INTRODUCTION :- In this we are going to discuss various Utilization & designs related to µP. & µC.

(1) * Microprocesor plays significant role in components of digital computer.

* If we look into any computers system the main computational element that we have there is the central processing unit or (CPU) along with. that we have another necessary components like the memory and the I/O devices that we need to have in the system for interacting with the environment.

in PPT

* So to have a better understanding on this course of µP & µC, we need to have good command on the basic digital logic designs, logic gates, basic computer architecture, the basic number system. Digital Bases.

Note

* These microprocesors are used very much in Systems because they provide us the design of the central processing unit & instead of having discrete components of CPU taken seperately as a different chips and integrated on to a printed circuit board (PCb) it is better to put them into a. Sillicon chip, so that this communication delay becomes minimum, as ON chip delay is much much less as compared to the OFF Chip delay. Why ??

* So ~~whatever~~ whenever you are pushing this PCB based design onto Sillicon based design, the speed of the system improves, so this was the basic objective with which this microprocessors got introduced & there is a flow of this design of these microprocessors starting with a very simple one & going towards the more & more complex one.

* So even today if we look into microprocessors architecture are evolving. But as this is a basic course, thus we will start with a basic microprocessor, the very simple one, which is 8085, & then we will slowly go to the higher microprocessors & microcontrollers.

* Why this microcontrollers?

Notes

Most of the electronic gadgets that we have today, they are based on the principle called embeded systems.

In embeded systems, we have got the devices which ~~are~~ do some specific jobs, which it does repetitively, and the architecture is optimized ?? for that particular purpose.

So the total size of the device like cell phone, digital cameras & washing machines or say telephone exchange or satellite launding System, everything is an example of the embeded systems.

* Now when we design this embeded system so it is ~~so~~ necessary that the ① overall size of the system is small.
② Its power consumption be low.
③ Its footprint is less.

So that we can say for a cellphone we can hold it in our hands like the battery backup should be very high so that it does not require much of charging etc.

* So microcontrollers, what they do?

They actually takes the microprocessor plus additional things like the memory & the I/O devices, timers, even data converters (like ADC & DAC into a single chip. and as a result we get a single chip computer (i.e. micro controller)

* Thus, in this course we are going to ~~to~~ look into number of micro controllers, as well as, we can understand that these are actually evaluations from microprocessors, where these components were separated -

CPU was one chip. and — ① chip.
memory & I/O devices were constituting Separate Separate chips. but in micro controller

what this second or ② & ③ chip??

we have one chip containing the whole thing with all components.

Again there are a large number of microcontroller that have been reported in the literature, so we will see into some of them like –

① 8051 (One of the basic micro controller, because of its utility) ??

then we will look into a number of advanced microcontrollers like –

② ARM (Advanced IC which provides low power, it is also programmable (ie. we can program that chip) + we can program it at the hardware level itself (it means if you does not require a part of the hardware so we can get rid of that hardware.)

So in your chip design you ~~can~~ may not take that part as a component of your chip. thus chip size will be small.

③ PIC and AVR :- They are family of micro-controllers, they have very simple to very complex designs. They also provide with some important facilities for which they are useful.

So now as far as microprocessor we will start with 8085, 8086 & for microcontroller we will have ARM, PIC & AVR microcontrollers.

After this we are going to look into number of interfacing strategies like - ① number of peripheral devices, we need to connect to the MP & MC.

~~① number of peripheral devices (we need to con~~

① So how to interface ?

② What are the standard interfaces that are available ?

③ What is the standard procedure for connecting those devices to the system.

———×———

Finally we will be taking a number of programming examples throughout the course so we will be taking a number of programming examples so that we get a very strong hold on this programming part of these MP & MC.

LECTURE ①

* Microprocessors & Microcontrollers : So they are the part of computing systems.. (Computing System ranges over a wide range, a wide set of applications). Starting from very small like calculators, then cell phones & very small applications till we have got very high end. Computing platforms like super computers.

* Now while we are talking about say small applications due to their smaller size, smaller space, power requirements we have to optimize & there we will see that micro controllers are most commonly used.

* On the other hand, when we are looking for the computational power, that is, we want ~~what~~ systems that will computationally, it will be able to solve a large number of users, different types of programs & computations.

There microprocessors are used, because ~~they have the flexibility~~,

- they have flexibility
- they have the capability to do work ~~at~~
- at a higher rate generally than the micro-controllers.

Of course, there ~~microprocessors are not because they have the~~ are microcontrollers which are better, which support high speed applications, but mostly we have got- microprocessors for doing this computation job. Now, whatever it is or both microprocessor & ~~the~~ micro controller. they are some computing element. In the sense that they perform computation over some data element that is taken as a input & that data element is represented inside the system in some fashion & then processing is done over that and ultimately it is output to the environment.

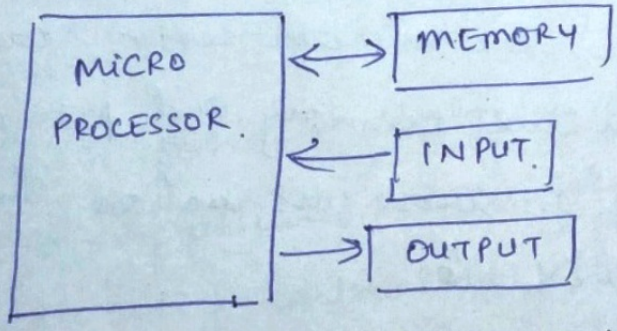
Though we know that the environment is mostly analog like when we are taking signals from a different from the environment the signals are analog in nature.

UNIT - 01

MICROPROCESSOR :-

A micro procesor is a multipurpose, programmable clock driven, register based electronics devices that read binary instructiai from a storage device called memory accept, binary data as input and procers data according to those instructions and provide result as output.

A programmable machine work for four component and perform the operatiai. These can be worked together for the given task and provide output.



A Programmable Machine.

The microprocesor application -

It can be divided into 2 categories -

1. Reprogrammable system.
2. Embeded system.

It includes large storing device for execution the result.

