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UNIT-I

INTRODUCTION TO MICROPROCESSOR & FAMILY.

24/1/17

1.1 Introduction.

→ The computer is a machine that processes data to generate information with speed and accuracy.

→ Electronic, Electromechanical devices and S/w make this programmable machine

→ The computer comprises four basic units namely Input (I/P), memory, output (O/P) & central processing unit (CPU)

→ The block diagram of a computer shown in fig 1

Input Devices

→ An i/p device accept data from the environment convert into digital form and sends it to the memory for storing.

→ The common i/p devices are punched cards, paper tapes, magnetic tapes, floppy disks and magnetic disks.

→ card readers, paper tape readers, magnetic tape readers, disk drives read data transmitted by i/p devices.

→ A keyboard terminal used as i/p to computer

→ optical mark readers and optical character readers are i/p devices scanned by an array of photocells.

→ bar-code readers read the information prepared in bar code for application

→ Electronic mouse, touch-screens and light pens are also used as i/p devices.

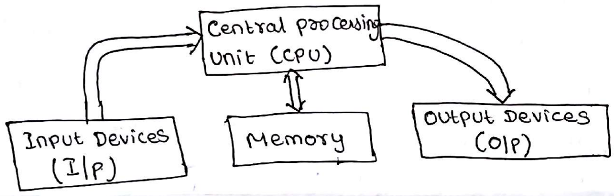


Fig1: Basic Block diagram of a computer.

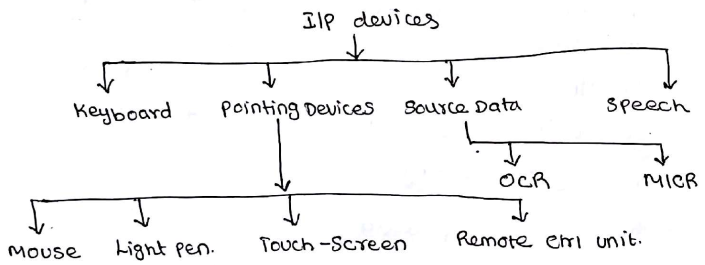


Fig : I/P devices.

Memory

→ The memory unit stores the information to be processed by the CPU.

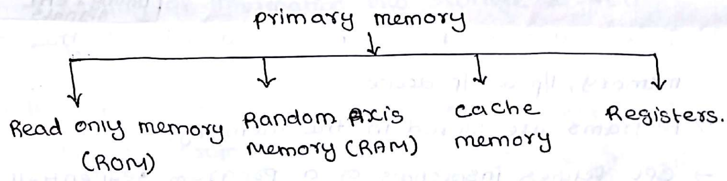
→ This information consist of program as well as data.

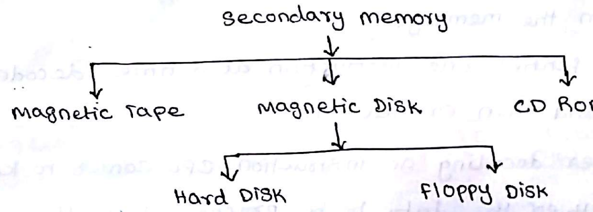
→ The storage available in the memory is also known as main or primary storage.

→ The data can be processed only when it is available in main memory.

→ magnetic tapes or magnetic disk are secondary storage.

→ The information stored in auxillary storage can be transferred to main memory for processing at a high speed.



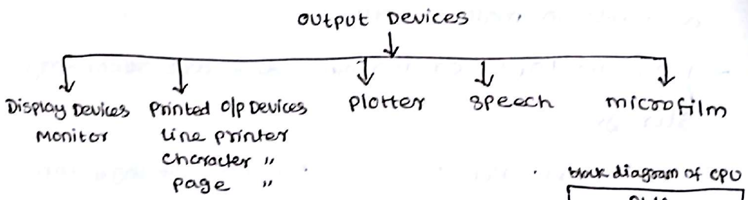


Output Devices

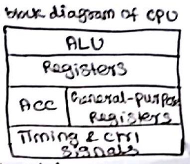
→ when a program is executed in the computer, the result will be computed and readily available for display.

