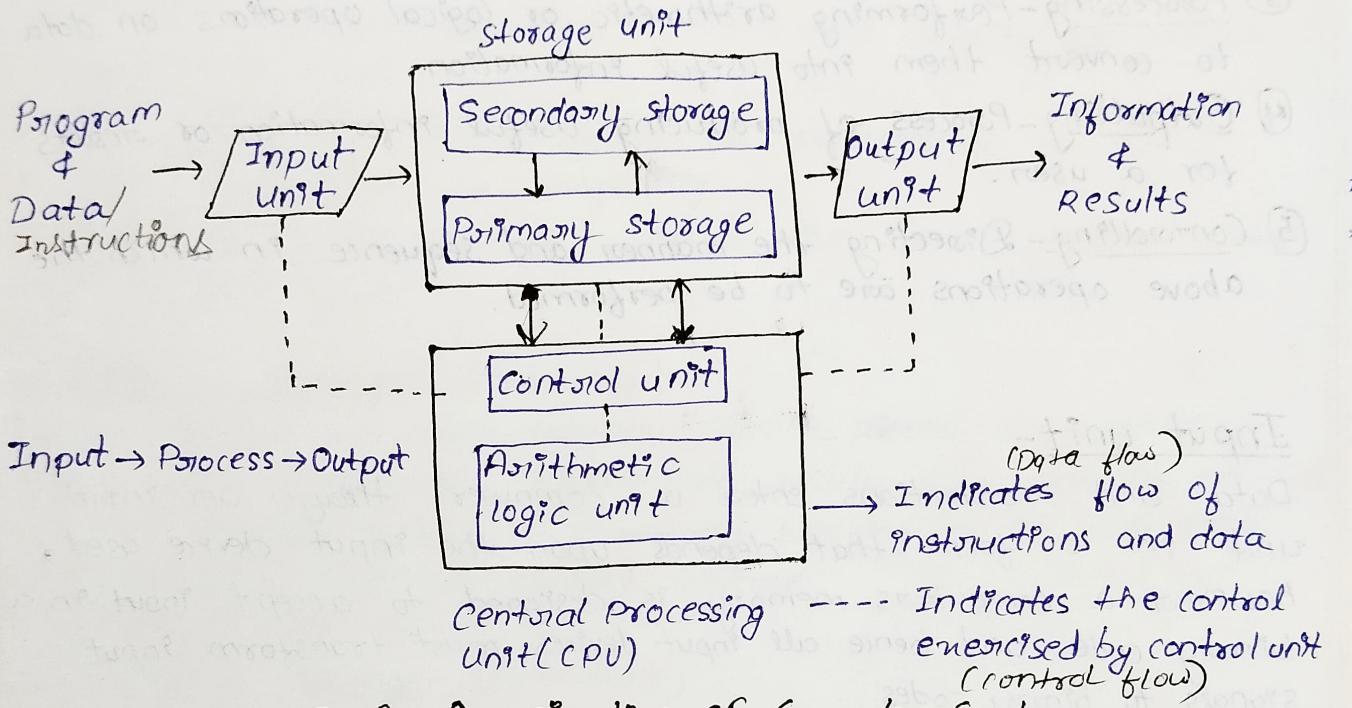


UNIT-IComputer FundamentalsBasic Organization of Computer System

EBCDIC → Extended Binary coded decimal interchange code

Ques - What is computer?

Ans - Computer is an electronic device that manipulates data/processes data, operates on data, data can be anything like biodata of applicants when computer is used for shortlisting candidates for recruiting, marks obtained by students in various subjects while used for preparing results, details of passengers when used for making reservation etc.

The word computer comes from the word 'compute' which means to calculate.

All computer systems perform 5 basic operations for converting raw input data into useful information and presenting it to user.

- ① Inputting - Process of entering data and instructions into a computer system.
- ② Storing - Saving data and instructions to make them readily available for initial or additional processing as and when required.
- ③ Processing - Performing arithmetic or logical operations on data to convert them into useful information.
- ④ Outputting - Process of producing useful information or results for a user.
- ⑤ Controlling - Directing the manner and sequence in which the above operations are to be performed.

### Input unit-

Data and instructions enter a computer through an input unit in a form that depends upon the input device used, however a computer's memory is designed to accept input in a binary code and hence all input devices must transform input signals to binary codes.

An input unit performs the following functions -

- It accepts instruction and data from the outside world.
- It converts these instructions and data in computer acceptable form.
- It supplies the converted instructions and data to computer system for further processing.

### Output unit-

The output unit of a computer provides the information and result of computation to the outside world. Output unit performs the following functions -

- It accepts the produced results which are in coded forms.
- It converts these coded results to human acceptable (readable) form. Units called output interface accomplish this task.
- It supplies the converted result to the outside world.

## Storage unit -

Data and instructions entered into a computer systems through input units have to be stored before actual processing and similarly results have to be stored after each processing.

Storage unit of a computer provides space for storing data and instructions, intermediate results and results for output.

Storage unit holds -

- Data and instructions required for processing.
- Intermediate results of processing.
- Final results of processing before the system releases them to an output.

### • Primary storage - (Temporary)

Also known as main memory, stores pieces of program instructions and data, intermediate results of processing on which computer system is currently working, it is very fast and volatile and has limited storage.

### • Secondary storage - (Permanent)

Also known as auxiliary memory which supplements the limited storage capacity and volatile characteristics of primary storage. A computer system uses secondary storage to store program instruction, data and information of those jobs on which computer system is currently not working but needs to hold them for later processing.

## CPU (central processing unit) -

Control unit and arithmetic logic unit (ALU) of a computer system all together is known as CPU. It is the brain of the computer systems and performs all the major calculations and comparison and also activates and controls the operations of other units of computer system.

### • Arithmetic logic unit-

All the calculations and logical comparisons (decision making) operations are performed in ALU. During processing of job computer transfers data and instructions stored in its primary storage to ALU as and when required.

### • Control unit -

A computer's control unit does not perform any actual processing but manages and coordinates the operations of all other components. It obtains instructions from a program stored in the main memory interprets the instructions and issues signal causing other units of the system to execute them.

## Characteristics of Computer-

- 1) Automatic - Computers are automatic machine because once started a job they carry out the job until it is finished.
- 2) Speed - Computer work at a very high speed ranging from milliseconds to picoseconds.
- 3) Accuracy - Computers are very accurate. The accuracy is consistently high and the degree of its accuracy depends on its design. Errors can occur which may be due to humans rather than technological weakness this is termed as Garbage In and Garbage Out. Computer error caused due to incorrect input data or unreliable program.
- 4) Diligence - Computers can continuously work for hours without creating an error, it is free from monotony, tiredness and lack of concentration.
- 5) Versatility - Computers are capable of performing variety of task such as preparing results, electric bills maintaining records etc.

6) Power of Remembering (memory) - Computers can store huge amount of data once recorded, a piece of information is never ~~forgotten~~ forgotten and the information can be retrieved almost instantly. instantaneously.

7) NO IQ - Computers have no intelligence of its own. It has to be instructed what to do and in what sequence.

8) NO feelings - Computers are devoid of emotions. Computers can't make judgement on their own based on feelings, knowledge etc. They only makes judgement based on instruction given to them in the form of programs written by human beings.

### History and Generations of computers

- Charles Babbage designed different engines in the year 1822 that could produce reliable tables.
- In 1842, he came out with the idea of analytical engine for performing basic arithmetic functions at an average speed of 60 additions per minute but he was unable to produce working model of the machines.
- In the 1940s, Dr. John Von Neumann introduced stored program concept that helped in overcoming hard wired program problem.

### Generations of Computer

## First generation (1942-1955)-

The early computers were manufactured using vacuum tubes. These could perform calculation in millisecond.

### Characteristics-

- Worked on the principle of storing program instruction along with data.
- Memory of these computers used electromagnetic relays and users fed all data and instruction in the system using punched cards.
- Thousands of vacuum tubes emitted large amount of heat and burnt out frequently.
- These system were too big and the power consumption was also very high.
- Their production was difficult and costly.
- These computers were difficult to program and use and hence had limited commercial use.

## Second Generation (1955-1964)-

They were manufactured using transistors. They were more powerful, more reliable, less expensive, smaller and cooler to operate than the first generation computers.

### Characteristics -

- They consumed less power and generated less heat than the first generation computer.
- They were more reliable and prone to hardware failures.
- They had faster and larger primary and secondary storage memory.
- Memory was composed of magnetic cores. In around 1957 magnetic tape was introduced and later became the main storage media of second generations computers.
- They were easier to program and hence widely used.
- Thousands of transistor had to be assemble manually into electronic circuits making it costly.

