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Assignment III

Microprocessor and 8085 microprocessor.

1) What is microprocesor, processor, microcomputer and microcontroller?

→ **Microprocesor:-**

A microprocesor is a multipurpose, programmable, clock driven, register based electronic device that reads binary instructions from a storage device called memory, accepts binary data as input and processes the data ~~acc~~ according to instructions and provides results as output. In simple words microprocesor is a control unit of a micro computer which is fabricated on a small chip capable of performing all the functions of a central procesing unit of a computer. It's often known simply as a processor, a central procesing unit or as a logic chip.

→ **Microcomputers:-**

Microcomputers is a ~~complete~~ full-fledged computer of small size which consists of microprocesor as its central procesing unit. It is generally designed for individual use. These computers are also referred as simply computers or personal computers (PC). It is smallest in the categorization of computers. These computers have a lot of power even though they have a small forum factor. The computers that we use everyday like laptop, mobile phones, tablets all fall under the category of microcomputers. With the advancement in technology the size of these computers is also being reduced with increased power

→ **Microcontrollers :-**

A microcontroller is a reduced coordinated circuit intended to oversee a particular activity in an installed framework. An ordinary microproc controller incorporates a processor, memory and input/output (I/O) peripherals on a solitary chip. In simple words microcontrollers are single-chip microcomputers which consists elements of computer on that same one chip. It is generally used in appliances, power tools, automobile engine control systems and many others.

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2) Write in short about the deveplopment history of microprocesor.

→ The first microprocessor was developed by Intel which was the 4004. When we see the history we go back to 1970's. This period was the first generation from 1971 to 1973. In 1971, 4004 was created by Intel. During this period the other microprocesors in the market including Rockwell International PPS-4, Intel 8008 and national semiconductors IMP-16 were in use. But all were not TTL compatible processors. The second generation of the microprocesor was from 1973 to 1978 in which very effrcient 8-bit microprocessors were implemented like motorola 6800 and 6801, Intel 8085 and Zilog's-Z80, which were among the most popular ones. Owing to their super fast speed, they were costly as they were based on NMOS technology fabrication.

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During the period from 1979 to 1980 16 bit processors were created and designed using the HMOS technology. This was the third generation of the chips. From 1979 to 1986, Intel 8086/80186/80286 and motorolla a 68000 and 68010 were developed. The speed of these processors was 4 times better than the second generation of processors. From 1981 to 1995 was the fourth generation of microprocessor chips. During this period, 32-bit microprocessors were developed by using HCMOS fabrication. Intel 80386 and motorola's 68020/68030 were the popular ~~popu~~ processors. After 1995 was the fifth generation of the microprocessor. From 1995 until now, this generation has been bringing out high performance and high sped processors that make use of 64-bit processors. Such processors include Pentium, celeron, Dual, quad core, hexa, octa core processors. Thus the microprocesor has evolved through all these generations and the fifth generation microprocessors represent an advancement in specifications

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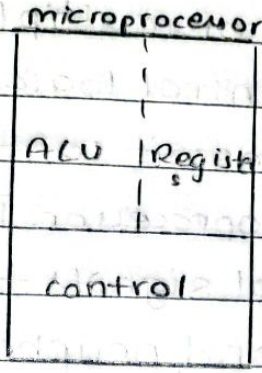
3) What are the different components of a microprocessor? Explain it.



The components of the microprocessor are described below:-

→ ALU

The "arithmetic and logic unit" (ALU) performs all the mathematical and logical operations that are specified by the instruction. The processor transmits its signals to the ALU which interprets the instructions and performs the calculations. It performs various operations like addition, substraction, multiplication, division and logical operations whose results are stored in the registers or in memory unit or is sent to the output unit.

→ Registers:-

The temporary data storage locations in microprocessors are called registers. There are different types of register depending upon the microprocessor. These memory areas maintain data, such as computer instructions, storage addresses, characters and other data. Some computer instructions may require the use of certain registers as part of a command.

→ Control unit:
Basically the control unit controls the operations. The control unit consists of multiple components such as decoder, clock and control logic circuits. these devices working together transmit control signals to certain locations on the microprocesor. It provides all the necessary timing and control signals to all the operations in the microprocesor and peripherals including memory

4) What is system bus? Explain about different buses present in microprocesor.

→ The system bus is a medium that is used to communicate the data ~~between~~, memory addres and control signal from one part to other part of computers.

Types of buses in microprocesor:-

I) Addres bus:- Addres bus is the type of system bus which carries the memory addres from the procesor to other components such as primary storage and input/output device. The addres bus is unidirectional in nature.

