

UNIT-I

(1)

Microprocessor is an integrated circuit that contains all the functions of a central processing unit of a computer.

- A microprocessor is a component that performs the instructions & tasks involved in computer processing
- CPU on a chip.
- Microprocessors may also be classified by their n/w architecture.

The two basic types of n/w are

- i) CISC (Complex instruction set computer)
- ii) RISC (reduced " ")

4-bit processors

- Intel 4004 - 1971.
1971 bit
- 8008
8 bit
- 8080 → execute additional instructions
1972 bit
- 8085
16 bit
- 80 Intel 8048
- " 8051
- " 8015)
- " 8025)

Companies

- Altera
- AMD
- Analog Devices
- Apollo
- ARM
- Atmel
- Hitachi
- IBM
- Intel
- ISRO
- Sunway
- Texas Instruments
- Zilog
- National Semiconductor

The Modern

- 16 bit Intel
→ 1978 → 8086 → 16 times faster than
the 8085
- 16 bit IBM → 8088

Microprocessor

g

Microcontrollers: —

- System on a chip.
- Microcontroller contains one or more CPUs (Processor cores) along with memory & programs, input/output peripherals
- Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM.

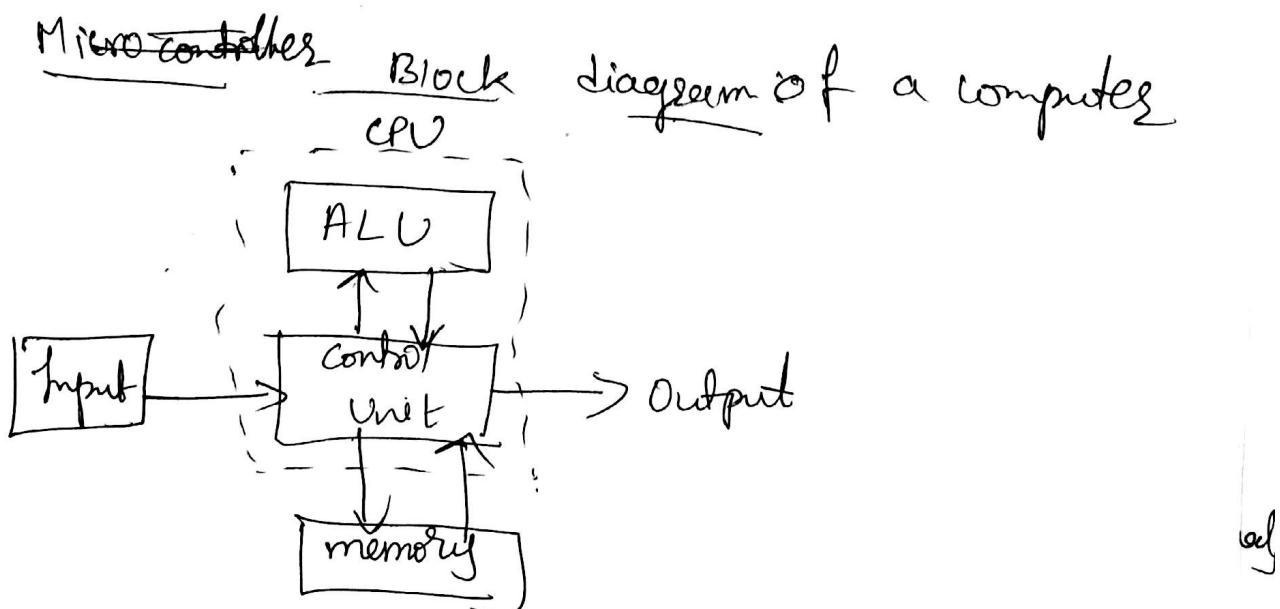
Applications of microcontrollers:

- 1) Embedded applications
 - 2) medical devices
 - 3) office machines.
 - 4) engine control systems
 - 5) remote controls
 - 6) toys
 - 7) power tools
 - 8) controlled devices.
- 1) → microcontroller brain is named as CPU
2) → " Memory chip works same as microprocessor.
3) → Input/output ports are basically employed to interface or drive different appliances such as printers, LCD's, LED's etc

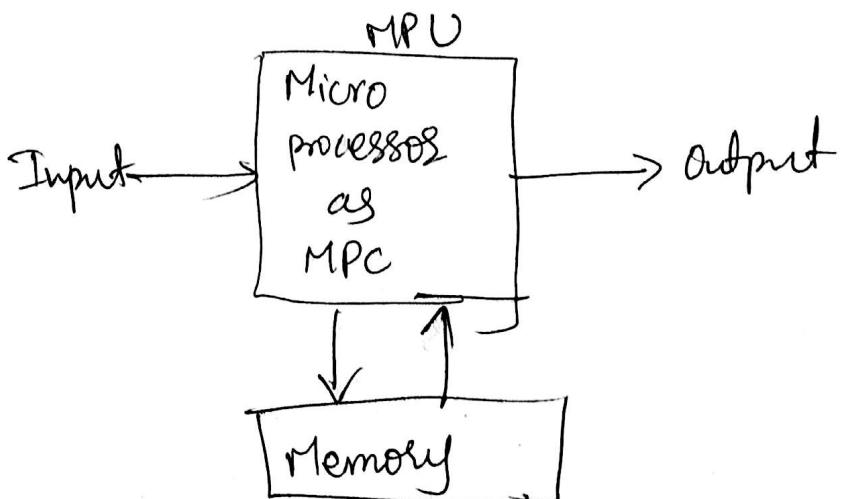


(2)

