Microcontroller

Core Concepts

• Microcontroller (MCU)

A compact integrated circuit containing:

- CPU (processing unit)
- RAM (volatile memory)
- Flash (program memory)
- I/O ports (GPIO, ADC, PWM, etc.)

Used in embedded systems for dedicated control tasks like IoT, robotics, and consumer electronics.

• 🖵 Microprocessor (MPU)

Contains only the CPU. Requires external components:

- RAM and ROM
- I/O controllers
- Peripherals (Timers, ADC/DAC)

Used in general computing systems: PCs, laptops, high-performance embedded applications.

• 🋍 Difference: MCU vs MPU

- MCU: Self-contained, low-power, embedded devices.
- MPU: High-power, requires external memory and peripherals, used in general computing.

• ♥ GPIO (General Purpose Input/Output)

Digital pins configurable as:

- Input \rightarrow Read sensors, buttons, switches
- Output \rightarrow Drive LEDs, motors, buzzers

• 🔽 Pull-up and Pull-down Resistors

Ensure defined voltage levels when input is unconnected (floating):

- Pull-down \rightarrow Logic LOW when switch is open
- Pull-up \rightarrow Logic HIGH when switch is open

• • Switch Bouncing

Mechanical switches may produce multiple rapid ON/OFF signals when pressed. **Solution:** Debouncing via software (delay, state check) or hardware (capacitor, Schmitt trigger).

• 🗱 Toolchain / Development Environment

Includes everything needed to develop and upload code:

- IDE (Arduino IDE, STM32CubeIDE, MPLAB X)
- Compiler (translates code to machine language)
- Programmer/Debugger (uploads code and debugs MCU)

• Serial Communication (UART)

Used for data transfer between MCU and computer:

- Debugging using Serial Monitor
- Full-duplex communication using TX and RX pins

• ¶ LED Blinking as "Hello World"

Simplest MCU test program:

- Toggles an LED ON/OFF
- Confirms proper MCU setup and toolchain working

• • Debouncing Example

Instead of acting immediately on button press:

- Wait 50–200 ms after detecting press
- Confirm stable input state before executing action