DEFINITIONS :-

(1) Micro Computer :- A computer that is designed using a microprocessor as its CPU. It includes Microprocessor, Memory & I/O (Input/output).

(2) Micro Controller :- A device that includes Microprocessor, Memory & I/O lines on a single chip, is called as Micro Controller.

(3) Bus :- A group of lines which are used to tranfer bits between the Microprocessor & the other Components of a Computer is called as Bus.

(4) Nibble :- A group of 4 bits is called as Nibble.

(5) Word :- A group of 16 bits is called as Word.

(6) Byte :- A group of 8 bits is called as Byte.

(7) Instruction :- A Binary Command Which is given to a Computer to accomplish a desired task is called as instruction.

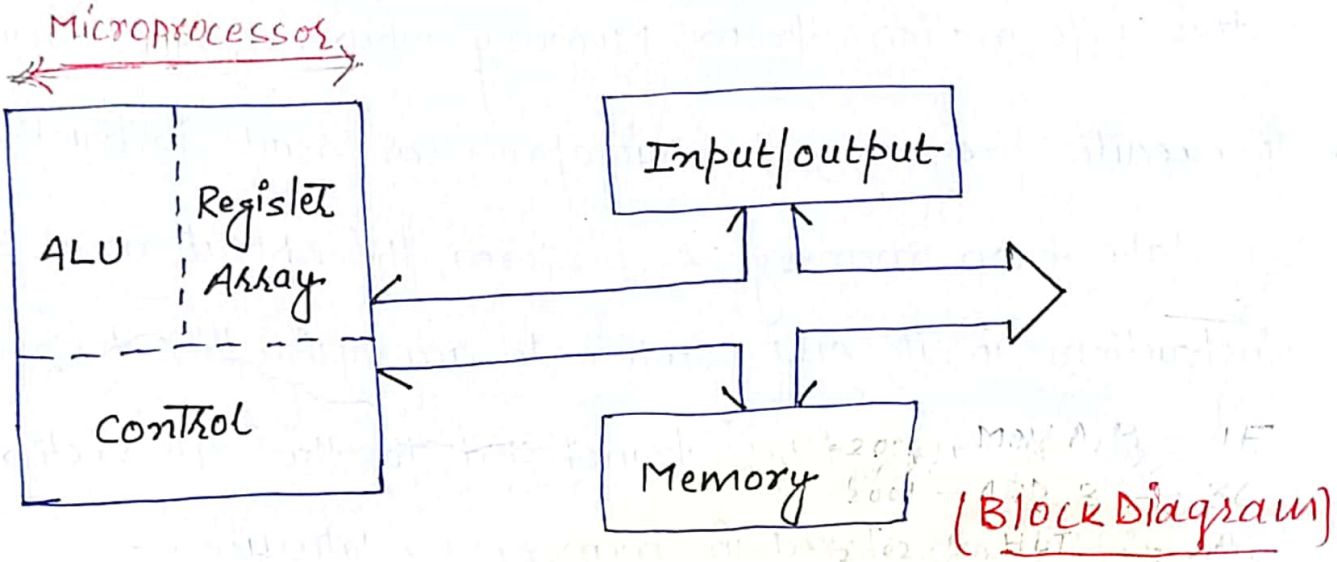
(8) Mnemonics :- The binary instructions are given Abbreviated names called as Mnemonics.

(9) Machine Language :- The language of OS & is for communication is known as Machine Language.

(10) Assembly Language :- The medium of Communication with a Computer in which programms are Written in mnemonics, is called as Assembly Language.

Organization of a Microprocessor Based System :- (Block Diagram)

→ The term peripheral is used for ⟶ input/output devices.



(Block Diagram)

(i) **Register Array :-** It consists of B, C, D, E, H & L Registers. These Registers are used to store data temporarily during the execution of a program.

(2) ALU :- This unit performs Arithmatic operations like Addition & subtraction & logical operations like AND, OR etc.

(3) Control Unit :- The control unit provides the necessary timing & control signals to all the operations. It controls the flow of data between the microprocessor and the peripherals & the memory.

control signals generated by the control unit are — (i) Memory Read (ii) Memory Write (iii) Input Read (iv) Input Write

Memory :- Memory stores binary informations like Instructions & data. The microprocessor takes this information from Memory whenever necessary.

⇒ To execute program, the Microprocessor reads instructions & data from memory & perform the operation as per instructions in its ALU section to accomplish the desired task. Results are either transferred to the o/p section for display or stored in memory for later use.

There are 2 types of Memory — (i) Read only Memory (ROM)
(ii) Random Access Memory (RAM)

⇒ How does Microprocessor (μP) Work.