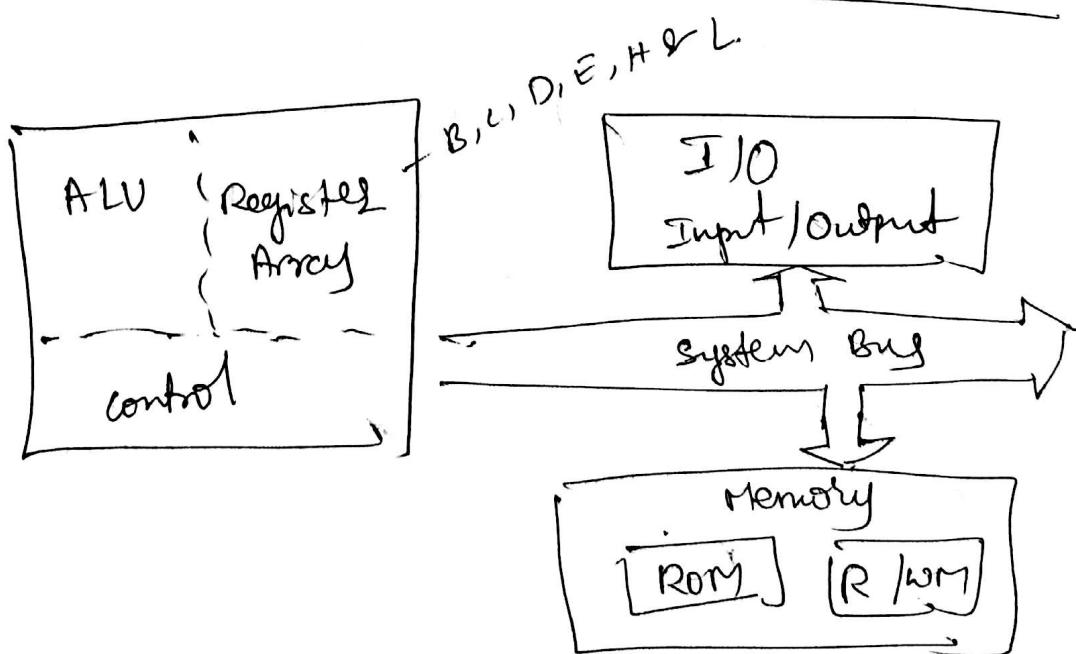
- 4) serial Ports: These ports give serial interface amid microcontrollers & various other peripherals such as parallel port.
- 5) Timers - A microcontroller may be in-built with one or more timer or counters. The timers & counters control all counting & timing operations within a microcontroller.
 → The main operations performed by timers are - pulse generations, clock functions, frequency measuring, modulations, making oscillations etc.
- 6) ADC
- 7) DAC
- 8) interrupt control - This controller is employed for giving delayed control for a working program.
 → The interrupt can be internal or external.
- a) special function block

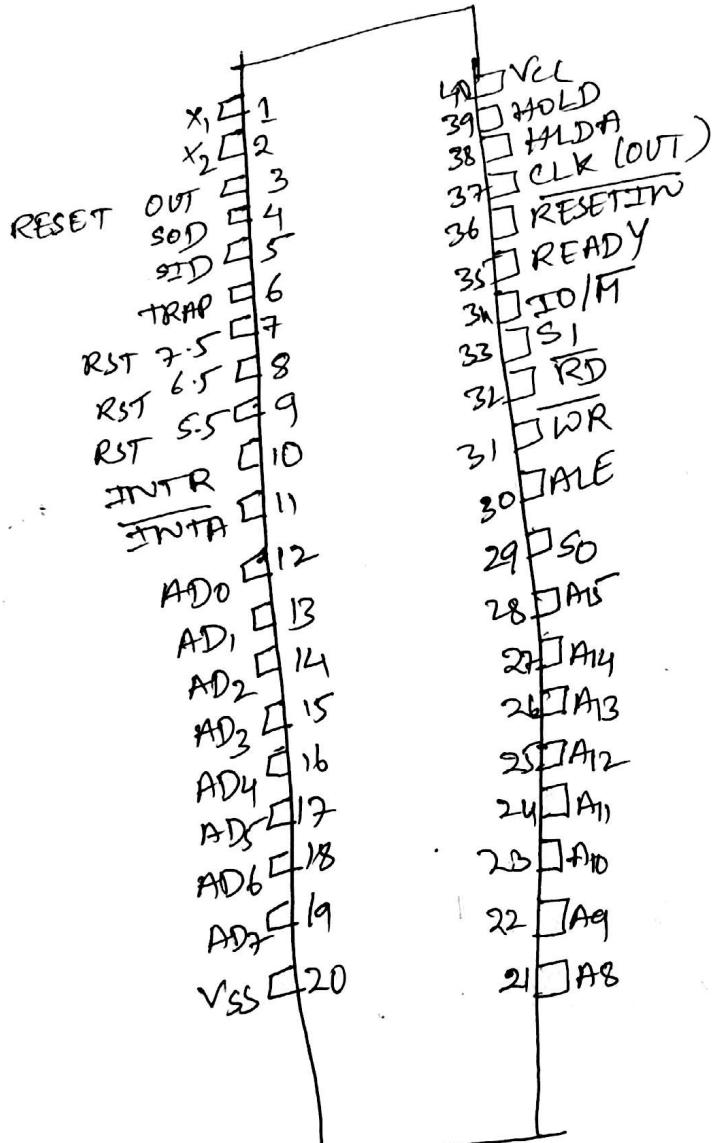


Block diagram of a computer with the MP as CPU (MPU)



Organization of a Microprocessor-Based System:





8085 Pinout

The 8085 MPU

The term microprocessing ~~control~~ unit is similar to the term central processing unit (CPU) used in traditional computers.

→ MPU as a device or a group of devices that communicate with peripherals, provide timing signals, direct data flow, & perform computing tasks as specified by the instructions in memory.

→ The 8085A is commonly 8-bit general purpose microprocessor capable of addressing 64K of memory.

→ The device has 40 pins requires +5V single power supply operate with 3MHz single-phase clock. 8085A-2 version can operate at the maximum freq of 5MHz.

→ All the signals can be classified into six groups.

- 1) Address bus
- 2) Data
- 3) Control & status signals
- 4) Power supply & frequency signals
- 5) Externally initiated signals
- 6) Serial I/O ports.

Address Bus:

A₁₅-A₈ - with unidirectional
Multiplexed Address/Data bus

A_{D7}-A_{D0} - are bidirectional - they serve a dual purpose.
Control & status signals;

DALE - Address Latch Enable : This is a positive going pulse generated every time the 8085 begins an operation.

2) RD

3) WR

4) IO/M : This is status signal used to differentiate b/n I/O & memory operation.

(4)

5) S₁ & S₀: These status signals, similar to IO/M, can identify various operations they are rarely used in small systems.

