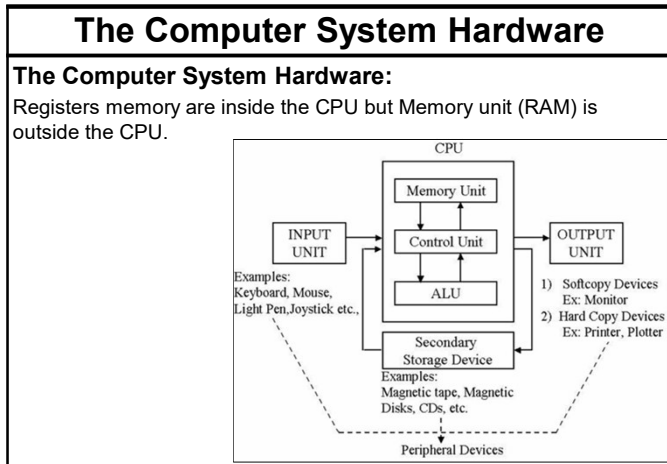
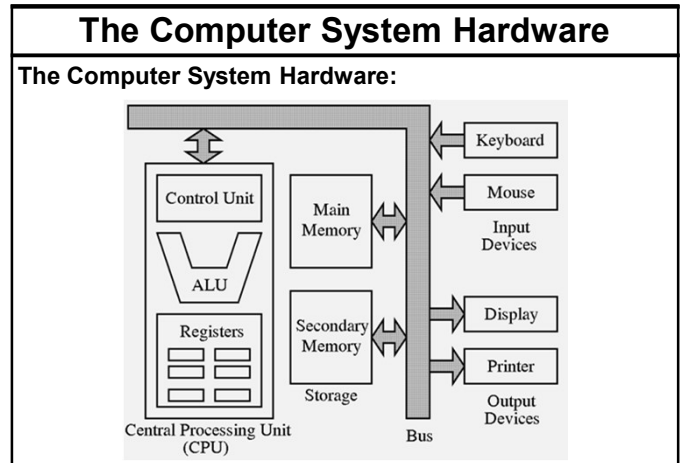


Course Contents

Unit-02: The Computer System Hardware (3 Hrs.)

- Introduction
- Central Processing Unit
- Memory Unit
- Instruction Format
- Instruction Set
- Instruction Cycle
- Microprocessor
- Interconnecting the Units of a Computer
- Inside a Computer Cabinet



The Computer System Hardware

Functions and Components of a Computer:

A computer does mainly the following four functions:

1. Receive input—Accept data/information from outside through various input devices like the keyboard, mouse, scanner, etc.
2. Process information—Perform arithmetic or logical operations on data/information.
3. Produce output—Communicate information to the outside world through output devices like monitor, printer, etc.
4. Store information—Store the information in storage devices like hard disk, floppy disks, CD, etc.

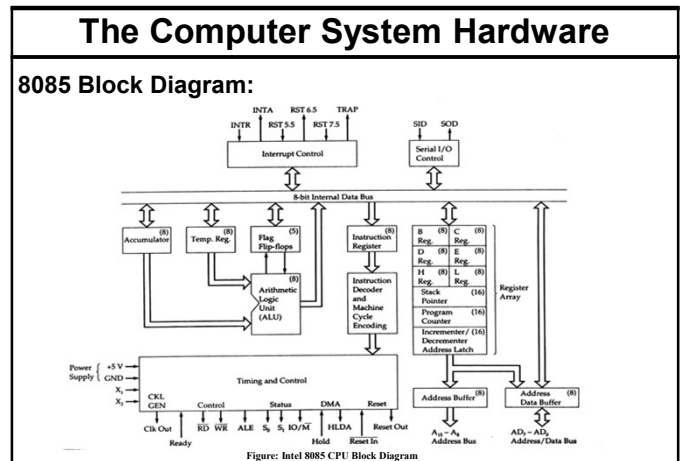
The hardware components of the computer specialize to do above four functions.

The Computer System Hardware

Functions and Components of a Computer:

- Computer hardware falls into two categories: processing hardware and the peripheral devices.
- The Processing hardware consists of the Central Processing Unit (CPU) where the data processing is done.
- Peripheral devices allow people to interact with the CPU.

Together, they make it possible to use the computer for a variety of tasks.



The Computer System Hardware

How a Computer Processor Works:

The working of the CPU is defined as a three-step process.

First, an instruction is fetched from memory.

Second, the instruction is decoded and the processor figures out what it's being told to do.

Third, the instruction is executed and an operation is performed.

These three steps repeat in a cycle that begins again with the CPU fetching the next instruction. The steps are referred to as the instruction cycle of the CPU.

The CPU uses a program counter to keep track of which instruction to fetch next. The program counter is the address of the memory location that holds the next instruction to be executed. It's stored in a register, which is a dedicated memory location in the CPU itself. The program counter is incremented to point to the next instruction after each fetch in the instruction cycle.

