CN 4.0

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🧠 1. Microcontroller

- A **microcontroller** is a small computer on a single chip.
- It contains:
  - **CPU (Processor)** – processes instructions
  - **Memory** – to store data and program
  - **Input/Output pins** – to connect sensors and devices
- Used to **control** electronic devices (like motors, LEDs, sensors).

✅ **Example:** Arduino, ESP32, PIC, ATmega328.

💻 2. Microprocessor

- A **microprocessor** is only the CPU — it doesn't have built-in memory or input/output ports.
- Needs external components like RAM, ROM, and I/O devices to work.
- Used in **computers, laptops, and Raspberry Pi**.

✅ **Example:** Intel i7, AMD Ryzen, ARM Cortex.

📘 **Difference:**

Feature	Microcontroller	Microprocessor
Components	CPU + Memory + I/O in one chip	Only CPU
Application	Embedded systems	Computers
Cost	Cheap	Expensive
Power usage	Low	High

🪫 3. Arduino

- **Arduino** is an **open-source microcontroller board** used to build electronic projects easily.
- It has input/output pins to connect sensors and actuators.
- You write code (called **sketch**) in the **Arduino IDE** using C/C++.

✅ **Example:** Arduino Uno, Arduino Nano.

Use case: controlling LEDs, motors, sensors, robots, etc.

🍓 4. Raspberry Pi

- **Raspberry Pi** is a **small computer** that can run an operating system (like Linux).
- It has USB ports, HDMI, Wi-Fi, and GPIO pins for sensors.
- Used for more complex tasks than Arduino — like web servers, AI, and IoT projects.

✅ **Example:** Raspberry Pi 4, Raspberry Pi Zero.

📘 **Difference from Arduino:**

Feature	Arduino	Raspberry Pi
Type	Microcontroller	Mini-computer
OS	No OS (runs one program)	Runs OS (Linux)
Language	C/C++	Python, etc.
Use	Simple hardware control	Complex IoT, automation

📶 5. ESP32

- **ESP32** is an advanced **microcontroller with built-in Wi-Fi and Bluetooth**.
- It's more powerful than Arduino and supports IoT (Internet of Things) projects.

✅ **Use cases:** Smart home devices, sensors sending data online, etc.

👁️ 6. PIR Sensor (Passive Infrared Sensor)

- Detects **motion** by sensing infrared radiation (heat) from humans or animals.
- Used in **motion detector lights**, **security alarms**, **automatic doors**, etc.

✅ Output: HIGH when motion detected, LOW otherwise.

🔦 7. IR Sensor (Infrared Sensor)

- Detects **objects or distance** using infrared light.
- Two types:
  - **Active IR** – emits and detects IR light (used in obstacle sensors).
  - **Passive IR (PIR)** – detects IR radiation from living things.

✅ Use: Line following robot, object detection, remote control systems.

🎛️ 8. Potentiometer

- A **variable resistor** — you can adjust its resistance by rotating a knob.
- Used to control **brightness, volume, or input voltage** to Arduino.

✅ Example: volume knob on a radio.

⬛ 9. Breadboard

- A **plastic board** used for **prototyping circuits** without soldering.
- You can easily plug in wires, sensors, and components to test a circuit.

✅ Useful for beginners to build temporary connections.

💡 10. Tinkercad

- **Tinkercad** is a **free online simulation tool** by Autodesk.
- You can design **circuits, 3D models, and Arduino projects** virtually without hardware.

✅ Great for practicing Arduino coding and circuit design online.

🌐 11. Cyber-Physical Systems (CPS)

- **CPS** are systems that integrate **computers, networks, and physical devices**.
- They sense the real world (physical), process data (cyber), and act back (control).

✅ Examples:
  - Self-driving cars
  - Smart grids
  - Smart factories
  - Medical monitoring systems

📘 **In short:**
CPS = Physical world + Computer control + Communication.