Words of Concern

Point to be As Allan Bloom has said "Education is the movement from darkness to light". Through this handbook, I have tried to illuminate what might otherwise appear as black boxes to some. In doing so, I have used references from several other authors to synthesize or simplify or elaborate information. This is not possible without omitting details that I deem trivial while dilating the data that I consider relevant to topic. Every effort has been made to avoid errors. In spite of this, some errors might have crept in. Any errors or discrepancies noted maybe brought to my notice which I shall rectify in my next revision.

Thanks,
Raghu Gurumurthy
Interface College of Computer Applications (ICCA)
Davangere

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Syllabus:

Course Code: 21BCA1C2L
Course Title: Fundamentals of Computers
Credits - 03
Sem - I
Hours- 42
Formative Assessment Marks: 40
Summative Assessment Marks: 60
Duration of ESA: 03 hrs.

Course Outcomes

At the end of the course the student should be able to:
1. Create an awareness of computers its classification and anatomy
2. Understand Number systems , Computer Languages and the steps for problem solving
3. Understand the fundamentals of operating systems and basic commands
4. Understand basic concepts of DBMS and Internet

Unit I 10 Hrs

Fundamentals of Computers:
Introduction to Computers - Computer Definition, Characteristics of Computers, Evolution and Generations of Computers, Basic Organization of a Digital Computer; Functions & Components of a Computer, Central Processing Unit, Microprocessor, Storage units, Input and output Devices. How CPU and memory works. Classification of Digital Computer Systems: Microcomputers, Minicomputers, Mainframes, Super computers.

Unit II 10 Hrs
Number Systems:
Different types, conversion from one number system to another; Computer Codes – BCD, Gray Code, ASCII; Boolean Algebra – Boolean Operators with Truth Tables; Computer Languages - Machine Level, Assembly Level & High Level Languages, Translator Programs – Assembler, Interpreter and Compiler; Planning a Computer Program – Algorithm and Flowchart with Examples.

Unit III 10 Hrs
Operating System Fundamentals:
Operating Systems: Introduction, Functions of an operating System, Classification of Operating Systems, System programs, Application programs, Utilities, The Unix Operating System, Basic Commands (cal, date, bc, echo, who, ls, pwd, cd, mkdir, rmdir), Commands to work with file (cat, cp, rm, mv, file, wc, head, tail).

Unit IV 12 Hrs
Introduction to Database Management Systems:
Database, DBMS, Why Database -File system vs DBMS, Database applications, Database users, Introduction to SQL, Classification of SQL-DDL, DML, DCL. Internet Basics: Introduction, Features of Internet, Internet application, Services of Internet, Logical and physical addresses, Internet Service Providers, Domain Name System. Web Basics: Introduction to web, web browsers, http/https, URL.

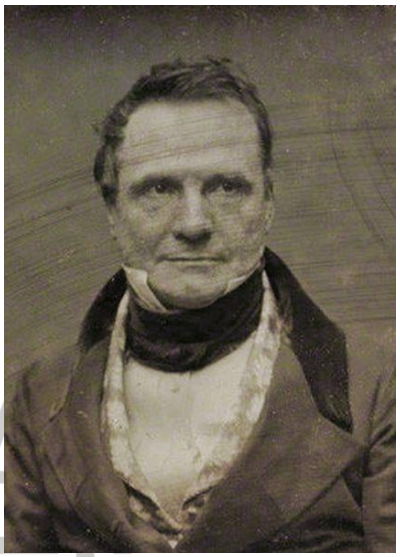
Unit I: Fundamentals of Computers

Introduction to Computers

Computer Definition

Introduction

- Being a modern-day kid, you must have used, seen, or read about computers.
- This is because they are an integral part of our everyday existence.
- Be it school, banks, shops, railway stations, hospital or your own home, computers are present everywhere, making our work easier and faster for us.
- As they are such integral parts of our lives, we must know what they are and how they function. Let us start with defining the term computer formally.
- Charles Babbage is considered as father of computer.

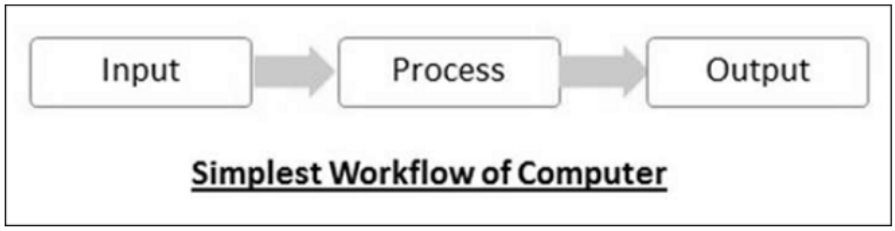


Note:
The literal meaning of computer is a device that can calculate.
However, modern computers can do a lot more than calculate.

Definition
Computer is an electronic device that receives input, stores, or processes the input as per user instructions and provides output in desired format.

Input-Process-Output Model

- Computer input is called data and the output obtained after processing it, based on user's instructions is called information.
- Raw facts and figures which can be processed using arithmetic and logical operations to obtain information are called data.



Simplest Workflow of Computer

Characteristics of Computers

- Speed of Computer
- Accuracy of Computer
- Diligence of Computer
- Reliability of Computer
- Versatility of Computer
- Storage Capacity of Computer
- Automatic
- Quick Decision
- Multitasking
- No Feeling
- Power of Remembering
- No IQ

- Speed of Computer
  - Computers are much faster to perform mathematical calculations than human.
  - The computer is capable of performing millions of tasks per second.
  - It takes an hour or a day for a person to do a mathematical calculation or any work, to do the same calculation or work to a computer do in microseconds or nanoseconds.
  - This means that while it takes some time for humans to do a small calculation, a computer can do millions of additions, subtractions, multiplications, divisions in the same amount of time.
  - The computer is so fast that it can do work in the blink of an eye. Let us understand this through an example.
  - The song plays as you instruct the computer to play the song. As soon as you give the instruction, the computer completes that instruction at full speed.
  - If you want to get more information about computer speed, then you can read the post given below.

- Accuracy of Computer
  - A computer is very accurate. It does not make any kind of mistake in calculating. Sometimes we get some error but these are because of the mistake performed by us.
  - The Accuracy of the computer is constantly high and it can perform hundred of operation with the carry-out calculation and analysis accurately and speedily.
  - It is also a feature of the computer that the computer completes any work with absolute accuracy, this means that any instruction received from the user is done by the computer with full accuracy and speed.
  - A computer never gives us wrong results under any circumstances. You can absolutely trust the output of the computer.

- To know more about Computer Accuracy, you can read the post given below.

- Diligence of Computer

  - Diligence means that the computer can do any work for a long time without getting tired and getting stops.
  - This is also one of the special features of the computer. Let us understand it in detail.
  - A person gets tired of doing some work in a few hours and a computer can do any work continuously for many hours, days, months.
  - Even after the computer has worked for such a long time, there is no decrease in its ability to work and the accuracy of the result.
  - The computer does work without any discrimination. A computer is free from monetary and tiredness.
  - Even if the computer does any work for weeks in a row, then the computer will do that work with the same speed and accuracy.
  - No matter how long the computer works, but it never gets boring.

- Reliability of Computer

  - Reliability is a very big characteristics of computer. Today almost all the big industries or big e-Commerce companies like Amazon and Flipkart, and big search engine companies like - Google and Bing, all these companies are dependent on computers.
  - Today every major industry and companies in the world have full confidence in their computers, and their entire business is running from computers.
  - Today the work of all companies is being done through computers. These companies store all their data in the computer, the data of these companies are many types of data such as the amount to be paid, the date of payment and many other types of data, which will be used in future when the time comes for that data use.
  - Data place to another place is transported through a computer in a very short time.
  - The computer does all its work very honestly. Night or day, the computer continues its work without being tired. Today this is the reason why big e-commerce companies and industries blindly trust computers.

- Versatility of Computer

  - Versatility means that the computer is capable of doing any kind of work. Let us understand computer Versatility in detail.
  - It means The computer is capable of performing any type of instruction given by the user, such as playing videos, downloading, running the Internet, the computer is capable of doing all these instructions.
  - Versatility is the Characteristics of a computer. Its means is that the computer is capable of working in almost every field.
  - Today computers are being used almost everywhere like schools, colleges, hospitals, offices, railway stations, hotels etc.
  - A computer system is multitasking so that you can do two tasks very easily at the same time.