II) Data bus:- Data bus is the type of system bus which carries the data between the procesor and other components. This bus is bidirectional in nature.

III) Control bus:- Control bus is the system bus which is used by the CPU to communicate with the other devices that are contained in the computer. The CPU transmits control signals which is carried by the control bus from the procesor to other components. The control bus also

carries the clock's pulses. The control bus is unidirectional.

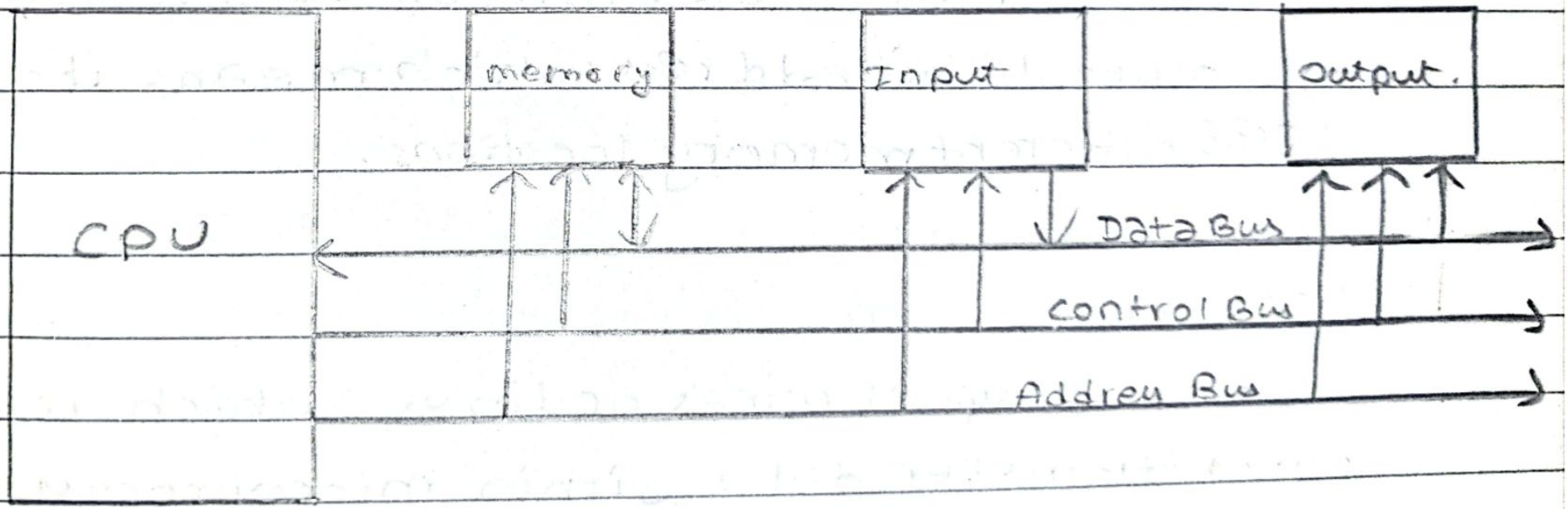
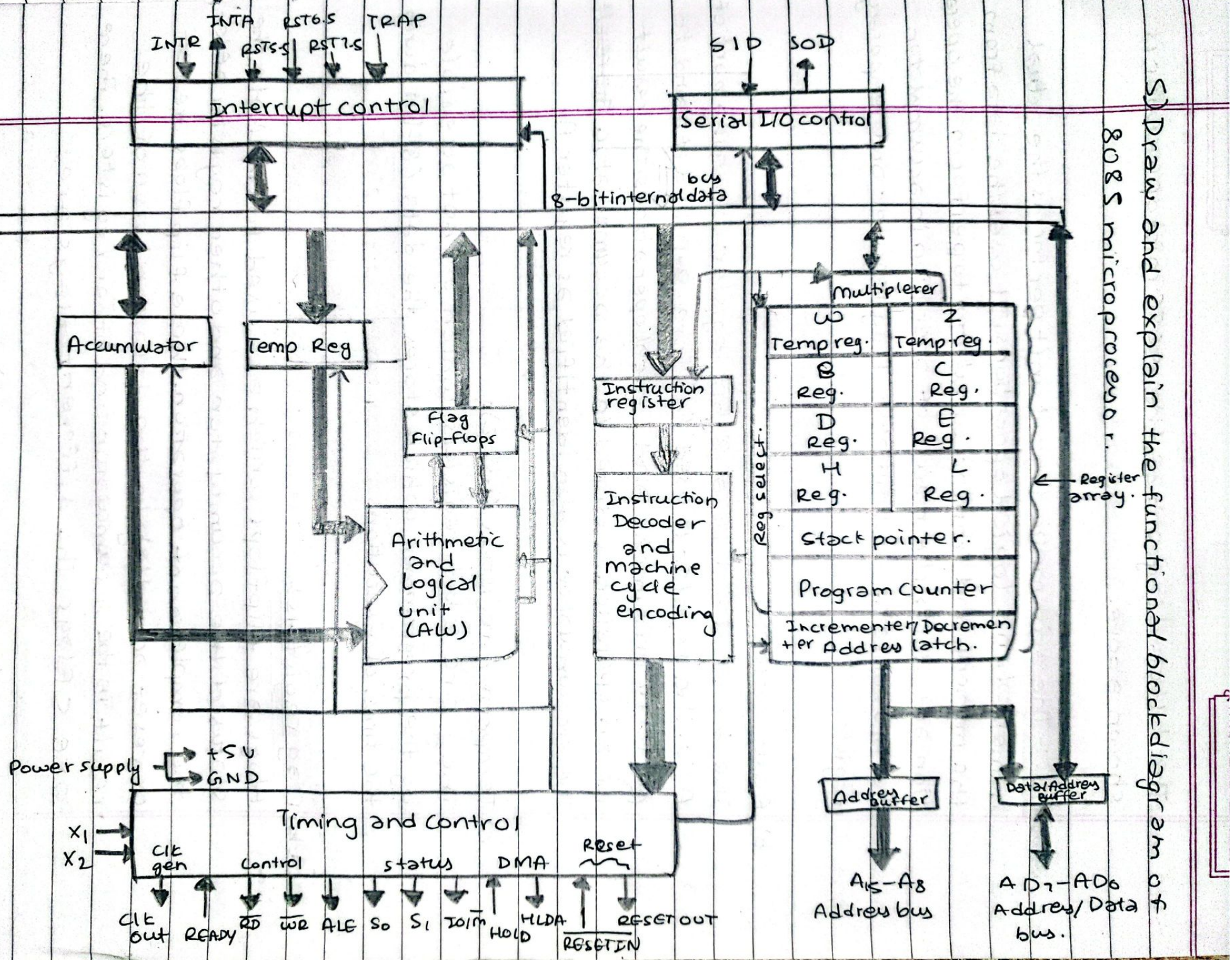