### Third Generation (1964-1975)-

These were manufactured using integrated circuits (ICs). Earlier ones used small scale integration (SSI) which was later replaced by medium scale integration (MSI).

#### Characteristics-

- Their manufacturing did not require manual assembly of components and hence commercial production of these systems was easier and cheaper.
- Standardization of high level programming language allowed programs to be easily ported to and executed on another computer.
- Time sharing operating system allowed interactive usage and simultaneous use of systems by multiple users.
- Third generation computers have few megabytes of main memory and magnetic disks capable of storing few tens of megabytes per disk drives.
- Mini computers of third generation made computers affordable even by smaller companies.

### Fourth Generation (1975- 1989)-

During the fourth generation microprocessor were developed using the technique VLSI (Very Large Scale Integration), (means 1 million component in a single chip). A microprocessor contains all circuits needed to perform arithmetic logic and control functions on a single chip, and hence fourth generation was known for personal computer revolution.

#### Characteristics-

- Semiconductor memories replaced magnetic core resulting in large RAM with fast access time.
- GUI (Graphical user interface) enabled users to quickly learn how to use computer.

- Their manufacturing did not required manual assembly of individual components into electronic circuits resulting in cheapest commercial production.
- Supported the use of high level programming language.
- LAN and WAN was developed giving rise to network of computers and distributed systems. This enabled sharing of resources among multiple users at geographically distant locations.
- Super Computers of 4th generations supported parallel processing on large number of processors.

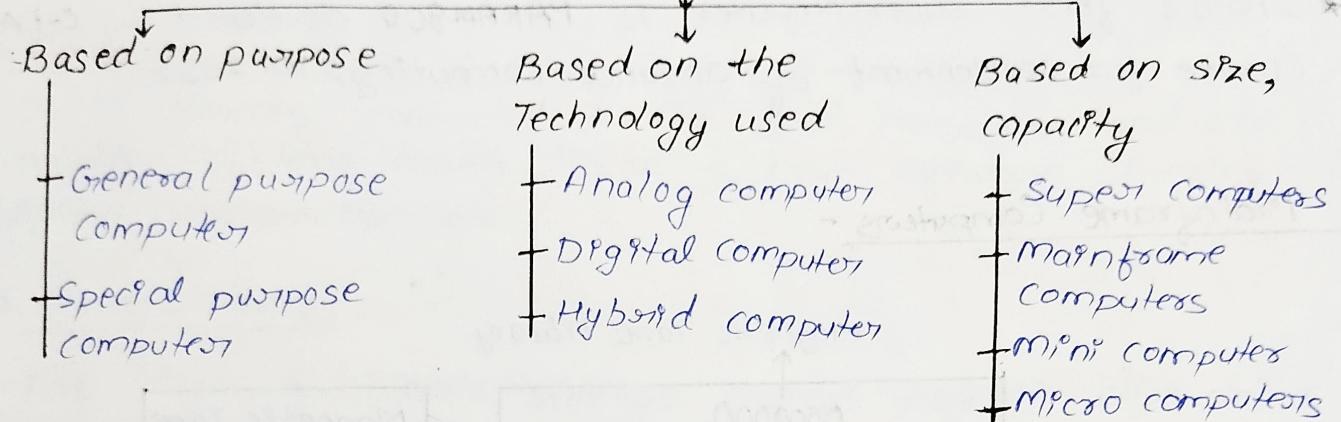
### Fifth Generation (1989- present)-

This generation witnessed dramatic increase in the power of microprocessor chips and VLSI technology became ULSI. CPUs of large mainframe systems became part of microprocessor architecture of fifth generation.

### Characteristics-

- This generation computers have several gigabytes of storage which is now extended upto several terabytes. CDs, DVDs and flash drive emerged as popular storage device.
- Multimedia applications made the systems more useful in every occupation.
- With the advent of www applications like e-commerce, virtual libraries etc, life of common people was influenced heavily.
- Multiprocessors and multicore technology popularised during this generation.
- Development of AI started at a great pace.

## Classification of Computers



General purpose computers- These computers follow instructions for general requirement such as sales analysis, financial accounting, inventory management.

Special purpose computers- These computers are designed to perform special tasks like scientific application and research, weather forecasting, medical diagnosis etc.

Analog computers- These computers measure physical quantities like temperature, pressure etc. These are used mainly for scientific and engineering purposes because they deal with the quantities that vary constantly.

Digital Computers- These computers are used to process information using digits, generally the binary number systems.

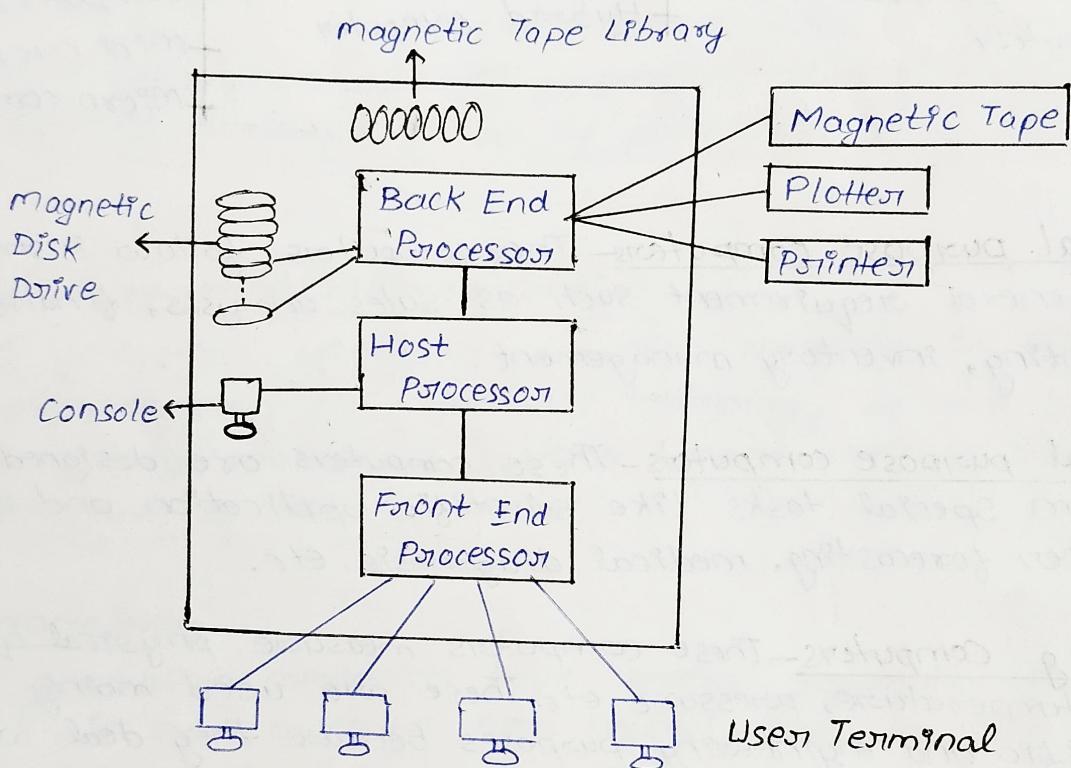
Hybrid computers- These computers store and process analog signals which have been converted into discrete numbers using analog to digital converters. and vice-versa.

Super Computers- Super computers are the most powerful and expensive computers available at any given time. They are used for processing complex scientific application. They use multiprocessing and parallel processing technologies to solve complex problems faster. Speed of super computer is measured in petaflops ( $10^{15}$  floating point).

Example- Automobile industries uses super computer to do crash simulation.

★ India's first supercomputer is PARAM 800 developed by C-DAC (Centre for development of advance computing) in 1991.

### Mainframe Computers -



Mainframe systems are type of computer that are generally known for their large size, amount of storage, processing power and high level of reliability. They are mainly used by government organisation such as banks, hospitals, railways etc. which require large number of transactions having massive data storage and processing capabilities.

#### → Host, Front end and back end computers-

- Host computers carries out most of the computation and has direct control of all other computers.
- Front end computers handles all communication to and from all user terminals.

- 11
- Back end computers handles all input/output operations and transferring data to and from it.

→ Console-

It is directly connected to the host computer and use to monitor systems health, installing new software changing system configuration etc.

→ Storage devices-

For large value data storage several magnetic disk drives are directly connected to back end computers. There are also additional storage device library for backup of data.

→ User terminals-

User terminals serve as access station, their operating system supports multiprogramming with multisharing.