→ The computer needs output devices to display the information to the user.

→ The commonly used o/p devices are monitor screens, printers, graphics plotters, speech and microfilm.



Central processing unit



→ The cpu is the brain of the computer

→ It executes the programmer's s/w and ctrls the memory, i/p & o/p devices.

→ Programs are stored in the memory.

→ CPU fetches instructions of a program sequentially from the memory.

→ It fetches one instruction at a time, decodes it and then executes it.

→ After decoding an instruction, CPU comes to know whether the data to be processed in the memory or general-purpose register or I/o ports. what operations to be performed

→ The major components of a CPU are ALU, timing & ctrl unit and registers.

Arithmetic Logic unit (ALU)

→ It performs the actual processing of data including addition, subtraction, multiplication & division.

→ also performs certain logical operations such as comparing two numbers (>, <, =)

Control unit (CU)

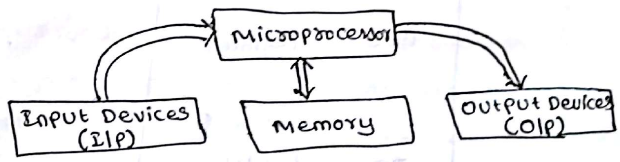
→ ctrl of I/p & o/p devices

→ Entry & retrieval of information from storage.

→ Routing of information b/w storage & ALU

→ Direction of arithmetic & logical operations.

The central processing unit built on a single IC is called a microprocessor. In microcomputer, the µp acts as the CPU.



Basic block diagram of a microcomputer.

1.2) Microprocessor

→ It is a multipurpose, programmable and clock-driven integrated circuit.

→ IC can read binary instructions from any storage device called memory.

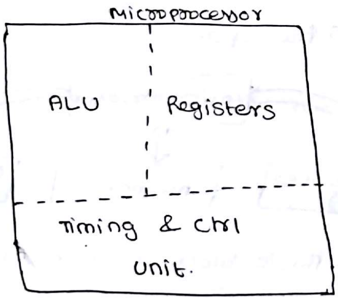
→ It also accepts binary data as i/p, processes data according to instructions and provides results as o/p

→ It is a data-processing unit.

→ Data processing includes both computation and data handling.

→ ALU is used to perform Add, Sub, MUL, DIV, AND, OR, XOR, Compare, Increment, & Decrement functions.

→ ALU cannot perform any functions without Ctrl signals.



Architecture of a microcomputer.

Step1: Microprocessor fetches an inst. from memory

↓

Step2: Control Logic decodes what the instruction has to do

↓

Step 3: Decoding

↓

Step4: µp executes the inst. & sends result as o/p

operation technique of a µp.

1.3) Microcontrollers.

→ It is a small computer on a single integrated circuit (IC) containing a processor, memory & programmable I/O ports.

→ The program memory, in the form of flash or ROM, is also incorporated on a chip and a small amount of RAM is also included on a single chip.

→ Specially designed for embedded applications.

Basics functional blocks of a microcontroller.

→ It is a programmable IC manufactured by VLSI technique and capable of performing ALU operations.

→ The basic functional blocks are ALU, Flag register, register array, program counter (PC), instruction decoding unit, Timing & ctrl unit, RAM memory, EPROM/

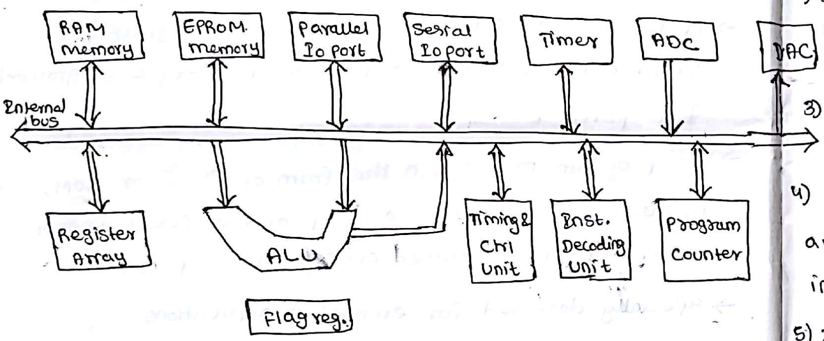
EEPROM memory, parallel IO port, serial IO port, programmable timer, ADC & DAC

→ ALU performs arithmetic & logical operations

→ The various conditions of the result are stored in status bits called flags in flag registers.

