

## Unit IV

**Central Processing Unit: Introduction, Operation code, Encoding, Decoding, Addressing modes, Registers, Clock Timing. Memory system: Basic concepts, Semiconductor RAM memories, Read only Memory, Speed, Size and Cost, Cache Memories.**

### Central Processing Unit (CPU)

#### 1. Introduction:

- **Heart of the Computer:** Executes instructions and performs calculations.

- **Control Unit and ALU:** Essential components for managing operations and executing arithmetic/logic operations.

## 2. Operation Code (OpCode):

- **Instruction Set:** Contains a collection of OpCodes that represent specific operations.
- **Encoding and Decoding:** Converting instructions into machine-readable formats and vice versa.

## 3. Addressing Modes:

- **Ways to Address Data:** Various techniques to specify operands in CPU instructions.
- **Examples:** Direct addressing, indirect addressing, immediate addressing, etc.

## 4. Registers:

- **Fast Temporary Storage:** Small, high-speed memory locations within the CPU.
- **Types:** Instruction Register (IR), Program Counter (PC), Accumulator (ACC), etc.
- **Purpose:** Used for holding operands, instructions, memory addresses, etc.

## 5. Clock Timing:

- **Synchronization:** Coordinating operations with clock signals.
- **Clock Cycles:** Dividing operations into clock cycles for synchronous execution.
- **Clock Speed:** Measured in Hertz, determines how many instructions can be executed per second.

# Memory System

## 1. Basic Concepts:

- **Storage Hierarchy:** Understanding the levels of memory hierarchy (registers, cache, RAM, secondary storage).
- **Volatility:** Differentiating between volatile (loses data on power loss) and non-volatile memory.

## 2. Semiconductor RAM Memories:

- **Dynamic RAM (DRAM):** Utilizes capacitors to store data.
- **Static RAM (SRAM):** Uses flip-flops to store data.
- **Access Speed:** Faster compared to secondary storage but slower than registers and cache.

## 3. Read-Only Memory (ROM):

- **Non-Volatile Memory:** Retains data even when power is turned off.
- **Firmware:** Often used to store system BIOS and firmware instructions.

## 4. Speed, Size, and Cost:

- **Trade-offs:** Balancing between access speed, storage size, and cost in different types of memory.
- **Cost-Performance Ratio:** Higher speed and larger size usually come at higher costs.

## 5. Cache Memories:

- **Intermediate Memory:** Situated between CPU registers and main memory (RAM).
- **Purpose:** Stores frequently accessed data to speed up CPU operations.
- **Levels (L1, L2, L3):** Multiple levels of cache with varying sizes and access speeds.