The microprocessor

is a programmable chip that can perform very basic functions namely (a) data transfer between itself, memory and I/O devices (b) arithmetic operations (c) boolean decisions.

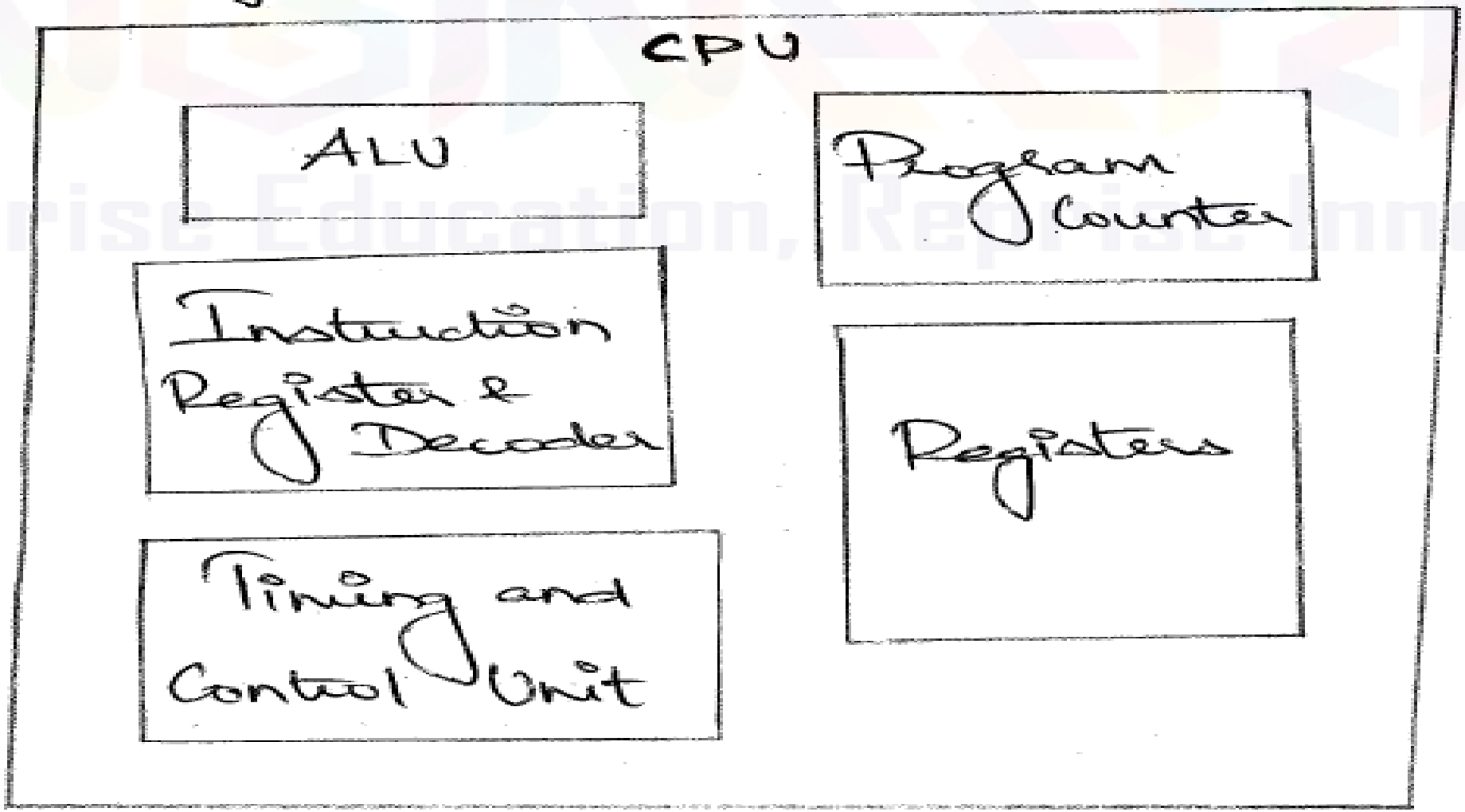
Through a program which is a logical arrangement of basic operations, the microprocessor can be made to accomplish very complex tasks.

The microprocessor is the controlling element in a computer and is also referred to as CPU.

1

Microprocessor……..

Block Diagram of Microprocessor :



Microprocessor……

* The CPU built on a single IC is called a microprocessor.

* The microprocessor requires the below, to perform any operation.