Fig - System Bus

5) Draw and explain the functional block diagram of 8085 microprocessor.



The block diagram of the 8085 microprocesor is shown above.

a) ALU:- The arithmetic logical unit performs the actual numerical and logical operations. It uses the data from the memory and from accumulator to perform the operation and stores the result of operation in accumulator. The ALU contains accumulator, flag register and temporary register.

b) Accumulator:-
The accumulator is a 8-bit register which is a part of ALU. The register is used to store 8-bit data and to perform arithmetic and logical operations. the result of an operation is stored in the accumulator. ~~The result~~ the accumulator is also identified as register A.

c) Temporary registers (w & z):
They are 8 bit registers which are not accesible by the programmer which stores the data (8-bit) during the time of execution.

d b) Flag registers:-
Flags are flipflops which are used to indicate the status of the accumulator and other register after the completion of operation. these flipflops are set or reset according to the data condition of the result in the accumulator and other registers. there are 5 flags. The different flags are;

- Carry:- If the last operation generates carry its status will be 1 otherwise zero. Also works for borrow.

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- Zero - If the result of the operation is zero then its status will be 1 otherwise 0.

- Sign (S): If the most significant bit of the result of the last operation is negative then it will be 1 otherwise zero.

- Parity (P): If the result of the last operation has even number of 1's then its status will be 1 otherwise zero.

- Auxillary carry :- In operation when carry is generated by bit D3 and pases on to bit D4. AC flag will be set otherwise reset.
In bit position,

D7	D6	D5	D4	D3	D2	D1	D0
S	Z	-	AC	-	P	-	CY

e) Timing and control unit.
This unit produces all the timing and control signal for all the operations. This unit synchronizes all the microprocesor operations with the clock and generates the control signals necesary for communication between the mp & peripherals.

f) Instruction register & decoder:-
The instruction register and decoder are also part of ALU. when an instruction is fetched from memory, it is loaded in the instruction register. The decoder decodes the instructions and establishes the sequence of events to follow. The IR is not

programmable & cant be accesed through and instructions.

g) Register array:-

→ The register unit of 8085 consists of:

* Six general purpose registers B, C, D, E, H, L.
* Two internal registers w and z.
* Two 16-bit address registers PC and SP.
* One increment/decrement counter register.