Ex. A Piano is a programmable machine, it is capable of generating various kind of tone based on the number of keys it has.

MEMORY :- It is the page of notebook with space for the fixed number or binary number. for each line. Each line is the 8 bit register it can store eight binary numbers.

1k is the closest approximation used for the memory location.

INPUT/OUTPUT :- The user can insert the instruction using I/P device. The microprocesor read the instruction from the memory and procss the data according to those instruction. The result displayed by the LED's

MICRO CONTROLLER :-

A microcontroller is a small computer on a single metal oxide, semiconductors integrated circuits. A micro controller contain one or more CPU along with memory and programmable input and output peripheral.

Micro controller are used in automatically controlled product and devices.

A micro controller is the chip optimized to control electronic device. It is stored single Integrated circuit which is dedicated to performing a particular task and execute one specific application.

It is specially designed circuit for embeded application & widely used in automatically controlled electronic devices. It contain memory, processor and programmable Input/output.

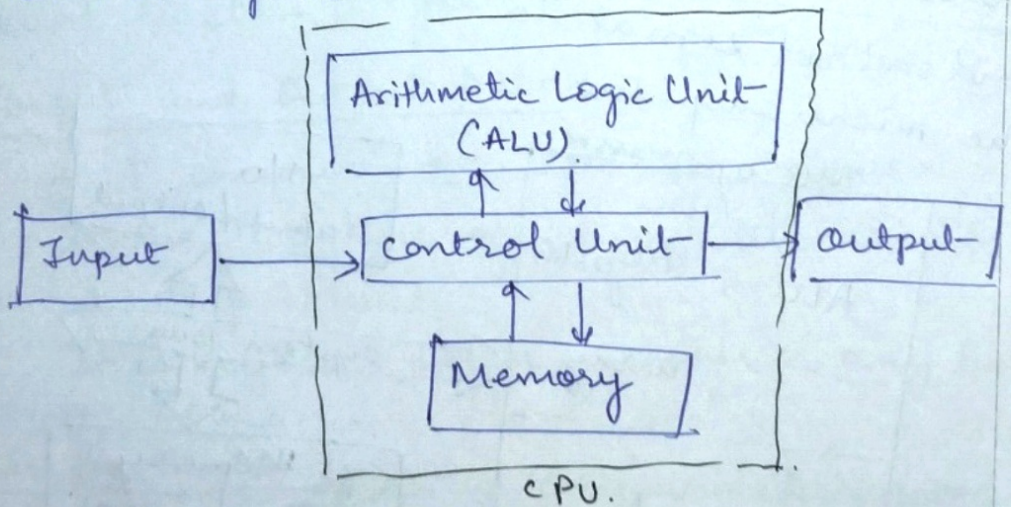
Difference between MICROPROCESSOR & MICROCONTROLLER:-

- Microprocesor consist of only a Central procesing unit, whereas microcontroller contain a CPU, memory I/p all Integrat in one chip.
- Microprocesor is used in personal Computer. Whereas microcontroller is used in an Embeded system.
- Microprocesor uses an external bus to interface to RAM, ROM and other peripherals, on the other hand, microcontroller uses an internal controlling bus.
- Microprocessor is complicated and expensive with a large number of instruction to procen but micro-controller is inexpensive and straightfoward with fewer instruction to procen.

Microprocessor as the CPU :-

The CPU reads instructions from the MPU and perform the task specified. It communicate with input output device for accepting & sending the data.

A computer with a microprocessor is known as micro computer. MPU implies a complete processing unit with the necessary control signal.



MPU as the CPU.

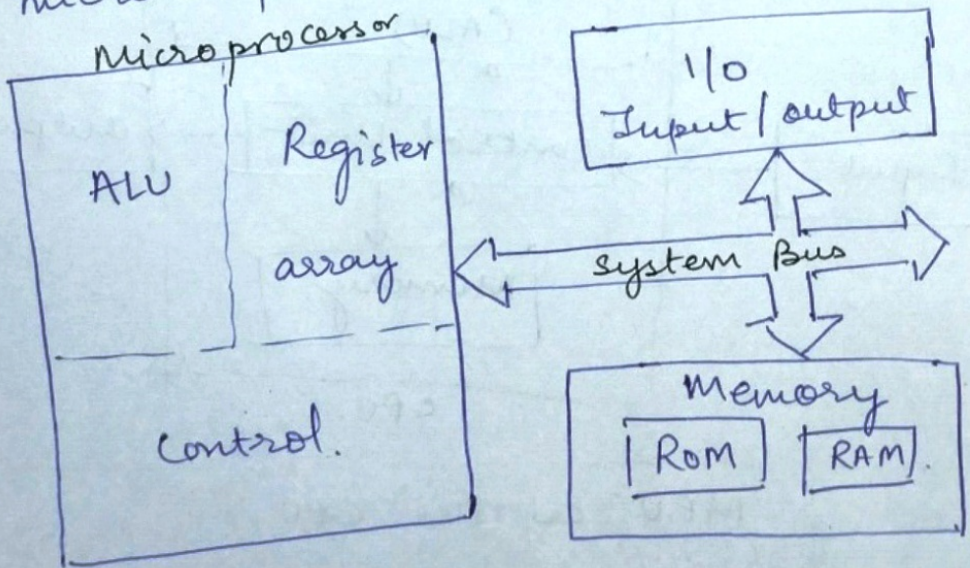
Bus Architecture of Microprocessor :-

A microprocessor is a clock driven, semi-conductor device consist with electronic device by using a large scale integration or very large scale integration technique.

Arithmetic Logic Unit :- It perform various operation on the data. It perform airthmetic operation such as AND, OR and Ex-OR.

Register Array :- The area covers various Register such as B, C, D, E, H & L. It used to store data during the execution of a program and it access through instruction.

Control Unit :- it provide the necessary timing and control signal to all the operation in the micro computer.



Bus structure of MPU.