- ALU – Computational unit which performs arithmetic / logical operations on binary data.
- Register Array –: Internal Storage device. The I/P (or) O/P data and any other binary information needed for processing are stored in the register array.

Microprocessor……

- Timing & Control Unit –: Generates the necessary control signals for internal / external operations of the microprocessor.
- Instruction Register & Decoder –: * The instruction fetched from the memory is stored in the instruction register
  * The decoder, decodes the content of instruction register.
- Program Counter –: It holds the memory address of the next instruction to be executed.

Microprocessor……

Advantages of Microprocessor :

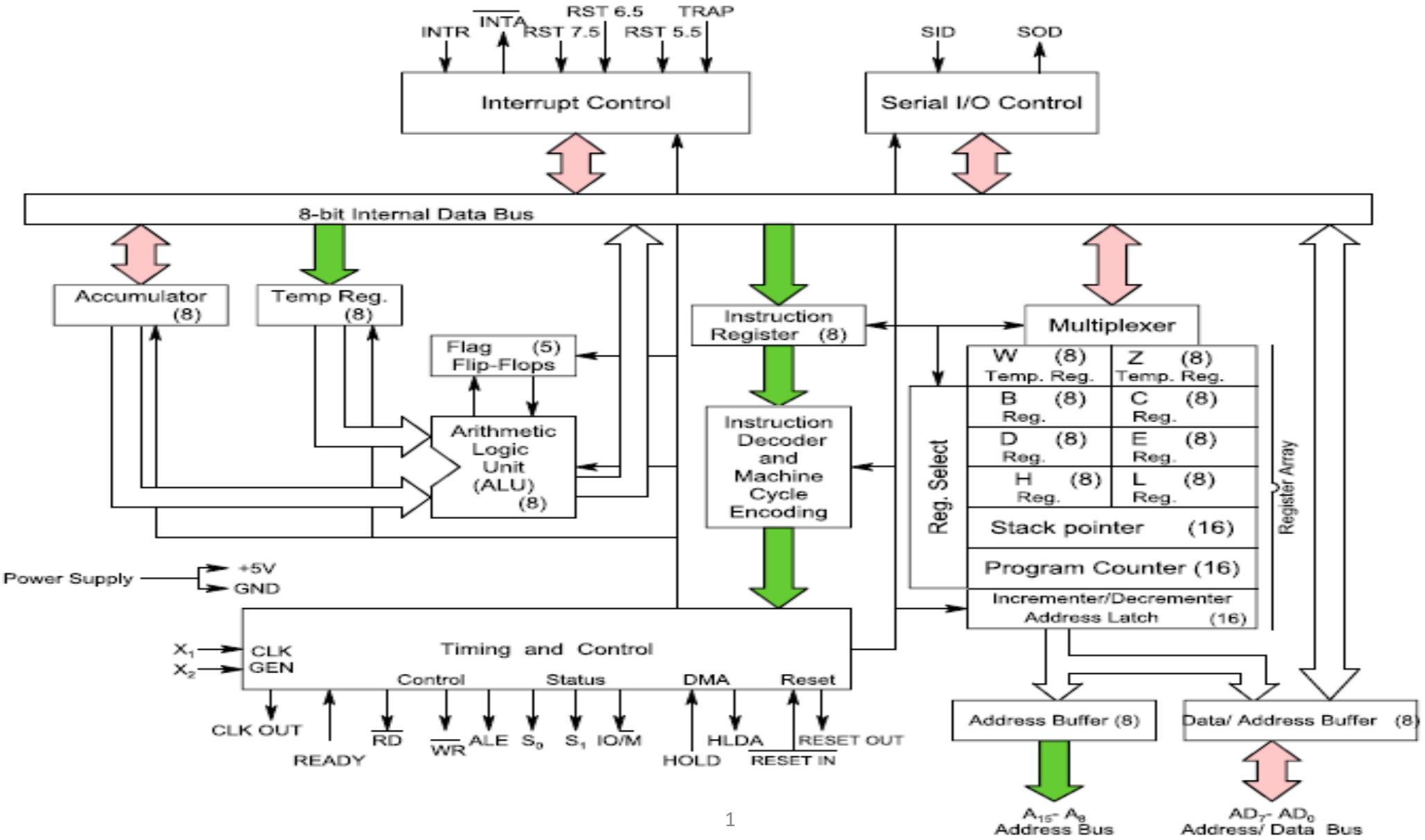
* low Cost
* Small Size
* low power consumption
* High Versatility & Reliability