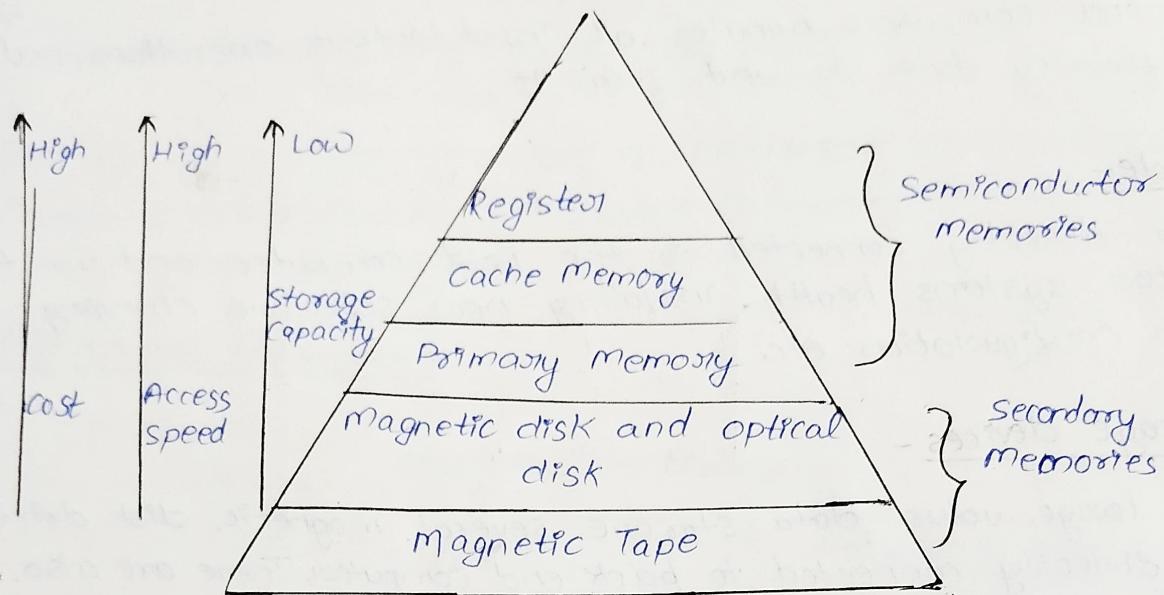
→ Output devices-

User terminals serve as soft copy output devices, for hard copy output several printers or plotters are connected to backend computers.

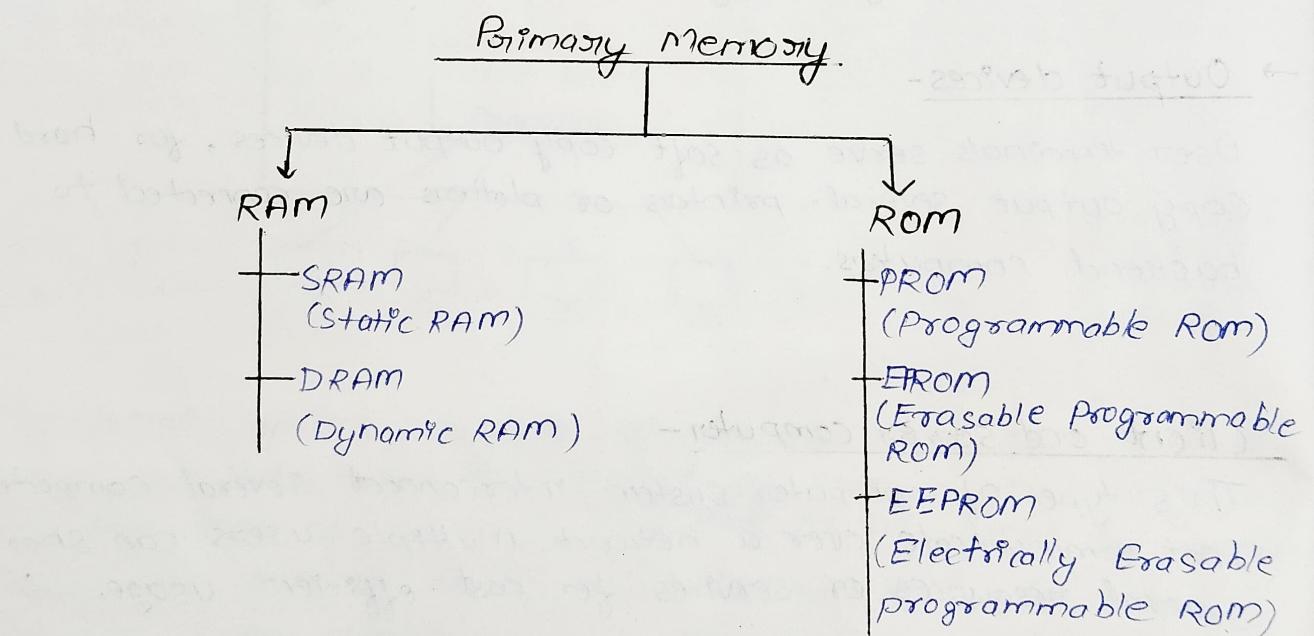
Client and server computer-

This type of computer system interconnect several computers that communicate over a network. Multiple users can share several resources or services for cost efficient usage.

- File server- Provide control storage facility to store files of several users on a network.
- Database server- It manages centralised database and enables several users on a network to have shared access on a same database.
- Print server- It manages one or more printer and accepts and processes print requests from any user in the network.



### Memory Hierarchy



### RAM -

It stands for Random access memory. It is volatile and a temporal storage memory.

- SRAM (Static RAM) -

It is a form of RAM made with flip flops. It retains data as long as computer is powered. It is more expensive and consumes more power than dynamic RAM. Technically SRAM

uses six transistors per data bit and hence is faster and used as cache memory.

- DRAM(Dynamic RAM)-

It is another form of RAM used as main memory. It retains information in capacitors for short period (a few millisecond) even though the computer is powered. The data is refreshed periodically to maintain in it. DRAM uses one transistor per data bit, it is slower than SRAM but it can store much more data or information.

### ROM- (store BIOS)

ROM is a long term internal memory. It is non-volatile memory that retains data without the flow of electricity. ROM comes with pre-written by the computer manufacturer to hold the instructions for booting up the computer.  
(initiating the OS.)

- PROM(Programmable ROM)-

It can be program only once and read many. PROM can be manufactured as blank memory and can be programmed by PROM burner and also by blowing internal fuses permanently.

- EPROM(Erasable Programmable Rom)-

It retains its content until it is exposed to intense ultraviolet light that clears its content making it possible to reprogram the memory.

- EEPROM(Electrically Erasable Programmable ROM)-

EEPROM can be program(burned) and erased by electrical waves in millisecond. A single byte of data or entire content of device can be erased.

## Binary 2s Complement Addition -

- 2s complement of positive numbers  
→ If both no. in 2s complement are positive, then result will be positive. And it will be same as simple binary addition.
- 2s complement of positive and negative numbers  
→ If one no. is positive and other one is negative then overall sign will depend on the sign of the bigger quantity.
- 2s complement of negative numbers  
→ If both no. are negative then corresponding result of addition will be negative.

### Questions -

$$\textcircled{1} \quad 26 - 15 \Rightarrow 26 + (-15)$$

$$26 \rightarrow 11010$$

$$15 \rightarrow 01111$$

- Find complement of digit with negative sign i.e.  $(-15)$
- 10000 → 1s complement of 15
- Now add 1 to 1s complement in order to get 2s complement

$$\begin{array}{r} 10000 \\ + 1 \\ \hline 10001 \end{array} \rightarrow \text{2s complement of } 15 \text{ i.e. } (-15)$$

- Add 11010 (26) and 2s complement of 15 (10001)

$$\begin{array}{r} 11010 \\ 10001 \\ \hline 01010 \end{array}$$

so,  $26 - 15$   
 $\Rightarrow 11010 - 01111 \Rightarrow 01010$

Ignore carry bit (leftmost bit)

(2)  $20 - 30$

$$20 \rightarrow 10100$$

$$30 \rightarrow 11110$$

- 1's complement of 30  $\rightarrow 00001$

- 2's complement of 30  $\rightarrow 00001$

$$\begin{array}{r} + 1 \\ \hline 00010 \end{array} \rightarrow (\text{i.e. } -30)$$

- Add 20 and 2's-complement of 30.

$$\begin{array}{r}
 10100 \\
 00010 \\
 \hline
 \boxed{10110}
 \end{array}
 \rightarrow
 \begin{array}{r}
 0110 \\
 \downarrow
 \end{array}
 \begin{array}{l}
 \text{After} \\
 \text{Find complement, when} \\
 \text{1 is encountered} \\
 \text{After this take complement}
 \end{array}$$

*Ignore this bit*

$$\begin{array}{r}
 \boxed{1010} \\
 \downarrow
 \end{array}$$

Final Answer

$$\text{i.e. } 20 - 30 \Rightarrow 10100 - 11110 \Rightarrow -1010$$

Unit - 2Algorithms And FlowchartsAlgorithm -

Algorithm is a sequence of steps to solve a particular problem. An algorithm should possess following characteristics

- Each instructions should be precise and unambiguous (clear)
- Each instructions should be executed in finite time.
- The algorithm should terminate after finite number of steps.
- After executing the instructions the desired results should be obtained. In other words each algorithm is expected to produce atleast one result.

