Introduction to Pulse Width Modulation (PWM)

• Definition: PWM is a technique that controls analog devices using digital outputs by delivering power in pulses.

• Applications: Commonly used in controlling variable-speed motors, dimmable lights, actuators, and speakers.

Digital vs. Analog Signals

• Digital Signals: Have two states—on (1) or off (0).

• Analog Signals: Can vary continuously, taking on any value within a range.

• PWM's Role: Bridges digital outputs and analog device control by simulating varying voltage levels.

How PWM Works

• Pulse Width: The duration a pulse remains in a high (on) or low (off) state.

• Duty Cycle: The percentage of one period in which a signal is active.

• Average Voltage: Determined by multiplying the duty cycle by the pulse's high voltage level.

Practical Example

Scenario: Controlling a fan motor with a high voltage of 24V.

• 50% Duty Cycle: The motor receives an average voltage of 12V (24V × 0.5), resulting in moderate speed.

• Increasing Duty Cycle: Raises the average voltage, causing the motor to run faster.

Visualizing PWM Signals

• Steady State: A constant duty cycle produces a consistent average voltage.

• Dynamic State: Varying the duty cycle over time changes the average voltage, allowing for dynamic control of the device.

Advantages of PWM

• Efficiency: Reduces power loss compared to linear control methods.

• Precision: Offers fine control over device behavior by adjusting the duty cycle.

• Versatility: Applicable in various fields, including motor control, lighting, and audio modulation.

Conclusion

- PWM is a powerful technique that enables digital systems to control analog devices effectively by modulating pulse widths to simulate varying voltage levels, providing efficient and precise control across numerous applications.