- Storage Capacity of Computer
    - Computer systems have a very large capacity to store any type of data. A computer can store and resell any information due to its storage capacity.
    - Computers have the ability to store all types of data such as data, pictures, files, programs, games, and sound for many years and later we can get any data in a few seconds at any time for taking that information and for future retrieval.
    - Computer storage is also called permanent storage because once in this store any data means - file, folder, text data, video, image is stored, then that data is stored for life, and when As long as you do not delete any data, the data is saved in your computer's storage.
    - This storage unit is present in every computer system. The storage device is also called the main part of the computer.

- Automation
    - Automation is also a special feature of computers.
    - A computer is an automatic machine because once started on a job they carry on until the job is finished without any human assistance.
    - Let us understand this with an example, suppose you have to copy 100 or 200 files of your computer in Pen drive.
    - As soon as you gave the computer the instruction to copy all the files, then the computer starts copying all your 100 or 200 files to the Pen drive, then you do not need to give instructions to copy every file again and again.
    - This whole process of a computer is called automation. I hope you understand.

- Quick Decision
    - The computer takes the decision very quickly, given by the user which is the instruction arithmetic data or logic data.
    - All Mathematical data is called arithmetic data.
    - Copy Document, Delete file, open camera etc this type of data is called Logical data.

- Multitasking
    - Multitasking is also a very special feature of computers. A user can do different types of tasks on the computer at the same time.
    - Like we are using MS Word in computer as well as listening to songs and also getting printouts.
    - We can do a lot of work at the same time.

- No Feeling
    - In computers, like humans, there is no feeling and emotion, nor does the computer have any knowledge and experience, because a computer is a machine which works continuously on the instruction of humans without any selfishness and without tiredness.

- Power of remembering

    - Power of remembering is also very special Characteristics of the computer.
    - You can store many types of information and data on your computer in very large quantities. Whenever you need this data in future, you can get that data in a few seconds matter why.
    - You can get the data even after a long time. It depends on you, after how long or after how many years you need the data.

- No IQ

    - A computer is a dumb machine, without a user, a computer is a useless machine and device.
    - Until a user does not give any instruction, it cannot do any work and only after completing the instruction, he completes that work very fast.
    - A computer system is completely dependent on us humans how to work.
    - For an example, if you want to multiply two numbers, then writing such 3 & 3, the computer will not give us any result, unless we instruct 3 * 3 =, the computer multiplies that number and gives the result. So a computer cannot make its own decision.

Evolution and Generation of Computers

Computer generation include five different phases they are explained as below.

First Generation Computers

- First generation computers bore little resemblance to computers of today, either in appearance or performance.
- The first generation of computers took place from 1940 to 1956 and was extremely large in size.
- The inner workings of the computers at that time were unsophisticated. These early machines required magnetic drums for memory and vacuum tubes that worked as switches and amplifiers.
- It was the vacuum tubes that were mainly responsible for the large size of the machines and the massive amounts of heat that they released.
- These computers produced so much heat that they regularly overheated despite large cooling units. First generation computers also used a very basic programming language that is referred to as machine language.

Second Generation Computers

- The second generation (from 1956 to 1963) of computers managed to do away with vacuum tubes in lieu of transistors.
- This allowed them to use less electricity and generate less heat.
- Second generation computers were also significantly faster than their predecessors.
- Another significant change was in the size of the computers, which were smaller.
- Transistor computers also developed core memory which they used alongside magnetic storage.

Third Generation Computers

- From 1964 to 1971 computers went through a significant change in terms of speed, courtesy of integrated circuits.
- Integrated circuits, or semiconductor chips, were large numbers of miniature transistors packed on silicon chips.
- This not only increased the speed of computers but also made them smaller, more powerful, and less expensive.
- In addition, instead of the punch cards and the printouts of previous systems, keyboards and monitors were now allowing people to interact with computing machines.

Fourth Generation Computers

- The changes with the greatest impact occurred in the years from 1971 to 2010.
- During this time technology developed to a point where manufacturers could place millions of transistors on a single circuit chip.
- This was called monolithic integrated circuit technology. It also heralded the invention of the Intel 4004 chip which was the first microprocessor to become commercially available in 1971.
- This invention led to the dawn of the personal computer industry. By the mid-70s, personal computers such as the Altair 8800 became available to the public in the form of kits and required assembly.
- By the late 70s and early 80s assembled personal computers for home use, such as the Commodore Pet, Apple II and the first IBM computer, were making their way onto the market.
- Personal computers and their ability to create networks eventually would lead to the Internet in the early 1990s.
- The fourth generation of computers also saw the creation of even smaller computers including laptops and hand-held devices.
- Graphical user interface, or GUI, was also invented during this time. Computer memory and storage also went through major improvements, with an increase in storage capacity and speed.

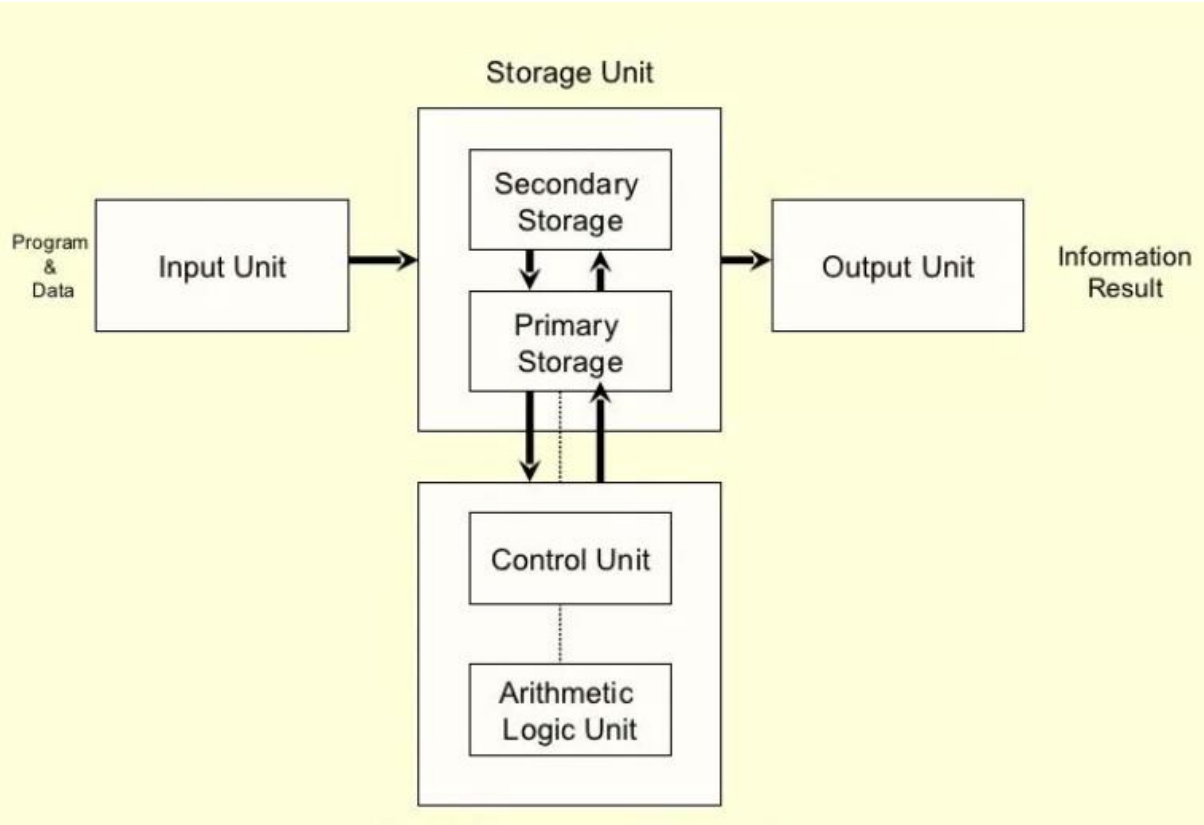
The Fifth Generation of Computers

- In the future, computer users can expect even faster and more advanced computer technology.
- Computers continue to develop into advanced forms of technology. Fifth generation computing has yet to be truly defined, as there are numerous paths that technology is taking toward the future of computer development.
- For instance, research is on-going in the fields of nanotechnology, artificial intelligence, as well as quantum computation.