⇒ The instructions are stored sequentially in the memory. The μP fetches the first instruction from its memory, decodes it in the decoder section & Executes that instruction. After execution, the results are either transferred to the o/p section or stored in memory for later use. This sequence of fetch, decode & execute is continued until the μP comes across an instruction to stop.

⇒ During the Entire process, the μP uses the system bus to fetch the binary instruction & data from memory. It uses registers from the register section to store data temporarily & it performs the Computing function in the ALU section.

Note :- [Fetch ⟷ (Means) Read.]
[Send ⟷ Write]

Microprocessor Initiated operations :- μP initiated operations are :-

(1) Memory Read :- Reads data or instructions from memory.

(2) Memory Write :- μP Writes data or instructions into memory.

(3) I/o Read :- µP Accepts data from input devices.

(4) I/o Write :- µP sends data to o/p devices.

⇒ In order to Communicate the µP with the peripherals (Memory, Input, output), the µP needs to perform the following steps :-

(i) Identify the peripheral (Memory or I/o) with its address

(ii) Provide timing & control signals ie Memory Read, Memory Write, I/o Read & I/o Write.

(iii) Transfer binary information (Data & instructions)

System Bus :- There are 3 types of system bus :-

(i) Address Bus :- The Address Bus is a group of 16 lines ie $A_{15} - A_0$. The Address bus is uni-directional ie data flows in only 1 direction — from µP to peripherals, Not from peripherals to µP.

The Address bus is used to identify the location of a peripheral or a memory location.

⇒ The no. of Address lines of the µp determines its capacity to identify different Memory locations.

⇒ The 8085 µp with its 16 address lines is capable of addressing $2^{16} = 65,536$ memory locations, which is known as $\left(\begin{array}{l} 2^{16} = 2^{10} \times 2^{6} \\ \quad\quad\;\downarrow \quad\;\downarrow \\ \quad\quad = 1K. \quad 64 \\ \quad\quad = 64\,K. \end{array}\right)$

(ii) Data Bus :- Data Bus is a group of 8 lines ie $D_0 - D_7$. The Data Bus is Bi-directional in Nature ie data flows from µp to peripherals & from peripherals to µp also. Data Bus is used to transfer data & instructions between µp & peripherals & Memory. The µp with 8 data lines can appear $2^8 = 256$ numbers on the data bus. The largest No. that can appears on the data Bus is 11111111 & the smallest is 00000000.

⇒ Intel 8086, Zilog Z8000 & Motorola 68000 Have 16 data lines; these are 16 bit µp.

(iii) Control Bus :- Control bus is used to provide timing & control signals. Control Bus is not a group of lines like Address Bus or Data Bus but it is an individual

line that provides a pulse to indicate an Microprocessor operation whether it is a Memory Read, Memory Write, I/o Read or I/o Write operation. These signals are used to identify the device with which µP wants to communicate.

Applications of Microprocessors :-

(1) Microprocessors are used in calculators, commercial appliances, videogames, toys etc.

(2) It is used in Laboratory for training the students.

(3) It can be used as a CPU of a Computer.

(4) They are used in Computers for Railway ticket reservations, air ticket reservations, books (Journals publishing), smart camera, energy meters etc.

(5) They are also used to measure & control the temp. of a Furnace & oven, to control the speed of motor etc.

Microprocessor characteristics :- The characteristics of the 8085 Microprocessor are as follows :-

(1) Processing Capability
(2) Word length
(3) Clock freq.
(4) Width of Address Bus
(5) Width of Data Bus
(6) I/o Addressing Capabilities
(7) Interrupt Capability
(8) Data types.

Program Counter:- Program Counter is used to sequence the execution of instructions. Program Counter is basically a 16-bit Register because the Memory locations have 16 bit Address. The function of the program Counter is to point the memory address from which the next instruction is to be fetched. When a byte/ instruction is being fetched, the program Counter is incremented by one

to point to the next Memory location.

stack pointer:- It is a 16 bit register. It is used to store data temporarily during the execution of a program in a defined R/W memory called stack. As we know that µp processes data bit by bit so after each process of bit by bit, it stores this processed data in the memory one upon another. In this way the whole data is stored in the form of stack & the desired task is executed.

Pin out of 8085:- 8085 is a 8 bit General purpose Microprocessor, capable of Addressing 64K of memory. The device has 40 pins, requires +5V single power supply & operates on 3 MHz clock frequency. All the 40 pins of µp can be classified into 6 groups :-

1) Address Bus 2) Data Bus 3) Control & status signals
4) Power supply & freq. signals 5) serial I/O ports 6) External initiated signals.

