

Microprocessor Interfacing & Programming

LECTURE 1&2

Introduction to Computing

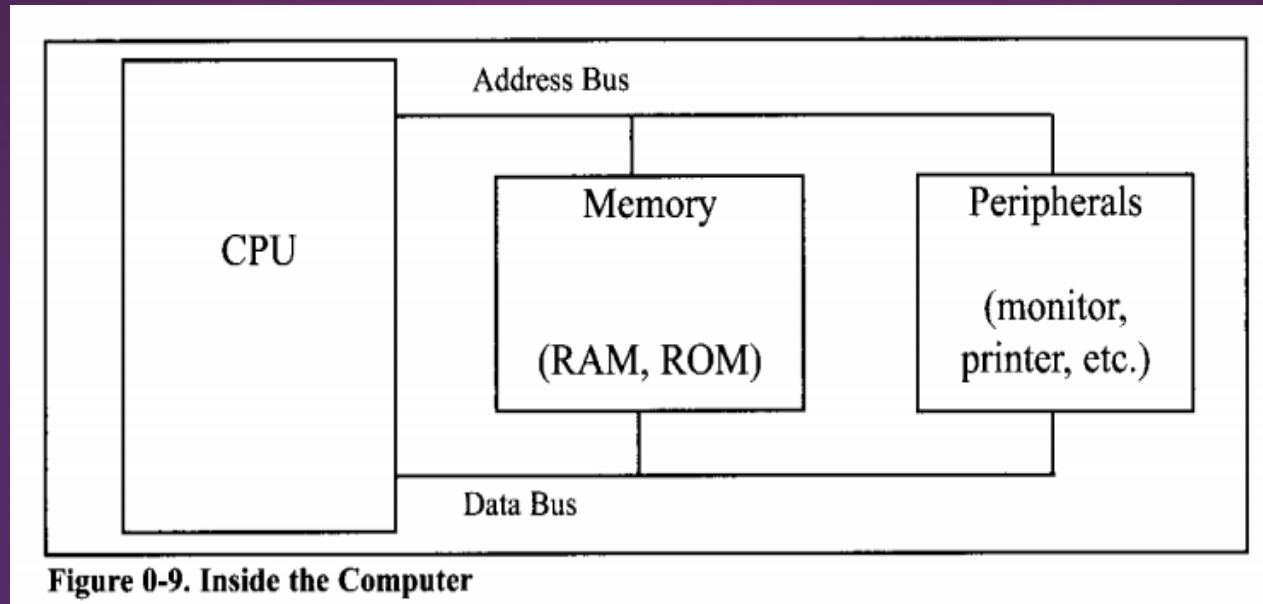
- ▶ Using computers or processors to solve problems, process information or perform tasks.
- ▶ Computer is an electronic device that converts **data** into **information** which is useful to people.



Anatomy of Computer & Analogous to Humans

- | | | |
|----|----------|--------------|
| 1. | CPU | brain |
| 2. | I/P unit | senses |
| 3. | O/P unit | body parts |
| 4. | Memory | human memory |

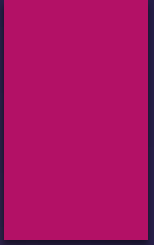
Internal Organization of Computers



- ▶ The CPU is connected to memory and I/O through stripes of wire called a **bus**.
- ▶ The bus inside a computer carries information from place to place just as a street bus carries people from place to place.

Types of buses:

1. **Address bus**
2. **Control bus**
3. **Data bus**

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- ▶ For a device (memory or I/O) to be recognized by the CPU, it must be assigned an address.
 - ▶ The CPU puts the address on the address bus, and the decoding circuitry finds the device.
 - ▶ Then the CPU uses data bus either to get data from that device or to send data to it.
 - ▶ The control buses are used to provide read or write signals to the device to indicate if the CPU is asking for information or sending information.

Data Bus

- ▶ The more data buses available, the better the CPU but a more expensive CPU and computer.
- ▶ The average size of data buses in CPUs varies between 8 and 64.
- ▶ Data buses are bidirectional. The processing power of a computer is related to the size of its buses, because 8 bit bus can send out 1 byte at a time, but a 16 bit bus can send out 2 bytes at a time, which is twice as fast.

Address Bus

- ▶ The more the address buses available, the larger the number of devices that can be addressed. In other word, the number of address buses for a CPU determines the number of locations with which it can communicate.
- ▶ The number of locations is always equal to 2^x .
- ▶ A CPU with 16 address lines can provide 64K addressable memory.
- ▶ Each location can have a maximum of 1 byte of data.
- ▶ The address bus is unidirectional, which means that CPU uses this bus only to send out addresses.