Applications of Microprocessors:

- Microcomputer: Microprocessor is the CPU of the microcomputer.
- Embedded system: Used in microcontrollers.
- Measurements and testing equipment: used in signal generators, oscilloscopes, counters, digital voltmeters, x-ray analyzer, blood group analyzers baby incubator, frequency synthesizers, data acquisition systems, spectrum analyzers etc.
- Scientific and Engineering research.
- Industry: used in data monitoring system, automatic weighting, batching systems 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 systems
  - Military applications

Internal Architecture of 8085



- **Arithmetic Logic Unit [ALU]:** A combinational circuit that performs the basic computations as per instructions.
- **Accumulator [A]:** A program-visible register that always contains the first operand to the ALU and the results of the ALU. The second operand is placed in a program-invisible temporary register.
- **Program-visible registers [B,C,D,E,H,L]:** These are used by the programmer as scratch-pad registers to provide accessory data for instructions and as pointers
- **Program-invisible registers [W,Z]:** These are used by the microprocessor as scratch-pad registers to place temporary data.
- **Stack Pointer [SP]:** contains pointer to the tip of the stack, a special area in the memory with a special purpose.
- **Program Counter [PC]:** contains the address of the next instruction to be executed.
- **Instruction Register [IR]:** After instruction fetch, the instruction opcode is placed in the IR for decode.

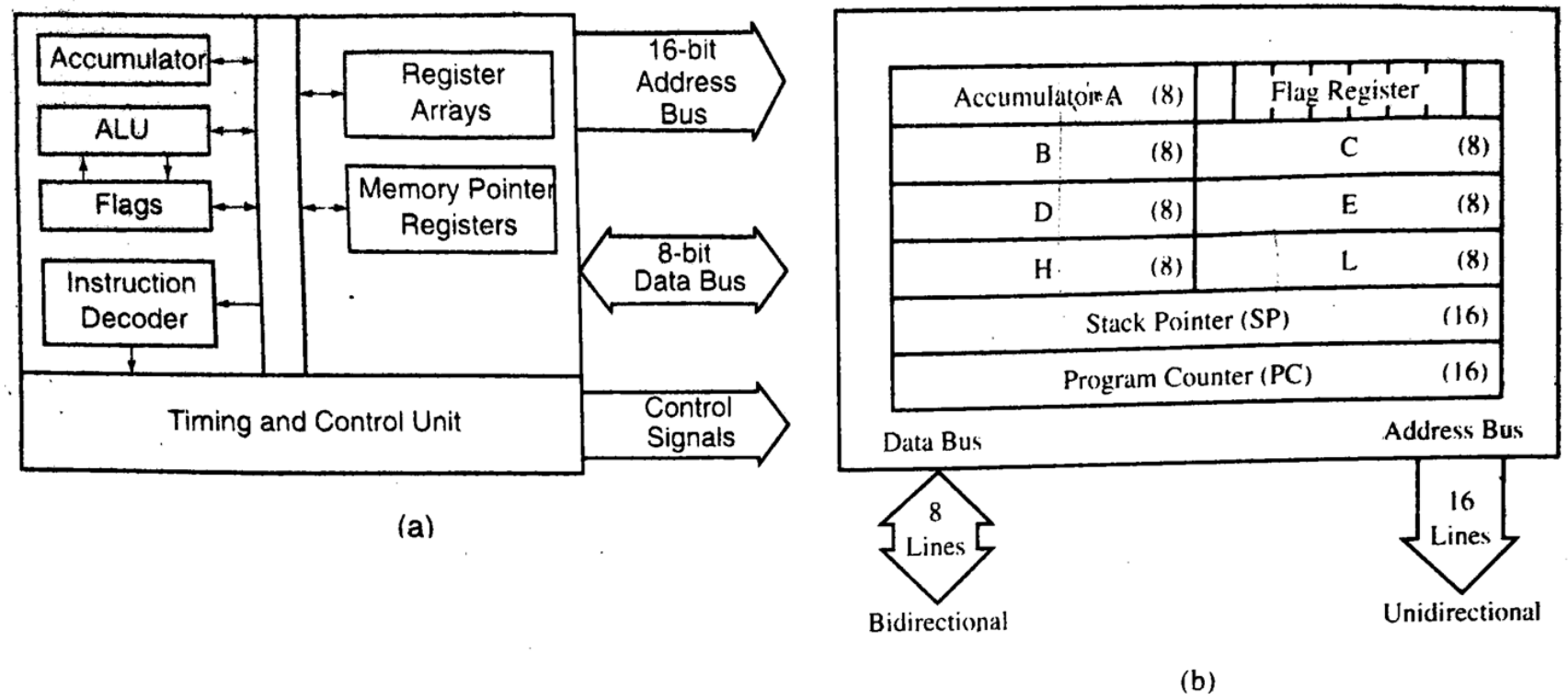
- **Instruction Decoder:** A part of the control unit whose objective is to decode the current instruction in the IR.
- **Timing and Control:** A part of the control unit whose objective is to synchronize all microprocessor operations with the clock and generate the control signals, such as RD, WR, as per the current instruction.
- **Interrupt Control:** Its functionalities include setting priority among various interrupt signals such INTR, RST5.5, RST6.5, RST7.5 and TRAP; enabling and disabling interrupts; masking interrupts and generating the acknowledge signal INTA.
- **Serial Control:** It controls serial communications, transmission from SOD and reception from SID.

