Unit 1: Introduction (4 Hrs.)

- *Definition of microprocessor and its application*
- *Evolution of microprocessor, Von Neumann and Harvard architecture*
- *Components of microprocessor*
    - *a) Microprocessor: Arithmetic and Logic Unit (ALU), Control Unit (CU), Registers*
    - *b) Memory*
    - *c) Input / Output*
- *System Bus: Data , Address and Control Bus*
- *Microprocessor with Bus Organization*

Process**:** *a series of actions or steps taken to achieve an end result*
Processor: *a machine that completes process*
IC*: multifunction circuit are combined in a single chip*
CPU: *Central processing unit which consists of ALU and control unit.*
Microprocessor*: Single chip containing all units of CPU.s*
Micro computer*: Computer having microprocessor as CPU.*
Microcontroller*: Single chip consisting of MPU, Memory, I/ and interfacing circuits.*
MPU: *Micro processing unit- Complete processing unit with the necessary control signals.*

Microprocessor: (An integrated circuit that contains all the functions of a central processing unit of a computer.)

- It is a multipurpose, programmable, clock-driven, register-based electronic device that reads binary instruction from a storage device (memory), accepts binary as input and processes data according to those instructions and provides result as output. Each Microprocessor communicates and operates in the binary number 0 and 1, called bits. Each MP has fixed sets of instructions in the form of binary pattern called a machine language.

Features of a Microprocessor

Here is a list of some of the most prominent features of any microprocessor are:

- ***Cost-effective:*** The microprocessor chips are available at low prices and results its low cost.
- ***Size***: The microprocessor is of small size chip, hence is portable.
- ***Low Power Consumption:*** Microprocessors are manufactured by using metal-oxide semiconductor technology, which has low power consumption.
- ***Versatility:*** The microprocessors are versatile as we can use the same chip in a number of applications by configuring the software program.
- ***Reliability:*** The failure rate of an IC in microprocessors is very low, hence it is reliable.

Advantages of microprocessor –

- ✓ High processing speed
- ✓ Compact size
- ✓ Easy maintenance
- ✓ Can perform complex mathematics
- ✓ Flexible
- ✓ Can be improved according to requirement

Disadvantages of microprocessors –

- ✓ Overheating occurs due to overuse
- ✓ Performance depends on size of data
- ✓ Large board size than microcontrollers
- ✓ Most microprocessors do not support floating point operations

Major function of MP:

- Fetch—Microprocessor gets a software instruction from memory telling it what to do with the data.
- Decode—Microprocessor determines what the instruction means.
- Execute—Microprocessor performs the instruction.

Applications of MP

The applications of microprocessors are not bound. They can be used virtually anywhere and in any field. However, the applications are sorted as follows:

Test Instruments

Microprocessors are widely used in devices such as signal generators, oscilloscopes, counters, digital multi-meters, x-ray analyzers, blood group analyzers, baby incubator, frequency synthesizers, data acquisition systems, spectrum analyzers etc. For example fluke 6010A synthesized signal generator uses 4004 microprocessor.

Communications

Communication today requires tens of thousands of circuits to be managed. Data should be received, checked for errors and further analysis should also be performed. The speed at which the microprocessor can take decisions and compute errors is truly substantial.

Computer

The microprocessor is a central processing unit (CPU) of the microcomputers. It can perform arithmetic and logic functions as well as control function. The control unit of microprocessor sends signals to input, output units, memory, ALU and arrange the sequence of their controlling operation.

Industries

The microprocessor is widely used in data monitoring systems, smart cameras for quality control, automatic weighing, batching systems, assembly machine control, torque certification systems, machine tool controller etc.

Security systems: smart cameras, CCTV, smart doors, etc.