8085 Machine cycle status & control signals.

Machine cycle	Status			Control Signals
	IO/M	S ₁	S ₀	
Opcode Fetch	0	1	1	$\overline{RD} = 0$
Memory Read	0	1	1	$\overline{RD} = 0$
Memory write	0	0	1	$\overline{WR} = 0$
IO Read	1	1	0	$\overline{RD} = 0$
IO write	1	0	1	$\overline{WR} = 0$
Interrupt acknowledge	1	0	1	$\overline{INTA} = 0$
Halt	z	0	0	
Hold	z	x	x	$\overline{RD}, \overline{WR} = z$
Reset	z	x	x	$\overline{INTA} = 1$

z - Tri-state

x = Unspecified.

Externally initiated signals, including interrupts.

1) INTR (Input) / interrupt request

2) \overline{INTA} (Output) " Acknowledge

3) RST 7.5

RST 6.5

RST 5.5

Restart interrupt

4) TRAP Output)

nonmaskable interrupt has the highest priority

5) HOLD (Input)

This signal indicates that a peripheral such as a DMA controller is requesting the use of the address & data buses.

6) HLDA (Output)

Hold Acknowledge : This signal acknowledges the HOLD request

7) READY (Input)

This signal is used to delay the microprocessor read or write cycles until a slow-responding peripheral is ready to send or accept data.

8) RESET IN

: When the signal on this pin goes low, the program counter is set to zero, the buses are tri-stated, & the MPU is reset.

9) RESET OUT

: This signal indicates that the MPU is being reset. The signal can be used to reset other devices.

serial I/O Ports :

→ The 8085 has two signals to implement the serial transmission : SID (Serial Input Data)
SOD (" Output ")

Power supply

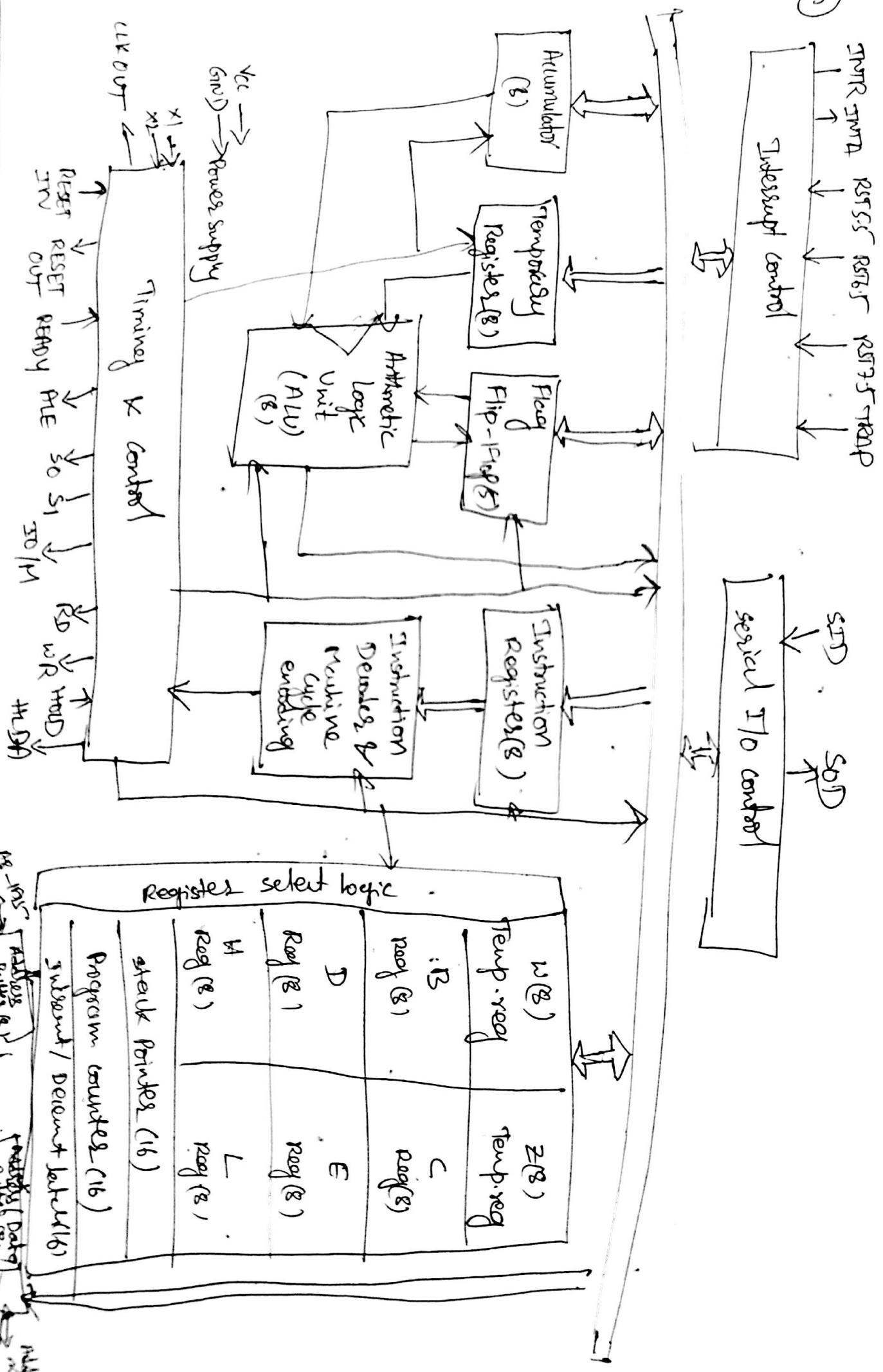
& clock frequency

V_{cc} : +5V

V_{ss} : Ground Reference.

X₁, X₂ : A crystal is connected at these two pins.