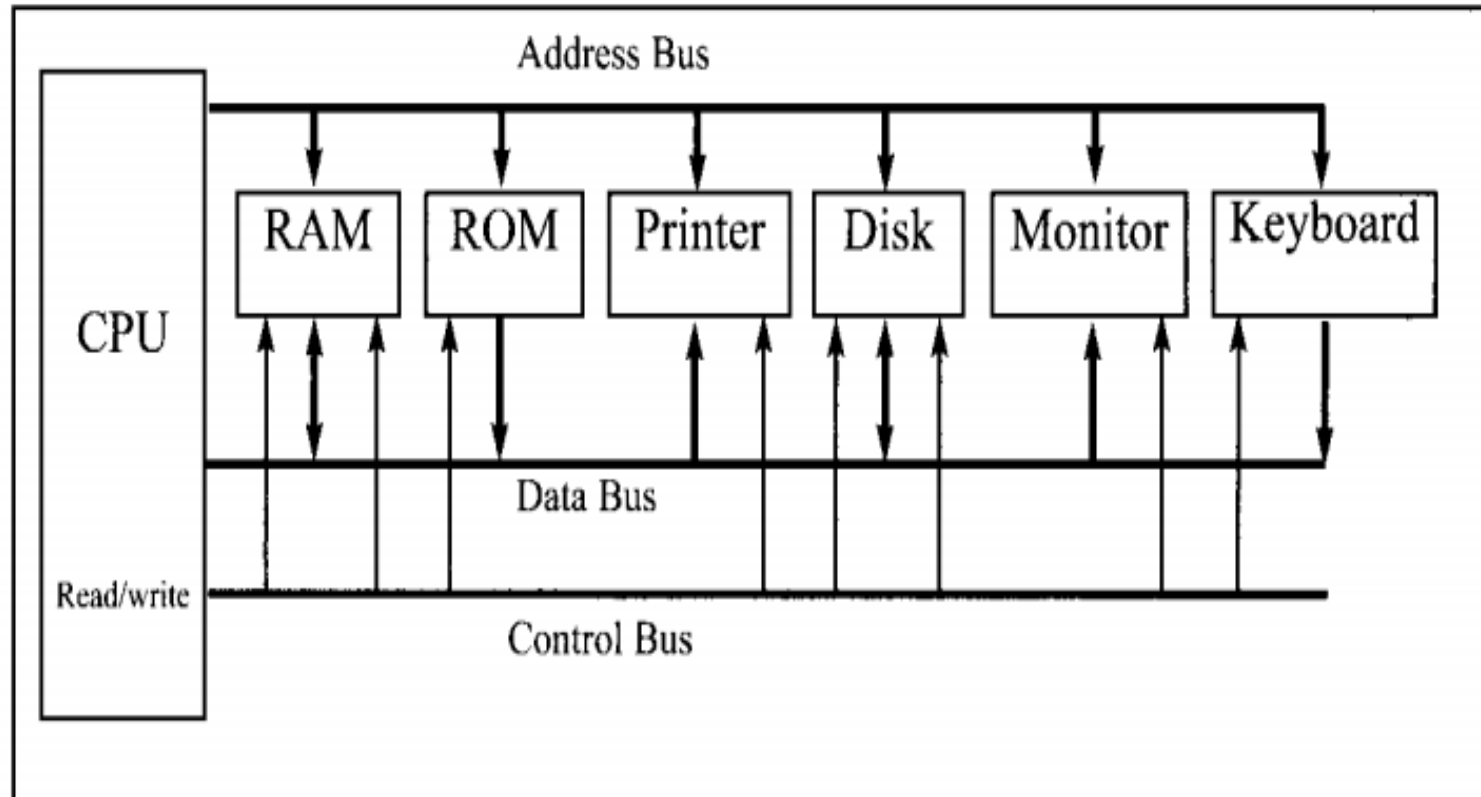


Figure 0-10. Internal Organization of a Computer

CPU and its relation to RAM and ROM

- For the CPU to process information, the data must be stored in RAM or ROM.