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Memory:- It stores binary information such as instruction and data and provide the information to the MPU, wherever necessary. To execute program the microprocessor read instruction & data from memory and perform, the computing operation in its ALU section. The ROM is used to store program and do not need the execution process.
The RWM is known as user memory, it is used to store program & data.

Input and Output Data :-

It communicate with the output device it is the two type of device, the circuit known as peripheral.

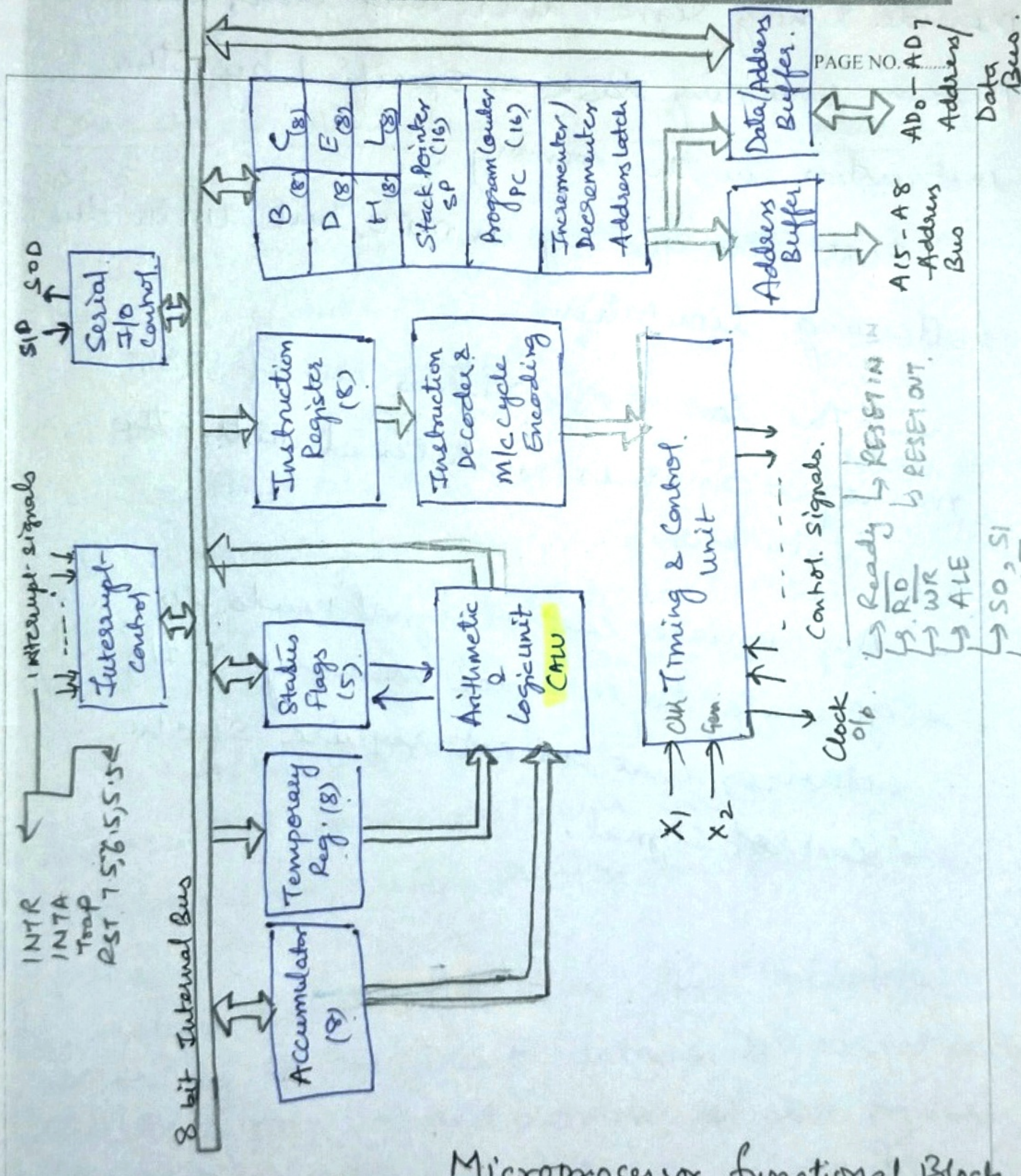
It is keyboard, printer, scanner or any hexadecimal device.

System Bus :- It is the communicating both between the microprocessor & peripheral.. It is the group of wire to carry bit.

Working of Microprocessor :-

It reads the first instruction and picks up the necessary component and perform. the task. The sequence of the procers is read interpret and perform. The instruction stored sequentially in the memory. The microprocesor fetch instruction from its memory speed, decode and execute the instruction.

The sequence is executed and system bus fetch the binary instruction & data from the memory. It uses register from the register section to store data. temporarily and perform the compiling operation in the ALU section.



Microprocessor functional Block diag.
(INTEL - 8085)

The MPU is similar to the Central Processing Unit (CPU) used in the traditional computer. The MPU is defined as a device or a group of device that communicate with the peripheral, provide timing signal direct data flow, and perform computing task as specified by the instruction in the memory.

8085 can qualify as MPU but with the following limitations -

- The low order address bus of 8085 microprocessor is multiplexed with the data bus.
- Appropriate control signal needs to generate to interface memory & I/O devices that do not require such control signal.

Concept of Multiplexing and Demultiplexing of Buses :

The microprocessor combined lower address bus to the data bus.