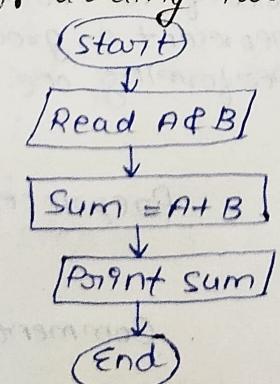
Algorithms are represented by

- ① Flowchart
- ② Pseudocode
- ③ Programs

Flowchart -

Flowchart is a pictorial representation of an algorithm. Flowchart uses different symbols to design a solution for a problem. It is often considered as a blueprint of a design used for solving a specific problem

Flowchart for adding two numbers -



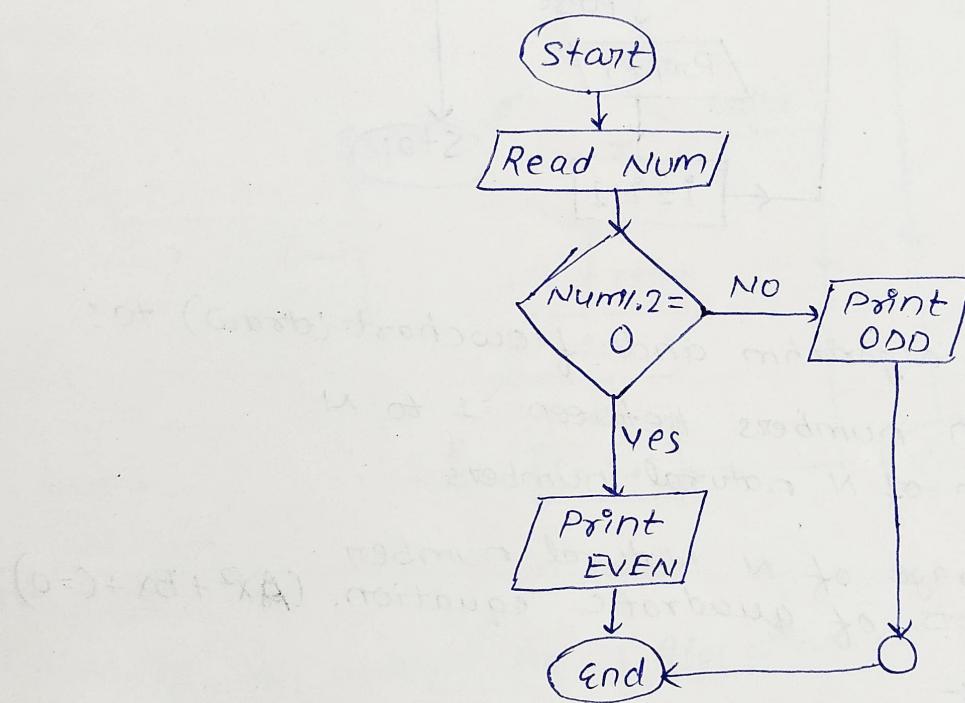
## Flowchart Symbols.

Symbol Name	Symbol	Function
Oval		used to represent start and end of flowchart.
Parallelogram		used for input and output operation
Rectangle		Processing: used for arithmetic operations and data-manipulation
Diamond		Decision making: Used to represent the operation in which there are two/three alternatives, true and false etc.
Arrows		Flow line: used to indicate the flow of logic by connecting symbols.
Circle		Page connector
		Off page connector
		Predefined Process/Function used to represent a group of statements performing one processing task.
		Preprocessor
		Comments

Q. Algorithm for checking even and odd number -

Step 1: Start  
 Step 2: Read a value num  
 Step 3: Divide num by 2 and check the number.  
 Step 4: If the number remainder in step 3 is 0 print "Even" else print "False".  
 Step 5: End

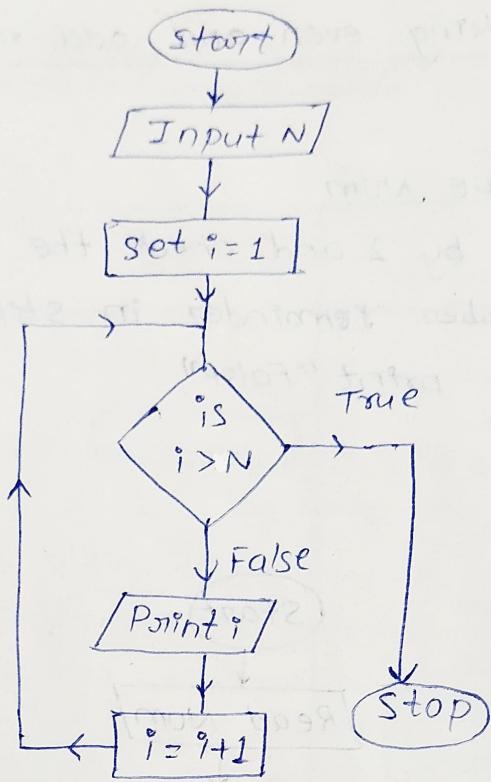
Flowchart -



Q. Write algorithm and flowchart to print natural no. from 1 to n.

~~Q. write~~

Step 1: Start  
 Step 2: Read N  
 Step 3: Set i=1  
 Step 4: If  $i > N$  go to step 8.  
 Step 5: Print i  
 Step 6:  $i = i + 1$   
 Step 7: Go to step 4  
 Step 8: End



& write an algorithm and flowchart (draw) to:

- ① find even numbers between 1 to N.
- ② find sum of N natural numbers
- ③ find average of N Natural number
- ④ find roots of quadratic equation. ( $AX^2 + BX + C = 0$ )

### ① Algorithm :-

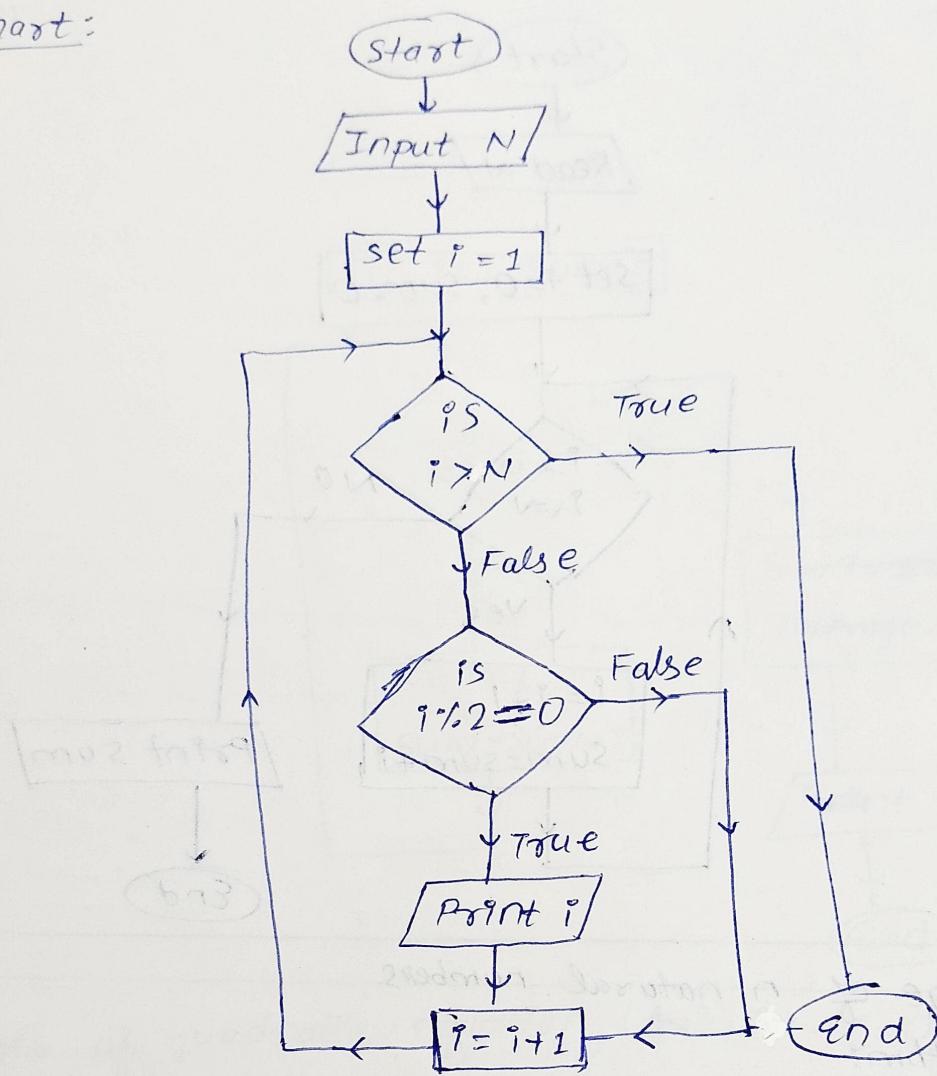
Step 1: Start  
 Step 2: Read N  
 Step 3: Set  $i = 1$   
 Step 4: If ( $i > N$ ), go to step 8  
     End If

