Microprocessor

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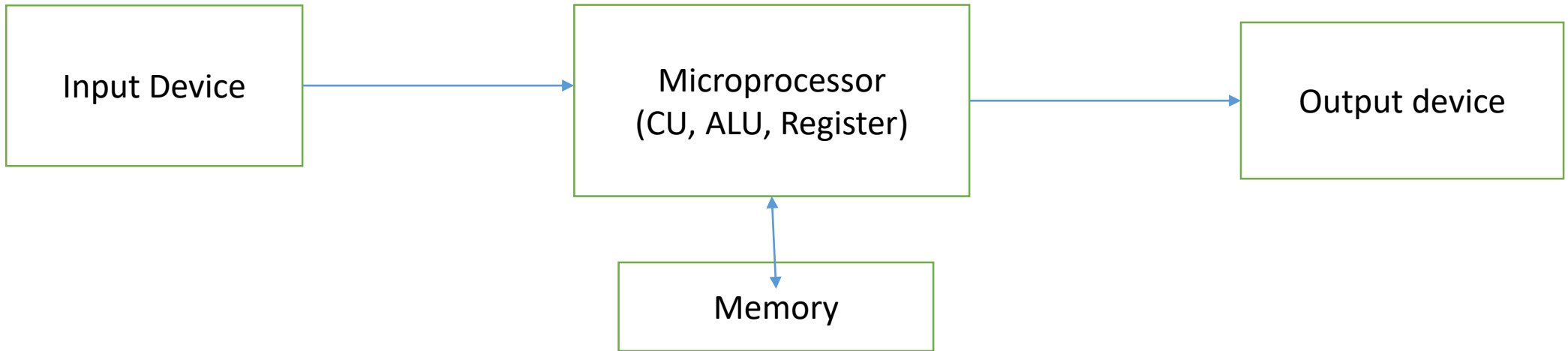
- **Microprocessor** is a controlling unit of a micro-computer, fabricated on a small chip capable of performing ALU operations and communicated with other devices connected to it.
- **Microprocessor** consists of an ALU, register array, and a control unit. ALU performs arithmetical and logical operations on the data received from the memory or an input device.
- Register array consists of register identified by letters like B, C, D, H, L and **accumulator**.
- The control unit controls the flow of data and instructions within the computer.



Working

- The microprocessor follows a sequence: **Fetch**, **Decode** and then **Execute**.
- The instructions are stored in a sequential order. The microprocessor fetches those instructions from memory, then decodes it and executes those instructions till stop instruction is reached.
- It sends the results in binary to the output port.
- Between these processes, the register stores the temporarily data and ALU performs the computing functions.

Name	Word length	Addressing capacity	Number of pins
4004	4 bits	640 bytes	16
8008	8 bits	16kb	18
8080	8 bits	64kb	40
8085	8bits	64kb	40
8086	16 bits	1Mb	40

Terms used in Microprocessor

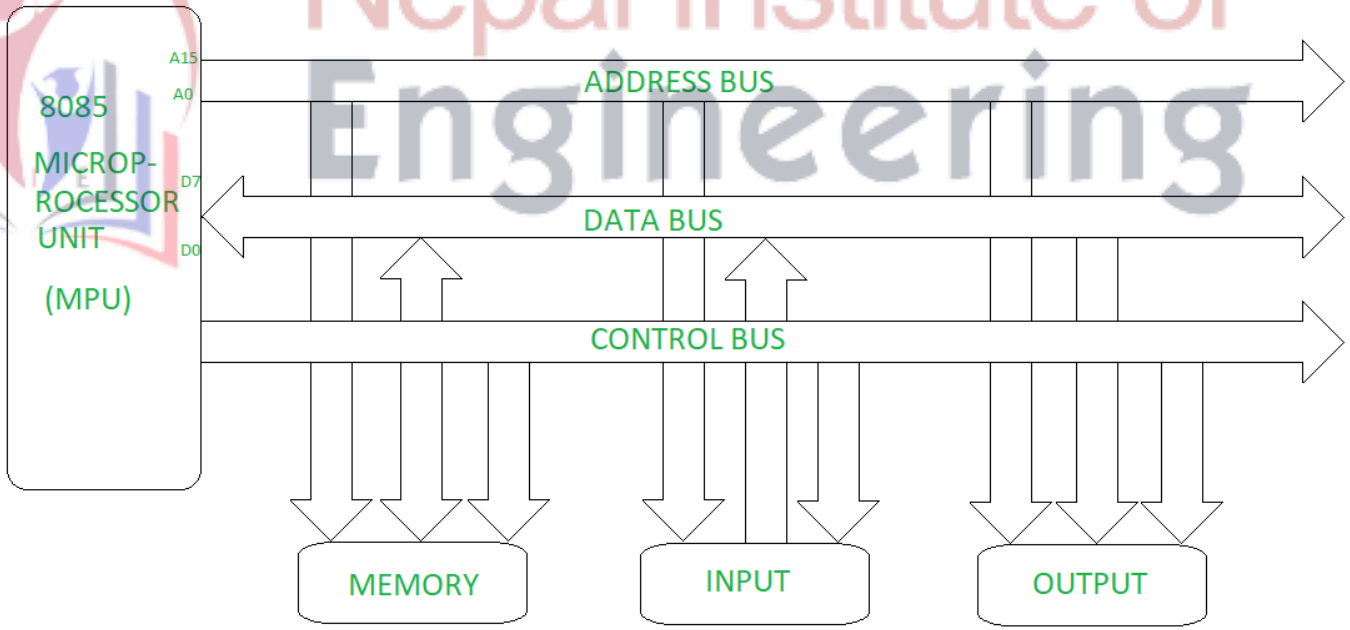
- **Instruction set-** it is the set of instruction that microprocessor understand.
- **Bandwidth-** it is the number of bits processed in a single instruction.
- **Clock speed-** it determines the number of operations per second the processor can perform. Eg Mhz, Hz.
- **Word length-** it depends upon width of internal data bus, registers, ALU, etc. An 8-bit microprocessor can process 8 bit data at a time.
- **Data type-** the microprocessor has multiple data type formats like binary, BCD, ASCII, signed and unsigned number.