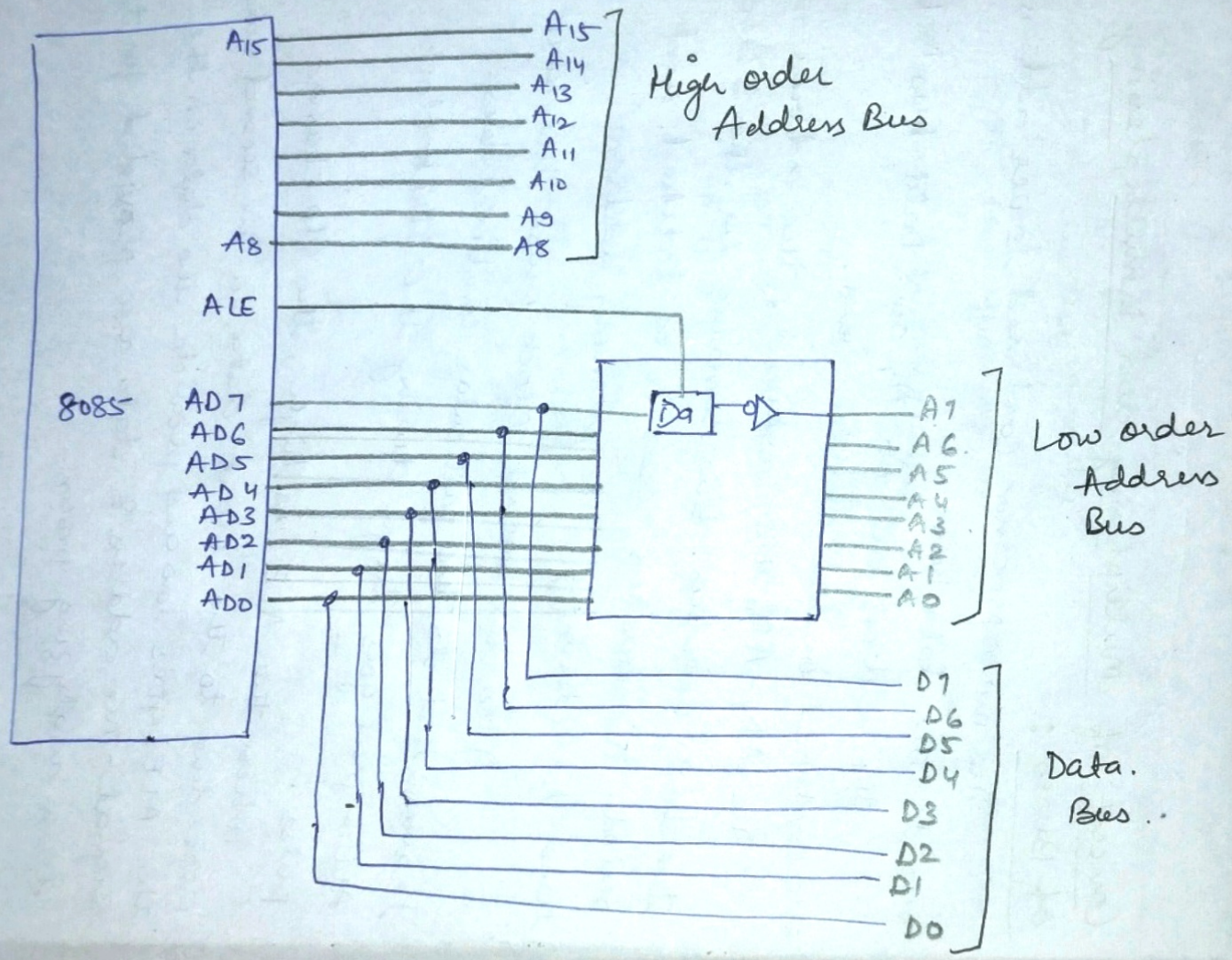
The address bus A_0-A_7 and Data bus D_0-D_7 are combined in the complex form.

The AD_7-AD_0 are combined, the address on the high order bus. Bus remains for the 3 clock period. The address needs to be latched and used for identify the memory address.

After the second clock pulse the data is transmitted to the particular combined bus. ALE signal goes high during the first clock pulse.

When the ALE is high, the O/P change according to the input data in the second pulse the ALE goes low and provide the data on the signal - The address & data are provided for the term analyzing process.

Multiplexed / Demultiplexed : $AD_7 - AD_0$



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Microprocessor Buses and its Structure :-

MPU perform 4 operations

→ Memory Read : Read data from memory
→ Memory Write : Write data into memory.
→ I/O Read : Accept the data from input device
→ I/O Write : Send data to output device.

All these operations one part of the communication process between the MPU & the peripheral devices. The operation perform with following steps -

Step ① :- Identify the peripheral or the memory location.

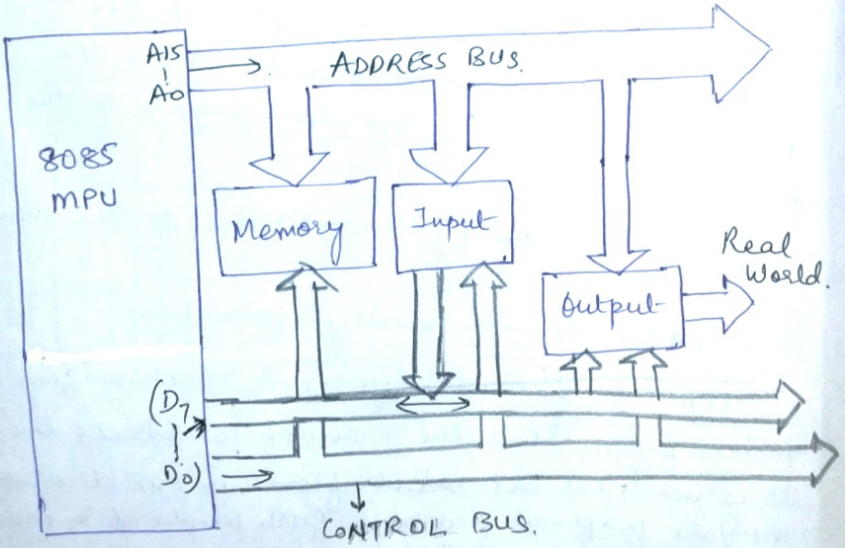
Step ② : Transfer binary information

Step ③ : Provide timing & synchronizing signal.

Address Bus :- It is the group of 16 address line A_0-A_{15} It is unidirectional & bit flows in one direction from MPU to peripheral devices. Each peripheral & memory location is identified by a binary number called an address.