The six general purpose registers are used to store 8-bit data They can be combined as pairs BC, DE and HL to perform some 16-bit operations. the two internal registers w and z are used to hold 8-bit data during execution of some instructions. SP is 16-bit register used to point the address of data stored in stack memory. It always indicates the top of the stack. PC is 16-bit register used to point the address of next instruction to be fetched & executed stored in the memory.

h) System Bus:

i) Data bus: It carries data in binary form, betn microprocessor, and other external units such as memory. Bidirectional in nature.

ii) Address Bus:- It carries the address ~~of~~ from processor to other components. Unidirectional in nature.

iii) control bus:- Provides signal for specific functions for coordinating & controlling microprocessor operations.

i) Interrupt control:-

Interrupt is a signal, which suspends the routine what the microprocessor is doing, brings the control to perform the subroutine, completes it and then returns to main routine. It may be a hardware or software interrupts. some interrupts may be ignored (maskable) and some cannot be ignored (non-maskable). eg. INTR, TRAP, RST 7.5, RST 6.5, RST 5.5.

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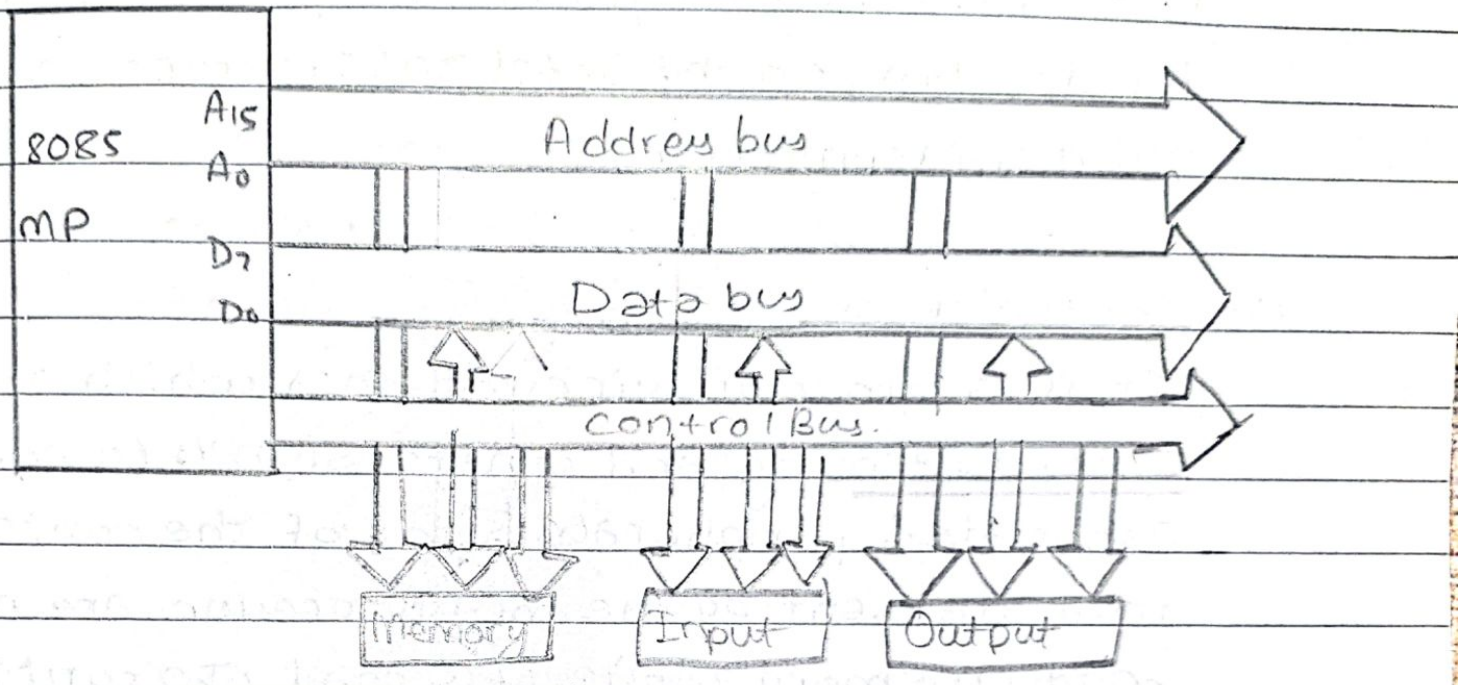
ii) Serial I/O control:-

The microprocessor performs ~~serial~~ serial data input or output (one bit at a time). In serial transmission, data bits are sent over a single line (one bit at a time). The 8085 has two signals to implement the serial transmission: SID (serial input data) and SOD (serial output data).