Features of Microprocessor:-

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

BUS

- The communication channel between the microprocessor and peripherals is known as bus. It is a just group of wires.
- All the peripherals share the same bus but the microprocessor communicates with only one peripheral at one time as per the timing provided by the control unit.



Bus organization system of 8085 Microprocessor

Address Bus:-

- This bus is unidirectional, i.e. bit flow in only one direction from MPU to memory and peripherals.
- The address bus is for identification of memory locations and peripherals.
- 8085 has 16 bit and 8086 has 20 bit address bus.

Data Bus:-

- This bus is bidirectional, i.e. data can flow in both directions between mpu and memory/ peripherals.
- 8085 has 8 data lines and 8086 has 16 data lines.

Control Bus:-

- The control lines which carry synchronization and timing signals are known as control bus.

8085 Microprocessor

- It is an 8 bit microprocessor designed by intel using NMOS technology.
- It has the following configurations :-
  - ✓8 bit data bus.
  - ✓16 bit address bus which address upto 64kb
  - ✓A 16 bit program counter.
  - ✓A 16 bit stack pointer.
  - ✓Six 8 bit register arranged in pairs : BC, DE, HL.
  - ✓Require +5v supply to operate at 3.2Mhz single clock frequency.
- It is used in washing machines, microwave, ovens, mobile phones, etc.

Functional unit:-

- **Accumulator** :- it is an 8 bit register used to perform arithmetic, logical, I/O and load, store operation. It is connected to internal data bus & ALU.
- **Arithmetic & logical unit** :- it performs arithmetic and logical operations like ADD, SUB, AND, NOT, OR etc.
- **General purpose register**:- there are 6 general purpose register in 8085 processor i.e. B,C,D,E,H and L. each register can hold 8 bit data. These register work in pair to hold 16 bit data like BC, DE, HL.
- **Program counter** :- it is a 16 bit register used to store the memory address location of the next instruction to be executed. Microprocessor increments the PC whenever the instruction is being executed so that it points the next instructions to be executed.
- **Stack pointer** :- it is also 16 bit register works like a stack, which is always incremented/ decremented by 2 during push and pop operation.

- **Temporary Register**:-It is an 8 bit register, which holds the temporary data of arithmetic and logical operation.
- **Flag register** :- it is an 8 bit register having 1 bit fil-flops, which holds either 0 or 1 depending upon the result sotred in the AC. These are the 5 flip-flops- Sign(S), Zero(Z), Auxiliary carry (AC), Parity(P), carry (C).
- **Instruction Register and decoder** :- it is an 8 bit register. When an instruction is fetched from the memory then it is stored in instruction register. Instruction decoder decodes the information present in the instruction register.
- **Timing and control unit** :- it provides the timing and control signals to microprocessor to perform operations. Following are some timing and control signals, which controls external and internal circuit.

  control signal – READY, RD, WR, ALE,

  status signal – S0,S1, IO/M

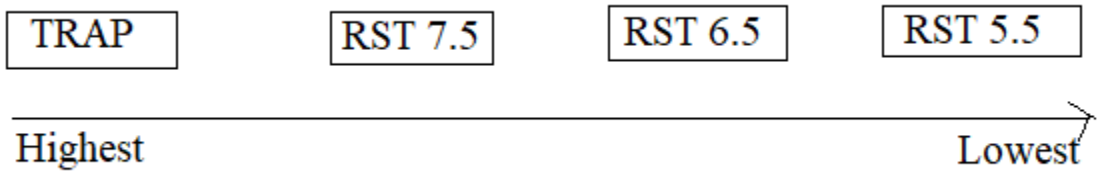
  DMA signal – HOLD, HLDA

  RESET signal – RESET IN, RESET OUT

- Interrupt :- It controls the interrupts during a process. When a microprocessor is executing a main program and whenever an interrupt occurs, the microprocessor shifts the control from the main program to process the incoming request. After the request is completed, the control goes back to the main program.