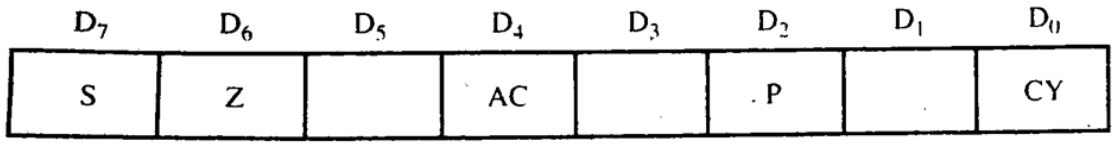
FLAGS

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

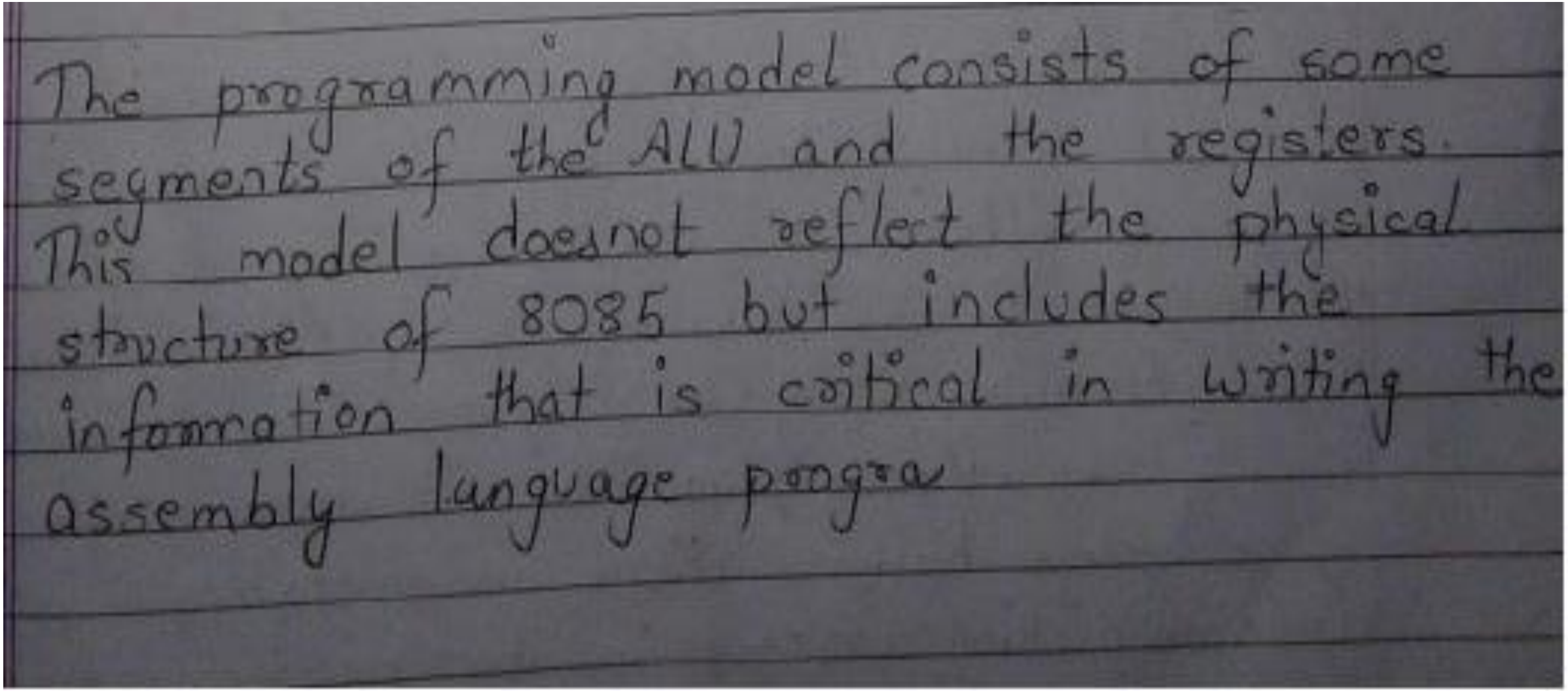
- **Carry**: - If the last operation generates a carry its status will 1 otherwise 0. It can handle the carry or borrow from one word to another.
- **Zero:** - If the result of last operation is zero, its status will be 1 otherwise o. It is often used in loop control and in searching for particular data value.
- **Sign:** - If the most significant bit (MSB) of the result of the last operation is 1 (negative), then its status will be 1 otherwise 0.
- **Parity:** - If the result of the last operation has even number of 1's (even parity), its status will be 1 otherwise 0.
- **Auxiliary carry:** - If the last operation generates a carry from the lower half word (lower nibble), its status will be 1 otherwise 0. Used for performing BCD arithmetic.

