Introduction to Microprocessor Based System

1. History of Microprocessors:

The microprocessor, also known as the Central Processing Unit (CPU), is the brain of a computer. The journey of microprocessors began with the development of the Intel 4004 in 1971. It was a 4-bit processor, designed for calculators, with a very limited instruction set. It could perform simple arithmetic and logical operations.

The next advancement was the Intel 8008, an 8-bit processor that could address more memory and was used in terminals. The Intel 8080 was a significant milestone in microprocessor history. Introduced in 1974, it could address up to 64KB of memory and became the foundation for many early personal computers.

The Intel 8085, introduced in 1976, was an enhanced version of 8080. It required a single +5V power supply (unlike the 8080s +5V, -5V, and +12V) and had an internal clock generator and system controller, making it easier to use in system design. It became very popular in academic and industrial applications.

Later, the Intel 8086 and 8088 (16-bit) opened the doors to modern computer architectures and eventually led to the x86 series used in personal computers today.

2. Architecture of 8085 Microprocessor:

The 8085 is an 8-bit microprocessor, meaning its data bus is 8 bits wide. It can process 8-bit data at a time. It has a 16-bit address bus, so it can access $2^{16} = 65536$ memory locations (64KB).

Key components in the architecture:

- **Accumulator (A)**: An 8-bit register used in arithmetic, logic, and data transfer operations.

- **Arithmetic and Logic Unit (ALU)**: Performs arithmetic (addition, subtraction) and logical (AND, OR, XOR, etc.) operations.

- **General Purpose Registers (B, C, D, E, H, L)**: These are 8-bit registers that can also be combined as register pairs (BC, DE, HL) to hold 16-bit data.

- **Program Counter (PC)**: A 16-bit register that holds the address of the next instruction to be executed.

- **Stack Pointer (SP)**: A 16-bit register used to point to the top of the stack.

- **Temporary Register**: Used internally for intermediate calculations.

- **Instruction Register and Decoder**: Temporarily holds the current instruction and decodes it.

- **Timing and Control Unit**: Generates timing and control signals required for the execution of instructions.

- **Interrupt Control**: Handles five hardware interrupts (INTR, RST7.5, RST6.5, RST5.5, TRAP).

3. Pin Details and Functional Block Diagram:

The 8085 microprocessor has 40 pins. Each pin has a specific function. The pins are divided into the following categories:

- **Power Supply and Clock**: Vcc (+5V), GND (ground), X1 and X2 (crystal oscillator inputs), CLK (clock output)

- **Address and Data Bus**: AD0AD7 (lower 8 bits multiplexed for address/data), A8A15 (higher-order address lines)

- **Control and Status Signals**: RD (read), WR (write), ALE (address latch enable), IO/M (selects between I/O and memory), S1 and S0 (status signals), READY (wait for slow devices), HOLD and HLDA (DMA control), RESET IN/OUT

- **Interrupts**: INTR, RST7.5, RST6.5, RST5.5, TRAP

- **Serial I/O Control**: SID (Serial Input Data), SOD (Serial Output Data)

Functional block diagram includes ALU, Register File, Instruction Decoder, Timing and Control Unit, Buses, etc.

4. 8085 Programming Model:

The programming model refers to how data is stored and manipulated in the microprocessor. It includes:

- **Accumulator**: Used in all arithmetic and logic operations.
- **General Purpose Registers**: Store temporary data. Pairs like BC, DE, HL are used for 16-bit operations.
- **Program Counter**: Keeps track of the instruction address.
- **Stack Pointer**: Used for stack operations.
- **Flag Register**: A special register whose bits are set/reset after ALU operations.
- **Sign Flag (S)**: Set if MSB of result is 1.
- **Zero Flag (Z)**: Set if result is 0.
- **Auxiliary Carry (AC)**: Used in BCD arithmetic.
- **Parity Flag (P)**: Set if result has even number of 1s.
- **Carry Flag (CY)**: Set if there is a carry out of MSB.

5. Address, Data and Control Buses:

- **Address Bus (16-bit)**: Carries address to memory or I/O ports (unidirectional).
- **Data Bus (8-bit)**: Transfers data between processor and memory/peripherals (bidirectional).
- **Control Bus**: Carries control signals like RD, WR, IO/M, S1, S0 that regulate the operations.

6. Demultiplexing of Buses:

The lower-order address bus (A0A7) is multiplexed with the data bus (D0D7) on lines AD0AD7 to reduce pin count. During the first clock cycle (T1), address is available. ALE is used to latch this address using an external latch (e.g., 74LS373).

7. Generation of Control Signals:

Control signals indicate whether the processor is reading, writing, or performing other operations. These are:

- **ALE (Address Latch Enable)**: Used to demultiplex AD0AD7.
- **RD (Read)**: Active low signal to read data.
- **WR (Write)**: Active low signal to write data.
- **IO/M**: Distinguishes between I/O and memory operations.
- **S1 and S0**: Indicate type of machine cycle.

8. Instruction Cycle, Machine Cycle and T-States:

- **Instruction Cycle**: The time taken to fetch and execute an instruction. May consist of multiple machine cycles.
- **Machine Cycle**: Time required to complete a basic operation like fetch, memory read/write, I/O read/write.
- **T-State**: One clock period. Multiple T-states make a machine cycle.

Example: For the instruction MVI A, 32H:

- Opcode Fetch (4 T-states)
- Memory Read (3 T-states)

Total = 7 T-states in 2 machine cycles.