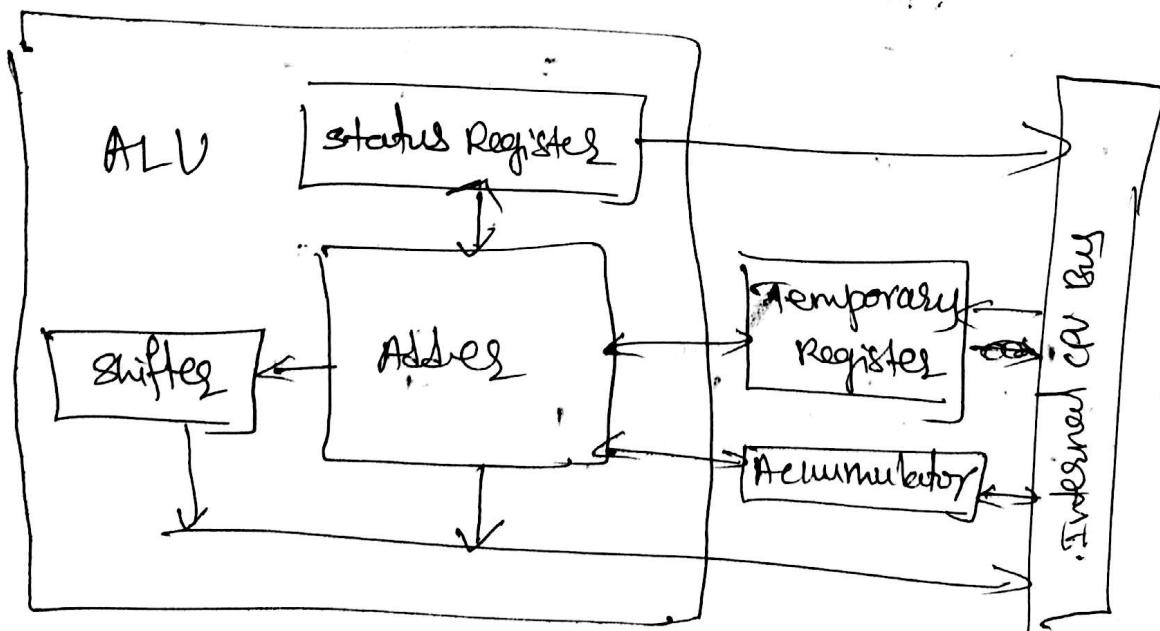
clock(out) : this signal can be used as the system clock for the other devices.



ALU

- It is multi operational combinational logic circuit
- It performs arithmetic & logical operations like ANDing, ORing, EX-ORing, ADDITION, SUBTRACTION
- It is not accessible by user
- The word length of internal data bus ALU depends upon of an
- It is 8 bit
- It is always controlled by timing & control circuits
- It provides status or result of flag register

Figure shown below shows some functional sections of ALU.



Adder :- It performs arithmetic operations. The result of operation is stored into accumulator.

Shifter :- It performs logical operations like rotate left, rotate right, etc. The result of operation is again stored in accumulator.

(6)

Status Registers: Also known as flag registers

- It contains a no. of flags either to indicate conditions arising after last ALU operation or to control certain operations.

Accumulator:

- It is one of the general purpose registers of microprocessor
- It is 8 bit register & that is part of ALU
- This register is used to store 8-bit data & to perform arithmetic & logical operations.
- The result of an operation is stored in the accumulator
- The user can access this register by giving appropriate instructions (commands)

Temporary Registers:

- It is also called as operand registers (8 bit)
- It provides operands to ALU. ALU can store immediate result in temporary registers.
- It is not accessible by user.

Status or Flag registers:

- Flag register is a group of flip flops used to give status of different operations result.
- The flag register is connected to ALU
- Once an operation is performed by ALU the result is transferred on internal data bus & status of result will be stored in flip flops.

→ They are called zero (Z), carry (CY), sign (S), parity (P), and auxiliary carry (AC) flags

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
S	Z	X	AC	X	P	X	CY

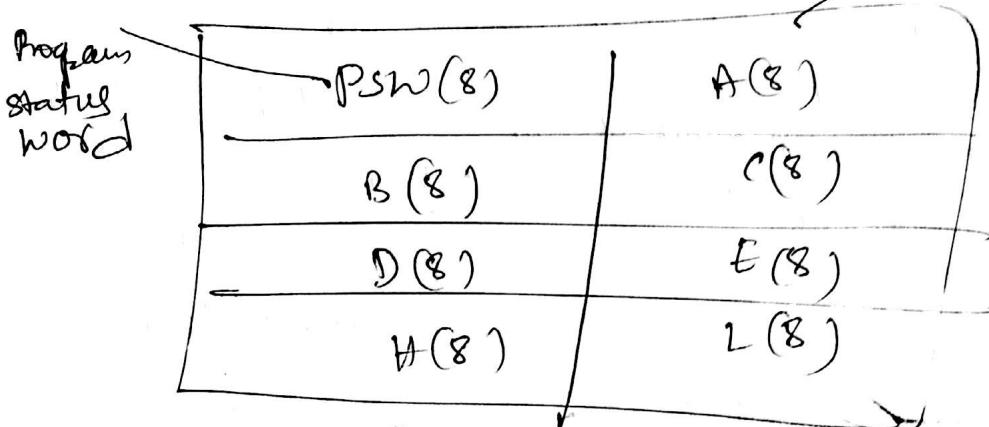
X-represents unspecified bits termed as "don't care"

- 1) Carry flag (CY): If an operation performed in ALU generates the carry from D_7 to next stage then CY flag is set, else it is reset.
- 2) Auxiliary carry (AC): If an operation performed in ALU generates the carry from lower nibble (D_0 to D_3) to upper nibble (D_4 to D_7) AC flag is set, else it resets.
- 3) Zero flag (Z): If an operation performed in ALU results 0 value of entire 8-bits then zero flag is set, else it resets.
- 4) Sign flag (S): if MSB bit = 0 then number is positive else it is negative.
- 5) Parity flag (P): If the result contains even no. of ones this flag is set & for odd no. of ones this flag is reset.

(7)

Temporary register (10 & 2)

- This temporary register can only be accessed by the microprocessor & it is completely inaccessible to the programmers
 - This is 8-bit register
 - This register is used by control systems to hold operand, intermediate operand, & address of memory & I/O devices temporarily
- Accumulator



General purpose register:

- Apart from accumulator 8085 consist of six special types of registers called General Purpose Registers.
- These general purpose registers are used to hold data like any other registers
- The general purpose registers in 8085 processors are B, C, D, E, H and L. Each register can hold 8-bit data.
- Apart from the above function these registers can also be used to work in pairs to hold 16-bit data.
- They can work in pairs such as B-C, D-E & H-L to store 16-bit data.