Block Diagram of a Digital Computer System and Functions of each Block

Below diagram shows the components of digital computer, it consists of

- Input unit
- Storage unit
  - Primary memory
  - Secondary memory
- Central processing unit
  - Control unit
  - Arithmetic and Logic unit
- Output unit



Input Unit

- The data and instructions are inputted into the computer using keyboard which is one of the most commonly used input devices.
- Other commonly used input devices are mouse, floppy disk drive, magnetic tape etc.
- Thus, we can conclude that, all the input devices accepts the data and instruction from outside world, convert it to a form that the computer can understand, supply the converted data to the computer system for further processing.

Storage Unit

- The storage unit of a computer holds data and instructions that are entered through the input unit, before they are processed.
- It stores programs, data as well as intermediate results and results for output. Its main function is to store information.

- The various storage devices can be divided into two main categories
    - Primary Storage (Main Memory)
        - This memory is generally used to hold the program being currently executed in the computer, the data being received from input device, the intermediate and final results of a program.
        - The primary memory is temporary in nature. The data is lost when the computer is switched off.
        - The data is electronically represented in the main memory chip's circuitry and while it remains in the main memory, central processing unit (CPU) can access it directly at a very fast speed.
        - Primary storage has limited storage capacity because it is very expensive and generally made up of semiconductor devices.
    - Secondary Storage (Auxiliary Memory)
        - It is used like an archive. It stores operating system, data files, compilers, assemblers, application programs etc.
        - The Program and data if needed by central processing unit (CPU) are first transferred from the secondary memory to main memory. The results are also stored in secondary memory to main memory.
        - It is a mass storage memory, slower but cheaper. It is non-volatile in nature i.e. data is not lost even if the power supply is switched off. Some of the most commonly used secondary storage devices are Hard Disk, Compact Disk etc. Their access time is in milliseconds.

<u>Central Processing Unit (CPU)</u>

- The control unit and arithmetic logic unit of computer are together known as central processing unit (CPU).
- The CPU is like brain and performs following functions: It performs all calculations, it takes all decisions, and it controls all units of a computer.
- A personal computer may have CPU-IC such as Intel 8088, 80386, 80486, Celeron, Pentium, Pentium Pro, Pentium II, III, IV, Dual Core, AMD etc.

- Control Unit
    - It controls all other units in a computer.
    - The control unit instructs the input unit where to store the data after receiving it from user. It controls the flow of data and instructions from the storage unit to Arithmetic logic unit (ALU), it does not perform any actual processing of data.
    - It manages and coordinates the entire computer system and synchronizes its working, thus referred to as "Central Nervous System" or "Brain of the Computer".

- Arithmetic and Logic Unit
    - The function of an Arithmetic logic unit (ALU) is to perform arithmetic and logical operations such as addition, subtraction, multiplication, division, AND, OR, NOT, Exclusive OR etc. It also performs increment, decrements, shift and clear operations.

- It is the place where the actual execution of instructions takes place during processing operation.
- To be precise, all calculations and comparisons are made in the Arithmetic and Logical Unit (ALU).

Output Unit

- An output unit performs the reverse operation of that of an input unit. As computers, work with binary code the results produced is also in binary form.
- So before applying results to the outside world it must be converted to human acceptable (readable) form. So, it supplies information obtained from processing to outside world. Units called output interfaces accomplish this task.

Input and Output Devices

Input Devices

- An input device can send data to another device, but it cannot receive data from another device. Examples of input devices include the following.
- Following are some of the important input devices which are used in a computer

  - Keyboard
  - Mouse
  - Joy Stick
  - Light pen
  - Track Ball
  - Scanner
  - Graphic Tablet
  - Microphone
  - Web Camera
  - Digital Camera
  - Magnetic Ink Card Reader(MICR)
  - Optical Character Reader(OCR)
  - Bar Code Reader
  - Optical Mark Reader(OMR)

Keyboard

- Keyboard is the most common and very popular input device which helps to input data to the computer.
- The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.
- Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

Mouse

- Mouse is the most popular pointing device.
- It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

- Generally, it has two buttons called the left and the right button and a wheel is present between the buttons.

- A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.

Joystick

- Joystick is also a pointing device, which is used to move the cursor position on a monitor screen.
- It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.
- The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

Light Pen

- Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen.
- It consists of a photocell and an optical system placed in a small tube.
- When the tip of a light pen is moved over the monitor screen and the pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

Track Ball

- Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse.
- This is a ball which is half inserted and by moving fingers on the ball, the pointer can be moved.
- Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button, or a square.

Scanner

- Scanner is an input device, which works more like a photocopy machine.
- It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation.
- Scanner captures images from the source which are then converted into a digital form that can be stored on the disk. These images can be edited before they are printed.

Microphone

- Microphone is an input device to input sound that is then stored in a digital form.
- The microphone is used for various applications such as adding sound to a multimedia presentation or for mixing music.

Web camera

- A webcam is a hardware camera and input device that connects to a computer and the Internet and captures either still pictures or motion video of a user or another object.
- The picture of the Logitech Webcam C270 is an example of what a webcam may look.
- Today, most webcams are either embedded into the display with laptop computers or connected to the USB or FireWire port on the computer.

Digital Camera

- A digital camera records and stores photographic images in digital form.
- Many current models are also able to capture sound or video, in addition to still images.
- Capture is usually accomplished by use of a photosensor, using a charged coupled device (CCD).
- These stored images can be uploaded to a computer immediately or stored in the camera for to be uploaded into a computer or printer later.
- Images may also be archived on a photographic compact disc or external hard disk.

Magnetic Ink Card Reader (MICR)

- MICR input device is generally used in banks as there are large number of cheques to be processed every day.
- The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.
- This reading process is called Magnetic Ink Character Recognition (MICR).
- The main advantages of MICR is that it is fast and less error prone.

Optical Character Reader (OCR)

- OCR is an input device used to read a printed text.
- OCR scans the text optically, character by character, converts them into a machine readable code, and stores the text on the system memory.

Bar Code Readers

- Bar Code Reader is a device used for reading bar coded data (data in the form of light and dark lines).
- Bar coded data is generally used in labelling goods, numbering the books, etc. It may be a handheld scanner or may be embedded in a stationary scanner.
- Bar Code Reader scans a bar code image, converts it into an alphanumeric value, which is then fed to the computer that the bar code reader is connected to.

Optical Mark Reader (OMR)

- OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil.
- It is used where one out of a few alternatives is to be selected and marked.
- It is specially used for checking the answer sheets of examinations having multiple choice questions.

Output devices

- An output device can receive data from another device and generate output with that data, but it cannot send data to another device.
- Following are some of the important output devices used in a computer.
    - Monitors
    - Graphic Plotter
    - Printer

Monitors

- Monitors, commonly called as Visual Display Unit (VDU), are the main output device of a computer.
- It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

Printers

- Printer is an output device, which is used to print information on paper.
- There are two types of printers
  - Impact Printers
  - Non-Impact Printers

Impact Printers

- Impact printers print the characters by striking them on the ribbon, which is then pressed on the paper.
- Characteristics of Impact Printers are the following
  - Very low consumable costs
  - Very noisy
  - Useful for bulk printing due to low cost
  - There is physical contact with the paper to produce an image
- These printers are of two types
  - Character printers
  - Line printers

Character Printers

- Character printers are the printers which print one character at a time.
- These are further divided into two types
  - Dot Matrix Printer(DMP)
  - Daisy Wheel

Dot Matrix Printer

- In the market, one of the most popular printers is Dot Matrix Printer.
- These printers are popular because of their ease of printing and economical price.
- Each character printed is in the form of pattern of dots and head consists of a Matrix of Pins of size (5*7, 7*9, 9*7 or 9*9) which come out to form a character which is why it is called Dot Matrix Printer.

Daisy Wheel

- Head is lying on a wheel and pins corresponding to characters are like petals of Daisy (flower) which is why it is called Daisy Wheel Printer.

- These printers are generally used for word-processing in offices that require a few letters to be sent here and there with very nice quality.

Line Printers

- Line printers are the printers which print one line at a time.
- These are of two types
  - Drum Printer
  - Chain Printer

Drum Printer

- This printer is like a drum in shape hence it is called drum printer. The surface of the drum is divided into a number of tracks.
- Total tracks are equal to the size of the paper, i.e. for a paper width of 132 characters, drum will have 132 tracks.
- A character set is embossed on the track.
- Different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line.
- Drum printers are fast in speed and can print 300 to 2000 lines per minute.