Automatic system

Communication system: some examples are:

- **Calculators**
- **Accounting system**
- **Games machine**
- **Complex industrial controllers**
- **Traffic light control**
- **Data acquisition system**
- **Military applications**

Evolution of MP (Intel Series)

4 Bits Microprocessor (Intel 4004)

Intel 4004: The Intel 4004 is a 4-bit central processing unit (CPU) released by Intel Corporation in 1971. It was the first commercially produced microprocessor, and the first in a long line of Intel CPUs. The chip design, implemented with the MOS silicon gate technology, started in April 1970 and completed in 1971

First 4-bit microprocessor

- ✓ lntroduced November 15, 1971 by Intel
- ✓ First commercially available computer processor
- ✓ Clock rate 740 kHz.
- ✓ Executes 60,000 instructions per second
- ✓ Instruction set contained 46 instructions
- ✓ Number of Transistors 2,300 at 10 μm
- ✓ Addressable Memory 640 bytes
- ✓ Register set contained 16 registers
- ✓ Designed to be used in Busicom calculator

Successor of Intel 4004 another 4 Bits Microprocessor is Intel 4040

- ✓ lntroduced in 1974
- ✓ Clock Speed 500 –740 kHz
- ✓ Instruction set increased to 60 instructions
- ✓ Number of Transistors 3,000 at 10 μm
- ✓ Register set increased to 24 registers

First 8-bit processor Intel 8008

- ✓ Introduced April 1, 1972
- ✓ Clock Speed 500 kHz
- ✓ Execute 50,000 instructions per second
- ✓ Number of Transistors 3,500 at 10 μm
- ✓ Addressable Memory 16 KB
- ✓ Register set contained 7 registers
- ✓ Designed for use in Datapoint2200 microcomputer9
- ✓

Intel 8080

- ✓ Introduced April, 1974
- ✓ Clock Speed 2 MHz
- ✓ Transistors 4,500 at 6 μm
- ✓ 10 times faster than Intel 8008
- ✓ Execute 500,000 instructions per second10
- ✓

Intel 8085

- ✓ Introduced 1976
- ✓ Clock Speed 3MHz
- ✓ Executes 0.37 MIPS
- ✓ Number of transistors 6,500 at 3 μm
- ✓ 100 million copies were sold

First 16-bit processor Intel 8086

- ✓ Introduced in June 8, 1978
- ✓ Introduction of x86 architecture
- ✓ Clock speed is 4.77 –10 MHz
- ✓ 29,000 transistors at 3 μm
- ✓ Execute 2.5 MIPS
- ✓ Used in portable computing, IBM PS/2 computers

Intel 8088

- ✓ Introduced June 1, 1979
- ✓ Backward compatible 8086
- ✓ Clock speed is 5 –10 MHz
- ✓ Created as a cheaper version of Intel's 8086
- ✓ Used first in IBM-PC
- ✓ Highly successful due to large sale of IBM-PC

Intel 80186 & 80188

- ✓ Introduced in 1982
- ✓ Clock speed was 6 MHz
- ✓ 80188 was a cheaper version of 80186
- ✓ 55,000 transistors at 3 µm
- ✓ Had additional components like
  - Interrupt Controller
  - Clock Generator
  - Local Bus Controller
  - Counters

Intel 80286

- ✓ Introduced in February 2, 1982
- ✓ Clock speed was 8 MHz
- ✓ 134,000 transistors at 1.5 µm
- ✓ Execute 4 MIPS
- ✓ First with memory management, protection abilities
- ✓ Introduces "Virtual Memory Concept"
- ✓ Widely used in IBM PC

First 32-bit processor Intel 80386

- ✓ Introduced in October 17, 1985
- ✓ Clock speed 16 –33 MHz
- ✓ 2,75,000 transistors at 1.5 µm
- ✓ Address 4 GB of memory
- ✓ Concept of paging was introduced ×Best selling microprocessor in history

First 64 bit processor Intel Core 2 Series

- ✓ Introduced on July 27, 2006
- ✓ Multi core on a single chip
- ✓ Dual, Quad Core processor
- ✓ Clock speed 1.06 –3.33 GHz
- ✓ 291 million transistors at 45nm
- ✓ 64 KB of L1 cache per core
- ✓ 4 MB of L2 cache
- ✓ Core 2 Duo widely used in desktops, laptops
- ✓ Core 2 Quad used for business purposes