6) Discuss the bus system in 8085 microprocessor.

⇒



Bus is a medium which is used by the microprocessor to communicate with different devices of a computer. The fig above shows the bus system in 8085 microprocessor. There are 3 types of buses in the 8085 microprocessor. The explanation of these buses is given below:-

i) Address Bus:-

It is a group of conducting wires or lines which carry the address only. It is unidirectional because data flows only in one direction (i.e out of the microprocessor).

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length of address bus in 8085 microprocessor is 16 bit which is ranging from 0000H to FFFFH. This means that the 8085 microprocessor can transfer maximum 16 bit address which means it can address 65536 different memory locations.

ii) Data Bus:-

It is a group of wires or lines which are used to carry/transfer data within microprocessor and memory/IP IO devices. Data bus is bidirectional because data flows in both the directions. Length of data bus of 8085 microprocessor is 8 bit ranging from 00H to FFH. The word length of the processor depends on the data bus, so the Intel 8085 microprocessor is called 8-bit microprocessor.

iii) Control Bus:-

It is a group of wires or lines which are used to generate timing and control signals to control all the associated peripherals. Some of the control signals that are sent by the microprocessor are memory read, memory write, IO read, IO write, opcode fetch.

7) What are the different types of registers that are available in the 8085 microprocessor. Explain the function of each of them.

⇒ The different types of registers are described below

a) General purpose registers:-

There are six general purpose registers in 8085 microprocessor. These registers store 8 bit data. These registers are specified as B, C, D, E, H and L. These registers can be combined as register pairs BC, DE and HL to perform some 16-bit operation. They are used to store the data temporarily during execution. When they are used as pairs, the left register is understood to have the more significant bit and the right register is understood to have the less significant byte

b) Specific Purpose registers:

i) Accumulator:-

The accumulator is an 8-bit register that is the part of the arithmetic and logical unit. After performing the arithmetical or logical operations the result is stored in the accumulator. It is also defined as register A

ii) Flag register:-

Flag register is a 8-bit register which is a special purpose register that stores the information in terms of flags. It indicates the status of accumulator and other registers after the completion of the operation. It consists of 8 bits but only 5 of them are useful and remaining three are used in future intel chips. These

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flags either are set or reset according to the data condition of the result in accumulator and other registers. There are 5 types of flag registers. They are:

- Sign flag
- Zero flag
- Auxillary carry flag.
- Parity flag.
- Carry flag.

iii) W and Z registers :-

W and Z registers are temporary registers. These registers are used to hold 8-bit data during the execution of some instructions. These registers arent available to programmers because it is internally used by the microprocesor.

iv) Program Counter:-

This register is used to sequence the execution of the instructions. The function of the program counter is to point to the memory address ~~form~~ from which the next byte is to be fetched. When a byte is being fetched, the program counter gets incremented by one to point to the next memory location.

v) Stack pointer:-

The stack is a reserved area of the memory in the RAM where temporary info may be stored. A 16-bit stack pointer is used to hold the address of most recent stack.

8) Explain the data flow between memory and microprocessor.

⇒ First of all, the 16 bit address is placed on the address bus from the program counter. Let us consider the memory address where the data is stored is 1020H. In this location the data is placed which we need to access. The higher order address i.e 10H is placed on the address lines A_8-A_{15}. The lower order address i.e 20H is placed on the multiplexed address and data bus i.e AD_0-AD_7. The lower order address continues to remain on this address bus as long as the signal of ALE (Address Latch Enable) remains high. Once the ALE goes low, this address lines change into a bidirectional data line and now they carry data. The control unit sends the signal to indicate what type of the operation is to be performed over the data. Since the data is to be read from the memory so it sends to enable the memory chip. The byte, from the memory location where it was stored is now placed on the data bus. The data that is placed on the data bus is now sent to the instruction decoder. As the name suggests, now the instruction decoder decodes the instruction. After the process of decoding the task is assigned and done accordingly as said by the ALU. So, in this way the data flows between memory and the microprocessor by the use of address and the data lines.

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9) Why addressing modes are required in microprocessor? Discuss different types of addressing modes with suitable examples.