Chain Printer

- In this printer, a chain of character sets is used, hence it is called Chain Printer.
- A standard character set may have 48, 64, or 96 characters.

Non-impact Printers

- Non-impact printers print the characters without using the ribbon.
- These printers print a complete page at a time, thus they are also called as Page Printers.
- These printers are of two types −
  - Laser Printers
  - Inkjet Printers

Characteristics of Non-impact Printers

- Faster than impact printers
- They are not noisy
- High quality
- Supports many fonts and different character size

Laser Printers

- These are non-impact page printers.
- They use laser lights to produce the dots needed to form the characters to be printed on a page.

Inkjet Printers

- Inkjet printers are non-impact character printers based on a relatively new technology.
- They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.

- They make less noise because no hammering is done and these have many styles of printing modes available.
- Color printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

Plotter

- A plotter is a computer hardware device much like a printer that is used for printing vector graphics.
- Instead of toner, plotters use a pen, pencil, marker, or another writing tool to draw multiple, continuous lines onto paper rather than a series of dots like a traditional printer.
- Though once widely used for computer-aided design, these devices have more or less been phased out by wide-format printers.
- Plotters are used to produce a hard copy of schematics and other similar applications.

- Advantages of plotters
  - Plotters can work on very large sheets of paper while maintaining high resolution.
  - They can print on a wide variety of flat materials including plywood, aluminium, sheet steel, cardboard, and plastic.
  - Plotters allow the same pattern to be drawn thousands of times without any image degradation.

- Disadvantages of plotters
  - Plotters are quite large when compared to a traditional printer.
  - Plotters are also much more expensive than a traditional printer.

Visual Display Unit

- Monitors, commonly called as Visual Display Unit (VDU), are the main output device of a computer.
- It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat-Panel Display
-

Cathode-Ray Tube (CRT) Monitor

- The CRT display is made up of small picture elements called pixels.
- The smaller the pixels, the better the image clarity or resolution.
- It takes more than one illuminated pixel to form a whole character, such as the letter ‘e’ in the word help.
- A finite number of characters can be displayed on a screen at once.
- The screen can be divided into a series of character boxes fixed location on the screen where a standard character can be placed.
- Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically.

Flat-Panel Display Monitor

- The flat-panel display refers to a class of video devices that have reduced volume, weight and power requirement in comparison to the CRT.
- You can hang them on walls or wear them on your wrists.
- Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, and graphics display.

The flat-panel display is divided into two categories

- Emissive Displays
    - Emissive displays are devices that convert electrical energy into light.
    - For example, plasma panel and LED (Light-Emitting Diodes).
- Non-Emissive Displays
    - Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns.
    - For example, LCD (Liquid-Crystal Device).

Projector

- A projector or image projector is an optical device that projects an image (or moving images) onto a surface, commonly a projection screen.
- Most projectors create an image by shining a light through a small transparent lens, but some newer types of projectors can project the image directly, by using lasers.
- A virtual retinal display, or retinal projector, is a projector that projects an image directly on the retina instead of using an external projection screen.

Computer Memory

- A memory is just like a human brain.
- It is used to store data and instructions.
- Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored.
- The memory is divided into large number of small parts called cells.
- Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64k words, then this memory unit has 64 * 1024 = 65536 memory locations.
- The address of these locations varies from 0 to 65535.
- Memory is primarily of three types
    - Cache Memory
    - Primary Memory/Main Memory
    - Secondary Memory

Cache Memory

- Cache memory is a very high speed semiconductor memory which can speed up the CPU.
- It acts as a buffer between the CPU and the main memory.

- It is used to hold those parts of data and program which are most frequently used by the CPU.
- The parts of data and programs are transferred from the disk to cache memory by the operating system, from where the CPU can access them.
- The advantages of cache memory are as follows
  - Cache memory is faster than main memory.
  - It consumes less access time as compared to main memory.
  - It stores the program that can be executed within a short period of time.
  - It stores data for temporary use.
- The disadvantages of cache memory are as follows
  - Cache memory has limited capacity.
  - It is very expensive.

Primary Memory (Main Memory)

- Primary memory holds only those data and instructions on which the computer is currently working.
- It has a limited capacity and data is lost when power is switched off. It is generally made up of semiconductor device.
- These memories are not as fast as registers. The data and instruction required to be processed resides in the main memory.
- It is divided into two subcategories RAM and ROM.
- Characteristics of Main Memory
  - These are semiconductor memories.
  - It is known as the main memory.
  - Usually volatile memory.
  - Data is lost in case power is switched off.
  - It is the working memory of the computer.
  - Faster than secondary memories.
  - A computer cannot run without the primary memory.

Secondary Memory

- This type of memory is also known as external memory or non-volatile. It is slower than the main memory.
- These are used for storing data/information permanently. CPU directly does not access these memories; instead they are accessed via input-output routines.
- The contents of secondary memories are first transferred to the main memory, and then the CPU can access it. For example, disk, CD-ROM, DVD, etc.
- Characteristics of Secondary Memory
  - These are magnetic and optical memories.
  - It is known as the backup memory.
  - It is a non-volatile memory.
  - Data is permanently stored even if power is switched off.
  - It is used for storage of data in a computer.
  - Computer may run without the secondary memory.
  - Slower than primary memories.

Difference between primary and secondary memory

Basis for comparison	Primary Memory	Secondary Memory
Basic	Primary memory is directly accessible by Processor/CPU	Secondary memory is not directly accessible by CPU.
Data	Instructions or data to be currently executed are copied to main memory.	Data to be permanently stored is kept in secondary memory.
Volatility	Primary memory is usually volatile.	Secondary memory is non-volatile.
Formation	Primary memories are made of semiconductors.	Secondary memories are made of magnetic and optical material.
Access Speed	Accessing data from primary memory is faster.	Accessing data from secondary memory is slower.
Size	The computer has a small primary memory.	The computer has a larger primary memory.
Expense	Primary memory is costlier than secondary memory.	Secondary memory is cheaper than primary memory

RAM and Its Types

- RAM (Random Access Memory) is a part of computer's Main Memory which is directly accessible by CPU.
- RAM is used to Read and Write data into it which is accessed by CPU randomly.
- RAM is volatile in nature; it means if the power goes off, the stored information is lost.
- RAM is used to store the data that is currently processed by the CPU.
- Most of the programs and data that are modifiable are stored in RAM.

RAM classified as fallows

- SRAM(Static RAM)
- DRAM(Dynamic RAM)

SRAM (Static RAM)

- The SRAM memories consist of circuits capable of retaining the stored information as long as the power is applied.
- That means this type of memory requires constant power. SRAM memories are used to build Cache Memory.
- SRAM is used primarily to create CPU's speed sensitive cache.
- Each memory cell of SRAM consists of multiple transistors for each memory cell and it does not have a capacitor in each cell.
- SRAM is not required to be refreshed which makes it significantly fast.

DRAM (Dynamic RAM)

- DRAM is required to be refreshed consistently.
- DRAM consist memory cells with paired transistors.
- DRAM has one more flavour called Synchronous Dynamic RAM (SDRAM) which enhances the system's performance by utilizing the burst mode concept.

ROM

- ROM stands for Read Only Memory.
- The memory from which we can only read but cannot write on it.
- This type of memory is non-volatile. The information is stored permanently in such memories during manufacture.
- A ROM stores such instructions that are required to start a computer. This operation is referred to as bootstrap.
- ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.

Types of ROM

MROM (Masked ROM)

- The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions.
- These kind of ROMs are known as masked ROMs, which are inexpensive.

PROM (Programmable Read Only Memory)

- PROM is read-only memory that can be modified only once by a user.
- The user buys a blank PROM and enters the desired contents using a PROM program.
- Inside the PROM chip, there are small fuses which are burnt open during programming. It can be programmed only once and is not erasable.

EPROM (Erasable and Programmable Read Only Memory)

- EPROM can be erased by exposing it to ultra-violet light for a duration of up to 40 minutes. Usually, an EPROM eraser achieves this function.
- During programming, an electrical charge is trapped in an insulated gate region.
- The charge is retained for more than 10 years because the charge has no leakage path.
- For erasing this charge, ultra-violet light is passed through a quartz crystal window (lid).
- This exposure to ultra-violet light dissipates the charge. During normal use, the quartz lid is sealed with a sticker.

