1. Definition of PWM

Pulse Width Modulation (PWM) is a technique used to control the amount of power delivered to a load by adjusting the duty cycle of a periodic signal. It is commonly used for motor control, LED dimming, signal processing, and voltage regulation.

2. Principle of PWM

The fundamental idea behind PWM is to switch a signal between high and low states at a fixed frequency while varying the width of the high state (pulse width). This variation in pulse width effectively controls the average voltage and power supplied to the load.

3. Working Logic of PWM

1. **Fixed Frequency Generation**: The signal oscillates at a constant frequency, determined by the application requirements.

2. **Duty Cycle Adjustment**: The duty cycle (percentage of time the signal is high within one cycle) is varied to control the output.

   - **High duty cycle (~80%)** → More power is delivered.

   - **Low duty cycle (~20%)** → Less power is delivered.

3. **Filtering (optional)**: When the PWM signal is passed through a low-pass filter, it smooths the signal to produce a DC-like voltage.

4. **Application-specific Behavior**:

   - In **motor control**, a higher duty cycle increases speed.

   - In **LED brightness control**, a higher duty cycle results in a brighter LED.

Servo Motor PWM Control

A **servo actuator motor** typically requires a **PWM signal** with:

- A **50Hz frequency** (20ms period)

- A pulse width between **1ms to 2ms** to define the rotation angle

For example:

- **1ms pulse** → Minimum position (0°)

- **1.5ms pulse** → Middle position (90°)

- **2ms pulse** → Maximum position (180°)

Connectivity with STM32 Board

To connect a **servo motor** with an **STM32 microcontroller**, follow these steps:

1. **Power the Servo Motor**:

    - Connect **VCC** (usually 5V) from an external power source.

    - Connect **GND** to the STM32 GND.

Wiring the Servo to STM32 Board

Most servo motors have **three wires**:

- **Red (VCC) → Connect to 5V** (use external power supply if needed)

- **Black (GND) → Connect to STM32 GND**

- **Yellow/White (PWM Signal) → Connect to STM32 PWM output pin**