⇒ Each instruction performs an operation on the specified data. An operand must be specified for an instruction to be executed. The method of specifying data to be operated by an instruction is called addressing mode. The different types of addressing modes used in 8085 processor are:-

i) Implied / Implicit Addressing mode:-

In implied/implicit addressing mode the operand is hidden and the data to be operated is available in the instruction itself. In other words the instructions of this mode have no operands. For eg:

EI (Enable interrupt)
STC (set the carry flag).
NOP (No operation)

ii) Immediate Addressing:-

This is the simplest mode of addressing. when it executes the instruction will operate on immediate hexadecimal number. The operand is present in instruction in this mode. This mode is used to defined and use constants of set initials of variables. The operand may be 8-bit data or 16-bit data. For eg.

MVI B, 01H (H).
LXI B, 7421H.
ADI 72H.
JMP address. etc.

iii) Register addressing:-

Register direct addressing mode means that a register is the source of an operand for an instruc on. The data to be operated is available inside the register and registers are the operands. It is similar to direct addressing mode. foreg.

~~MOVCARB~~. MOV A, B

ADD B.

iv) Direct addressing mode :-

When using direct addressing mode, the address of the operand is specified in the instruction. The processor will retrieve data directly from the address specified in the instruction. Instructions using this mode may contain 2 or 3 bytes. eg.

LDA 2035H.

STA 2500H.

IN 07H.

v) Register indirect addressing.

The address of the operand is specified by the register pair. eg.

LDAX B. [If B = 23 & C = 50 then A = 2032350H]

STAX D [If D = 30 & E = 10 then M[3010H] ← A].

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10) What is interrupts? What are maskable and non maskable interrupts? What are the various interrupts that are available in 8085 microprocessor?

=) Interrupts are the mechanism by which an I/O or an instruction can suspend the normal execution of processor and get itself serviced. Generally a particular task is assigned to the interrupt signal. In simple words interrupts are the signals generated by the external devices to request the microprocessor to perform a task. There are 5 interrupt signals i.e TRAP, RST 7.5, RST 6.5, RST 5.5 & INT R. ~~Intar~~ Interrupts are classified into following groups:

i) Vector interrupt:

Vectored interrupts are those interrupts whose service routine address is known to the processor. So, once a vectored interrupt is generated then the processor automatically suspends its main program and switches to the vector location. For eg. RST 7.5, RST 6.5, RST 5.5, TRAP.

ii) ~~to~~ Non-vectored interrupt:-

Non-vectored interrupt are those interrupts whose memory address is not known to the processor. So in this case the processor is unknown about the memory location where the interrupt is generated and needs to be serviced. So, in such case the interrupt generating device sends the address where the interrupt is to be serviced. eg INT R.

iii) Maskable interrupt:

maskable interrupt ~~or the~~ are those interrupts which

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can be disable or ignored by the microprocessor. The interrupts are either edge-triggered or level triggered. So they can be disabled. eg: INTR, RST 7.5, RST 6.5, RST 5.5

iv) Non-maskable interrupts:-

Non-maskable interrupts are those interrupts which cannot be disabled or ignored by microprocessor. eg: TRAP. TRAP interrupt is edge & level triggered. Thus, the signal at this pin must be high and remain enabled until it is acknowledged by the processor.

v) Hardware interrupt:-

These interrupts are associated with peripheral devices generated at the time of data transfer between I/O device and microprocessor. An external devic generates interrupt by placing an interrupt signal over the pins of the microprocessor. There are 5 HW interrupts, they are INTR, RST 7.5, RST 6.5, RST 5.5, TRAP.

vi) Software interrupt:-

Software interrupts are those which are inserted in between the program which means these are the mnemonics of microprocessor. In this case of the internally generated ~~program~~ interrupt, the processor suspends the current execution and switches to handle the interrupt. There are 8 software interrupts, they are RST 0, RST 1, RST 2, RST 3, RST 4, RST 4: RST 5, RST 6, RST 7.

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11) Explain various types of instructions based on word length and function.

a) Types of instructions based on word length:
The 8085 instruction set is classified into 3 categories by considering the length of the instruction. Three types of instructions are: 1-byte instruction, 2-byte ~~inst~~instruction and 3-byte instruction.

i) 1-byte instruction:-
In 1-byte instruction, the opcode and the operand of an instruction are represented in one byte.
examples:
MOV B, C
ADD B.

ii) 2-byte instruction:-
This type of instruction has opcode and one operand. The first byte represents the opcode and second byte represents the 8-bit operand data or 8-bit port address.
Example:
MVI A, 50H
OUT 50H.

iii) 3-byte instruction:-
Three-byte instruction is the type of instruction in which the first 8 bits indicates the opcode and the next two bytes specify the 16 bit address. The lower ~~level~~ order address is represented in second byte & high order address is represented in the ~~third~~ byte.