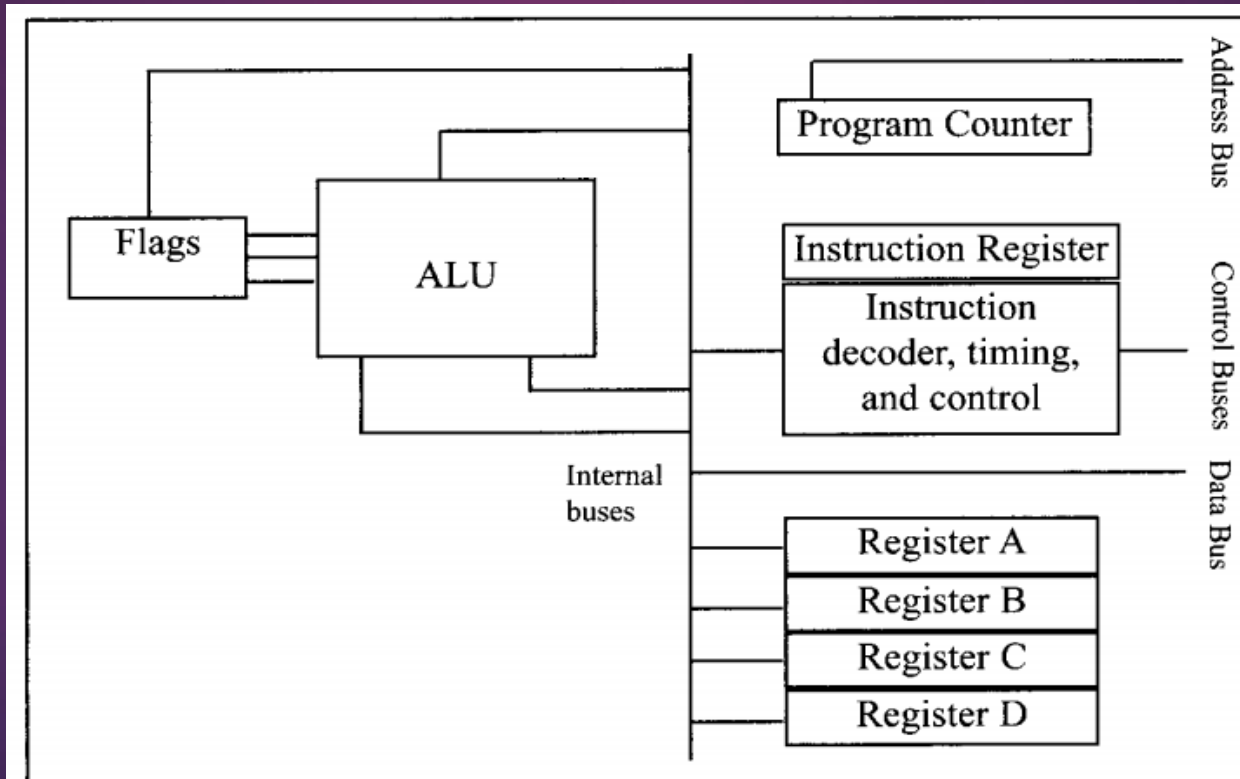
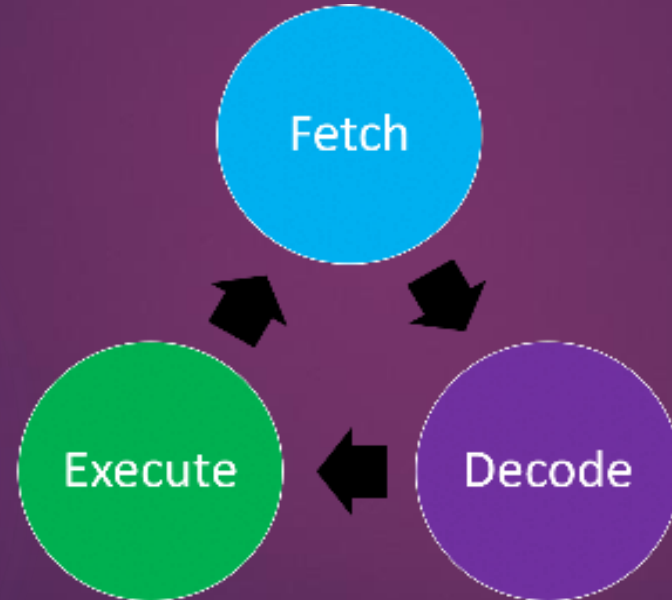


Figure 0-11. Internal Block Diagram of a CPU

Inside CPUs

- ▶ A program stored in memory provides instructions to the CPU to perform an action.
- ▶ The function of the CPU is to fetch these instructions from memory and execute them.
- ▶ To perform the actions of fetch and execute, CPU has some resources.
- ▶ **Registers** can be 8, 16 , 32 or 64 bit.
- ▶ **ALU** responsible to perform arithmetic functions.
- ▶ Every CPU has a **program counter**. It points to the address of the next instruction to be executed. The contents of the program counter are placed on the address bus to find and fetch the desired instruction.