Step 5: If ( $i \cdot 2 = 0$ ). then , print  $i$   
     end If

Step 6:  $i = i + 1$   
 Step 7: Go to Step 4  
 Step 8: End

Flowchart:

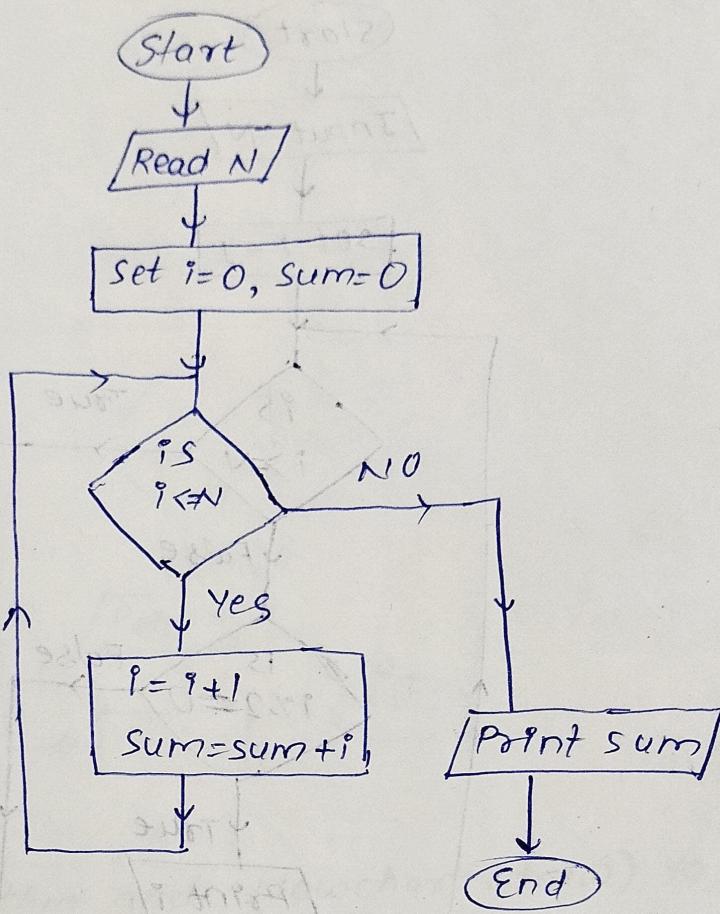
20



ii) Sum of  $N$  natural no. (Algorithm):-

- Step 1 : Start
- Step 2 : Read  $N$
- Step 3 : Set  $i=1$ ,  $sum=0$
- Step 4 ; If ( $i \leq N$ ), go to step 5.
- Step 5 :  $i = i + 1$ ,  $sum = sum + 1$
- Step 6 : Go to step 4.
- Step 7 : If ( $i > N$ ), print sum
- Step 8 : end

Flowchart-



(P1) Average of  $n$  natural numbers.

Algorithm:-

Step 1: Start

Step 2: Read  $N$

Step 3:  $i=1$ ,  $sum=0$

Step 4: If  $i \leq N$ , goto step 5

Step 5:  $i = i + 1$ ,  $sum = sum + i$

Step 6: Go to Step 4

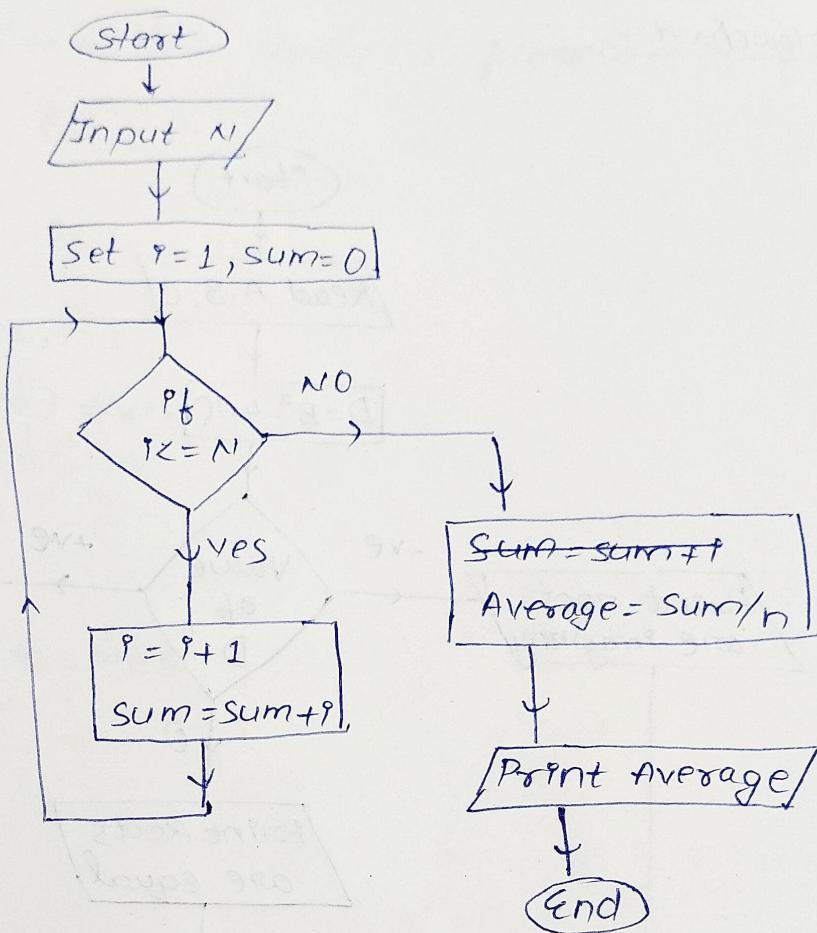
Step 7: If  $i > N$ , average =  $sum/N$  and  
print average, go to step 8.

Step 8: End.

Flowchart:-

Flowchart -

22



#### ⑨ Roots of quadratic equation ( $Ax^2 + Bx + C = 0$ )

Algorithm:-

Step 1: Start

Step 2: Read the coefficient of the equation as A, B & C.

Step 3: Calculate  $D = B^2 - 4AC$

Step 4: If ( $D < 0$ ) then print "Roots are imaginary" and go to Step 7.  
End if

Step 5: If ( $D = 0$ ) then, print "Roots are equal"

$$X = -B / 2 \times A$$

Go to Step 7.

End if.

Step 6: If ( $D > 0$ ) then print "Roots are Real and unequal".