Example:

#) STA 5000H

LXI B, 5000H

b) Types of instructions on the basis of function

On the basis of function, the instructions are classified in to the following types:

i) Data transfer instructions:-

These instructions move (or copy) data from source to destination. The content of the source which is moved is unchanged. The earlier content of the destination is altered. No flags are altered. Examples of data transfer instructions are

* MOV A, M * MVI B, 05H etc
* MOV A, B

ii) Arithmetic instructions:

Arithmetic ~~instructions~~ operations like addition, substraction, increment, decrement are performed by this category of instructions. One of the operand is taken from the accumulator and the other may be register or memory. The result of the operation is stored in the accumulator. The examples of arithmetic instructions are:

* ~~ADD A~~ INR A * SUB C
* ADD B * DCR B etc.

iii) Logic and bit manupulation instructions:-

These instructions include operations like AND, OR, XOR, compare, rotate etc. Logical functions are performed by these instruction and are performed

in relation with the contents of accumulator. In simple words these instructions perform the logical operations to the data stored in register, memory & status flags. examples are:

* ANA B * CMP B etc.
* ANI 2H 25H

iv) Branch instructions:-

Branch instructions change the sequence of program sequence. There are two types of branch instructions: Unconditional and conditional. Unconditional branch instructions jump the execution to a new location wfrom where program continues execution is execution. Conditional jump instructions: a jump to a new program location is executed if a special condition is met. Otherwise, the program normally proceeds with the next instruction.

Examples:

* JMP 5000 H. JC 2025 H
* JNC 2030 H JNZ 2034H etc.

v) Machine control instructions:

The instructions which deal with the interrupt handling and system operations are classified into this category of instructions. In other words, these instructions affect the operation of the proccesor. Some examples of machine control instructions are:

* HLT * NOP etc.
* EI

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12) What is flag and its application in the microprocessor Discuss different types of flags with suitable examples.

⇒ Flags are the flipflops that store bit 0 or 1 based on the arithmetic or logical operation performed unit (ALU). These flipflops indicate the status of accumulator and other registers after the completion of the operation. These flipflops are set or reset according to the data condition of the result in the accumulator and other registers. There are five types of flag registers in 8085 microprocessor. They are described below:-

i) Sign flag:-

Sign flag indicates whether the result of a mathematical or logical operation is negative or positive. The sign flag is denoted by S. If the result is -ve then this flag will be set (i.e S=1) and if the result is +ve this flag will be reset (i.e S=0). example.

```
MVI A, 40H
MVI B, 30H
SUB B
```

Since the result will be +ve, the sign flag will be reset.

ii) Zero flag:-

Zero flag indicates whether the result of a mathematical or logical operation with is zero or not. It is denoted by Z. If the result is zero the flag will be set (i.e Z=1) and if the result is non zero then the flag will be reset (Z=0).

Example:

```
MVI A 25H.
SUB A (A-A=A)
```

Since the difference here will be zero, the zero flag will be set.

iii) Auxillary carry flag (AC):

In operation when a carry is generated by the bit D_3 and pases on to bit D_4, the AC flag will be set otherwise it will be reset. This flag will be used internaly for BCD operation.

Example:

```
MVI A 2CH
MVI B 49H
ADD B.
```

Since the lower order digits addition will give carry, the auxillary flag will be set to

iv) Parity flag (P):

This flag indicates whether the current result of even parity (no of 1 even) or odd parity (no of 1 odd). If the parity is even, then P will be set otherwise it is reset.

```
Example.
MVI A, 06
```

The parity flag will be set because in BCD code of 06H there are two ones which is even (00000110).

v) Carry flag:-

This flag indicates whether carry or borrow is generated or not. If carry / borrow generated then it's set else reset. Ex.

```
MVI A 60H
MVI B 80H
SUB B
```

the carry flag will be set because 60-80 generates answer with

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13) what is multiplexed signal lines and how does multiplexed lines are demultiplexed?