Programming Model of the 8085

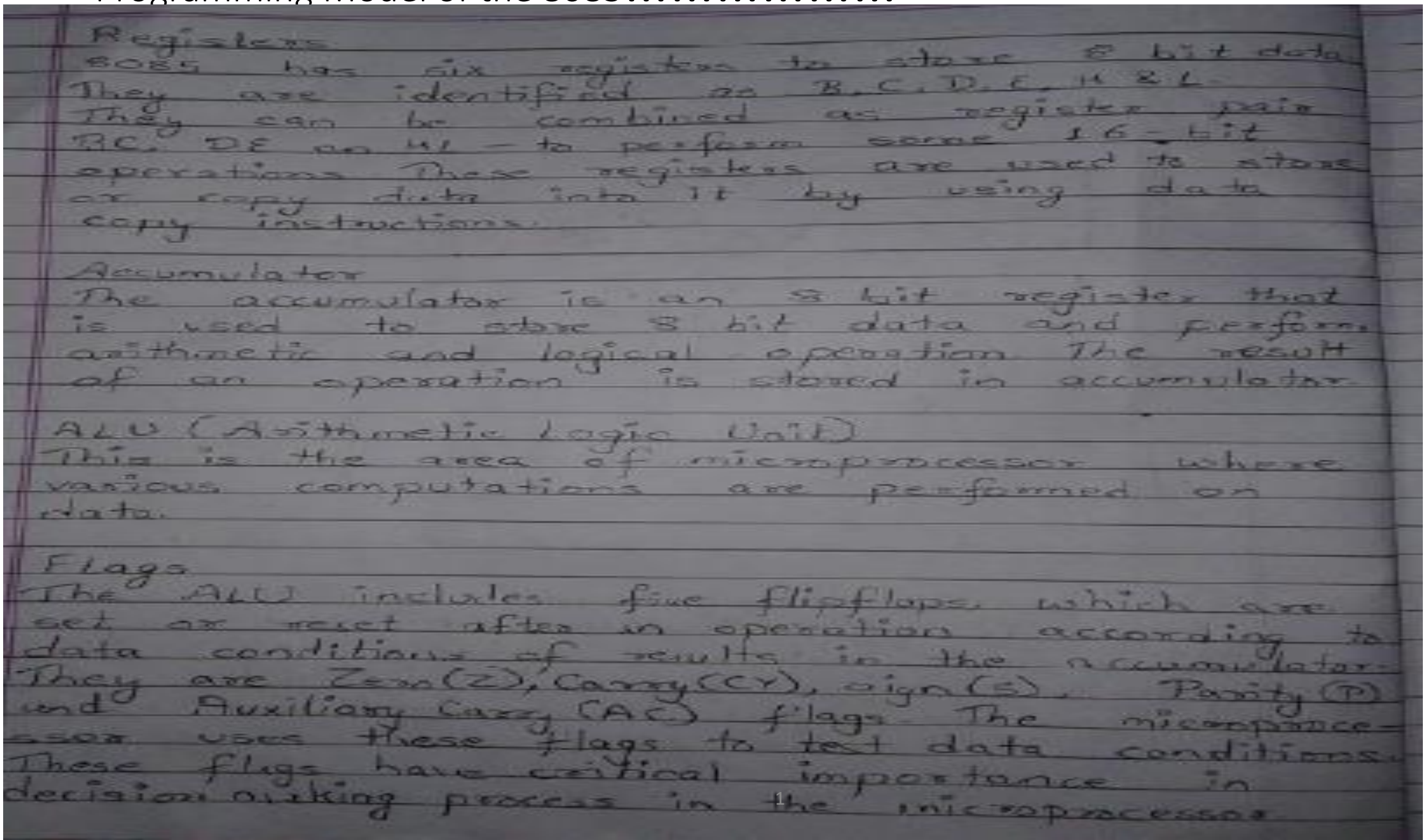




Programming Model of the 8085……



Programming Model of the 8085.....



Registers
8085 has six registers to store 8 bit data. They are identified as B, C, D, E, H & L. They can be combined as register pair BC, DE and HL - to perform some 16-bit operations. These registers are used to store or copy data into it by using data copy instructions.

Accumulator
The accumulator is an 8 bit register that is used to store 8 bit data and perform arithmetic and logical operation. The result of an operation is stored in accumulator.

ALU (Arithmetic Logic Unit)