Maskable *Interrupts* are those which can be disabled or ignored by the microprocessor. *INTR, RST 7.5, RST 6.5, RST 5.5* are maskable interrupts in 8085 microprocessor.

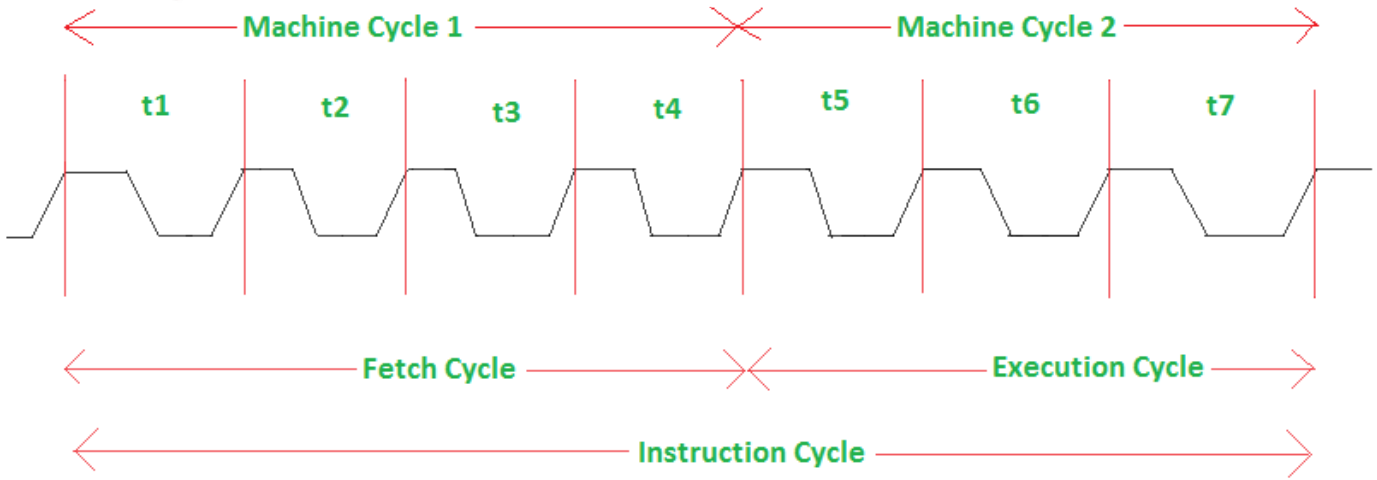
Non-Maskable Interrupts are those which cannot be disabled or ignored by microprocessor. *TRAP* is a non-maskable interrupt.