Data Bus :- It is the group of 8 lines & used for data flow. These lines are one bidirectional it goes between the MPU & the memory devices. The 8 data line enable the data transfer operation. The 8 data lines are enable to MPU to manipulate 8 bit data ranging from 00 to FF H.

Control Bus :- The control bus carry synchronization signal to communicate with the memory. for example: To read instruction from the memory location these devices are used to communicate. The MPU sends a pulse called. memory read or write as per applied signal.



8085 BUS STRUCTURE

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8085 MICROPROCESSOR.

1. **Address Bus** :- The 8085 has 16 signal lines it is divided into two segments (A_{15} - A_8) and (AD_7 - AD_0). The A_8 - A_{15} are unidirectional and used for more significant bit called the high order address 16 bit address. The signal line AD_7 - AD_0 are used for a dual purpose for data and address bus.

Multiplexed Address / Data Bus :- The signal line AD_7 - AD_0 are bidirectional as they works for dual purpose. They are used as low order address bus as well as data bus. In the earlier part these line worked as address bus & later on it behaves like data bus.

Control and Status Signal:- The group of signal includes two control signal ($\overline{RD}$ & $\overline{WR}$) and 3 status signals (IO/$\overline{M}$, S_1 and S_0), one special signal (ALE) indicate the beginning of the operation.

a) ALE :- Address latch enable. It is the positive going pulse generated every time, so that 8085 begins the operation. It indicates that the bit on $AD_7 - AD_0$ are address bit when it goes low than it indicates the address lines $A_7 - A_0$

b) $\overline{RD}$: It is the Read control signal. The signal indicates that the selected I/O or memory device is to be read and data available on the address bus.

c) $\overline{WR}$: It is the write signal control. The signal indicates that the selected data on the data bus are to be written into the selected memory.

d) IO/$\overline{M}$: It is used to differentiate between I/O and memory. When it is HIGH it indicates I/O operation and when it is LOW it indicates the memory operations.

Machine Cycle	Status $IO/\overline{M}$	S_1	S_0	Control Signal
OPcode fetch	0	1	1	$\overline{RD}=0$
Memory Read	0	1	0	$\overline{RD}=0$
Memory Write	0	0	1	$\overline{WR}=0$
I/O Read	1	1	0	$\overline{RD}=0$
I/O Write	1	0	1	$\overline{WR}=0$
Interrupt Acknowledge	1	1	1	$\overline{INTA}=0$
Halt	Z	0	0	$\overline{RD}, \overline{WR}=Z$
Hold	Z	X	X	$\overline{INTA}=1$
Reset	Z	X	X	

(2) **Power Supply & clock frequency:**

V_{cc} = +5V Power supply
V_{ss} = Ground Reference.
X_1, X_2 = A crystal (RC, LC Network) connected with 2 pins. The frequency is internally divided by two.
Clk = It can be used as the system clock for other devices.

③ Externally initiated signal, Interrupts :-

It has five interrupts. It can be used to interrupt a program execution. INTR (interrupt Request) is identical to the particular instruction.

For proces interrupt signal INT is used for acknowledging the interrupt request by the ($\overline{INTA}$) signal.

Three pins Reset, Hold, Ready accept the externally initiated signal as input.

a) INTR (input): Interrupt request it is general purpose interrupt generate the interrupt request.

b) $\overline{INTA}$ (output): Interrupt Acknowledge it is used to acknowledge an interrupt.

c) RST (7.5) (Input): Restart interrupt
RST (6.5)
RST (5.5)
These are vectored interrupt that transfer the program control to specific memory location.

d) TRAP (IP): It is non-maskable interrupt and has highest priority.

e) HOLD (IP): Indicates the peripherals such as DMA controller used for accessing the address and data bus.

f) HLDA (O/P): - Hold acknowledge. It acknowledge the hold request.

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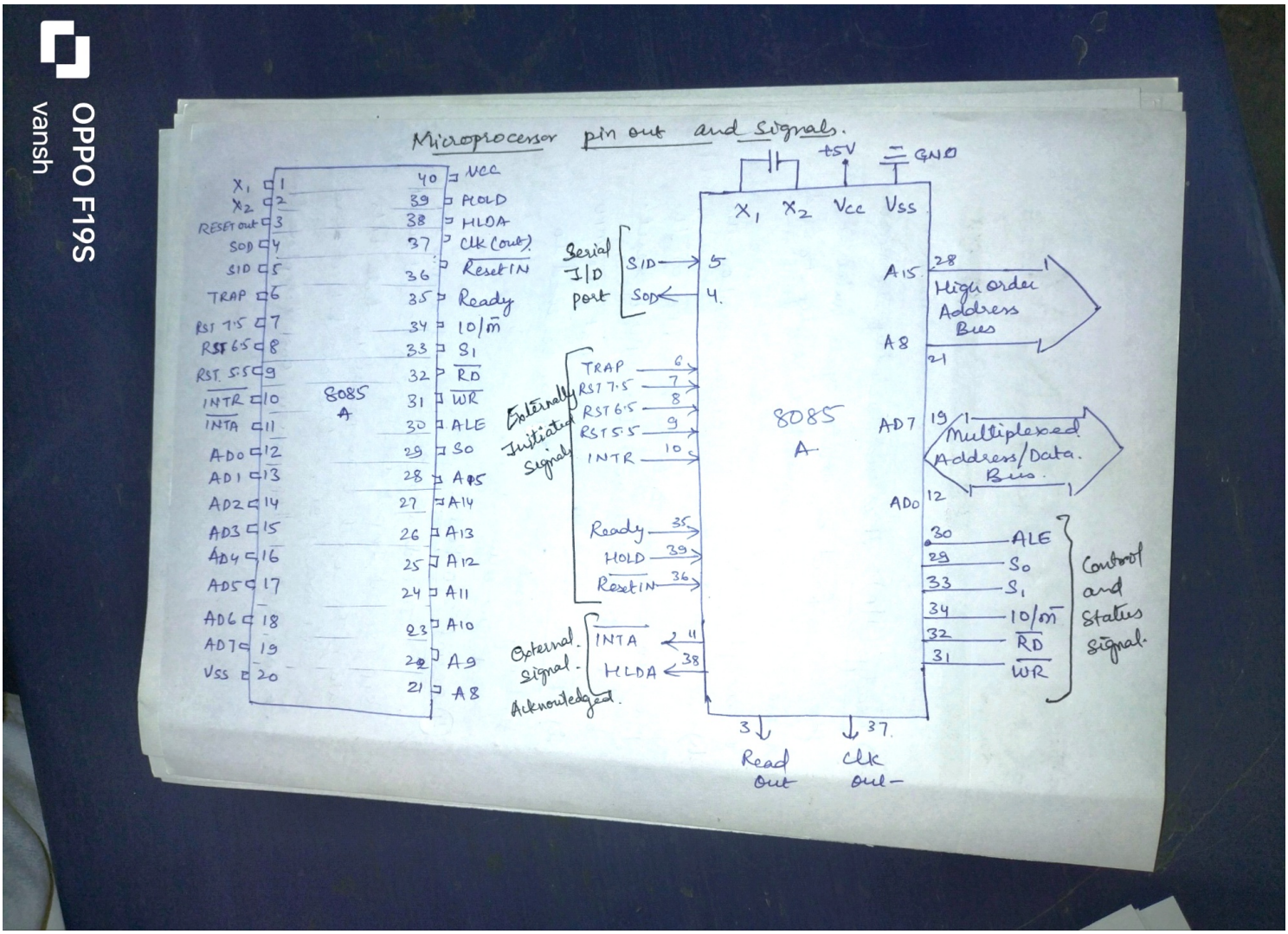
g) Ready (I/P): It is used to delay the microprocessor, Read or write cycle until a slow responding peripheral is ready to send or accept data.