- ▶ **Instruction decoder** to interpret the instruction fetched into the CPU.



How “kilo” works in computer

- ▶ In binary (base-2): Memory is organized in powers of 2, because computers use bits.
- ▶ Closest power of 2 to 1,000 is $2^{10} = 1,024$.

So, 1 KB = 1,024 bytes.

- ▶ Memory chips and addresses are naturally in powers of 2:

1 byte = 8 bits

1 KB = 2^{10} bytes = 1,024 bytes

1 MB = 2^{20} bytes = 1,048,576 bytes

1 GB = 2^{30} bytes = 1,073,741,824 bytes



Term	Bits
1 bit	1 binary digit (0 or 1)
1 nibble	4 bits
1 byte	8 bits (2 nibbles)
1 word	Processor-dependent: 8, 16, 32, or 64 bits

- ▶ A word is the natural unit of memory for a specific computer design.

Microprocessor

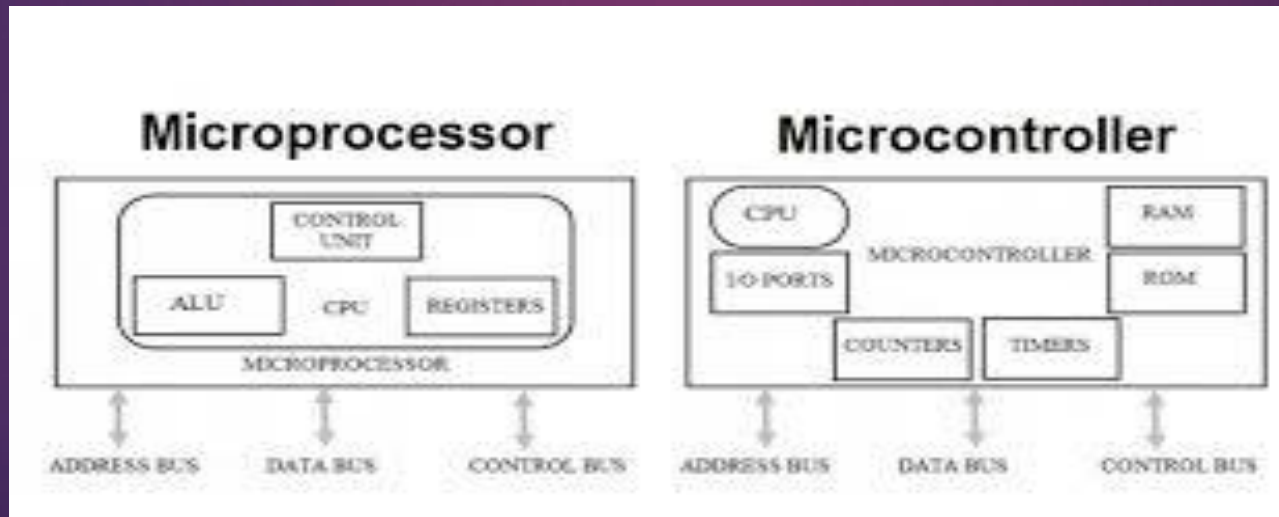
- ▶ As brain serves as the functioning mechanism in our body, μ P serves for the computer.
- ▶ μ Ps are used in the equipment that require processing.
- ▶ They have algorithms/ Programs and they work according to the instructions given to them.

CPU vs μ P

- ▶ CPU is specifically designed to be the brain of a computer.
- ▶ μ P is a type of CPU implemented on a single IC chip.
- ▶ μ Ps are modern CPUs designed to be compact and efficient, integrating the arithmetic, logic, and control circuits onto a single chip.

Microcontrollers

- ▶ Microprocessor in addition to a fixed amount of RAM, ROM, I/O ports and a timer on a single chip.
- ▶ On-chip ROM, RAM and number of I/O ports makes them ideal for many applications.





► A **small computer on a single chip** that contains:

- ❖ CPU
- ❖ RAM
- ❖ ROM
- ❖ I/O ports
- ❖ Timers, ADC/DAC, etc.

Limited processing power and memory compared to microprocessors.