Instruction Cycle

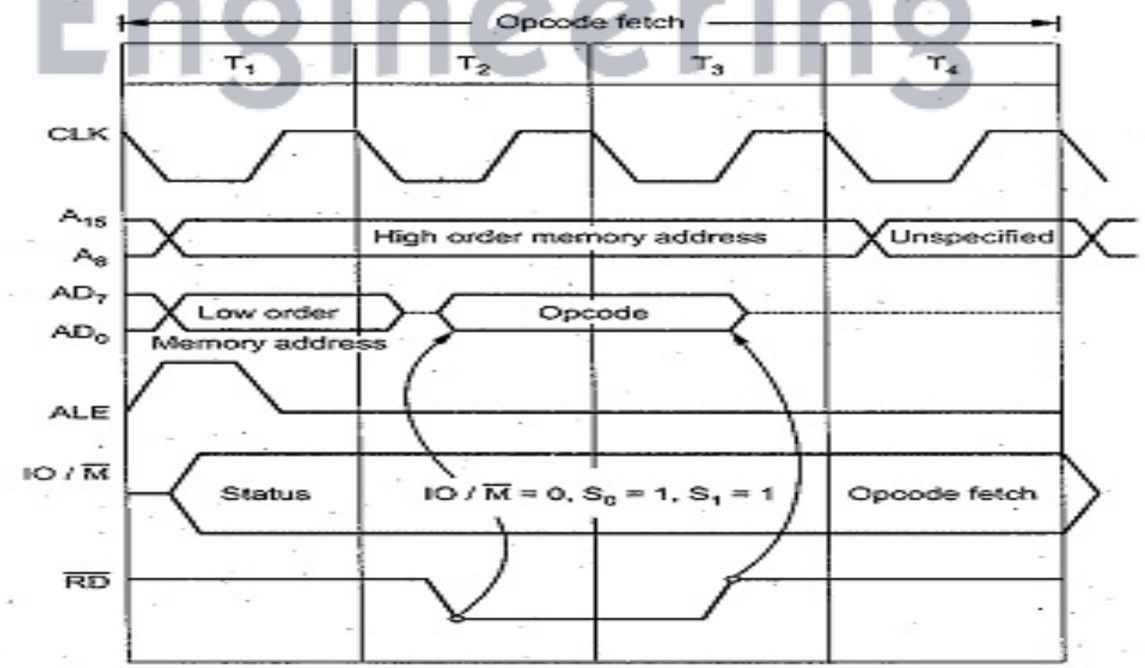
- Time required to execute and fetch an entire instruction is called instruction cycle. A program residing in the memory unit of the computer consists of a sequence of instructions.
- The program is executed in the computer by going through the cycle for each instruction. Each instructions cycle in turn subdivided into sequence of a sub cycle. Each instructions cycle consists of following phases :-
  1. Fetches instructions from memory.
  2. Decode the instruction.
  3. Read the effective address from memory.
  4. Execute the instruction.

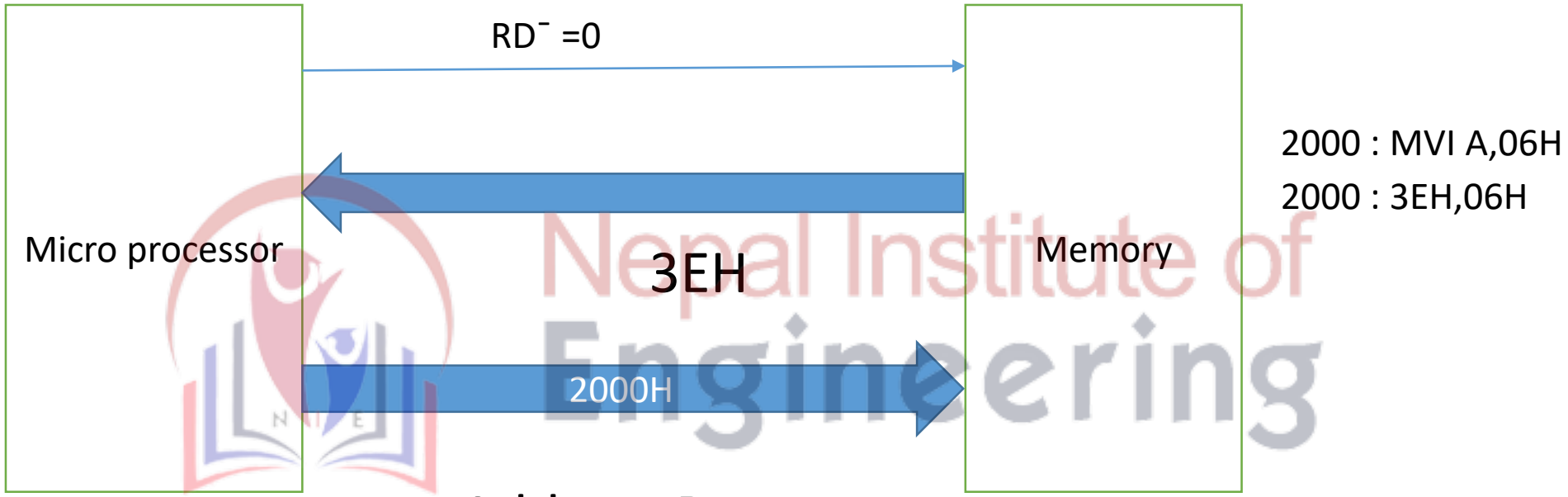
- The time required by the microprocessor to complete an operation of accessing memory or input/output device is called the machine cycle. Following are the different types of machine cycles :-
  - Opcode fetch – which takes 4t-states
  - Memory read – which takes 3t-states
  - Memory write – which takes 3t-states
  - I/O read – which takes 3t-states
  - I/O write – which takes 3t-states
  - One time period of frequency of microprocessor is called t-state. T-state is measured from the falling edge of one clock pulse to the falling edge of next clock pulse.



Opcode fetch cycle :-

- The first machine cycle of every instruction is **opcode fetch cycle** in which the 8085 finds the nature of the instruction to be executed. In this machine cycle, processor places the contents of the Program Counter on the address lines, and through the read process, reads the opcode of the instruction. The length of this cycle is not fixed. It varies from 4T states to 6T states as per the instruction.