h) Reset IN: When the signal goes Low the program counter gets to zero (PC=0) the bus are tri stated and the MPU is reset.

i) RESET OUT: It indicates that the MPU is being reset. The signal can be used to reset the other devices.

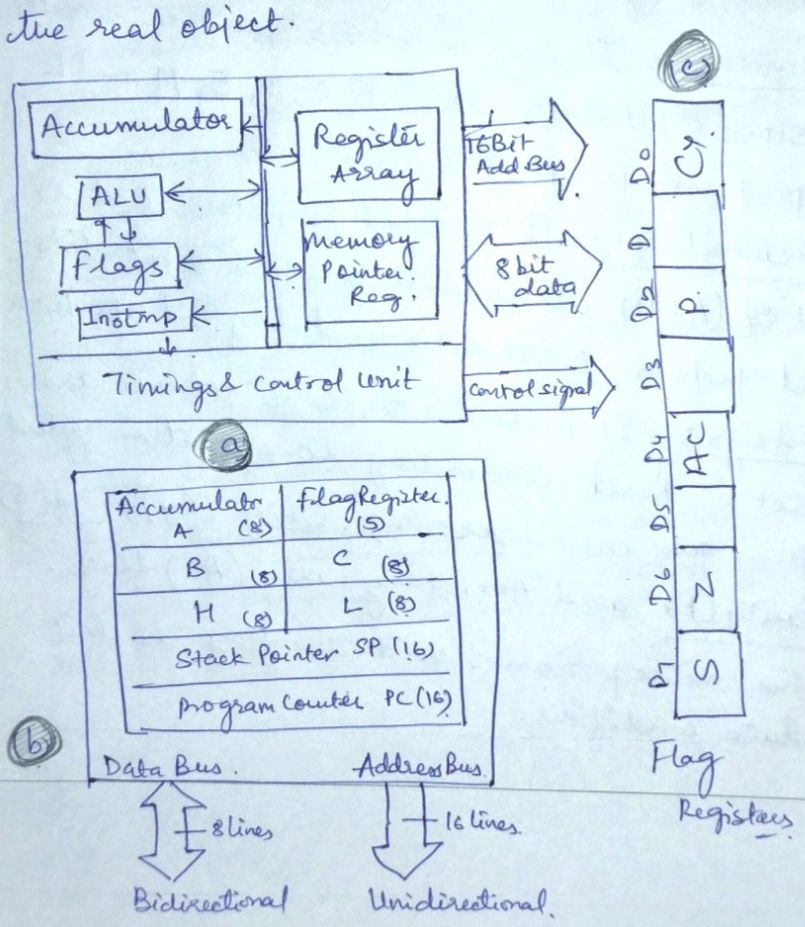
(4) Serial I/O Port:

It indicates the serial transmission SID (Serial Input data), SOD (Serial output data). In serial transmission, data bits are sent over a single line one bit at a one time such as transmission over telephone lines.


Microprocessor pin out and Signals.
8085 A
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
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
+5V
GND
X1 X2 Vcc Vss
Serial I/O port
SID 5
SOD 4
External Initiated Signals
TRAP 6
RST 7.5 7
RST 6.5 8
RST 5.5 9
INTR 10
Ready 35
HOLD 39
Reset IN 36
External Signal Acknowledged.
INTA 11
HLDA 38
A15 28
A8 21
AD7 19
AD0 12
High order Address Bus
Multiplexed Address/Data Bus.
30 ALE
29 S0
33 S1
34 IO/M
32 RD
31 WR
Control and Status signal.
3 Read out
37 Clk out

8085 Programming model –

It is the computational representation of the real object.



Accumulator A (8)	Flag Register (S)
B (8)	C (8)
H (8)	L (8)
Stack Pointer SP (16)	
Program Counter PC (16)	

It includes the arithmetic and logic unit (ALU), 8 bit register called accumulator instruction decoder and flag. The arithmetic operation performed in the ALU, Results are stored in the accumulator and flip flop called Flag, set or reset to reflect the result.

8085 Programming Model :

It includes six registers, one accumulator and one flag register.

① Register :- It has 6 general purpose register to store 8 bit data. It is B, C, D, E, H and L to perform 16 bit operation.

② Accumulator :- It is 8 bit Register that is part of (ALU). It is used to store 8 bit data and peefoem Arithmetic and dogical operation.