- The H-L pair work as a memory pointer
- A memory pointer holds the address of particular memory location.
- They can store 16-bit address as they work in pairs

Special purpose registers!

i) Program Counter

- Consider that an instruction is being executed by processor. As soon as the ALU finished executing the instruction, the processor looks for the next instruction to be executed.
- So, there is necessity for holding the address of the next instruction to be executed in order to save time. This is taken care by the program counter.
- A program counter stores the address of the next instruction to be executed.
- It is 16 bit register.

ii) Stack pointer!

- Stack pointer is also 16-bit register which is used as memory pointer.
- Stack is nothing but portion of RAM.
- Stack pointer maintains the address of the last byte that is entered into stack.
- Each time when the data is loaded into stack, stack pointer gets decremented. Conversely it is incremented when data is retrieved from stack.

Increment / decrement register !

- The 8-bit contents of a register or a memory location can be incremented or decremented by 1.
- This 16-bit register is used to increment or decrement the content of program counter & stack pointer register by 1.
- Increment or decrement can be performed on any register or memory location.
~~Address / Data buffer & Address buffer~~
- The contents of the stack pointer and program counter are loaded into the address buffer and address data buffer.
- These buffers are then used to drive the external address bus and address-data bus.
- As the memory & I/O chips are connected to these buses, the CPU can exchange desired data to the memory and I/O chips.
- The address-data buffer is not only connected to the external data bus but also to the internal data bus which consists of 8-bits.
- The address data buffer can both send & receive data from internal data bus.

Interrupt control section !

- As the name suggests this control interrupt a process.
- The microprocessor temporarily stops the execution of main program and transfers control to specific special routine known as "Interrupt service routine(ISR)"

→ Interrupt signals present in 8085 are

1. INTR
2. RST 7.5
3. RST 6.5
4. RS 5.5
5. TRAP

→ TRAP is non-maskable interrupt & other ~~maskable~~ ^{will} maskable interrupts.

→ A non-maskable interrupt is an interrupt which is given highest priority.

→ The non-maskable interrupts cannot be disabled by programmer at any point of time.

→ whereas maskable interrupts can be enabled and disable using EI & DI instructions.

→ Among the maskable interrupts RTS 7.5 is given the highest priority above RST 6.5, RST 5.5 & least priority is given INTR.

Serial I/O control section:

serial Input data - SID
n Output n - SOD

Instruction register & decoder

→ Instruction register is 8-bit register just like every other register of microprocessor

→ The instruction may be anything like adding two decodes, moving a data, copying a data etc.

→ When such an instruction is fetched from memory, it is directed to instruction register. So the instruction registers are specially to store the instructions that are fetched from memory.

→ There is an instruction decoder which decodes the information present in the instruction register for further processing.

Timing and control Unit :

→ Timing & control unit is a very important unit as it synchronizes the registers & flow of data through various registers and other units.

→ This unit consists of an oscillator & controller sequences which sends control signals need for internal & external control of data & other units.

→ The oscillator generates two-phase ~~per~~ clock signal which aids in synchronizing all the registers of 8085 microprocessor.

→ Signals that are associated with Timing & control unit are:

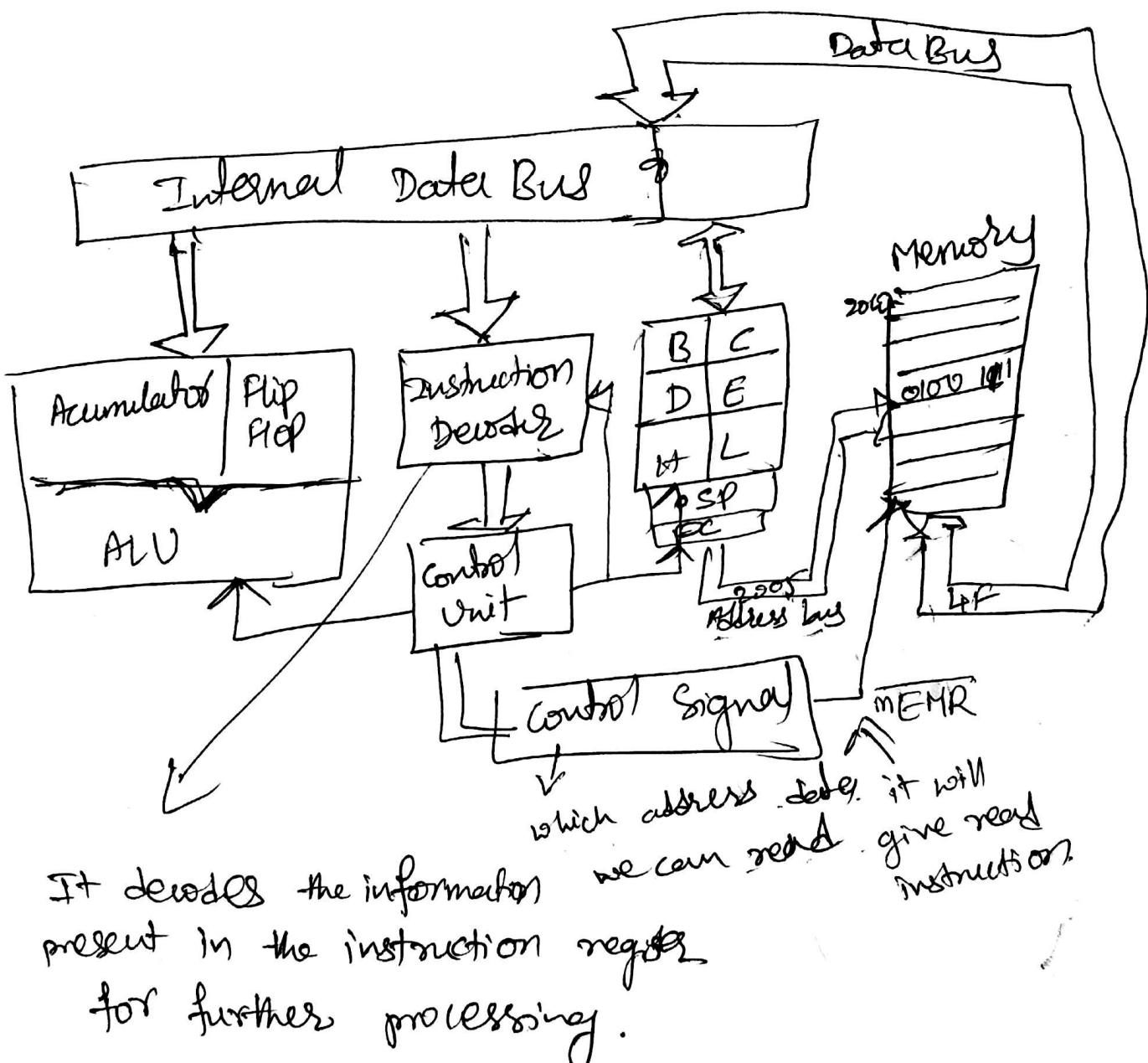
1. Control Signals: READY, \overline{RD} (out), WR, ALE