Modern Trends of Processor

- ✓ Intel was the first microprocessor producer
- ✓ Intel owns more than 83% microprocessor market share
- ✓ Intel supplies processors to Apple, Samsung, HP, Dell & others
- ✓ Intel Core i3, i5 Dual Core are most sold in India
- ✓ Gaming Geeks use i7 processors, along with a high power GPU for enhanced performance
- ✓ Processors with suffix "K" can be Over clocked for getting ultimate performance
- ✓ Servers, Workstations are deployed on Intel Xeon chips

Conclusion

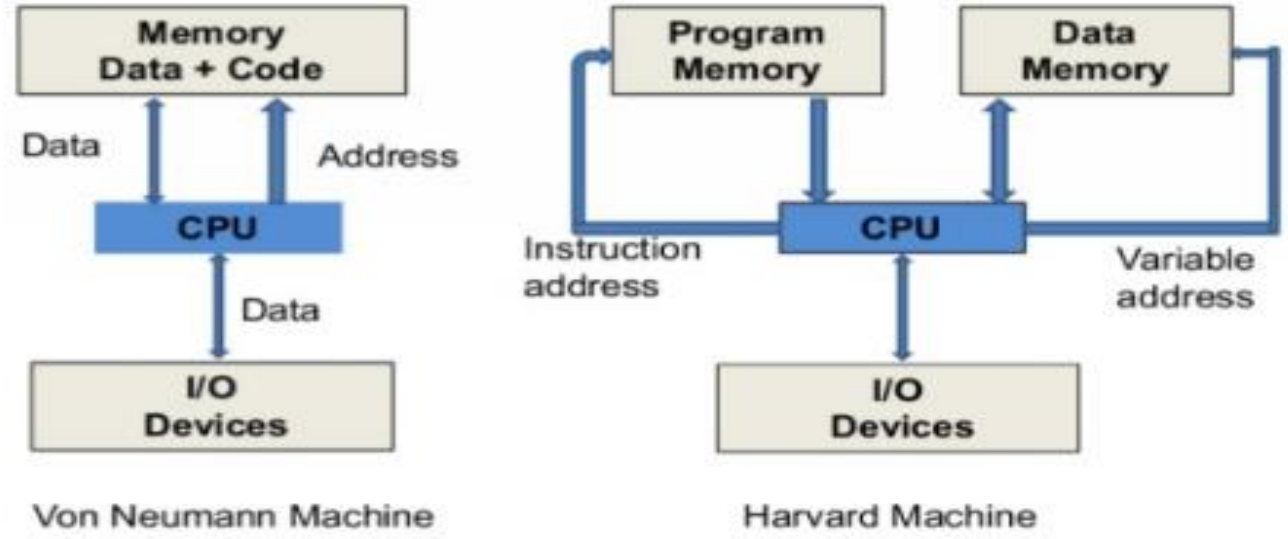
- ✓ Microprocessor Growth is tremendous
- ✓ Speed of microprocessor is increasing day-by-day
- ✓ Architecture has been reduced to very small, 22 nm
- ✓ Microprocessor are also used in various devices like mobiles, watches, ATM, cameras
- ✓ Price reduced in recent years
- ✓ Much more in the upcoming years

Computer architecture

The Von Neumann architecture is a theoretical computer design based on the concept of stored-program where programs and data are stored in the same memory. The concept was designed by a mathematician John Von Neumann in 1945 and currently serves as the foundation of almost all modern computers. Neumann machine consists of a central processor with an arithmetic/logic unit and a control unit, a memory, mass storage and input and output.

Von Neumann Architecture

- Program can be saved like data in the memory unit and can be accessed when needed. This approach is called 'Stored Program Concept' and was first adopted by John von Neumann.
- In this architecture, data and instructions are stored in a single set of main memory.
- Instruction fetch and data operation cannot occur at the same time because they share a common bus.
- The program control unit (PCU) reads program instruction, decodes instruction for ALU and determines the sequence of instruction to be executed.
- The ALU performs arithmetic and logical operations.
- It is a basic architecture of today's computer.
- The another architecture like this is Harvard architecture in which instruction and data have separate memory space; and data & instruction can be accessed at the same time. This is newer approach to von Neumann architecture.