EEPROM (Electrically Erasable and Programmable Read Only Memory)

- EEPROM is programmed and erased electrically.
- It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (millisecond).
- In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of reprogramming is flexible but slow.

Advantages of ROM

- Non-volatile in nature
- Cannot be accidentally changed
- Cheaper than RAMs
- Easy to test
- More reliable than RAMs
- Static and do not require refreshing
- Contents are always known and can be verified

Difference between RAM and ROM

Basis for comparison	RAM	ROM
Basic	It is a read-write memory.	It is read only memory.
Use	Used to store the data that has to be currently processed by CPU temporarily.	It stores the instructions required during bootstrap of the computer
Volatility	It is a volatile memory.	It is a non-volatile memory.
Modification	Data in ROM can be modified.	Data in ROM can not be modified.
Cost	RAM is a costlier memory.	ROM is comparatively cheaper than RAM.
Size	RAM sizes from 64 MB to 4GB.	ROM is comparatively smaller than RAM.
Type	Types of RAM are static RAM and dynamic RAM.	Types of ROM are PROM, EPROM, EEPROM.

Secondary memory

- If we need to store large amount of data or programs permanently, we need a cheaper and permanent memory. Such memory is called secondary memory. Here we will discuss secondary memory devices that can be used to store large amount of data, audio, video and multimedia files.
- Characteristics of Secondary Memory
  - It is non-volatile, i.e. it retains data when power is switched off
  - It is large capacities to the tune of terabytes
  - It is cheaper as compared to primary memory
  - Depending on whether secondary memory device is part of CPU or not, there are two types of secondary memory – fixed and removable.

Types of Secondary Memory

Hard Disk Drive

- Hard disk drive is made up of a series of circular disks called platters arranged one over the other almost ½ inches apart around a spindle.
- Disks are made of non-magnetic material like aluminum alloy and coated with 10-20 nm of magnetic material.
- Standard diameter of these disks is 14 inches and they rotate with speeds varying from 4200 rpm (rotations per minute) for personal computers to 15000 rpm for servers.
- Data is stored by magnetizing or demagnetizing the magnetic coating.
- A magnetic reader arm is used to read data from and write data to the disks. A typical modern HDD has capacity in terabytes (TB).

CD Drive

- CD stands for Compact Disk. CDs are circular disks that use optical rays, usually lasers, to read and write data.
- They are very cheap as you can get 700 MB of storage space for less than a dollar.
- CDs are inserted in CD drives built into CPU cabinet.
- They are portable as you can eject the drive, remove the CD and carry it with you.
- There are three types of CDs

- CD-ROM (Compact Disk – Read Only Memory)
  - The data on these CDs are recorded by the manufacturer. Proprietary Software, audio or video are released on CD-ROMs.

- CD-R (Compact Disk – Recordable)
  - Data can be written by the user once on the CD-R. It cannot be deleted or modified later.

- CD-RW (Compact Disk – Rewritable)
  - Data can be written and deleted on these optical disks again and again.

DVD Drive

- DVD stands for Digital Video Display.
- DVD is optical devices that can store 15 times the data held by CDs.
- They are usually used to store rich multimedia files that need high storage capacity.

- DVDs also come in three varieties – read only, recordable and rewritable.

Pen Drive

- Pen drive is a portable memory device that uses solid state memory rather than magnetic fields or lasers to record data.
- It uses a technology similar to RAM, except that it is non-volatile. It is also called USB drive, key drive or flash memory.

Floppy Disk

- A floppy disk is a magnetic storage medium for computer systems.
- The floppy disk is composed of a thin, flexible magnetic disk sealed in a square plastic carrier.
- In order to read and write data from a floppy disk, a computer system must have a floppy disk drive (FDD).
- A floppy disk is also referred to simply as a floppy. Since the early days of personal computing, floppy disks were widely used to distribute software, transfer files, and create back-up copies of data.
- When hard drives were still very expensive, floppy disks were also used to store the operating system of a computer.

Classification of Computers

Classification on the basis of data handling are as follows

Analog Computers

- An analog computer is a computer which is used to process analog data.
- Analog computers store data in a continuous form of physical quantities and perform calculations with the help of measures.
- It is quite different from the digital computer, which makes use of symbolic numbers to represent results.
- Analog computers are excellent for situations which require data to be measured directly without converting into numerals or codes.
- Analog computers, although available and used in industrial and scientific applications like control systems and aircraft, have been largely replaced by digital computers due to the wide range of complexities involved.

Digital Computers

- A computer that performs calculations and logical operations with quantities represented as digits.
- Digits include binary number system of “0” and “1”.
- Computer capable of solving problems by processing information expressed in discrete form.
- From manipulation of the combinations of the binary digits.
- Digital computers perform mathematical calculations, organize and analyse data, control industrial and other processes, and simulate dynamic systems such as global weather patterns.

Hybrid Computers

- Hybrid computers are computers that exhibit features of analog computers and digital computers.
- The digital component normally serves as the controller and provides logical and numerical operations, while the analog component often serves as a solver of differential equations and other mathematically complex equations.
- A hybrid computer system for use in cardiology.
- Although the digital computer has traditionally been used to perform these tasks, a hybrid computer (combined analog and digital) has been found to provide many advantages over the digital computer, especially where on-line data processing is concerned.

Classification of digital computers

- The digital computers that are available now days vary in their sizes and types.
- These digital computers are broadly classified into four categories based on their size and type.

    - Micro Computer
    - Mini Computer
    - Mainframe Computer
    - Super Computer

Micro Computer

- Micro Computer are small low cast and single user digital computers.
- It is a device with microprocessor, Input unit, storage unit and CPU(Central Processing Unit).
- Microcomputer Computer formerly a commonly used term for Personal Computers particularly any of class of any small digital computers. Its CPU contained on a single integrated semiconductor chip.
- IBM PC based on Pentium microprocessor and Apple Macintosh are some Examples of microcomputers. Microcomputers include desktop computers, notebook computers or laptop, tablet compute, handheld computer, smartphones and notebook.

Types of Micro Computers

- Desktop Computer or Personal Computer(PC)
    - It is the most type of microcomputer.
    - A desktop computer is a personal computer designed for regular use at a single location on or near a desk or table due to its size and power requirements.
    - It is not very expensive and is suited the needs of a single user at home, small business units, and organization.

- Notebook Computers or Laptop

    - A laptop is a small, portable computer and has all the features of a desktop computer.
    - The advantage of the laptop is that it is small in size, so it can be carried anywhere. Notebook computers use a variety of techniques, known as flat-panel technologies, to produce a lightweight and non-bulky display screen. Laptops Computers are costlier than the desktop computers.

- Tablet
    - A tablet is a wireless, portable personal computer with a touchscreen interface. The tablet form factor is typically smaller than a notebook computer, but larger than a smartphone.
- Handheld Computer or Personal Digital Assistant(PDA)
    - It is a small computer that can be held on the top of the palm.
    - It is small in size.
    - PDA uses a pen or a stylus for input, instead of the keyboard.
    - They have a limited memory and are less powerful.
    - PDAs can be connected to the internet via wireless connection.
- Smart Phones
    - A smartphone is a mobile phone with highly advanced features.
    - A typical smartphone has a high-resolution touch screen display, Wi-Fi connectivity, Web browsing capabilities, and the ability to accept sophisticated applications.
    - The majority of these devices run on any of these popular mobile operating systems

<u>Mainframe Computers</u>

- Mainframes are computers used by organizations like banks, airlines and railways to handle millions and trillions of online transactions per second.
- Important features of mainframes are
    - Big in size
    - Hundreds times Faster than servers, typically hundred megabytes per second
    - Very expensive
    - Use proprietary OS provided by the manufacturers
    - In-built hardware, software and firmware security features

<u>Supercomputer</u>

- Supercomputers are the fastest computers on Earth. They are used for carrying out complex, fast and time intensive calculations for scientific and engineering applications.
- Supercomputer speed or performance is measured in teraflops, i.e. 1012 floating point operations per second.
- Chinese supercomputer Sunway TaihuLight is the world's fastest supercomputer with a rating of 93 petaflops per second, i.e. 93 quadrillion floating point operations per second.
    - Most common uses of supercomputers include −
    - Molecular mapping and research
    - Weather forecasting
    - Environmental research
    - Oil and gas exploration

Mini computer

- A minicomputer is a type of computer that possesses most of the features and capabilities of a large computer but is smaller in physical size.
- A minicomputer fills the space between the mainframe and microcomputer, and is smaller than the former but larger than the latter. Minicomputers are mainly used as small or mid-range servers operating business and scientific applications. However, the use of the term minicomputer has diminished and has merged with servers.
- A minicomputer may also be called a mid-range computer.