This is the area of microprocessor where various computations are performed on data.

Flags
The ALU includes five flipflops, which are set or reset after an operation according to data conditions of results in the accumulator. They are Zero (Z), Carry (CY), sign (S), Parity (P) and Auxiliary Carry (AC) flags. The microprocessor uses these flags to test data conditions. These flags have critical importance in decision making process in the microprocessor.

Programming Model of the 8085……

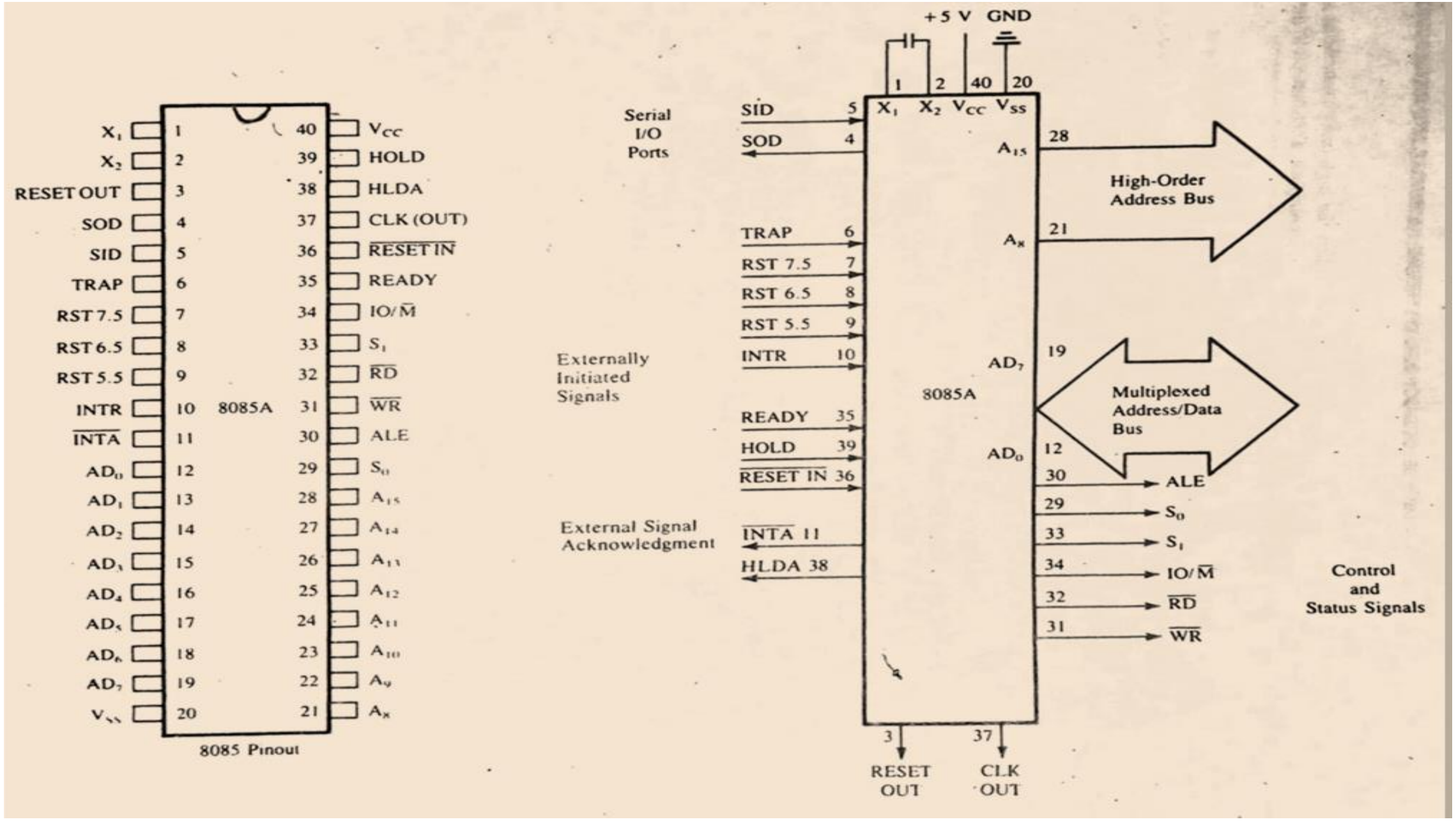
Memory Pointers
It is also called as stack pointer. It points to a memory location in R/W memory called as stack.