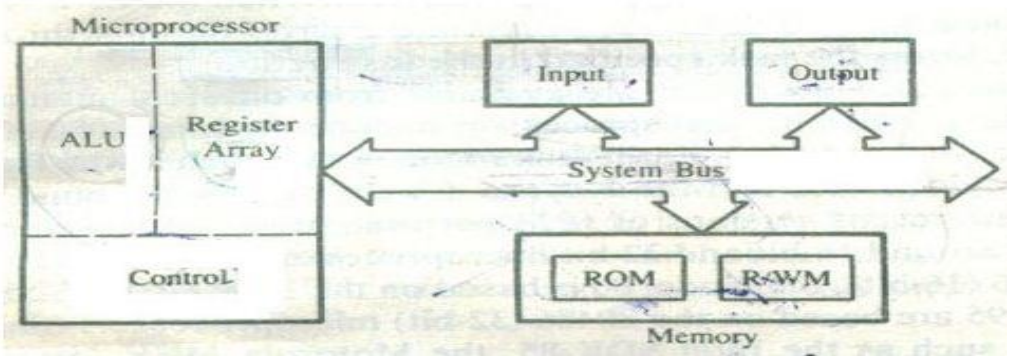
The Harvard architecture is a computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters. Some examples of Harvard architectures involve early computer systems where programming input could be in one media, for example, punch cards, and stored data could be in another media, for example, on tap. More modern computers may have modern CPU processes for both systems, but separate them in a hardware design.

Difference between Von Neumann and Harvard Architecture

Architecture of a micro computer or a micro controller refers to the arrangement of the CPU with respect of the RAM and ROM. Hence, the Von-Neumann and Harvard architecture are the two ways through which the micro controller can have its arrangement of the CPU with RAM and ROM.

Point of Comparison	Harvard Architecture	Von Neumann Architecture
Arrangement	In Harvard architecture, the CPU is connected with both the data memory (RAM) and program memory (ROM), separately.	In Von-Neumann architecture, there is no separate data and program memory. Instead, a single memory connection is given to the CPU.
Hardware requirements	It requires more hardware since it will be requiring separate data and address bus for each memory.	In contrast to the Harvard architecture, this requires less hardware since only a common memory needs to be reached.
Space requirements	This requires more space.	Von-Neumann Architecture requires less space.
Speed of execution	Speed of execution is faster because the processor fetches data and instructions simultaneously	Speed of execution is slower since it cannot fetch the data and instructions at the same time.
Space usage	It results in wastage of space since if the space is left in the data memory then the instructions memory cannot use the space of the data memory and vice-versa.	Space is not wasted because the space of the data memory can be utilized by the instructions memory and vice-versa.
Controlling	Controlling becomes complex since data and instructions are to be fetched simultaneously.	Controlling becomes simpler since either data or instructions are to be fetched at a time.

Basic Organization of Microcomputer



Microprocessor

It is clock driven semiconductor device consisting of electronic logic circuits manufactured by using either a large scale integration (LSI) or very large scale integration (VLSI) technique. It is capable of performing various computing functions and making decisions to change the sequence of program execution.

It can be divided into three segments.

- **Arithmetic/Logic unit**: It performs arithmetic operations as addition and subtraction and logic operations as AND, OR & XOR.
- **Register Array :** The registers are primarily used to store data temporarily during the execution of a program and are accessible to the user through instruction. ***The registers can be identified by letters such as B,C,D,E,H and L.***
- **Control Unit:** It provides the necessary timing and control signals to all the operations in the microcomputer. It controls the flow of data between the microprocessor and memory & peripherals.
- **Memory:** Memory stores binary information such as instructions and data provides that information to the up whenever necessary. To execute programs, the microprocessor reads instructions and data from memory and performs the computing operations in its ALU. Results are either transferred to the output section for display or stored in memory for later use. Memory has two sections.

a) **Read only Memory (ROM):** Used to store programs that do not need alterations and can only read.

b) **Read /Write Memory (RAM) :** Also known as user memory which is used to store user programs and data. The information stored in this memory can be easily read and altered.