Personal computer

- A personal computer is a general-purpose, cost-effective computer that is designed to be used by a single end-user.
- Every PC is dependent on microprocessor technology, which allows PC makers to set the entire central processing unit (CPU) on a single chip.
- Businesses make use of PCs to perform tasks like accounting, desktop publishing and word processing as well as to run database and spread sheets. At home, PCs are mainly used for multimedia entertainment, playing PC games, accessing the Internet, etc. Even though PCs are intended to use as single-user systems, it is normal to connect them together to create a network, such as a local area network (LAN).
- A PC can be a microcomputer, desktop computer, a laptop computer, a tablet PC or a handheld PC.

Palm Computer

- A palmtop computer is a personal computer or other electronic device that has many of the same features as a computer and fits in the palm of your hand.
- A good example of an early palmtop computer is the PalmPilot.
- Because of their size, early palmtop computers did not have a keyboard or a mouse and often relied on a pen that used Graffiti or something similar.
- The term "palmtop computer" was an early term used when computers were big and cumbersome and small cell phones and even smartphones were not yet invented. Today, this term is rarely used to describe a computer that fits in your hand because of the invention of the smartphone.

Unit II: Number Systems

Fundamentals of Computers.

UNIT-II → NUMBER SYSTEMS.

Number System:-

→ The number system of the numeral system is the system of naming or representing numbers.

→ We know that a number is a mathematical value that helps to count & measure objects and it helps in performing various mathematical Calculations.

→ There are different types of number systems in Maths like decimal number system, binary number system, Octal number system, hexadecimal number system.

Number System in Maths.

→ A number system is defined as a system of writing to express numbers. It is the mathematical notation for representing numbers of a given set by using digits or other symbols in a consistent manner.

→ It provides a unique representation of every number & represents the arithmetic and algebraic structure of the figures.

→ It also allows us to operate arithmetic operations like Add^{n}, Sub^{n} and Division.

→ The Value of any digit in a number can be determined by:

* The digit.
* Its position in the number.
* The base of the number system.

→ In a number system, these numbers are used as digits. 0 and 1 are most common digits in the number system, that are used to represent binary numbers. On the other hand, 0 to 9 digits are also used for other number systems.

Types of Number System [classification]

→ Number Systems are basically classified into two types. They are

* Non- positional number system
* Positional number system.

* Non- Positional number system.

→ The non- positional number system consists of different symbols that are used to represent numbers.

A Roman Number system is an example of the non-positional number system.

i.e., I = 1, V = 5, L = 50, X = 10 etc

* Positional Number System.

→ A positional number system is a system for representation of numbers by an ordered set of numerals symbols (called digits) in which the value of a numeral symbol depends on its position.

→ The value of a symbol is given by the weight of its position expressed in the bases (or Radices) of the system.

→ A positional number system is also known as weighted number system.

→ Decimal number system, Binary number system, Octal number system, hexadecimal number system are few examples of positional number system.

Decimal Number System [Base 10 Number System].

→ The decimal number system has a base 10 because it uses ten digits from 0 to 9 [i.e., 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9].

→ In this system, the positions successive to the left of the decimal point represents units, tens, hundreds, thousands and so on.

→ This system is expressed in decimal numbers.
→ Every position shows a particular power of the base (10).

Example:- ⓐ 1457, and can be written as,

$(1\times10^3) + (4\times10^2) + (5\times10^1) + (7\times10^0)$

$= (1000\times1) + (4\times100) + (5\times10) + (7\times1)$

$= 1000 + 400 + 50 + 7 = 1457.$

ⓑ Consider a decimal no $542.76_{(10)}$ which can be represented in equivalent value as;

$(5\times10^2) + (4\times10^1) + (2\times10^0) + (7\times10^{-1}) + (6\times10^{-2})$

$= (5\times100) + (4\times10) + (2\times1) + (7\times 1/10) + (6\times 1/100)$

$= 500 + 40 + 2 + 7/10 + 6/100 = 542.76.$

Binary Number System [Base 2 Number System].

→ The base 2 number system is also known as the Binary number system wherein, only two binary digits exist, i.e., 0 and 1.

→ The figures described under this system are known as binary numbers which are the combination of 0 and 1.

Ex:- 110101 is a binary number.

→ We can convert any system into binary and Vice-Versa.

Example:- Write $(14)_{10}$ as a binary number.

Soln:-

2 | 14		
2 | 7	0	
2 | 3	1	
1	1	

$\therefore (14)_{10} = (1110)_2$.

Octal Number System (Base 8 Number System)

→ In this, the base is 8 and it uses numbers from 0 to 7 [i.e., 0, 1, 2, 3, 4, 5, 6 and 7] to represent numbers.

→ Octal numbers are commonly used in Computer applications.

→ Converting an octal number to decimal is the same as decimal conversion and is explained below using an example.

Example:- Convert 215_8 into decimal.

Soln:- $215_8 = (2\times8^2) + (1\times8^1) + (5\times8^0)$

$= (2\times64) + (1\times8) + (5\times1)$

$= 128 + 8 + 5 = (141)_{10}$.

Hexadecimal Number System [Base 16 number System].

→ In this system, numbers are written or represented with base 16.

→ In this system, the numbers are first represented just like in decimal system.

i.e., from 0 to 9. Then, the numbers are represented using the alphabets A to F. The below-given table shows the representation of numbers in the hexadecimal number system.

Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Numbers System Conversion.

→ In representing the data on computers we need to convert the data from one number system to other no system.

→ In this section, we study the inter conversions of number systems

a) Decimal to binary Conversion:-

→ Divide the given decimal number by 2.
→ Note the quotient and Remainder.
→ Repeat steps 1 & 2 until the quotient becomes zero.
→ The first remainder will be the LSB and the

last remainder is the MSB. The equivalent binary 7
no is then written from left to right i.e., from MSB to LSB.

Ex:- @Consider the decimal no $53_{(10)}$ which can be represented in binary as:

2 | 53		
2 | 26	1 (R)	→ LSB.
2 | 13	0 (R)	
2 | 6	1 (R)	
2 | 3	1 (R)	
2 | 1	1 (R)	
0	1 (R)	→ MSB

$\therefore 53_{(10)} = 110101_{(2)}$

(b) Consider the decimal fraction $0.3125_{(10)}$ to binary.

→ Multiply the decimal fraction by 2, note the carry & the product.

→ Repeat the first step until the fractional product becomes zero.

→ The first carry will be the MSB & the last carry will be the LSB. The equivalent binary fraction is then written from MSB to LSB (right to left).

Multiply by 2	Carry.	Product.
0.3125×2	0 (MSB)	0.625.
0.625×2	1	0.25.
0.25×2	0	0.50.
0.50×2	1 (LSB).	0.00.

$\therefore (0.3125)_{10} = 0.0101_{(2)}$.

(b) Binary to decimal Conversion.

→ Multiply each bit of the binary number by its positional weight.

→ Add all the products.

Example:- Consider the binary no $11011.101_{(2)}$ which can be represented in decimal value. as.

$11011.101_{(2)}$

$= 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

Bits = 1, 1, 0, 1, 1, 0, 1

Values = 16 + 8 + 0 + 2 + 1 + 0.5 + 0.25 + 0.125 = 27.625.

$\therefore 11011.101_{(2)} = 27.625_{(10)}$.

(c) Decimal to Octal Conversion.

→ Divide the given decimal number by 8.

→ Note the quotient and remainder

→ Repeat the steps 1 & 2 until the quotient becomes zero.

→ The first remainder will be the LSB and the last remainder is the MSB. The Equivalent octal no is then written from left to right i.e., from MSB to LSB.

Example:- Consider the decimal number $459_{(10)}$.

8 | 459		
8 | 57	3 → LSB	
8 | 7	1	↑
0	7 → MSB	↑

$\therefore 459_{(10)} = 713_{(8)}$

Octal to decimal Conversion.

→ Multiply each digit of an octal number by its weight.

