1. Introduction to Microprocessor

Definition:
- *"The microprocessor is a multipurpose, clock driven, register based, digital-integrated circuit which accepts binary data as input, processes it according to instructions stored in its memory, and provides results as output."*
- "Microprocessor is a computer Central Processing Unit (CPU) on a single chip that contains millions of transistors connected by wires."

Introduction:
- A microprocessor is designed to perform arithmetic and logic operations that make use of small number-holding areas called registers.
- Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another.

2. Components of Microprocessor

- Microprocessor is capable of performing various computing functions and making decisions to change the sequence of program execution.
- The microprocessor can be divided into three segments as shown in the figure, Arithmetic/logic unit (ALU), register array, and control unit.
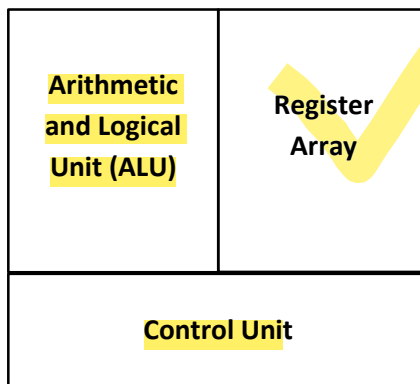- These three segment is responsible for all processing done in a computer

Figure: Components of Microprocessor

Arithmetic and logic unit (ALU)
- It is the unit of microprocessor where various computing functions are performed on the data.
- It performs arithmetic operations such as addition, subtraction, and logical operations such as OR, AND, and Exclusive-OR.
- It is also known as the brain of the computer system.

Register array
- It is the part of the register in microprocessor which consists of various registers identified by letters such as B, C, D, E, H, and L.
- Registers are the small additional memory location which are used to store and transfer data and programs that are currently being executed.

Control unit
- The control unit provides the necessary timing and control signals to all the operations in the microcomputer.
- It controls and executes the flow of data between the microprocessor, memory and peripherals.
- The control bus is bidirectional and assists the CPU in synchronizing control signals to internal devices and external components.
- This signal permits the CPU to receive or transmit data from main memory.

3. System bus (data, address and control bus).
- This network of wires or electronic pathways is called the 'Bus'.
- A system bus is a single computer bus that connects the major components of a computer system.
- It combines the functions of a data bus to carry information, an address bus to determine where it should be sent, and a control bus to determine its operation.
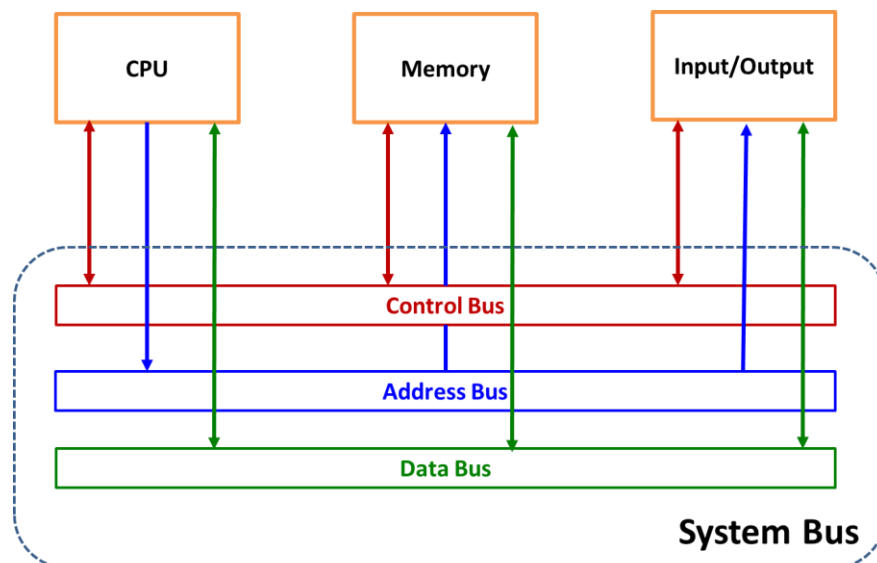- The technique was developed to reduce costs and improve modularity.

Figure: System Bus

Address Bus

- It is a group of wires or lines that are used to transfer the addresses of Memory or I/O devices.
- It is unidirectional.
- The width of the address bus corresponds to the maximum addressing capacity of the bus, or the largest address within memory that the bus can work with.
- The addresses are transferred in binary format, with each line of the address bus carrying a single binary digit.
- Therefore the maximum address capacity is equal to two to the power of the number of lines present (2^{lines}).

Data Bus

- It is used to transfer data within Microprocessor and Memory/Input or Output devices.
- It is bidirectional as Microprocessor requires to send or receive data.
- Each wire is used for the transfer of signals corresponding to a single bit of binary data.
- As such, a greater width allows greater amounts of data to be transferred at the same time.

Control Bus

- Microprocessor uses control bus to process data, i.e. what to do with the selected memory location.
- Some control signals are Read, Write and Opcode fetch etc.
- Various operations are performed by microprocessor with the help of control bus.
- This is a dedicated bus, because all timing signals are generated according to control signal.

4. Microprocessor systems with bus organization
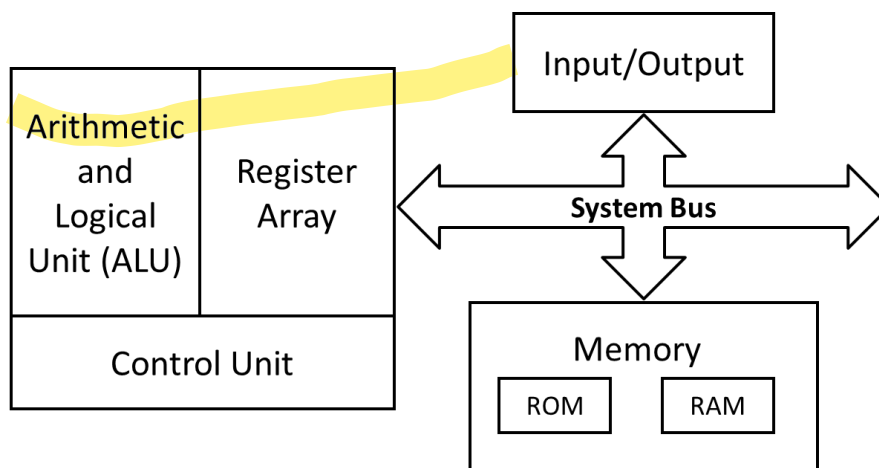

Figure: Microprocessor systems with bus organization

- To design any meaningful application microprocessor requires support of other auxiliary devices.
- In most simplified form a microprocessor based system consist of a microprocessor, I/O (input/output) devices and memory.
- These components are interfaced (connected) with microprocessor over a common communication path called system bus. Typical structure of a microprocessor based system is shown in Figure.
- Here, microprocessor is master of the system and responsible for executing the program and coordinating with connected peripherals as required.
- Memory is responsible for storing program as well as data. System generally consists of two types of memories ROM (Read only and non-volatile) and RAM (Read/Write and volatile).
- I/O devices are used to communicate with the environment. Keyboard can be example of input devices and LED, LCD or monitor can be example of output device.
- Depending on the application level of sophistication varies in a microprocessor based systems. For example: washing machine, computer.