2. Status " : SO, S₁, $\overline{IO/M}$

3. DMA signals: HOLD, HLDA

4. RESET " : $\overline{RESET\ IN}$, RESET OUT.

Fetch - decode & execute cycle:



Addressing Modes of 8085

- To perform any operation, we have to give the corresponding instructions to the microprocessor.
- In each instruction, programmer has to specify 3 things:
 - Operation to be performed.
 - Address of source of data.
 - Address of destination of result.

Addressing Modes of 8085

- The method by which the address of source of data or the address of destination of result is given in the instruction is called **Addressing Modes**.
- The term addressing mode refers to the way in which the operand of the instruction is specified.

Types of Addressing Modes

- Intel 8085 uses the following addressing modes:
 1. Direct Addressing Mode
 2. Register Addressing Mode
 3. Register Indirect Addressing Mode
 4. Immediate Addressing Mode
 5. Implicit Addressing Mode

Direct Addressing Mode

- In this mode, the address of the operand is given in the instruction itself.

LDA 2500 H Load the contents of memory location 2500 H in accumulator.

- LDA is the operation.
- 2500 H is the address of source.
- Accumulator is the destination.

Register Addressing Mode

- In this mode, the operand is in general purpose register.

MOV A, B	Move the contents of register B to A.
-----------------	--

- MOV is the operation.
- B is the source of data.
- A is the destination.

Register Indirect Addressing Mode

- In this mode, the address of operand is specified by a register pair.

MOV A, M	Move data from memory location specified by H-L pair to accumulator.
-----------------	--

- MOV is the operation.
- M is the memory location specified by H-L register pair.
- A is the destination.

Immediate Addressing Mode

- In this mode, the operand is specified within the instruction itself.

MVI A, 05 H Move 05 H in accumulator.

- MVI is the operation.
- 05 H is the immediate data (source).
- A is the destination.

Implicit Addressing Mode

- If address of source of data as well as address of destination of result is fixed, then there is no need to give any operand along with the instruction.

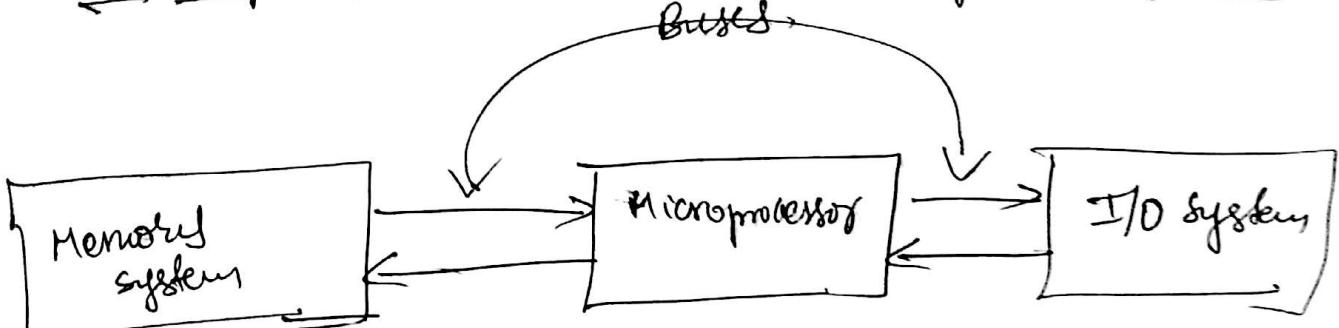
CMA

Complement accumulator.

- CMA is the operation.
- A is the source.
- A is the destination.

Motorola			
6800	8	64 K	
6805	8	2K	
6809	8	64K	
68000	16	16M	
68008 Q	8	1M	
68008 D	8	4M	
68010	16	16M	
68020	32	4G	
68030	32	4G	
68040	32	4G + 256 cache	
68050	32	Proposed, but never released	
68060	64	4G + 16K cache	
PowerPC	64	4G + 32K cache.	

The microprocessor - Based Personal computer system:



Dynamic RAM (DRAM)
Static RAM (SRAM)

Cache
Read-only (ROM)
Flash memory
EEPROM.

Printer
Mouse
CD-Rom
key board
Plotter etc.

The block diagram of a microprocessor based computer system.

<u>Many modern Intel & Motorola microprocessors,</u>			
<u>Manufacturers</u>	<u>Part</u>	<u>Data Bus Width</u>	<u>memory size</u>
Intel	8048	8	2k internal
Intel	8051	8	8k internal
	8085	8	64k
	8086	16	1M
	8088	8	1M
	8096	16	8k internal
	80186	16	1M
	80488	8	1M
	80251	8	16k internal
	80286	16	16M
	80386EX	16	64M
	80386DX	32	4G
	80386SL	16	32M
	80386SLC	16	32M+8k cache
	80386SX	16	16M
	80486DX/DX2	32	4G+8k cache
	80486SX	32	4G+ 16k cache
	80486DX4	32	4G+16M
	Pentium	64	4G+ 16k cache
	Pentium Overdrive (P200)	32	4G+16k cache
	Pentium Pro processor	64	64G+16k L1 cache +256k L2 cache.