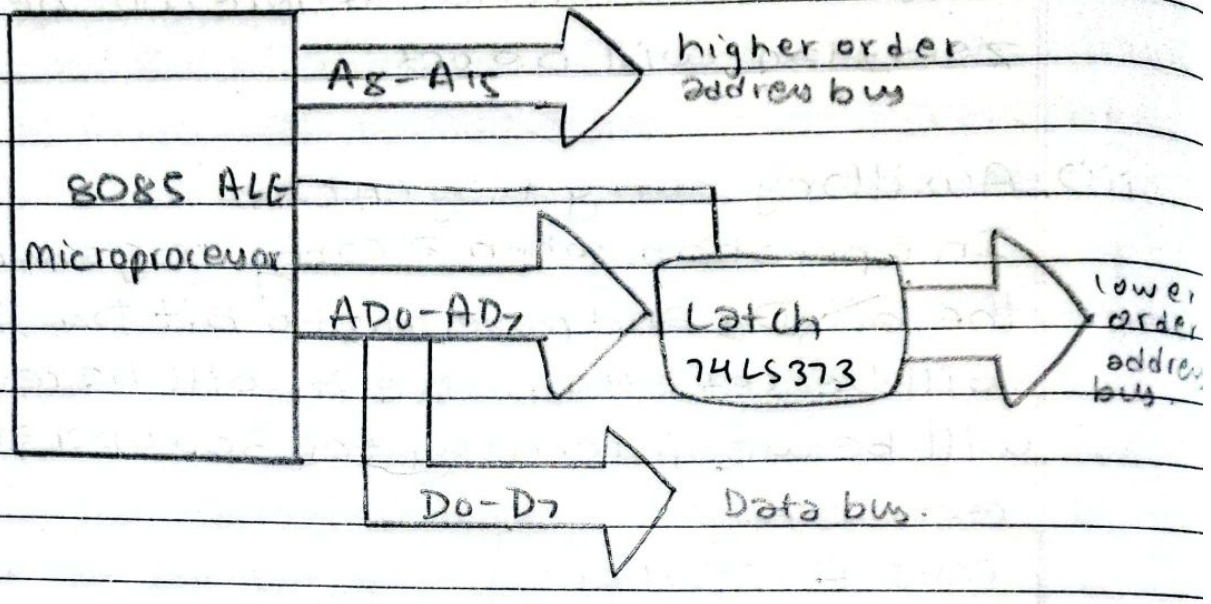

Fig. Multiplexing & demultiplexing of signal lines.

The address bus has 8 signal lines A8-A15 which are unidirectional. The other 8 address bits are multiplexed with the 8 data bits. So, the lines AD0-AD7 are bidirectional and these lines carry the address bits (A0-A7) during early parts & then during late parts of execution they carry 8-bit data bits. (D0-D7). In order to separate the address from the data, latch is used. the higher order address is placed on the address bus and is held for 3 clock periods. The lower order address remains for only one clk period and if they arent saved, it will be lost. To make sure we have the entire address for full three cycles, we will use an external latch to save the value of AD7-AD0 when its carrying the address bits. We use ALE signal to enable this latch. The ALE operates as a pulse during T1 we will be able to latch the address. Then when ALE goes low, address is saved and these lines can be used as bidirectional data lines.

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14) Assume that the memory location 1024H holds data byte 2FH and the accumulator holds data byte F2H. Now, state the changes in the different flags after adding content of memory location 1024H with the accumulator.

Here,

Given by question.

memory location 1024H has data byte 2FH & accumulator has data F2H.

memory	Data.
1024H	2FH
A	F2H.

By It is said that the accumulator content and the content of memory location is added. Using quick maths, 2FH + F2H = 121.

Since the result is positive, sign flag is ~~reset~~

The result is non zero, so, zero flag is reset.

Since, the during addition of 2FH & F2H, as on adding them, addition of these lower order will generate a carry so, the auxillary carry flag will beset.

Converting the sum to binary we get ~~(1111001)~~

i.e 21 = (100001). Since the numbers ~~are~~ of 1 are even, parity flag is one

Also, cause the answer is generated with carry the carry flag is 1. So, in summary,

Z = 0

S = 0

AC = 1

P = 1

C = 1

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15) What are the different control signals that can be generated in 8085 microprocessor and how are they generated? Explain it.

⇒ The control signals that can be generated in 8085 are:-

i) $\overline{RD}$:-

The $\overline{RD}$ is an lively low signal which is used for the controlling of read operation. If the signal is high or one the data isn't read by the microprocessor but when the signal ~~beat~~ becomes low or zero the microprocessor reads the data from the desired memory or IO device.

ii) $\overline{WR}$:-

The $\overline{WR}$ is a lively low signal which is used for controlling of the write operation. If the signal is high or one, no data is written by the microprocessor. If signal is low or zero, then the microprocessor writes the data to the desired memory or IO device.

iii) ALE:-

Address latch enable or ALE is a ~~pulse~~ pulse signal which is generated when the new operation is started by the microprocessor and it specifies the content in the memory location. when the pulse goes high it indicates address and when the pulse goes down the lines now indicate & carry data.