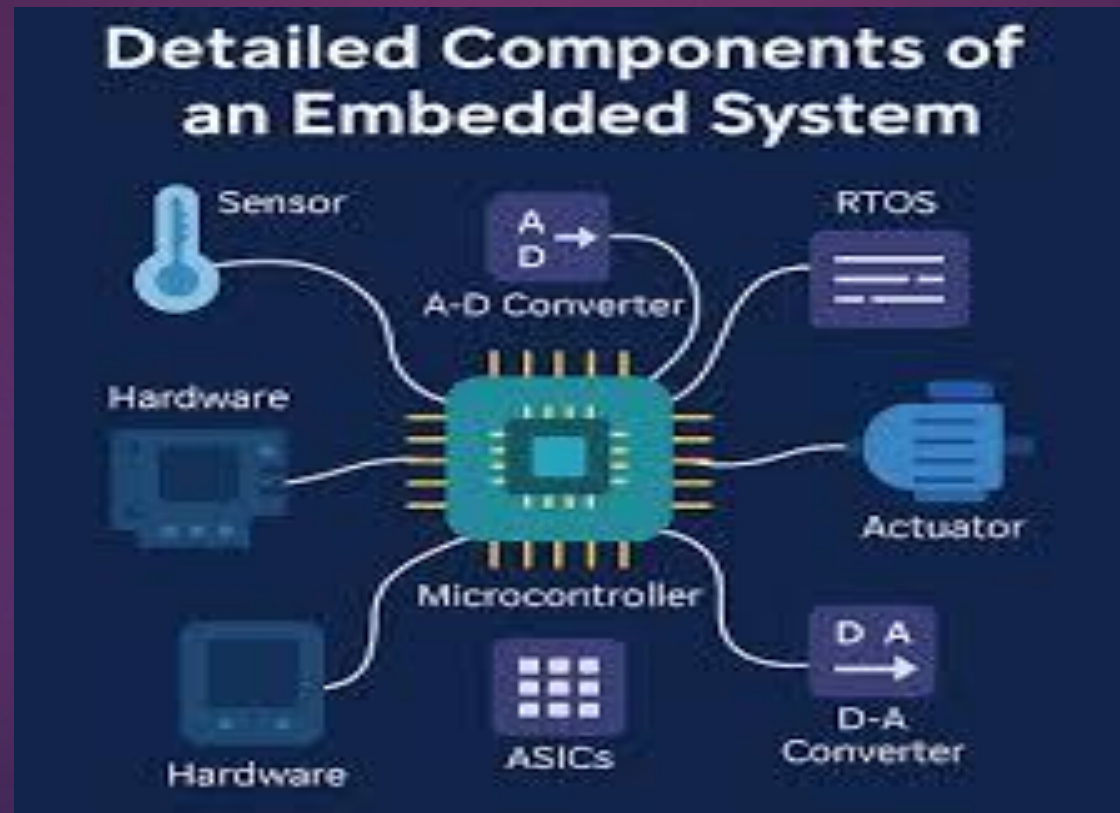
Embedded Systems

- ▶ A special purpose system built around a microcontroller or microprocessor to perform a specific designated task.

Components:

- ▶ MCU or MPU
- ▶ Memory (internal or external)
- ▶ Sensors/actuators
- ▶ Software (firmware) for specific function

- ▶ Microcontroller is general-purpose hardware
- ▶ In an embedded system, usually used for one dedicated/specific task.
- ▶ Once programmed, they behave as a **dedicated embedded system**.



Examples of Microcontroller



Atmel AVR



AVR



ATX Mega



ATmega 328P



PIC 18F877A



8051



Arduino



ARM

Embedded Systems

- ▶ In an embedded system, the microcontroller's ROM is burned with a purpose for specific functions needed for the system.

- ▶ **Example:**

A printer as the processor inside it performs one task only; namely, getting the data and printing it.

Microcontrollers are the heart of embedded systems.

1. A microcontroller is placed inside an embedded system.
2. The firmware makes it perform the exact required task.

- ▶ **Examples:**

In a remote control, the MCU only reads button presses and sends IR signals.

In a car, the MCU only monitors sensors and controls actuators.

Examples of embedded systems



Central heating systems



Domestic appliances



Digital watches



Electronic calculators



GPS systems



Fitness trackers

Practice Questions

- ▶ Convert 34 to binary and hex.
- ▶ Convert 110101 to hex and decimal.
- ▶ Perform binary addition: $101100 + 101$
- ▶ Add $36BH + F6H$
- ▶ Subtract $36BH - F6H$
- ▶ How many bytes is 224 kilobytes?