8085 Timing

It consists of

Graphical representation diagram: → of execution of one instruction
i) Fetch cycle
ii) Execute cycle

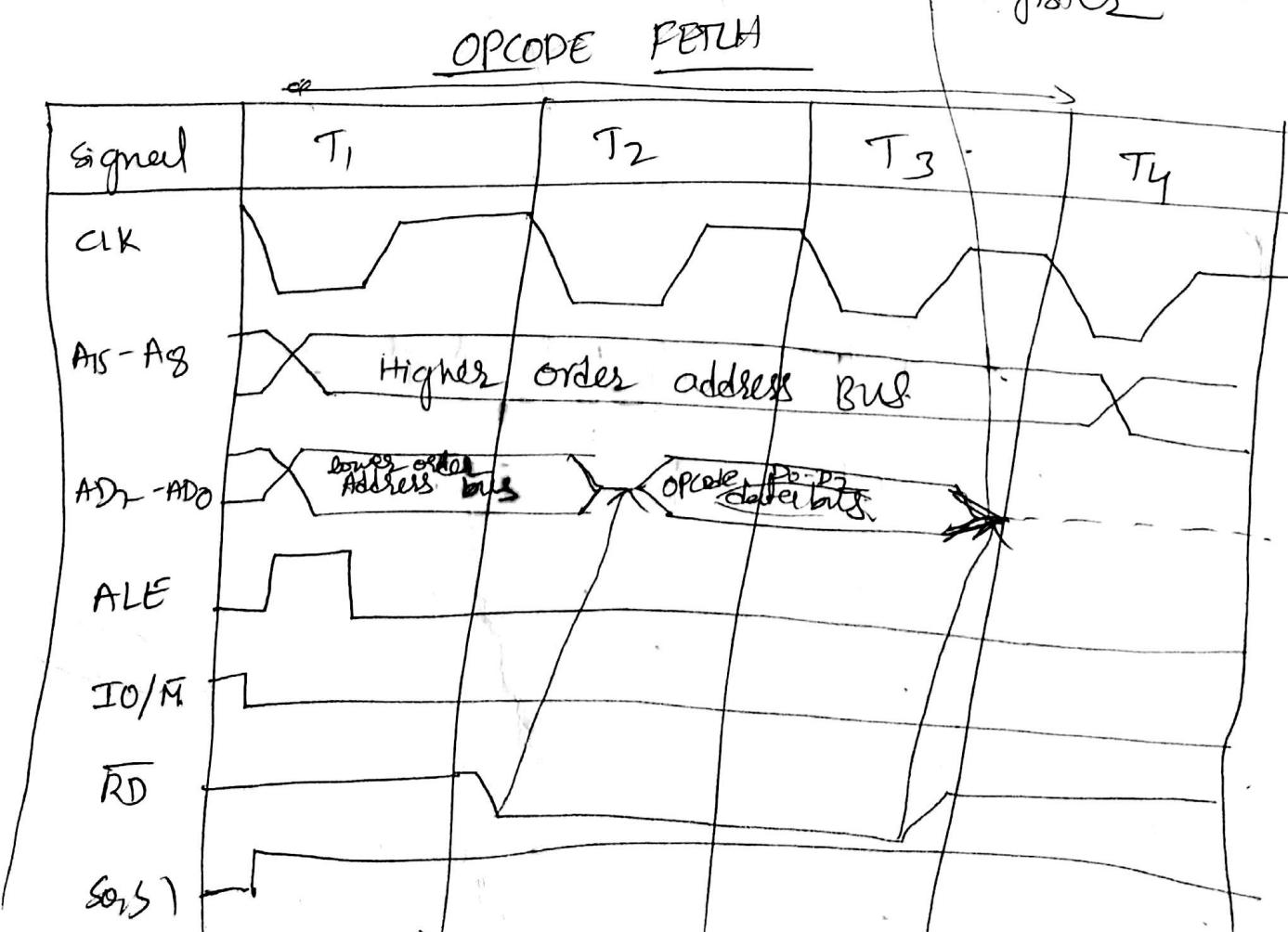
→ Instruction Cycle: Time taken to execute the instruction MVI A, 02

→ Machine cycle: Time taken to perform one operation (MVI A, 02)

→ T-state: One subdivision of the operation is performed by one clock period.

Various operations performed by any microprocessor

- 1) Opcode fetch
 - 2) Memory Read
 - 3) n write
 - 4) I/O Read
 - 5) I/O write
- first 3 T-states to ~~execute~~ ^{Fetch}
T₄ - for execute.
- after this it will go to ~~execute~~ ^{to execute} instruction registers