The Computer System Hardware

How a Computer Processor Works:

Example:

MVI A, 7F	Copy value 7F from memory to accumulator register "A"
ADI 0F	Add 0F with accumulator and save in register "A"

Opcode	Operand	Machine code/Hex code	Byte description
MVI	A, 7FH	3E	First byte
		7F	Second byte
ADI	0FH	C6	First byte
		0F	Second byte

Table 4 Examples of three byte instructions

Opcode	Operand	Machine code/Hex code	Byte description
JMP	9050H	C3	First byte
		50	Second byte
		90	Third byte
LDA	8850H	3A	First byte
		50	Second byte
		88	Third byte

MEMORY	
Memory Address	Memory Contents
1000	3E = 0011 01110
1001	7F = 0111 1111
1002	C6 = 1100 0110
1002	0F = 0000 1111

The Computer System Hardware

How the CPU Uses Memory:

- Computer memory refers to the area where data and programs are stored. Memory is not part of the CPU, but the CPU must interact closely with it.
- There are two types of computer memory: **primary, or main**, and **secondary**. The CPU relies heavily on main memory for storing program instructions and the data the instructions operate on.
- Main memory is temporary in nature and only holds instructions and data for a program while the program is executing.
- Secondary memory is the more permanent storage provided by hard drives and flash drives.
- A component of the CPU known as the control unit is responsible for moving instructions and data from secondary storage into main memory prior to instruction execution. The control unit also moves the results of an instruction to secondary storage.

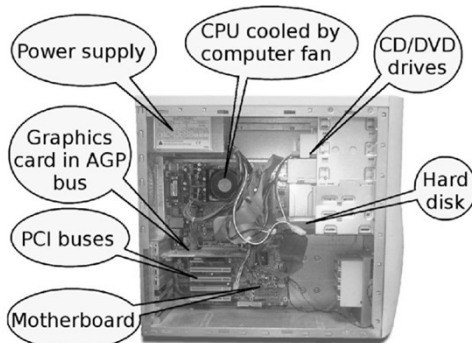
The Computer System Hardware

All general purpose computers require the following hardware components:

- Central Processing Unit (CPU):** The 'brain' of the computer, the component that actually executes instructions.
- Memory:** It enables a computer to store, at least temporarily, data and programs.
- Input device:** Usually a keyboard or mouse is used to read data and programs into the computer.
- Output device:** A display screen, printer, etc. that lets you see what the computer has accomplished.
- Mass storage device:** It allows a computer to permanently store large amounts of data. Common mass storage devices include disk drive and tape drive.

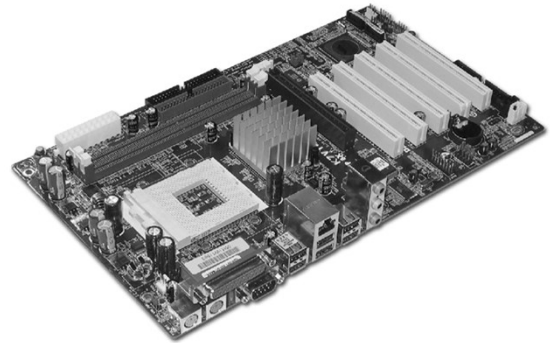
The Computer System Hardware

Inside a Computer Cabinet :



The Computer System Hardware

Motherboard:



The Computer System Hardware

Central Processing Unit (CPU)

- Part of the computer that executes program instructions is known as the processor or Central Processing Unit (CPU).
- In a microcomputer, the CPU is based on a single electronic component, the microprocessor chip.
- The system unit also includes circuit boards, memory chips, ports and other components.
- A microcomputer's system cabinet will also house disk drives, hard disks, etc., but these are considered separate from the CPU.

The CPU has two parts —The **Control Unit (CU)** and the **Arithmetic Logic Unit (ALU)**. In a microcomputer, both are on a single microprocessor chip.

The Computer System Hardware

Control Unit (CU)

- The control unit tells the rest of the computer system how to carry out a program's instructions.
- It directs the movement of electronic signals between memory which temporarily holds data, instructions and processes information - and the ALU.
- It also directs these control signals between the CPU and input/output devices.

The Computer System Hardware

Arithmetic - Logic Unit (ALU):

- Arithmetic Logic Unit, usually called the ALU, performs two types of operations - arithmetical and logical.
- Arithmetical operations are the fundamental mathematical operations consisting of addition, subtraction, multiplication, division and logical operations.

The Computer System Hardware

Memory:

- Memory - also known as the primary storage or main memory - is a part of the microcomputer that holds data and instructions.
- Contents of the memory is held only temporarily, that is, it is stored only as long as the microcomputer is turned on.
- When you turn the machine off, the contents are lost.
- The capacity of the memory to hold data and program instructions varies in different computers.

The Computer System Hardware

Registers:

- Computers also have several additional storage locations called registers.
- These appear in the Control Unit and ALU and make processing more efficient.
- Registers are a sort of special hi-speed storage areas that hold data and instructions temporarily during processing.
- They are parts of the Control Unit and ALU rather than the memory.
- Their contents can, therefore be handled much faster than the contents of the memory.

The Computer System Hardware

Addresses:

- To locate the characters of data or instructions in the main memory, the computer stores them in locations known as addresses.
- A unique number designates each address.
- Addresses can be compared to post office mailboxes.
- Their numbers remain the same, but contents continuously change.