→ register array & internal RAM memory are used as temporary storage devices.

→ program codes & permanent data stored in EPROM|EEPROM



functional block diagram of a microcontroller.

→ Program counter generates the address of the instructions to be fetched from the memory & sends through internal bus to memory.

→ timing & ctrl signals will generate the necessary ctrl signals for internal & external operation.

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→ parallel & serial IO ports are used for interfacing IO devices like switches, keyboard, LCD|LED, ADC, DAC, ...etc.

Comparison of microprocessor & microcontroller.

Microprocessor	Microcontroller
1) The functional blocks of a µp are ALU, registers and timing & ctrl unit	1) It includes the functional block of a µp & in addition has a timer, parallel IO port, serial IO port, internal RAM, EPROM|EEPROM, ADC & DAC.
2) It is concerned with rapid movement of code & data b/w external memory & the µp.	2) It is concerned with rapid movement of code & data within the microcontroller.
3) It has large number of data b/w external memory & µp	3) It has few instructions for data transfer b/w external memory & µC
4) It operate on byte|word data and very few bit manipulating instructions	4) It manipulate with bits & have a large number of bit manipulating instructions.
5) It requires a large number of additional ICs to form micro-computer based system	5) It can be used to form a single chip microcomputer-based system without any additional ICs
6) In this system PCB will be large & costly	6) In this system PCB will be small & cheap.
7) used for designing general purpose digital computing system	7) ~~It~~ used for designing application specific dedicated systems.

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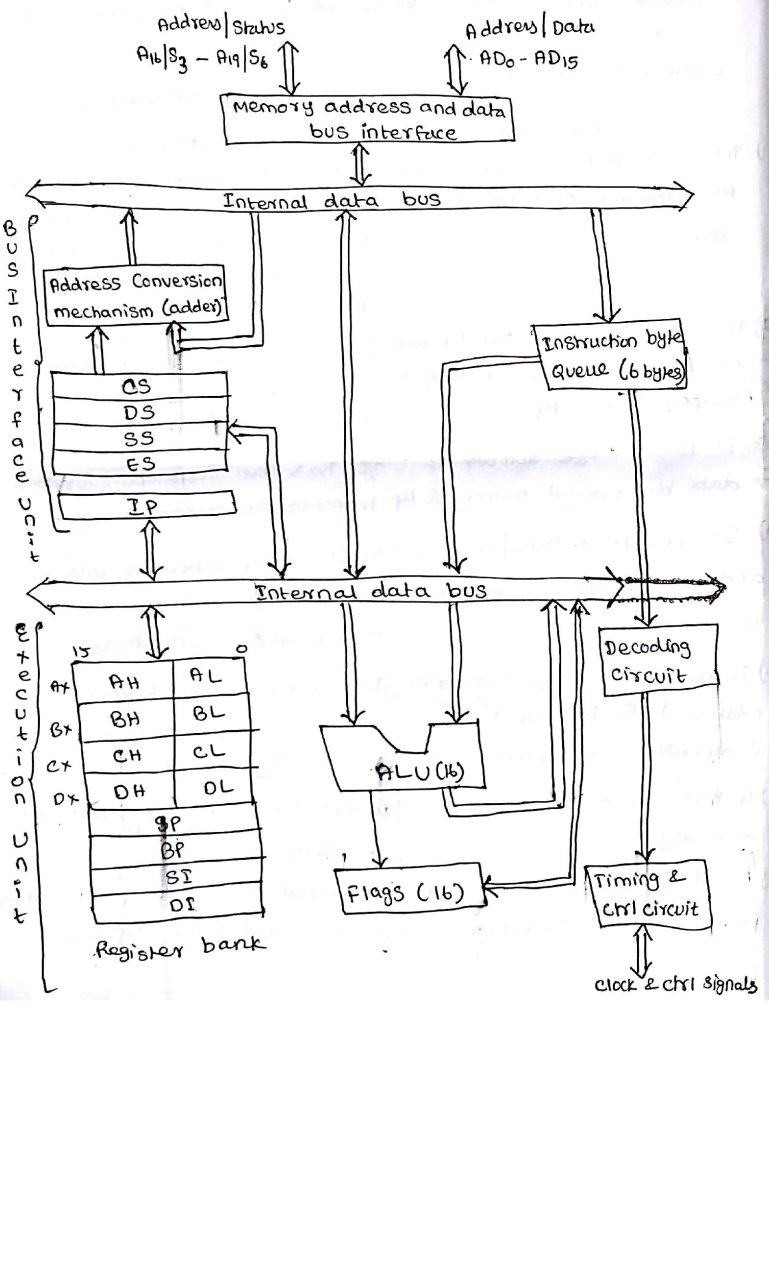
1.4) 8086 Architecture.