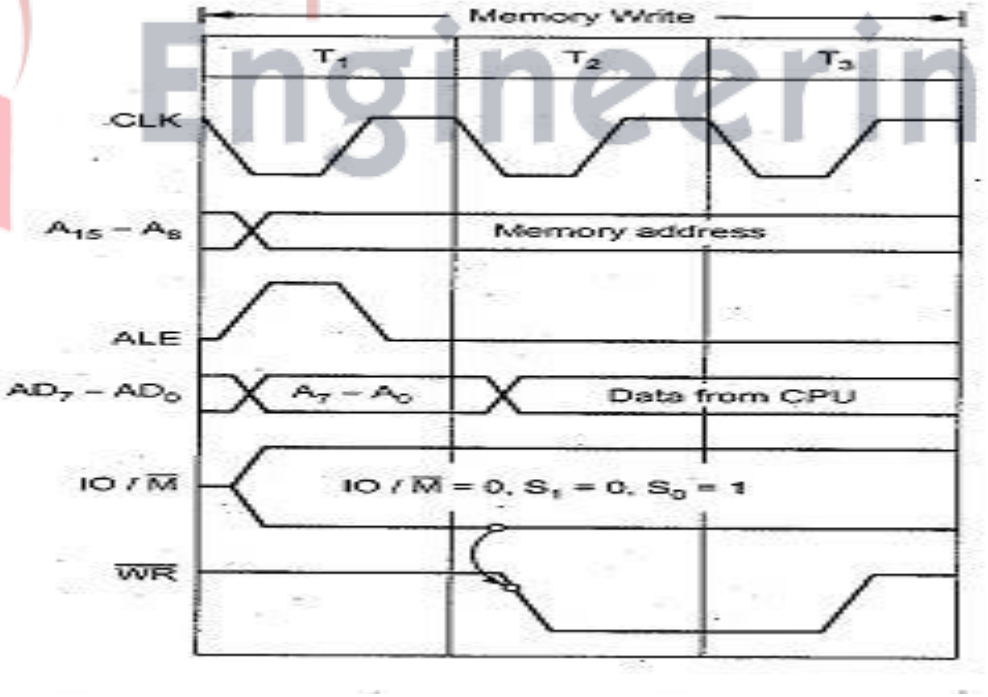
AD_0 –AD_7 =00H after $\overline{RD}$ =0 , it contains 3H. For 1st T-state it contains address (ALE=1)and then it contains data (ALE=0).

A_8 –A_{15} =20H S0,S1 =opcode fetch, =1,1

IO/$\overline{M}$ =0 for memory related operation.