1) Address Bus :- The Address Bus is of 16 lines ie from $A_{15} - A_0$. These 16 lines are divided into 2 parts ie low order Address Bus ($A_7 - A_0$) & High order Address Bus ($A_{15} - A_8$). High order Address Bus ($A_{15} - A_8$) is uni-directional which is used to carry the higher order bits ⟶ of the Address of the memory location. Where as the lower order address bus ie ($A_7 - A_0$) is multiplexed with data bus ie $D_7 - D_0$. This is the multiplexed Address Data Bus $AD_7 - AD_0$.

2) Multiplexed Address Data Bus :- When the low order Address Bus $A_7 - A_0$ is multiplexed with data bus $D_7 - D_0$ then this is known as Multiplexing of Address Data Bus or Multiplexed Address Data bus ($AD_7 - AD_0$). This multiplexed Address Data bus is bi-directional & is served as a dual purpose means it can be used as a Address bus as well as data bus.

During the early part of the cycle, this is used as low order Address bus; to carry the lower order bits of the

Address of the memory location. Where as in the later part of the cycle, it is used as data bus; to carry the data between the µP, peripherals & Memory.

These lower order Address bus can be seperated or demultiplexed from the data bus by using a latch. Latch is the only signal which is used to seperate the lower order Address bus & Data bus.

Q.No7 Why do we need for multiplexed Address Data bus.

Sol^n) We have 16 Address lines ie $A_{15}-A_0$ & 8 Data lines D_7-D_0 so we have total 16+8 = 24 lines or wires to carry the Address or data in the 8085 µP.

As we know, more are the Wires or lines, less is the speed of transferring data. so due to 24 lines/wires the speed of transferring of bits is reduced, so in order to increase this speed, lower order Address bus A_7-A_0 is multiplexed with data bus D_7-D_0 & the multiplexed Address Data bus is AD_7-AD_0. Now by doing multiplexing, we have 8 multiplexed Address Data lines & 8 lower order Address lines so we have total 8+8=16 lines/wires.

Thus We can see that the total no. of Wires are reduced from 24 to 16 so the speed of tranferring bits is increased. This is the only reason for multiplexing of Address Data bus.

Note:- So out of 40 pins in the pin diagram of 8085, pins No. from 12–19 are the 8-Multiplexed Add-Data bus & pins No from 21–28 are the 8 lower order address bus.

3) Control & status signals :- pin numbers 29, 30, 31, 32, 33 & 34. Comes under Control & status signals.

⇒ There are 2 control signals < $\overline{RD}$ / $\overline{WR}$

⇒ There are 3 status signals < $IO/\overline{M}$, S_0, S_1 Which are used to identify the nature of operation.

⇒ There is one special signal ALE, Which is used to indicate the beginning of the operation.

ALE (Address Latch Enable) :- This is the (+ve) going pulse which is generated everytime when 8085 begins an operation. This pin is used to seperate the lower order address bus from the Multiplexed Address data bus.

$\overline{RD}$ (Read):- This is a active low pin. This pin is used to indicate that µp Wants to Read/Fetch data from selected Memory or I/O device.

$\overline{WR}$ (Write) :- This is a active low pin. This pin is used to indicate that µp Wants to Write some data into a selected memory or I/O device.

IO/$\overline{M}$:- This is a status signal which is used to differentiate whether it is a I/O or Memory operations. When this pin is high, it indicates that it is a I/O operation. When this pin is low, it indicates that it is Memory operation.

S_0 & S_1 :- These are the status signals which are used to indicate whether it is a Read operation or Write operation.

$IO/\overline{M}$	S_1	S_0	Control signals	Machine cycle
0	1	1	$\overline{RD}$	Opcode Fetch
0	1	0	$\overline{RD}$	Memory Read
0	0	1	$\overline{WR}$	Memory Write
1	1	0	$\overline{RD}$	I/O Read
1	0	1	$\overline{WR}$	I/O Write

4) Power supply & freq. signals :- pin Numbers 1, 2, 20, 40 & 37 comes under power supply & freq. signals.

V_{cc} :- We need a +5V power supply.

V_{ss} :- Ground Reference

X_1, X_2 :- A crystal oscillator (LC or RC N/W) is connected between pins X_1 & X_2. crystal should have a freq. of 6 MHz.

CLOCK OUT :- This signal can be used as system clock for the devices.

5) Externally Initiated signals Including Intrupts :-

pin nos 3, 6, 7, 8, 9, 10, 35, 36, 38, 39 & 11 comes under Externally Initiated signals including intrupts.