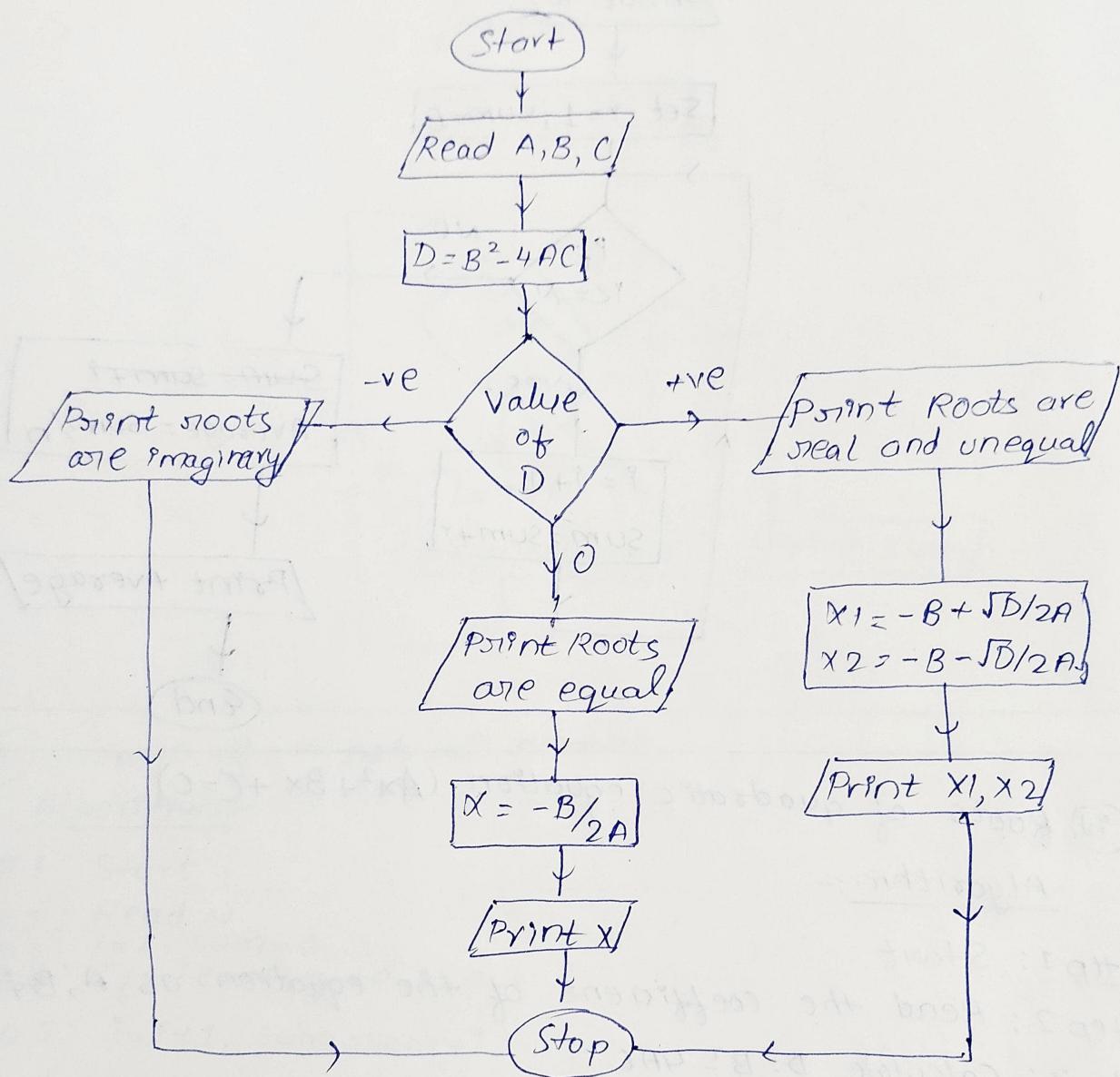
$$X_1 = (-B + \sqrt{D}) / 2 \times A$$

$$X_2 = (-B - \sqrt{D}) / 2 \times A$$

Go to Step 7. End if

Step 7: Stop

Flowchart:-



Q- Write an algorithm and draw a flowchart to find the factorial of a number

Algorithm -

Step1: Start

Step2: Read Num

Step3: Set fact=1, i=1

Step4: If ( $i \leq num$ ) then

fact=fact\*i

$i = i + 1$

End If

Else

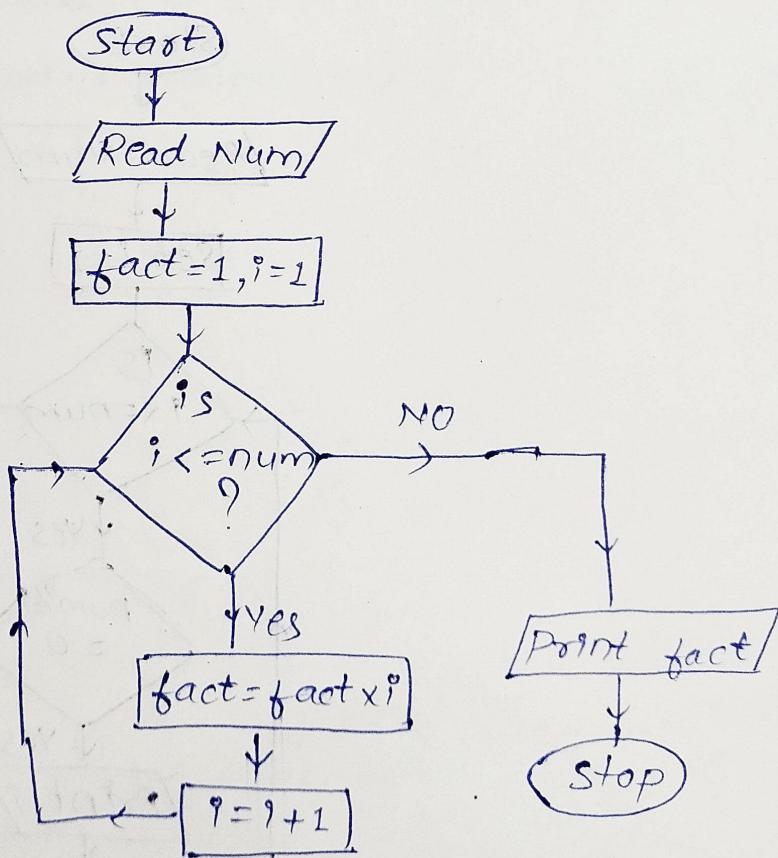
    got to step5

End Else

Step5: Print fact

Step6: End

Flowchart -



Q- Write algorithm and flowchart to find factors of a given number.

Algorithm -

Step 1: Start

Step 2: Read Num.

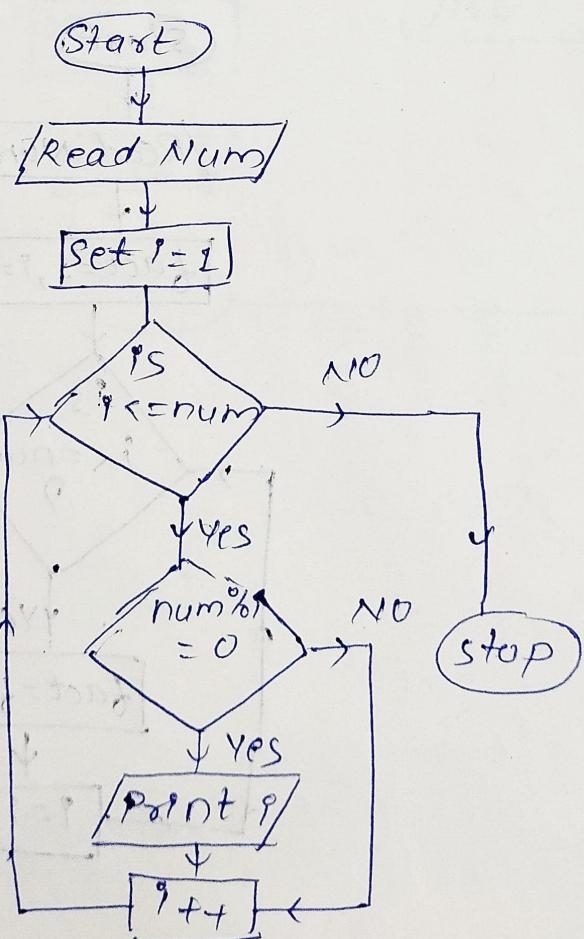
Step 3: Set  $i=1$

Step 4: If ( $n \% i == 0$ ) then  
~~print~~

Step 5: If  $num \% i \neq 0$ , print ; end if else go to Step 6.

Step 6:  $i = i + 1$ , then go to step 4, end if step 7.

Step 7: Stop.



Q. Write an algorithm and draw flowchart for prime number.

26

Algorithm -

Step 1: Start

Step 2: Read number

Step 3: Assign/set  $i=2$  and  $\text{flag}=0$

Step 4: Check if  $\text{num} < 1$ , then go to step 5, otherwise  
go point invalid input.