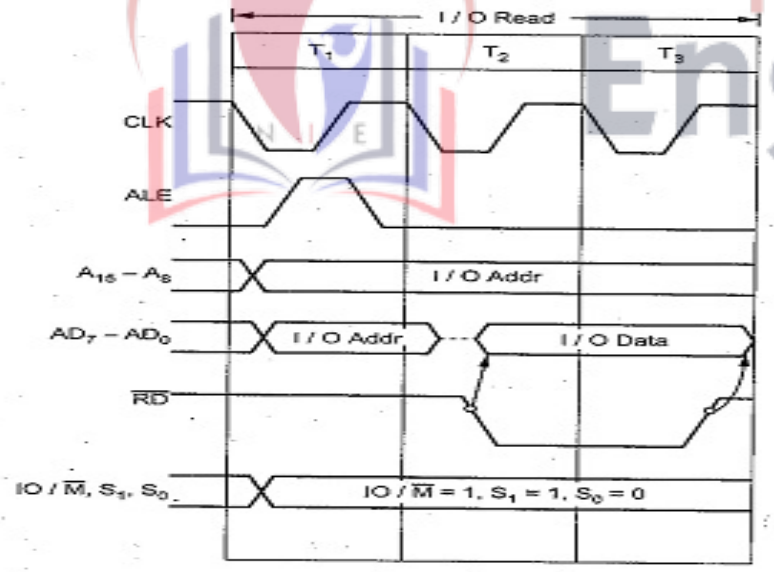
Memory Write Cycle :-

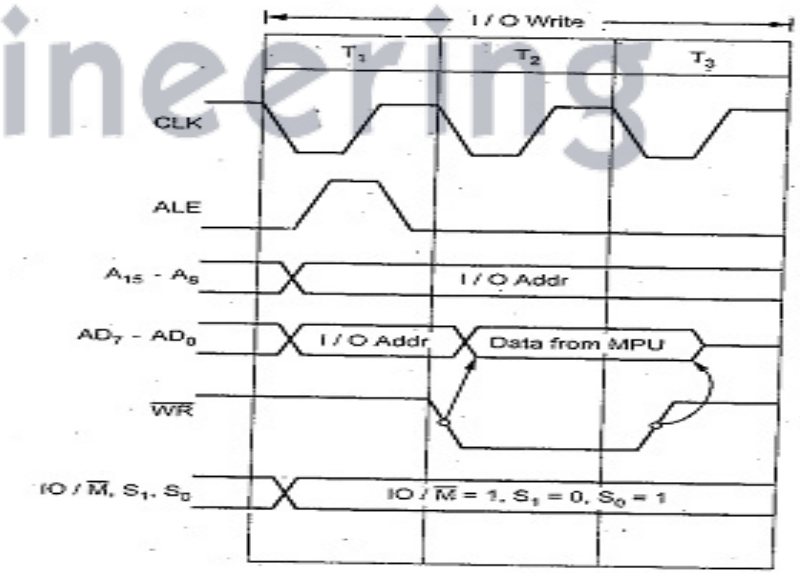
- The 8085 executes the memory write cycle to store the data into data memory or stack memory. The length of this machine cycle is 3T states. In this machine cycle, processor places the address on the address lines from the stack pointer or general purpose register pair and through the write process, stores the data into the addressed memory location.



I/O Read cycle :-

- The I/O read and I/O write machine cycles are similar to the memory read and memory write machine cycles, respectively, except that the I0/M signal is high for I/O read and I/O write machine cycles. High IO/M signal indicates that it is an I/O operation.

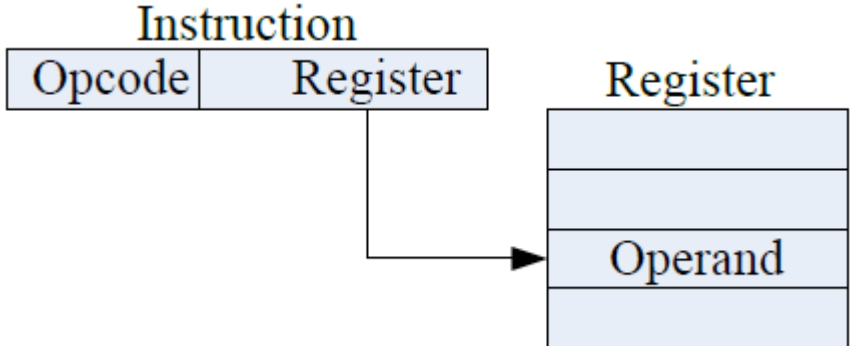




Addressing Mode in 8085 :-

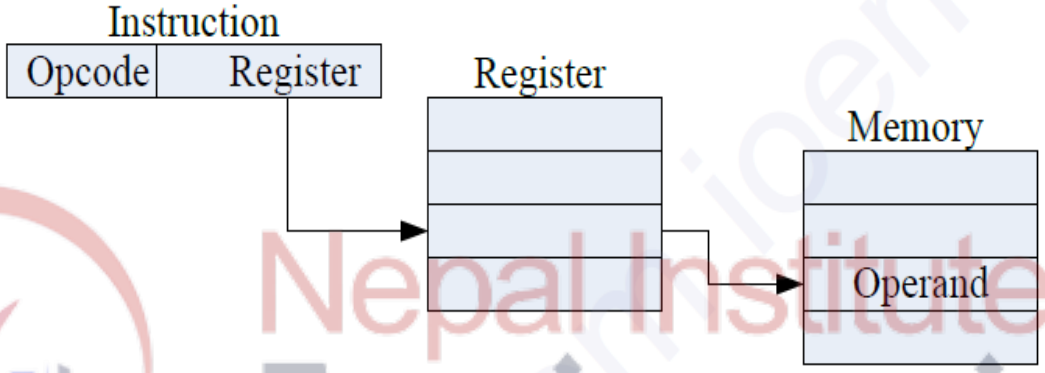
- In each instruction, programmer has to specify 3 things:
  - Operation to be performed.
  - Address of the source data.
  - Address of the destination result.
- Direct addressing mode :- the data to be operated is available inside a memory location and that memory location is directly specified as an operand. The operand is directly available in the instruction itself.

  e.g LDA 2050 (load the contents of memory location into accumulator A)
- Register addressing mode :- In register addressing mode, the data to be operated is available inside the register(s) and register(s) is(are) operands.

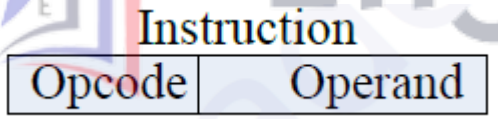


Register indirect addressing mode :-

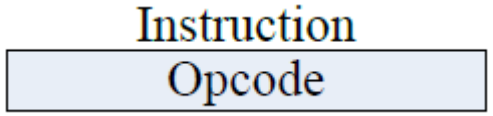
- The data to be operated is available inside a memory location and that memory location is indirectly specified by a register pair. e.g. LDAX B.