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→ It supports a 16-bit ALU, a set of 16-bit registers and provides segmented memory addressing capability, a rich instruction set, powerful interrupt structure, fetched instruction Queue for overlapped fetching & execution instruction etc.

→ It can be divided into two parts.

a) BUS Interface unit (BIU)

b) Execution unit (EU)

→ The bus interface unit contains the circuit for physical address calculations and a preceding instruction byte Queue (6 bytes long)

→ The complete physical address which is 20 bits long is generated using segment & offset registers (16-bit long)

→ a physical address from contents of these two registers, the content of a segment register also called as segment address is shifted left bit-wise four times & to this result, a content of an offset register also called as offset address is added, to produce a 20-bit physical address.

→ the segment addressed by the segment value 1005H can have offset values from 0000H to FFFFH, ie maximum 64K locations may be accommodated in the segment.

Segment address	→	1005 H
Offset address	→	5555 H
Segment address	→ 1005 H →	0001 0000 0000 0101
Shifted by 4-bit position	→	0001 0000 0000 0101 0000
	(+)	
Offset address	→	0101 0101 0101 0101
Physical address	→	0001 0101 0101 1010 0101
		1 5 5 A 5

→ The segment register indicates the base address of a particular segment

offset indicates the distance of the required memory location in the segment from the base address.

→ The offset is a 16-bit number, Each segment have a maximum of 64K locations.

→ The BIU has a separate adder to perform this procedure for obtaining a physical address

→ The segment address value taken from an appropriate segment register depending upon whether code, data or stack to be accessed.

→ the offset may be the content of IP, BX, SI, DI, SP, BP or immediate 16-bit value.

→ The fetched instruction is executed internally, the external bus is used to fetch the machine code of the next instruction & arrange it in a Queue known as precoded instruction byte queue.

It is 6-bytes long, FIFO structure.

→ The opcode is fetched by the BIU, EU executes the previously decoded instruction concurrently.

→ The BIU manages the complete interface of execution unit with memory & I/O devices, of course, under the ctrl of timing & ctrl unit.

→ The EU contains the register set of 8086 except segment registers & IP

It has a 16-bit ALU perform arithmetic & logical operation

→ The 16-bit flag register reflects the result of execution by the ALU

→ The decoding unit decodes the opcode bytes.

→ The timing & ctrl ~~signals~~ unit derives the necessary ctrl signal

Memory segmentation.

→ The complete physical available memory may be divided into a number of logical segments

→ Each segment is 64K bytes in size.

→ The 16-bit content of the segment register actually point to starting location of particular segment.

→ 1MB memory can be divided into 16-segments, each of 64KB size.

→ The segment address may assigned as 0000H to F000H

→ The offset address values from 0000H to FFFFH

→ The physical addresses range from 00000H to FFFFFH

Flag Register

→ 16-bit flag register is divided into two parts

a) Condition code or status flags

b) machine control flags.

→ The condition code flag register is the lower byte of the 16-bit flag register along with overflow flag.