INTR (Intrupt Request) :- This is a Active high pin which is used to indicate that an external device wants to intrupt the up, so the external device sends an intrupt request.

$\overline{\text{INTA}}$ (Intrupt Acknowledge) :- This is a Active low pin, which is used to indicate that Microprocessor has got the intrupt Request.

RST 7.5 :- (Re-start Intrupts) :- These are the Vectored Intrupts which are used to intrupt a program Execution. There are 3 Re-start intrupts ie RST 7.5, RST 6.5 & RST 5.5. Among These three, the priority order is 7.5, 6.5 & 5.5. These are maskable intrupts.

READY :- When up wants to Communicate with a slow Responding device then Ready signal is used to delay the up Read or Write cycles unless until the slow responding device becomes ready to send or Accept data.

HOLD :- This signal indicates that a peripheral such as DMA Controller is requesting the up to use of the Address & Data buses.

HLDA :- This is a Active high Hold Acknowledgement signal which Acknowledges the hold request.

TRAP :- Trap is the Non-maskable intruptt which is having the highest priority among all the intruptts.

Reset In :- This is a Active low pin, when this pin goes low, the program counter is set to zero.

Reset out :- This pin is used to Re-set other devices.

6) Serial I/O ports :- Pin 4 & 5 Comes under serial I/O portt.

serial I/p Data :- This pin is used to indicate that the data will be received serially.

serial o/p Data :- This pin is used to indicate that the data will be xmitted serially.

Architecture of 8085 Microprocessor :- Architecture of 8085 µp includes the ALU, Timing & Control unit, Flags, Instruction Register & Decoder etc.

(i) Arithmatic And Logic Unit (ALU) :- All the Arithmatic And logical operations are performed in ALU section. ALU includes the Accumulator, the temporary Register, Arithmatic & logic ckts & 5 Flags. The temporary Register is used to hold data during Airthmatic/Logic operations. The Result is stored in the Accumulator.

Flags :- ALU includes 5 Flags (Flip-Flops) which are set or reset according to the result of the operation. The physical significance of the Flags is to test the data conditions in the ALU. The 5 Flags are as follows:- Flag is a 8 bit Register.

(1) Sign Flag :- After the execution of an Airthmatic or logic operation, if the D_7 bit of the result is 1, then the sign flag is set otherwise reset.

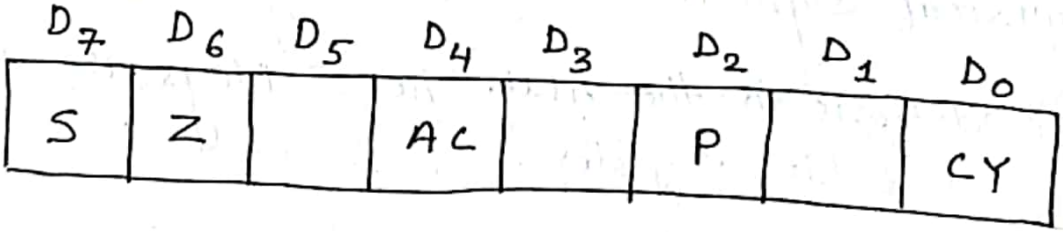
Note :- [Set = 1, Reset = 0]

2) Zero Flag :- After the ALU operation if the result is zero then zero Flag is set otherwise it is reset.

3) Auxillary Carry Flag :- In an Airthmatic operation, If a carry is generated from digit D_3 to D_4 then Auxillary carry Flag is set, otherwise it is reset. This Flag is used for BCD airthmatic.

4) Parity Flag :- After the ALU operation, if the result has even no. of 1's then the Flag is set otherwise it is reset.

5) Carry Flag :- After an Airthmatic operation, if the carry is generated then Carry Flag is set otherwise it is reset. This Flag is also used as a borrow Flag for Subtraction.



Flag Register

(3) Timing And Control Unit :- Timing & Control unit provides all the necessary timing & control signals to the Microprocessor. It Controls the flows of data between up & peripherals. The various timing And Control signals generated by timing & control unit are —

(1) Memory Read (2) Memory Write (3) I/O Read (4) I/O Write.

(4) Instruction Register And Decoder :- Instruction Register And decoder are the part of the ALU. When an instruction is fetched from memory, it is stored in the instruction Register. The decoder is used to decode the instructions.

(5) Register Array :- It includes programmable registers like B, C, D, E, H & L. These registers are used to store data temporarily during the execution of a program. These are 8 bit registers, which stores 8 bit data. If we want to store 16 bit data then pairing is done like BC, DE & HL. Two more registers are included in the Register Array; W & Z. These registers are also called as temporarily Registers.