③ Flags :- It includes 5 flags which are set or Reset according to operation applied. They are called ~~zero~~ (Z), Carry (Cy), Sign (S), Parity (P) and Auxillary Carry (AC) flags. The microprocessor used the flag to test data conditions.

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Flag Registers :

① Z - (ZERO) - The zero flag is set to 1 when the result is zero, otherwise it is reset

② CY - (CARRY) - If any arithmetic operation has carry the value of CY is 1, set otherwise it is reset.

③ S - (SIGN) - The sign flag is set if bit D_7 of the Result = 1 otherwise it is reset.

④ P - (PARITY) - If the result has even number of 1, the flag is set for an odd number of is the flag is reset.

⑤ AC - (Auxillary Carry) - When a carry is generated by digit D_3 and passed to D_4 the AC flag is set.

Program Counter and Stack Pointer (PC & SP)-

Two 16 bit register used to hold memory address. The size of the register is 16 bit because the memory address is 16 bit. The microprocessor use the PC register to sequence the execution of the instruction. The function of the program counter is to point the memory address from which the next byte is to fetched. When the byte is being fetched, the program counter is increamented by 1 to point the next memory location.

The stack pointer is also a 16 bit. register used as memory pointer. It points the memory location in the R/w memory called the stack. The beginning of the stacked defined by the stack pointer.

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Memory classification :

Memory can be classified into two group prime (System or main) and storage memory.

The R/W memory and ROM are example of prime memory this is the memory the microprocessor uses in executing and storing program. The memory would be fast enough to keep the execution speed of the microprocessor. The Random access memory means that the microprocessor should be able to access information from any register with the same speed. The other group of storage memory such as magnetic disk and tape, used for completing the execution of the program.

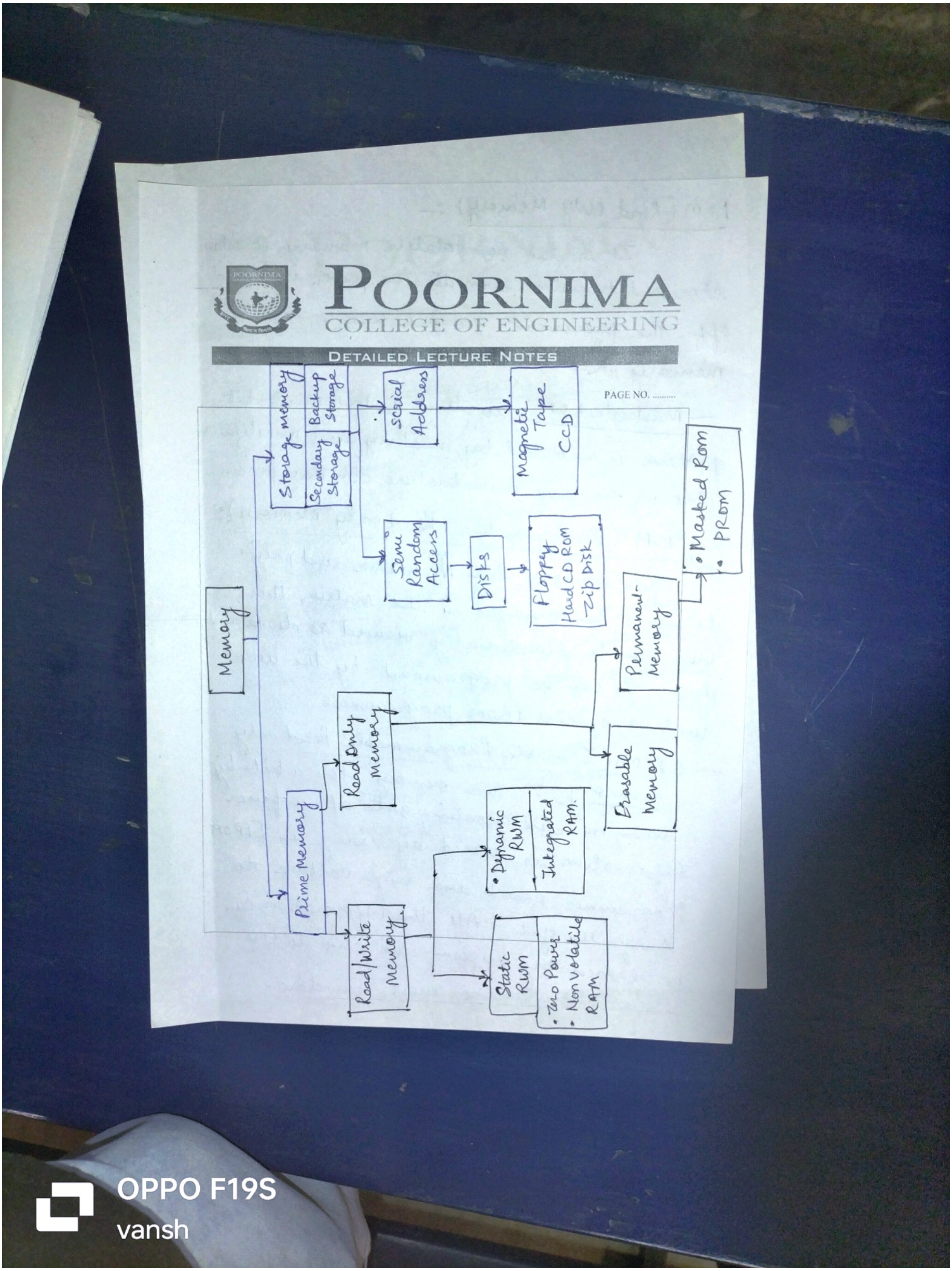
It has 2 groups in the secondary storage memory: Secondary storage & backup storage. If include device such as disk, magnetic tape, magnetic bubble memory & Charged couple device for storing the data.

Prime memory is divided into two main groups Read/write memory (RWM) and Read Only memory (ROM)

Read/write Memory (RWM): MPU can read or write from the memory it is properly known as Random Access Memory. Used for information for the writing and receiving the data.