Program Counter register
The microprocessor uses the PC register to sequence the execution of the instructions. i.e. it points to the memory address from which the next byte is to be fetched.

Timing and Control Unit
It provides necessary clock pulses to all the components and controls in the operation.

16-bit Address Bus
It is used to carry 16-bit address of phesipheral or memory locations.

8 bit Data Bus
It is used to transfer binary informations.


X1 1
X2 2
RESET OUT 3
SOD 4
SID 5
TRAP 6
RST 7.5 7
RST 6.5 8
RST 5.5 9
INTR 10
INTA 11
AD0 12
AD1 13
AD2 14
AD3 15
AD4 16
AD5 17
AD6 18
AD7 19
VSS 20
8085A
40 VCC
39 HOLD
38 HLDA
37 CLK (OUT)
36 RESET IN
35 READY
34 IO/M
33 S1
32 RD
31 WR
30 ALE
29 S0
28 A15
27 A14
26 A13
25 A12
24 A11
23 A10
22 A9
21 A8
8085 Pinout
+5 V
GND
1
2
40
20
X1
X2
VCC
VSS
Serial I/O Ports
SID 5
SOD 4
TRAP 6
RST 7.5 7
RST 6.5 8
RST 5.5 9
Externally Initiated Signals
INTR 10
READY 35
HOLD 39
RESET IN 36
External Signal Acknowledgment
INTA 11
HLDA 38
A15 28
A8 21
High-Order Address Bus
AD7 19
AD0 12
Multiplexed Address/Data Bus
8085A
30 ALE
29 S0
33 S1
34 IO/M
32 RD
31 WR
Control and Status Signals
3
37
RESET OUT
CLK OUT

Characteristics (features) of 8085A microprocessor and its signals

The 8085A (commonly known as 8085) is a 8-bit general purpose microprocessor capable of addressing 64K of memory. The device has 40 pins, require a +5V single power supply and can operate with a 3-MHZ, single phase clock.

The all the signals associated with 8085 can be classified into 6 groups:

1: Address bus: The 8085 has 16 signal lines that are used as the address bus; however, these lines are split into two segments A_{15}-A_8 and AD_7- AD_0. The eight signals A_{15}-A_8 are unidirectional and used as high order bus.

2. Data bus: The signal lines AD_7- AD_0 are bidirectional, they serve a dual purpose. They are used the low order address bus as well as data bus.

3. Control and status signals: This group of signals includes two control signals ($\overline{RD}$ and $\overline{WR}$), three status signals (IO/$\overline{M}$, S_1 and S_0) to identify the nature of the operation, and one special signals (ALE) to indicate the beginning of the operation.