→ Add all the products.

Example:- Consider an octal no $234.56_{(8)}$ which can be represented in decimal value as:

$$2\times8^{2} + 3\times8^{1} + 4\times8^{0} + 5\times8^{-1} + 6\times8^{-2}$$

$$= 64 + 8 + 1 + 0.125 + 0.03125 = 156.71875$$

$\therefore 234.56_{(8)} = 156.71875_{(10)}$.

Decimal to hexadecimal conversion.

→ Divide the given decimal no by 16.
→ Note the quotient and remainder.
→ Repeat step 1 & 2 until the quotient becomes zero.
→ The first remainder is the LSB and the last is MSB. The hexadecimal no is written from left to right with MSB occuring first.

Example:- Consider a decimal number $559_{(10)}$

16	559		
16	34	15	→ LSB
16	2	2	↑
	0	2	→ MSB

$\therefore 559_{(10)} = 22F_{(16)}$.

Hexadecimal to decimal Conversion.

→ Multiply each digit of the hexadecimal no by its positional weight.
→ Add all the products.

Example:- Consider a hexadecimal no 5AF.D$_{(16)}$ which can be represented in decimal value as.

$$5\times16^2 + A\times16^1 + F\times16^0 + D\times16^{-1}$$

Weight = 16^2 16^1 16^0 16^{-1}

Digits = 5 A F D.

Values = $256\times5 + 16\times10 + 15\times1 + 13\times\frac{1}{16}$.

$= 1280 + 160 + 15 + 0.8125$

$= 1455.8125$

$\therefore$ 5AF.D$_{(16)}$ = 1455.8125$_{(10)}$.

Binary to Octal Conversion.

→ In the given binary number, the binary digits are grouped into groups of three bits starting from the binary point and convert each group into its equivalent octal no.

→ For whole numbers, it may be necessary to add a zero as the MSB.

→ Ill'y, when representing fractions, it may be necessary to add a trailing zero in the LSB to complete grouping of three bits.

Note:- Adding a leading 0 as the MSB into the whole number and adding a 0 trailing 0 as the LSB into the fractional binary number does not change the value of the number.

Example:- (a) Consider the binary number $1010111_{(2)}$

1	010	111
1	2	7

$\therefore 1010111_{(2)} = 127_{(8)}$

(b) Consider the binary number $0.110111_{(2)}$

110	111
6	7

$\therefore 0.110111_{(2)} = 0.67_{(8)}$.

Octal to binary Conversion.

→ The application of octal conversion is to represent binary numbers, as it is easier to read large number in octal form than in binary form.

→ Each octal digit is represented by a three-bit binary number as in table given below.

→ Hence it is very easy to convert from octal to binary.

Octal digit.	0	1	2	3	4	5	6	7
Binary digit	000	001	010	011	100	101	110	111

Example:- (a) Consider the octal number $456_{(8)}$.

4 ⟶ 100.

5 ⟶ 101

6 ⟶ 110

$\therefore 456_{(8)} = 100101110_{(2)}$.

(b) Consider the Octal number $73.16_{(8)}$

7 ⟶ 111

3 ⟶ 011

1 ⟶ 001

6 ⟶ 110

$\therefore 73.16_{(8)} = 111011.001110_{(2)}$.

Binary to Hexadecimal Conversion.

→ The binary bits are grouped into four bits starting from the binary point and replace each group by a hexadecimal digit.

→ For whole numbers, it may be required to add a zero as the MSB to complete a group of four bits.

→ While representing fractions, it may be required to add a trailing zero as the LSB to complete a group of four bits.

→ This addition of zeroes will not change the value of the binary number.

Following table shows each hexadecimal number may be represented as a 4-digit number.

Decimal	Binary	Hexadecimal.
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Examples

(a) Consider a binary number $1011001_{(2)}$

$\underbrace{0101}_{5}$ $\underbrace{1001}_{9}$

Therefore, $1011001_{(2)} = 59_{(16)}$

(b) Consider a binary number $0.11010111_{(2)}$.

$\underbrace{1101}_{D}$ $\underbrace{0111}_{7}$

$\therefore 0.11010111_{(2)} = 0.D7_{(16)}$.

Hexadecimal to binary Conversion.

Each digit of a hexadecimal number is replaced by a 4-bit binary no

Example:- Consider a hexadecimal number $CEBA_{(16)}$.

C → 12 → 1100.

E → 14 → 1110.

B → 11 → 1011

A → 10 → 1010.

$\therefore CEBA_{(16)} = 1100111010111010_{(2)}$.

16.

Octal to Hexadecimal Conversion.

Using binary system, we can easily convert octal no's to hexadecimal no's & Vice-Versa

Step 1:- Write the binary equivalent of each octal digit.

Step 2:- Regroup them into 4 bits from the right side with zeroes added, if necessary.

Step 3:- Convert each group into its equivalent hexadecimal digit.

Example:- Consider an octal number $274_{(8)}$

$2 \longrightarrow 010$

$7 \longrightarrow 111$

$4 \longrightarrow 100$

$\therefore 274_{(8)} = 010111100_{(2)}$

Group the bits into groups of 4-bits as

0 1011 1100

0 → 0

1011 → B

1100 → C.

$\therefore 274_{(8)} = BC_{(16)}$.

Hexadecimal to Octal Conversion.

→ Write the binary equivalent of each hexadecimal digit.

→ Regroup them into 3-bits from the right side with zeroes added, if necessary.

→ Convert each group into octal equivalent.

Example:- Consider a hexadecimal no $FADE_{(16)}$

F ⟶ 15 ⟶ 1111

A ⟶ 10 ⟶ 1010.

D ⟶ 13 ⟶ 1101

E ⟶ 14 ⟶ 1110.

$\therefore FADE_{(16)} = 1111\ 1010\ 1101\ 1110_{(2)}$.

001	111	101	011	011	110.
1	7	5	3	3	6.

$\therefore FADE_{(16)} = 175336_{(8)}$.

Computer Languages

Instruction

- An instruction is an order given to a computer processor by a computer program.
- At the lowest level, each instruction is a sequence of 0s and 1s that describes a physical operation the computer is to perform (such as "Add").
- Depending on the particular instruction type, the specification of special storage areas called registers that may contain data to be used in carrying out the instruction, or the location in computer memory of data.

Program

- A computer program is a collection of instructions that performs a specific task when executed by a computer.
- Most computer devices require programs to function properly.
- A computer program is usually written by a computer programmer in a programming language.

Programming language

- A programming language is a formal language, which comprises a set of instructions that produce various kinds of output.
- Programming languages are used in computer programming to implement algorithms.
- Most programming languages consist of instructions for computers.
- There are programmable machines that use a set of specific instructions, rather than general programming languages.

Conclusion:

- Programming languages are the languages which are used to communicate with computers by the programmers.
- Even computers use programming languages to communicate each other

Classification of programming languages

Programming languages are classified into three types

- Machine level Language
- Assembly level Language
- High level Language

Machine Language

- Machine level language instructions are in binary form, which can be directly understood by the computer (CPU) without translating them, is called a machine language or machine code.
- Machine language is also known as first generation of programming language.
- Machine language is the fundamental language of the computer and the program instructions in this language are in the binary form (that is 0's and 1's).
- This language is different for different computers.
- It is not easy to learn the machine language.

Note:
No language translators required, since machine level language directly understood by machine that is computers

Advantage of Machine Language

- The only advantage of machine language is that the program of machine language runs very fast because no translation program is required for the CPU.

Disadvantage of Machine Language

- Machine Dependent
  - The internal design of every computer is different from every other type of computer, machine language also differs from one computer to another.
  - Hence, after becoming proficient in the machine language of one type of computer, if a company decides to change to another type, then its programmer will have to learn a new machine language and would have to rewrite all existing program.
- Difficult to Modify
  - It is difficult to correct or modify this language. Checking machine instructions to locate errors is very difficult and time consuming.
- Difficult to Program
  - A computer executes machine language program directly and efficiently, it is difficult to program in machine language.
  - A machine language programming must be knowledgeable about the hardware structure of the computer.

Assembly Level Language

- It is another low-level programming language because the program instructions written in this language are close to machine language.
- Assembly language is also known as second generation of programming language.
- With assembly language, a programmer writes instructions using symbolic instruction code instead of binary codes.
- Symbolic codes are meaningful abbreviations such as SUB is used for substation operation, MUL for multiply operation and so on. Therefore this language is also called the low-level symbolic language.
- The set of program instructions written in assembly language are also called as mnemonic code.
- Assembly language provides facilities for controlling the hardware.