Static Memory (SRAM): It is made up of flip flop and store the bit as the voltage each memory cell require 6 transistor, the memory chip has low density and high speed.

Dynamic Memory (DRAM): It is made up of MOS transistor gate, it store the bit as change. The advantage of memory are that it has high density and low power consumption and cheaper than the static memory. The disadvantage is that the change leaks therefore stored information need to read and write again for every few milisecond. It is called refreshing the memory & require extra circuit, adding to the cost of the system.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Memory
Storage memory
Secondary Storage
Backup Storage
Serial Address
Magnetic Tape
CCD
Semi Random Access
Disks
Floppy
Hard CD ROM
Zip Disk
Prime Memory
Read Only Memory
Permanent Memory
Masked Rom
PROM
Erasable Memory
Read/Write Memory
Dynamic RWM
Integrated RAM
Static RWM
Zero Power
Non volatile RAM
OPPO F19S
vansh

ROM (Read Only Memory) :-

It is the non volatile memory, it retain stored information even if the power is turned off. The permanent group include 2 types of memory ROM and PROM.

— **Masked ROM**: in that a permanent bit pattern is recorded by masking and metalization procas memory manufacture do this procers.

— **PROM (Programmable Read only Memory)**:

This memory has Nichrome and poly Silicon wire arranged in the matrix, these wire can be functionally viewed as diode and fuse. It can be programmed by the user with a special PROM programmer.

— **EPROM (Erasable Programmable Read only memory)**: This memory store a bit by changing the floating gate of an fuse. Information is stored by using an EPROM Programmer which use high voltage to charge the gate. All the information can be erased by exposing the chip to UV light through the quartz window.

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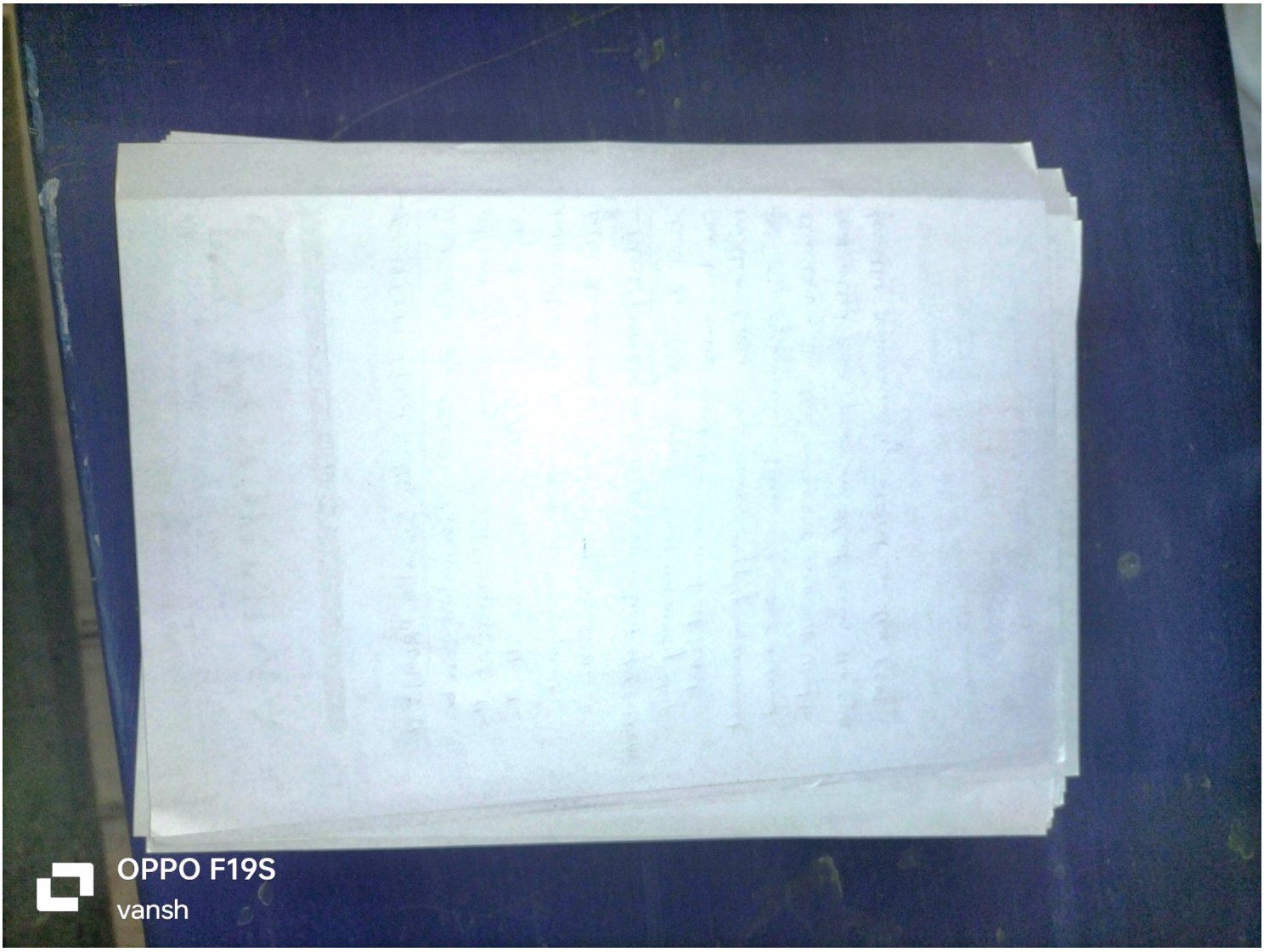
- EE-PROM (Electrically Erasable PROM): It is similar to EPROM, information can be attend by using electrical signal at the register level rather than erasing all the information it is having advantage in field and remote control application.

- Flash Memory – It is the variation of EE-PROM that is widely used. These memory chip can be erased and programmed at least million times. The power supply requirement for reprogramming these chip one around the 12 V. In the microprocessor it used to controlled over, program that runs the over for the permanently stored in the ROM.


OPPO F19S
vansh