- ALE- Address Latch Enable: This is a positive going pulse generated every time the 8085 begins an operation (machine cycle): it indicates that the bits AD_7-AD_0 are address bits. This signal is used primarily to latch the low-order address from the multiplexed bus and generate a separate set of eight address lines $A_7 - A_0$.
- $\overline{RD}$- Read: this is a read control signal(active low). This signal indicates that the selected I/O or memory device is to be read and data are available on the data bus.
- $\overline{WR}$- Write: This is a write control signal (active low) . This signal indicates that the data on the data bus are to be written into a selected memory or I/O location.
- $IO/\overline{M}$: This is a status signal used to differentiate between I/O and memory operations. When it is high , it indicates an I/O operation; When it is low indicates a memory operation. This signal is combined with $\overline{RD}$ (Read) and $\overline{WR}$ (Write) to generate I/O and memory signals.
- S_1 and S_0 : These status signals, similar to $IO/\overline{M}$, can identify various operations, but they are rarely used in small systems.

4. Power Supply and Clock frequency:

- VCC: +5V power supply
- VSS: Ground reference
- X1 and X2: A crystal (RC or LC network) is connected at these two pins for frequency.

- CLK OUT: It can be used as the system clock for other devices.

5. Externally Initiated signals:

-**INTR (**input**):** interrupt request, used as a general purpose interrupt.

- $\overline{INTA}$ (Output): This is used to acknowledge an Interrupt.

-RST 7.5, 6.5, 5.5 (inputs): These are vectored interrupts that transfer the program control to specific memory locations. They have higher priorities than INTR interrupt. Among these three, the priority order is 7.5, 6.5, and 5.5.

- TRAP (input): This is a non-maskable interrupt with highest priority.

-HOLD (input): This signal indicates that a peripheral such as a DMA(Direct Memory Access) controller is requesting use of Address and data bus.

-HLDA (output): Hold Acknowledge: This signal acknowledges the HOLD request

- 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. When this signal goes low, the microprocessor waits for an integral number of clock cycles until it goes high.

-**$\overline{\text{RESET IN}}$:** When the signal on this pin goes low, the program counter is set to zero, the buses are tri-stated, and MPU is reset.

-**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) and SOD (Serial Output Data). In serial transmission, data bits are sent over a single line, one bit at a time, such as the transmission over telephone lines.

Instruction description and format:

An instruction manipulates the data and a sequence of instructions constitutes a program. Generally each instruction has two parts: one is the task to be performed, called the **operation code** (Op-Code) field, and the second is the data to be operated on, called the **operand** or address field**.** The operand (or data) can be specified in various ways. It may include 8-bit (or 16-bit) data, an internal register, a memory location, or an 8-bit (or 16-bit) address. The Op-Code field specifies how data is to be manipulated and address field indicates the address of a data item. For example:

ADD R_1, R_0

Op-code address

Here R_0 is the source register and R_1 is the destination register. The instruction adds the contents of R_0 with the content of R_1 and stores result in R_1.

8085 A can handle at the maximum of 256 instructions (2^8)(246 instructions are used) . The sheet which contains all these instructions with their hex code, mnemonics, descriptions

and function is called an instruction sheet. Depending on the number of address specified in instruction sheet, the instruction format can be classified into the categories.

- **One address format** (1 byte instruction)**:** Here 1 byte will be Op-code and operand will be default. E.g. ADD B, MOV A,B
- **Two address format** (2 byte instruction) :Here first byte will be Op-code and second byte will be the operand/data.
  E.g. IN 40H, MVI A, 8-bit Data

- **Three address format** (3 byte instruction): Here first byte will be Op-code, second and third byte will be operands/data. That is

  2^{nd} byte- lower order data.

  3^{rd} byte – higher order data

  E.g. LXI B, 4050 H

Micro operation specifies the transfer of data into or out of a register.

Classification of an instruction

An instruction is a binary pattern designed inside a microprocessor to perform a specific function (task). The entire group of instructions called the instruction set. The 8085 instruction set can be classified in to 5- different groups.

- Data transfer group: The instructions which are used to transfer data from one register to another register or register to memory.
- Arithmetic group: The instructions which perform arithmetic operations such as addition, subtraction, increment, decrement etc.
- Logical group: The instructions which perform logical operations such as AND, OR, XOR, COMPARE etc.
- Branching group: The instructions which are used for looping and branching are called branching instructions like jump, call etc.
- Miscellaneous group: The instructions relating to stack operation, controlling purposes such as interrupt operations are fall under miscellaneous group including machine control like HLT, NOP.