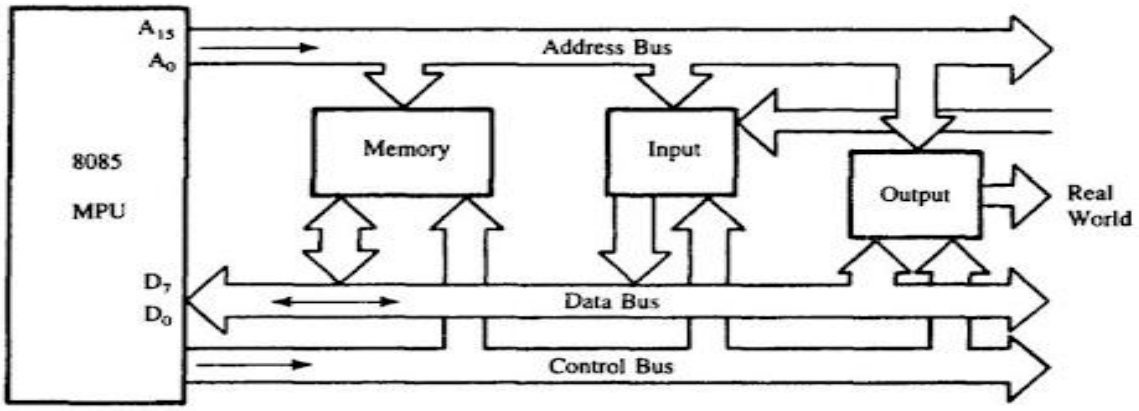
INPUT/ OUTPUT

- It communicates with the outside world using two devices input and output which are also known as peripherals.
- The input device such as keyboard, switches, and analog to digital converter transfer binary information from outside world to the microprocessor.
- The output devices transfer data from the microprocessor to the outside world. They include the devices such as LED, CRT, digital to analog converter, printer etc

System bus

The system bus is a communication path between MP and peripherals. It is used to carry data, address and control signals .It is a group of wires that connect different components of the computer. It is used for transmitting data, control signal and memory address from one component to another. A bus can be 8 bit, 16 bit, 32 bit and 64 bit. A 32 bit bus can transmit 32 bit information at a time. A bus can be internal or external.

Or Bus is a group of conducting wires which carries information; all the peripherals are connected to microprocessor through Bus.



Types of bus:

Address Bus:

It is a group of conducting wires which carries address only.Address bus is unidirectional because data flow in one direction, from microprocessor to memory or from microprocessor to Input/output devices (That is, Out of Microprocessor).

Length of Address Bus of 8085 microprocessor is 16 Bit (That is, Four Hexadecimal Digits), ranging from 0000 H to FFFF H, (H denotes Hexadecimal). The microprocessor 8085 can transfer maximum 16 bit address which means it can address 65, 536 different memory location.

Data bus

It is a group of conducting wires which carries Data only.Data bus is bidirectional because data flow in both directions, from microprocessor to memory or Input/Output devices and from memory or Input/Output devices to microprocessor.

Length of Data Bus of 8085 microprocessor is 8 Bit (That is, two Hexadecimal Digits), ranging from 00 H to FF H. (H denotes Hexadecimal).

Control bus

`It is a group of conducting wires, which is used to generate timing and control signals to control all the associated peripherals, microprocessor uses control bus to process data, that is what to do with selected memory location. Some control signals are:

- Memory read
- Memory write
- I/O read
- I/O Write
- Opcode fetch

If one line of control bus may be the read/write line. If the wire is low (no electricity flowing) then the memory is read, if the wire is high (electricity is flowing) then the memory is written.s

Important Question for Exam:

1) *What is Microprocessor? Draw the architecture of Microprocessor and explain the each unit.*
2) *What is System Bus? Explain the difference types of Bus used in computer or 8085 Microprocessor*
3) *Explain Von Neumann Architecture and Harvard architecture with suitable diagram.*
4) *Explain the Evolution of Microprocessor.*

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