The Computer System Hardware

Memory Addresses:

Address	Data
0 (000)	1 0 1 0
1 (001)	0 0 1 1
2 (010)	1 1 0 1
3 (011)	1 0 1 0
4 (100)	0 1 1 1
5 (101)	0 0 0 1
6 (110)	1 0 1 1
7 (111)	0 0 1 0

Figure 1. Basic Memory: Addressing an array of 8 x 4-bit registers

The Computer System Hardware

Memory Unit:

- Memories are made up of registers. Each register in the memory is one storage location. Storage location is also called as memory location. Memory locations are identified using Address. The total number of bit a memory can store is its capacity.
- A storage element is called a Cell. Each register is made up of storage element in which one bit of data is stored. The data in a memory are stored and retrieved by the process called writing and reading respectively.

The Computer System Hardware

Memory Unit:

A) Write operation B) Read Operation

The Computer System Hardware

Memory Unit:

- A word is a group of bits where a memory unit stores binary information. A word with group of 8 bits is called a byte.
- A memory unit consists of data lines, address selection lines, and control lines that specify the direction of transfer.

The Computer System Hardware

Memory Unit:

- Data lines provide the information to be stored in memory. The control inputs specify the direction transfer. The k-address lines specify the word chosen.
- When there are k address lines, 2^k memory word can be accessed.

The Computer System Hardware

Instruction Format

An instruction format defines the different component of an instruction. The main components of an instruction are opcode (which instruction to be executed) and operands (data on which instruction to be executed).

- High Level Language
- Assembly Language
- Machine Language

Opcode	Operand	Machine code/Hex code	Byte description
MVI	A, 7FH	3E	First byte
		7F	Second byte
ADI	0FH	C6	First byte
		0F	Second byte

Opcode	Operand	Binary Code	Hex Code	Task
MOV	C, A	0100 1111	4FH	Copy the contents of the accumulator in the register C.
JMP	9050H		C3	First byte
			50	Second byte
ADD	B	1000 0000	80H	Add the contents of register B to the contents of the accumulator.
HLT		0111 0110	76H	

Opcode	Operand	Machine code/Hex code	Byte description	
			90	First byte
			50	Second byte
LDA	8850H		3A	First byte
			50	Second byte
			88	Third byte

The Computer System Hardware

Instruction Set

- **Instruction set size** – It tells the total number of instructions defined in the processor.
- **CPU Manufacturer design Hardware circuit together with Instruction set for that hardware circuit.**
- **Example: 8085 has 246 instructions.**

Instruction Cycle

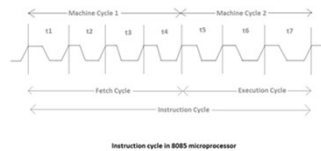
- The instruction cycle (also known as the Fetch–Decode–Execute cycle or the fetch-execute cycle) is the basic operational process of a computer system.
- The time taken for the execution of an instruction is known as **Instruction Cycle**.
- It is the process by which a computer retrieves a program instruction from its memory, determines what actions the instruction describes, and then carries out those actions.
- This cycle is repeated continuously by a computer's central processing unit (CPU), from boot-up until the computer has shut down.
- In simpler CPUs the instruction cycle is executed sequentially, each instruction being processed before the next one is started.
- But in most modern CPUs the instruction cycles are instead executed concurrently and often in parallel.

The Computer System Hardware

Instruction Cycle:

- Instruction cycle can be define as total time required by the microprocessor to completely fetch and execute an instruction
- An instruction cycle is comprised of one or more number of machine cycles.

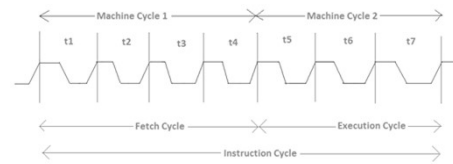
Opcode	Operand	Binary Code	Hex Code	Task
MOV	C, A	0100 1111	4FH	Copy the contents of the accumulator in the register C.
ADD	B	1000 0000	80H	Add the contents of register B to the contents of the accumulator.
HLT		0111 0110	76H	



The Computer System Hardware

Instruction Cycle:

Machine Cycle is the sequence of steps in performing the various operation like opcode fetch, memory read, memory writes, I/O Read, I/O Write etc.



Example: opcode fetch and read machine cycle

The Computer System Hardware

Microprocessor:

- The central processing unit (CPU) is a chip that functions as the brains of the computer. It is made of transistors--millions of transistors.
- Microprocessors are also the circuitry that surround the CPU.
- The microprocessor is more than the CPU. It contains other processors, for example, the graphics processor unit. Sound cards and network cards are encased in microprocessors. So a CPU is part of a microprocessor, but a microprocessor is more than the CPU.

The Computer System Hardware

Microprocessor:

- The CPU (Central Processing Unit) is the core of any computer, while the microprocessor refers to the whole functional chip that is inserted into a motherboard. The CPU is the sub architecture of the microprocessor that interprets the program instructions and cascade triggers the sub-functions of each instruction.