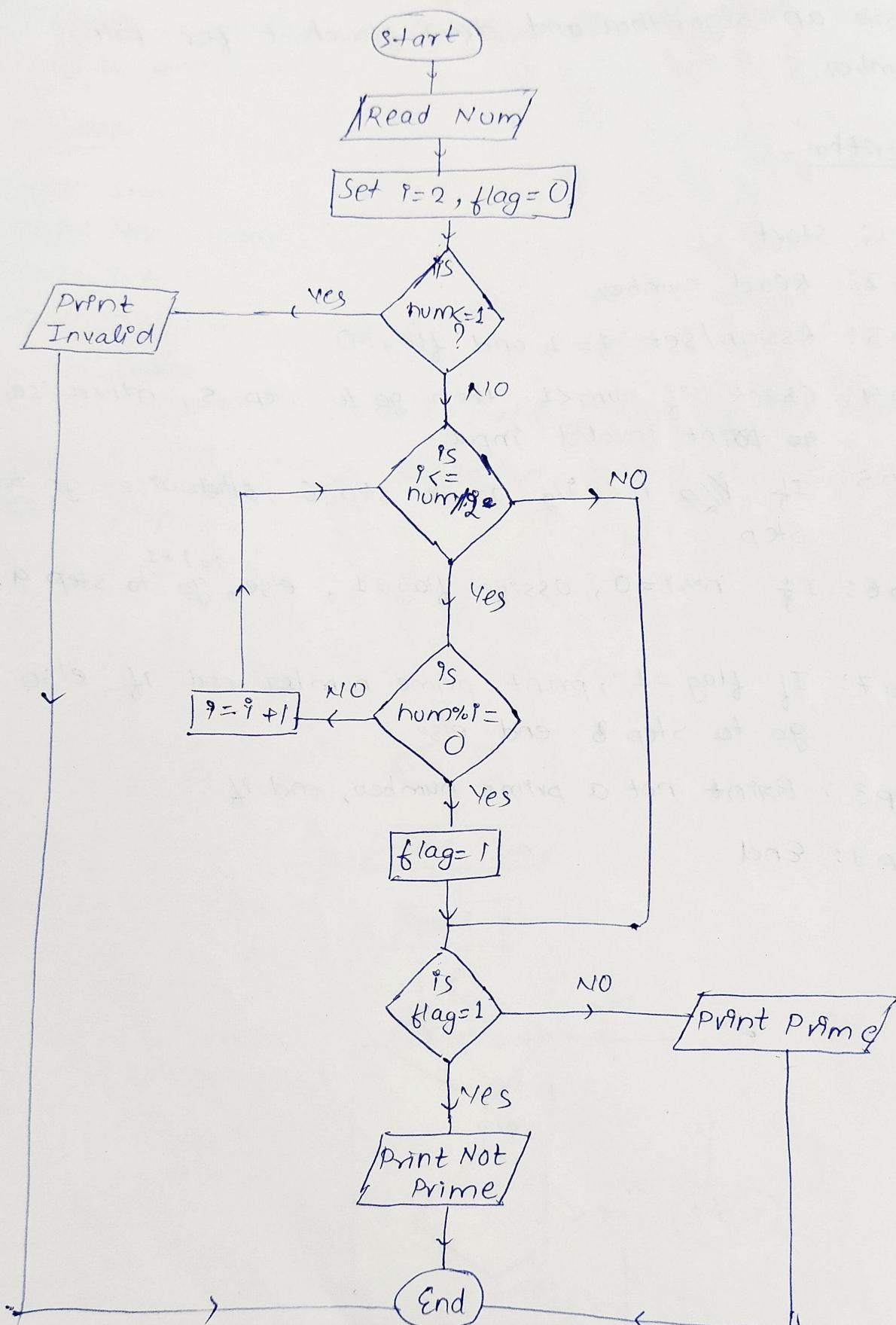
Step 5: If  $n \leq i^2$  go to step 6, otherwise go to  
Step

Step 6: If  $n \% i = 0$ , assign  $\text{flag}=1$ , else,  $i = i + 1$  go to step 4.

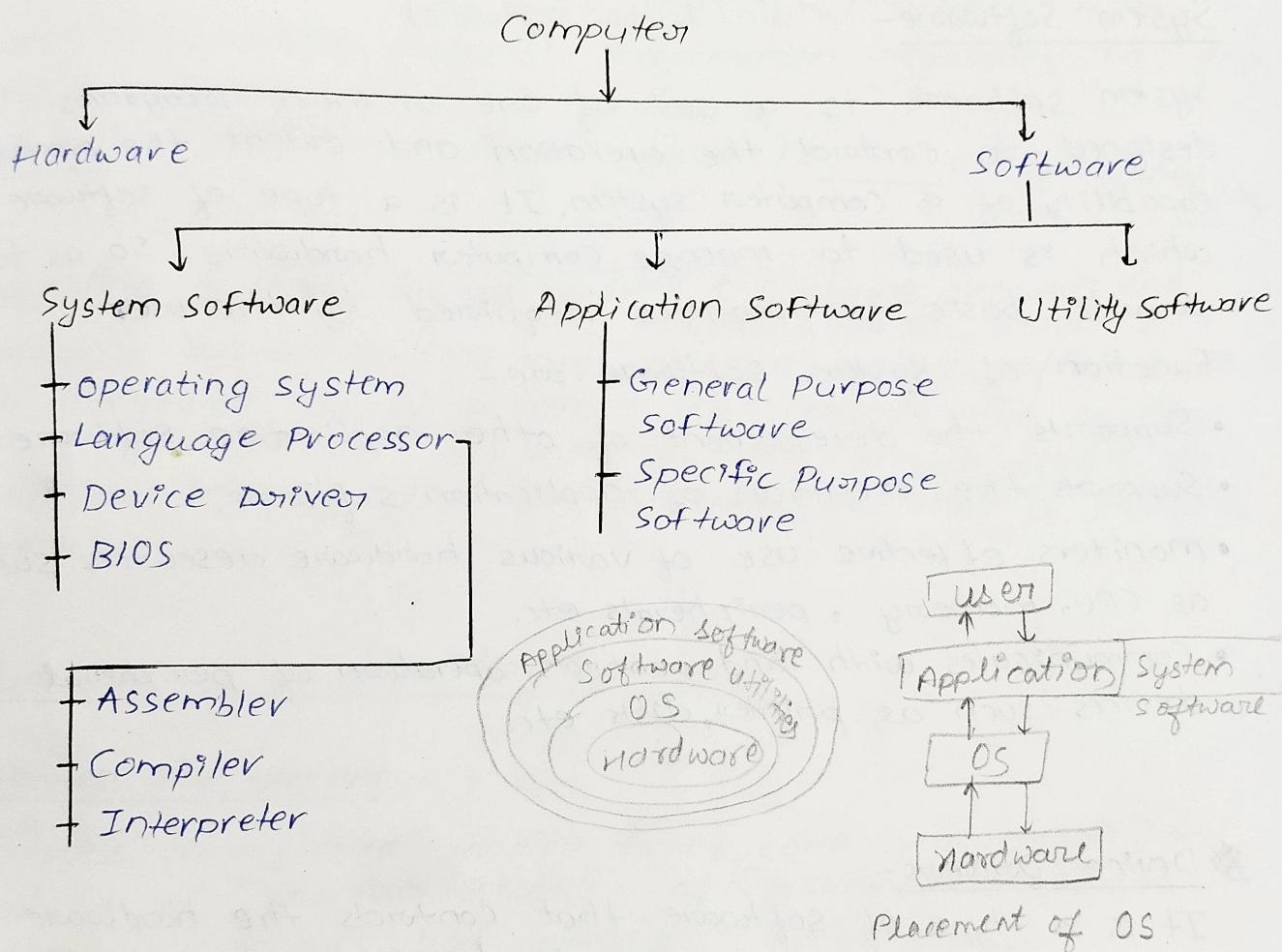
Step 7: If  $\text{flag} = 1$ , print prime number end if. else  
go to step 8 end else.

Step 8: Print not a prime number, end if

Step 9: End



## Computer System Software and Operating System



Software - (tell computer what to do)

The term software refers to a set of programs, procedures and associated documents (flowcharts, DFDs etc.) describing the program and how they are used, used to operate computers and execute specific task.

Relationship between hardware and software -

- Both hardware and software are necessary for a computer to work efficiently.

- Same hardware can be loaded with different software to make a computer to perform different types of job accurately.
- Except for upgrades hardwares are normally a one time expense whereas software is continuing expense.

### System Software - (main/alpha software)

System software is a set of one or more programs designed to control the operation and <sup>improve</sup> ~~extent the processing~~ performance ~~of~~ capability of a computer system. It is a type of software which is used to manage computer hardware so as to provide basic functionalities required by the user.

Function of system software are-

- Supports the development of other application software.
- Supports the execution of application software.
- Monitors effective use of various hardware resources such as CPU, memory, peripherals etc.
- Communicates with and controls operation of peripheral devices such as printer, disk etc.

### Device Drivers -

It is a type of software that controls the hardware device attached to the system. Hardware devices that need a driver to connect to a system include displays, soundcards, pointers, mouse, harddisk.

### Utility Software -

This software is designed to aid/help/support in analyzing, optimizing, configuring and maintaining a computer system. This software focuses on how an operating system functions and then accordingly it decides its trajectory to smoothen the functioning of the system.