- **Immediate addressing mode** :- the source operand is always data. e.g. MVI B 45



- **Implied addressing mode :-**the operand is hidden, and data to be operated is available in the instruction itself. e.g. CMA



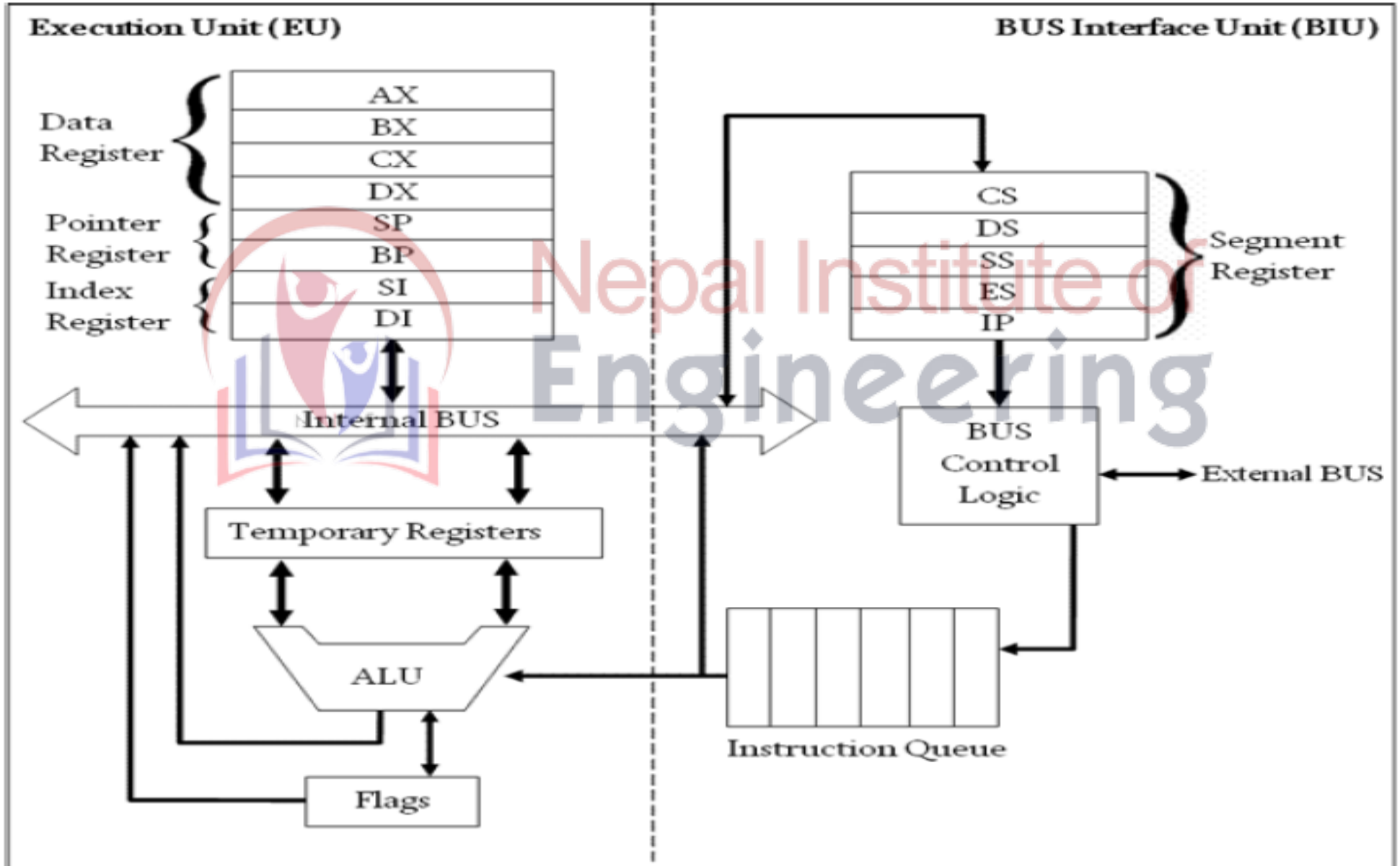
8086 Microprocessor :-

- 8086 Microprocessor is an enhanced version of 8085Microprocessor that was designed by Intel in 1976.
- It is a 16-bit Microprocessor having 20 address lines and16 data lines that provides up to 1MB storage. It consists of powerful instruction set, which provides operations like multiplication and division easily.
- It supports two modes of operation, i.e. Maximum mode and Minimum mode. Maximum mode is suitable for system having multiple processors and Minimum mode is suitable for system having a single processor.