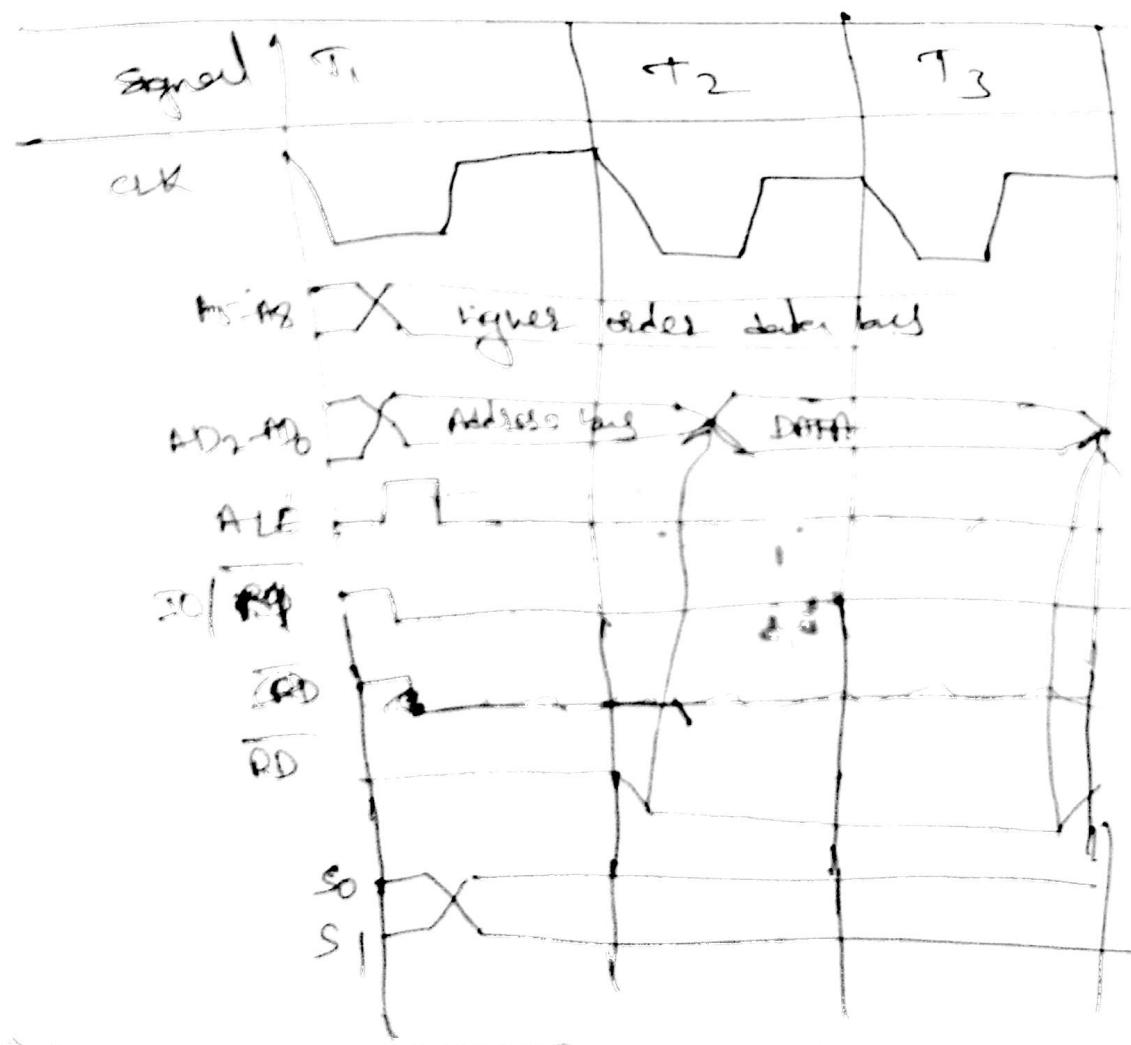


- Address bus multiplexing with data bus, then it has to demultiplex.
- whenever the instruction is executed microprocessor generates a pulse ~~ALE~~ loaded into D₀-D₇
- After the latch opcode will be available in the data bus
- after that ~~opcode~~ opcode will move to instruction register
- whenever the instruction is being executed Address & data buses are free during that time some other peripherals may steal the cycle "cycle stealing"
eg DMA controller

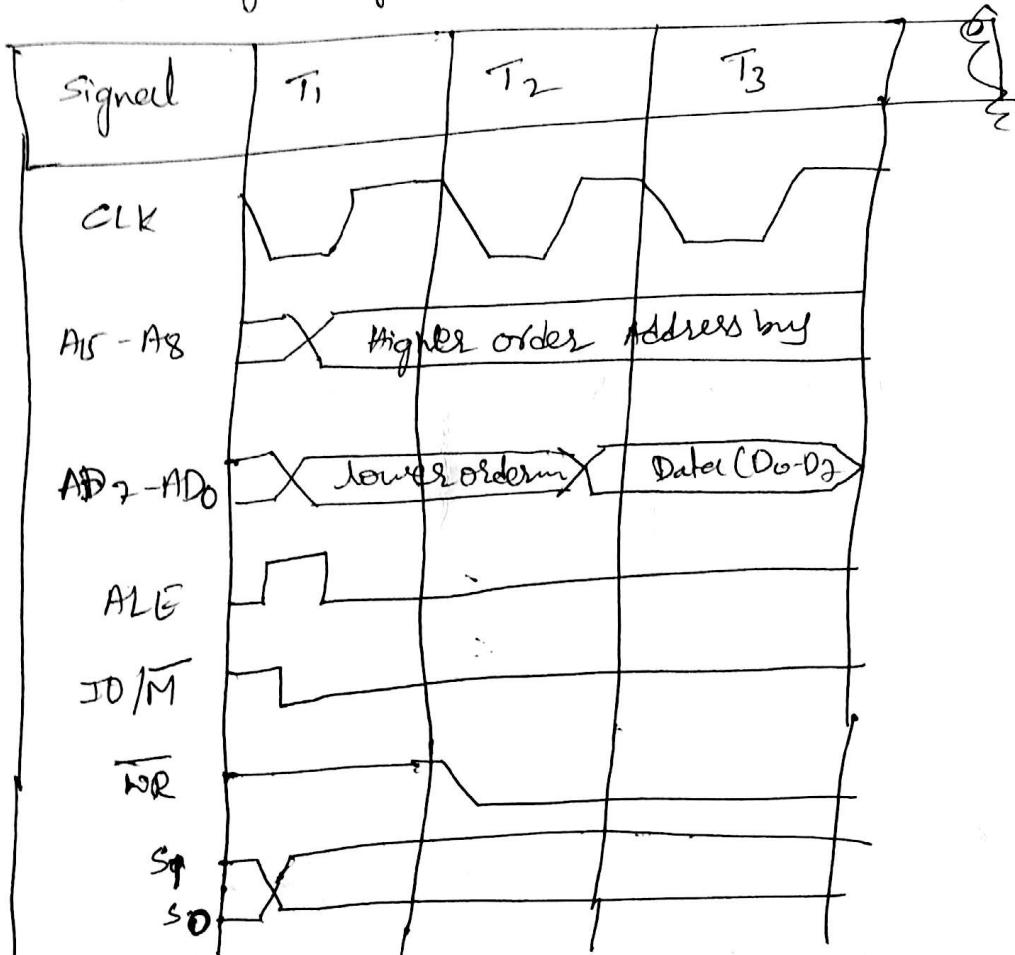
S ₁ , S ₀	
0 0	none
0 1	write
1 0	read
1 1	opcode fed

Timing diagram for memory read

- data need not be executed.



Timing diagram for memory write:



Timing diagram for memory \rightarrow Read.