→ The control flag register is the higher byte of the flag register. It contains 3 flags

1) Direction flag (D)
2) Interrupt " (I)
3) Trap " (T)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X	X	X	X	O	D	I	T	S	Z	X	AC	X	P	X	CY

8086 flag registers.

Sign flag (S) → The sign flag equals the MSB of the result

S = 1 The result is negative

S = 0 The result is positive.

Zero flag (Z) → The result becomes zero (Z = 1) otherwise Z = 0

Parity flag (P) → The lower byte of the result contains even ~~nber~~ number of 1's (P=1) otherswise (P=0)

Carry flag (C) → There is a carry out of MSB in case of addition or borrow in case of subtraction (C=1) no carry when (C=0)

Trap flag (T) → The processor enters the single step execution mode (T = 1)

The processor executes the current instruction & ctrl is transferred to the Trap interrupt service routine.

Interrupt flag (I) → The maskable interrupts are recognised by the CPU (I=1) otherswise ignored.

Direction flag (D) →

D=0 ; The string is processed beginning from the lowest address to the highest address i.e autoincrementing mode

D=1 ; The string is processed from the higher address towards the lowest address i.e autodecrementing mode

Auxillary carry flag (AC) → a carry from the lowest nibble is bit three, during addition or borrow for the lowest nibble (AC = 1) otherwise no carry.

Overflow flag (O) → if the result of a signed operation is large enough to be accomodhodated in a destination register. (O = 1)

for ex:- ~~7 bits~~ more than 7-bits in size (8-bit)
more than 15-bits in size (16-bit)

1.5) Historical Background

→ Events leading to development of the microprocessor

→ 80x86, pentium, pentium pro, pentium-III, Pentium4 and core2 microprocessors

→ while not essential to understand the microprocessor furnishes:

* interesting reading
* historical perspective of fast-paced evolution.

The Mechanical Age.

→ idea of computing system not new.

→ Calculating with a machine dates to 500BC

→ Ancient people invented the abacus

* first mechanical calculator
* strings of beads perform calculations

→ used by ancient priests to keep track of store houses of grain.

* Still in use today.

→ In 1642 mathematician Blaise pascal invented a calculator constructed of gears & wheels.

* each gear contained 10 teeth

→ when moved one complete revolution, a second gear advances one place.

* same principle used in automoblie odometer.

→ Basis of all mechanical calculators

→ pascal programming Language is named in honor of Blaise pascal.

→ first practical geared mechanical machines to compute information date to early 1800s

* Human dreamed of mechanical machines that could ~~complete~~ compute with a program.

→ One early pioneer of mechanical computing machinery was Charles Babbage.

* aided by Ada Byron, countess of Lovelace

→ Commissioned in 1823 by Royal Astronomical society to build programmable calculating machine

* to generate Royal navy navigation tables.

→ He began to create his Analytical Engine

→ steam-powered mechanical computer ~~stored~~

* stored a thousand 20-digit decimal numbers

→ variable program could modify function of the machine to perform various calculating tasks.

* i/p through punched cards, much as computers in the 1950s & 1960s used punched cards.

→ It is assumed idea of punched cards is from Joseph Jacquard, a frenchman.

* used punched cards as input to a weaving machine he invented in 1801.

→ Jacquard's loom used punched cards to select intricate weaving patterns in cloth it produced

* punched cards programmed the loom.

→ After many years of work Babbage's dream began to fade.

* machinists of his day unable to create the parts needed to complete his work.

→ Analytical Engine required more than 50,000 machined parts.

* They could not be made with enough precision to allow his engine to function reliably.

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The Electrical Age.

→ 1800s saw advent of the electric motor.

* conceived by micheal faraday.

→ Also a multitude of electrically motor-driven adding machines based on the pascal mechanical calculator.

* common office equipment until 1970s

→ Introduced by Bomar corporation the Bomar Brain, was a handhold electronic calculator.

* first appeared in early 1970s

→ monroe also pioneer of electronic calculators, making desktop models.

* four function ; size of cash registers.

→ In 1889, Herman Hollerith developed the punched card for storing data.

* apparently also borrowed Jacquard ideas.