Features :-

- It has an instruction queue, which is capable of storing six instruction bytes from the memory resulting in faster processing.
- It was the first 16-bit processor having 16-bit ALU, 16-bit registers, internal data bus, and 16-bit external data bus resulting in faster processing.
- It uses two stages of pipelining, i.e. Fetch Stage and Execute Stage, which improves performance.
- It consists of 29,000 transistors.

Internal Architecture of 8086 :-



Bus interface unit

- Handles transfer of data and addresses,
- Fetches instruction codes, stores fetched instruction codes in first-in-first-out register set called a **queue**,
- Reads data from memory and I/O devices,
- Writes data to memory and I/O devices.

Execution unit

- The **EU** receives opcode of an instruction from the queue, decodes it and then executes it. While Execution, unit decodes or executes an instruction, then the BIU fetches instruction codes from the memory and stores them in the queue.

Pin configuration of 8086

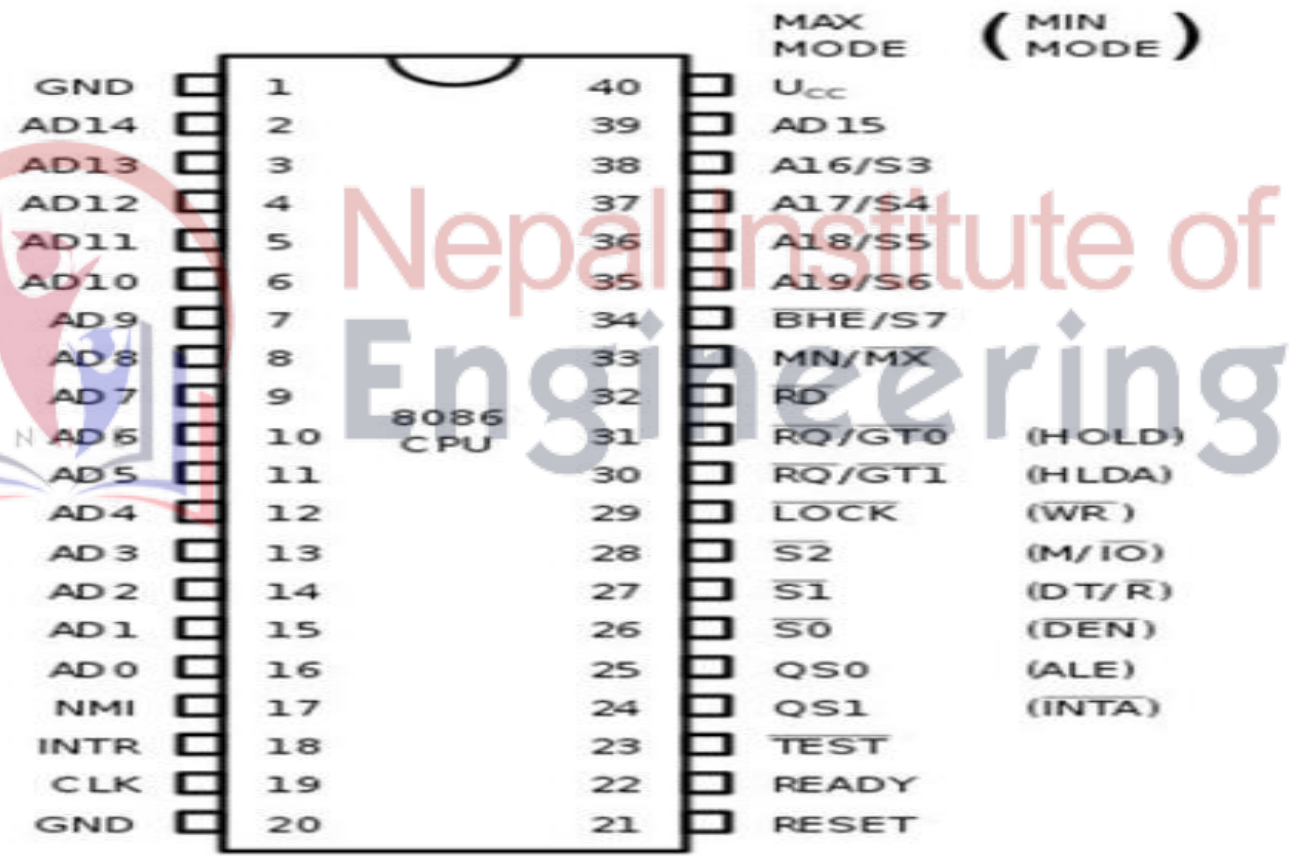


Fig: Pin Diagram of 8086