactions (as in batteries). It consists of two electrodes separated by an electrolyte and a porous separator. The electrodes have extremely **high surface area materials** like activated carbon to **allow large charge accumulation**. It offers **high power density, fast charging, and long cycle life**.

#### **Working:**

##### **1. Charging Process:**

- When a voltage is applied, positive and negative ions in the electrolyte move to the opposite electrodes.
- Charges accumulate on the electrode surface.

##### **2. Formation of Electric Double Layer**

- **A double layer of charges formed between electrode and electrolyte.**
- No chemical reaction occurs in EDLC type.

##### **3. Energy Storage**

- Electrical energy is stored in the electrostatic field created between charges.

##### **4. Discharging**

- When connected to a load, the stored energy is released quickly.

#### **Main components:**

- Electrodes (activated carbon)
- Electrolyte
- Separator
- Current collectors

#### **Types of Super-capacitors**

##### **1. Electric Double Layer Capacitors (EDLC)**

- Store energy via electrostatic charge
- No chemical reaction
- Long life

## 2. Pseudocapacitors

- Use fast **redox reactions**
- Higher capacitance than EDLC

## 3. Hybrid Capacitors

- Combination of battery and capacitor
- Balance between energy and power density

### Advantages

- Very fast charging and discharging
- Long life cycle
- High power density
- Low maintenance

### Disadvantages

- Lower energy density than batteries
- Higher cost
- Voltage decreases linearly during discharge

### Comparison with Batteries

Feature	Super-capacitor	Battery
Energy Density	Low	High
Power Density	High	Moderate
Charging Time	Seconds	Hours
Life Cycle	Very high	Limited

### Applications

#### 1. Electric and Hybrid Vehicles

Used for quick energy storage and regenerative braking systems.

#### 2. Renewable Energy Systems

Helps store energy in solar and wind power systems.

#### 3. Consumer Electronics

Used in cameras, mobile phones, and wearable devices.

#### **4. Industrial Equipment**

Provides high power bursts for machines and robotics.

#### **5. Power Stabilization**

Used in **UPS and power supply** circuits to maintain voltage stability.

#### **6. Memory Backup**

Used in computer and electronic devices for short-term power backup.