Softwares like antivirus, disk cleanup and management tools, compression tools, defragmentors etc. are all utility tools.

### Firmware -

It is a permanent software that is embedded into ROM. It provides essential information regarding how the device interacts with other hardware.

Eg- BIOS (Basic Input Output System)

Operating System - manages hardware & Software resources and provides common services.

Operating System is the most popular system software. It is an integrated set of programs that controls the system resources such as CPU, memory, input/output devices etc. and provides its users with an interface that is easier to use.

### Functions of an operating System-

#### 1) Process Management -

Process management module takes care of creation and deletion of processes scheduling of system resources to different processes and providing mechanism for synchronization and communication among process.

#### 2) Memory management -

This module takes care of allocation and deallocation of memory space to programs in need of this resource.

#### 3) File Management -

This module takes care of file related activities such as organisation, storage, retrieval, naming, sharing and protection of files.

#### 4) Security -

This module protects the resources and information of a computer system against destruction and unauthorized access.

#### 5) Command Interpretation -

This module takes care of interpreting user commands and directing the system resources to process the commands.

### Measures of System Performance -

#### Throughput -

It is the amount of work that the system is able to do per unit time. It is measured as the number of processes completed by the system per unit time.

#### Turnaround Time -

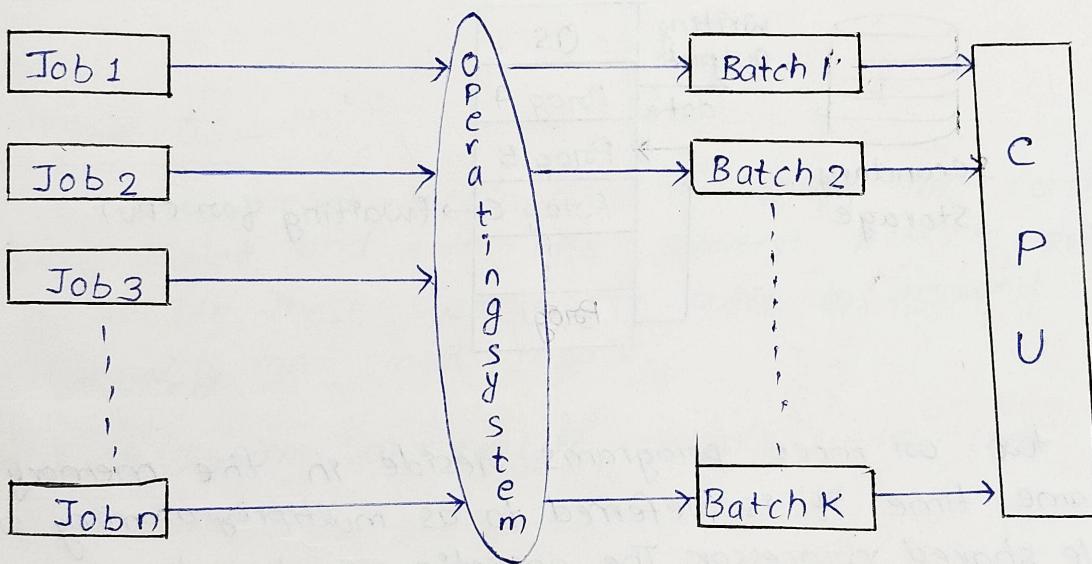
It is the time interval between the time of submission of a job (process) to the system for processing to the time of completion of the job.

#### Response Time -

It is the interval between the time of submission of a job to the system for processing to the time of the system producing the first response for the job.

## Types of Operating System -

- Batch OS
- Multiprogramming OS
- Multiprocessing OS
- Time sharing OS
- Real Time OS
- Network OS
- Distributed OS
- Embedded OS



## ↳ Batch Operating System -

This type of OS does not interact with computer directly. There is an operator which takes similar job having some requirement and group them into batches. It is the responsibility of operator to sort the jobs with similar modes.

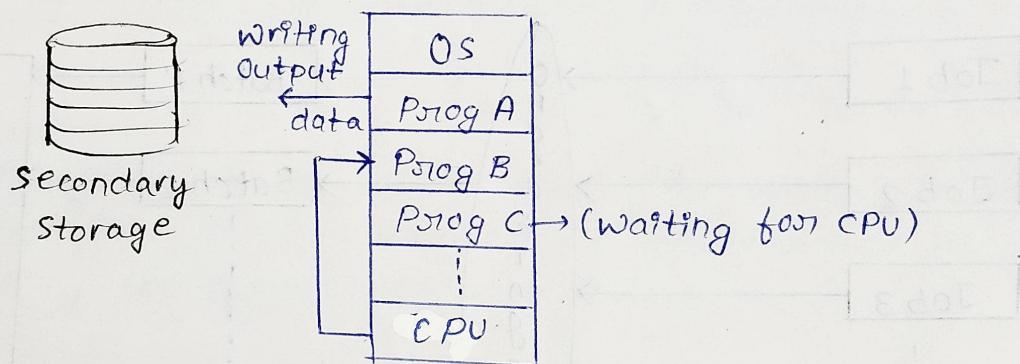
### Advantage -

- Idle time of CPU is very less.
- Multiple user can share the batch systems.
- It is easy to manage large work repeatedly in batch systems.

## Disadvantages-

- The dependency on the computer operators who should be well known with the batch system.
- Other jobs will have to wait for an unknown time if any job fails.
- Batch systems are costly and hard to debug.

## ↳ Multiprogramming Operating System -



When two or more programs reside in the memory at the same time it is referred to as multiprogramming with a single shared processor. The operating system keeps several jobs (process) in memory at a time. It picks and begins to execute one of the jobs in the memory.

Multiprogramming OS monitors the state of all the active programs and system resources to ensure that CPU is never idle.

## Advantages -

- Increased throughput because CPU has always one program to execute.
- High and efficient CPU utilization.

### Disadvantages -

- CPU scheduling is required.
- To accommodate many jobs in the memory, memory management is required.

### Multiprocessing Operating System -

Multiprocessing is achieved with the help of parallel computing there are more than one processor present in the system which can execute more than one process at a time.

### Real Time OS -

These OS are meant for applications where time constraints are very strict and even the shortest possible delay is not acceptable. These systems are built to respond instantaneously on small inputs.

Ex- missile systems, air traffic controls system etc.

### Types of Real time OS -

- Hard Real time system
- Soft Real time system

### Hard Real time OS -

This system is built for saving life automatic ~~parasites~~ parachutes or for generating responses in strict time such as air traffic control etc.

### Soft Real time OS -

These OS are for applications where time constraint is less strict such as online gaming server etc.

#### Advantages -

- Task and time is assigned for each task so shifting is less.
- It is application focused.
- Maximum utilisation of devices and system.

#### Disadvantage -

- Very costly to develop.
- Very complex and can consume critical CPU cycles.
- Limited task.

### ↪ Embedded OS -

It is a specialised OS designed to perform specific task for a device that is not a computer. Embedded OS runs the code and make the device's hardware accessible to software that is running on the top of the OS.  
Ex - Traffic lights, elevators, smart meters etc.

## 35 ↳ Time sharing OS -

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These system are also known as multitasking system. The task can be from a single user or different users. Each task is given some time known as quantum to execute so that all the task work smoothly. After every quantum is executed by a process the OS switches over to the next task.

### Advantages -

- Each task get equal opportunity.
- Idle time and response time of the CPU is reduced.
- Effective utilisation and sharing of resources.
- 

### Disadvantages -

- High overhead (need for scheduling and context switching).
- Complex and require advanced softwares to manage multiple users.
- Security and integrity of user program loaded in memory and data need to be maintained as many users access the system at the same time.

## ↳ Distributed operating Systems -

These are referred to as loosely coupled system. The distributed OS is not installed on a single machine, it is divided into parts and these parts are loaded in different machines. A part of the distributed OS is installed on each machine to make the communication between them possible. Different machines act as independent systems having their own memory unit and CPU. The system communicate with each other using a shared communication network.

### Advantages -

- Fault tolerant.
- Efficient sharing of resources.
- High computation speed and reliability.

### Disadvantages -

- Failure of main communication network will stop the entire working of distributed OS.
- Expensive and complex software.

### ↳ Network operating System -

Network OS also referred to as tightly coupled system. These systems run on a server and provide the capability to manage data, users, groups, security, applications and other networking functions. This OS allows shared access of files, printers, applications etc. over a small private network.

### Advantages -

- Highly stable centralised server.
- New technologies and hardware upgradation are easily integrated into the system.
- Server access is possible remotely from different location and types of systems.

### Disadvantages -

- Servers are costly.
- Dependence on central location for most operations.
- Maintenance and <sup>update</sup> upgrade are required.