Note:

- Language translators are required, since assembly level language not directly understood by machine that is computers
- Assembler is the translator which used to convert assembly code into machine code.

Advantage of Assembly Language
Here are some of the main advantages of using assembly language

- Easy to understand and use
  - Due to the use of mnemonic instead of numeric op-codes and symbolic names for data location instead of numeric addresses, it is much easier to understand and use in contrast with machine language.

- Easier to locate and correct errors
    - The programmers need not to keep track of storage location of the data and instruction, fewer errors are made while writing programs in assembly language and those that are made, are easier to find and correct.
- Easy to modify
    - Assembly language is easier to understand, it is easier to locate, correct and modify instruction of an assembly language program.
- Efficiency of machine language
    - An assembly language program will be just as long as the resulting machine language program.
    - Hence, leaving out the translation time required by the assembler, the actual execution time for an assembly language program and its equivalent machine language program.

Disadvantage of Assembly Languages

- Machine dependent
    - Each instructions of assembly language program is translated into exactly one machine language instruction, an assembly language programs are dependent on machine language.
- Knowledge of hardware required
    - Assembly languages are machine dependent, an assembly language programmer must have a good knowledge of characteristics and logical structure of his/her computer to write a good assembly language computer code.
- Machine level coding
    - Assembly language instruction is substituted for one machine language instruction. Hence like machine language programs, write assembly language program is also time consuming and difficult.

High Level Languages

- The programming languages that are close to human languages (example like English languages) are called the high-level languages.

- The examples of high-level languages are
    - Fortran
    - COBOL
    - Basic
    - Pascal
    - C
    - C++
    - Java
    - C#
    - PHP
    - Ruby
    - Python
    - Kotlin

- The high level languages are similar to English language. The program instructions are written using English words, for example print, input etc.
- But each high level language has its own rule and grammar for writing program instructions. These rules are called syntax of the language.

- The program written in high level language must be translated to machine code before to run it. Each high level language has its own translator program.

Note:

- Language translators are required, since high level language not directly understood by machine that is computers
- Complier and Interpreters are the translator which used to convert assembly code into machine code.

Advantages of High Level Languages

- Easy to learn
  - The high level languages are very easy to learn than low level languages. The statements written for the program are similar to English-like statements.
- Easy to understand
  - The program written in high level language by one programmer can easily be understood by another because the program instructions are similar to the English language.
- Easy to write program
  - In high level language, a new program can easily be written in a very short time. The larger and complicated software can be developed in few days or months.
- Easy to detect and remove errors
  - The errors in a program can be easily detected and removed. mostly the errors are occurred during the compilation of new program.
- Built-in library functions
  - Each high level language provides a large number of built-in functions or procedures that can be used to perform specific task during designing of new programs. In this way, a large amount of time of programmer is saved.
- Machine Independence
  - Program written in high level language is machine independent. It means that a program written in one type of computer can be executed on another type of computer.

Limitation of High Level Language

- Low efficiency
  - A program written in high level languages has lower efficiency than one written in a machine/assembly language to do the same job. That is, program written in high level languages result in multiple machine language instruction that may not be optimize, taking more time to execute and requiring more memory space.
- Less flexibility
  - High level languages are less flexible than assembly languages because they do not normally have instructions or mechanism to control a computer's CPU, memory and register.

Translators

A translator is a programming language processor that converts a computer program from one language to another. It takes a program written in source code and converts it into machine code. It discovers and identifies the error during translation.

Purpose of Translator

It translates high-level language program into a machine language program that the central processing unit (CPU) can understand. It also detects errors in the program.

Different Types of Translators
There are 3 different types of translators as follows

- Compiler
  - A compiler is a translator used to convert high-level programming language to low-level programming language. It converts the whole program in one session and reports errors detected after the conversion. Compiler takes time to do its work as it translates high-level code to lower-level code all at once and then saves it to memory.
  - A compiler is processor-dependent and platform-dependent. But it has been addressed by a special compiler, a cross-compiler and a source-to-source compiler. Before choosing a compiler, user has to identify first the Instruction Set Architecture (ISA), the operating system (OS) and the programming language that will be used to ensure that it will be compatible.

    Ex:
    Microsoft Visual Studio
    GNU Compiler Collection (GCC)
    Common Business Oriented Language (COBOL)

  - Advantages of the Compiler
    - The whole program is validated so there are no system errors.
    - The executable file is enhanced by the compiler, so it runs faster.
    - User do not have to run the program on the same machine it was created.
  - Disadvantages of the Compiler
    - It is slow to execute as you have to finish the whole program.
    - It is not easy to debug as errors are shown at the end of the execution.
    - Hardware specific, it works on specific machine language and architecture.

- Interpreter
  - Just like a compiler, is a translator used to convert high-level programming language to low-level programming language. It converts the program one at a time and reports errors detected at once, while doing the conversion. With this, it is easier to detect errors than in a compiler. An interpreter is faster than a compiler as it immediately executes the code upon reading the code.
  - It is often used as a debugging tool for software development as it can execute a single line of code at a time. An interpreter is also more portable than a compiler as it is not processor-dependent, you can work between hardware architectures.

    Ex:
    OCaml
    List Processing (LISP)
    Python

  - Advantages of the Interpreter
    - You discover errors before you complete the program, so you learn from your mistakes.
    - Program can be run before it is completed so you get partial results immediately.
    - You can work on small parts of the program and link them later into a whole program.
  - Disadvantages of the Interpreter
    - There's a possibility of syntax errors on unverified scripts.
    - Program is not enhanced and may encounter data errors.
    - It may be slow because of the interpretation in every execution.

- Assembler
  - An assembler is is a translator used to translate assembly language to machine language. It is like a compiler for the assembly language but interactive like an interpreter. Assembly language is difficult to understand as it is a low-level programming language. An assembler translates a low-level language, an assembly language to an even lower-level language, which is the machine code. The machine code can be directly understood by the CPU.
  - Advantages of the Assembler
    - The symbolic programming is easier to understand thus timesaving for the programmer.
    - It is easier to fix errors and alter program instructions.
    - Efficiency in execution just like machine level language.

    Disadvantages of the Assembler
    - It is machine dependent, cannot be used in other architecture.
    - A small change in design can invalidate the whole program.
    - It is difficult to maintain.

Planning a Computer Program

Algorithm

- Algorithm can be defined as: “A sequence of activities to be processed for getting desired output from a given input.”
- Webopedia defines an algorithm as: “A formula or set of steps for solving a particular problem.
- To be an algorithm, a set of rules must be unambiguous and have a clear stopping point”. There may be more than one way to solve a problem, so there may be more than one algorithm for a problem.
- Now, if we take definition of algorithm as: “A sequence of activities to be processed for getting desired output from a given input.” Then we can say that:
  - Getting specified output is essential after algorithm is executed.
  - One will get output only if algorithm stops after finite time.
  - Activities in an algorithm to be clearly defined in other words for it to be unambiguous.
- Before writing an algorithm for a problem, one should find out what is/are the inputs to the algorithm and what is/are expected output after running the algorithm.
- Now let us take some exercises to develop an algorithm for some simple problems: While writing algorithms we will use following symbol for different operations

  ‘+’ for Addition
  ‘-’ for Subtraction
  ‘*’ for Multiplication
  ‘/’ for Division and
  ‘ ’ for assignment.

Ex: A X*3 means A will have a value of X*3.

Example of Algorithm

Problem 1: Find the area of a Circle of radius r.

Inputs to the algorithm:
Radius r of the Circle.
Expected output:
Area of the Circle

Algorithm:
Step1: Read\input the Radius r of the Circle
Step2: Area PI*r*r // calculation of area
Step3: Print Area

Problem2: Write an algorithm to read two numbers and find their sum.

Inputs to the algorithm:
First num1.
Second num2.
Expected output:
Sum of the two numbers.

Algorithm:

Step1: Start
Step2: Read\input the first num1.
Step3: Read\input the second num2.
Step4: Sum num1+num2 // calculation of sum
Step5: Print Sum
Step6: End

Problem 3: Convert temperature Fahrenheit to Celsius

Inputs to the algorithm: Temperature in Fahrenheit
Expected output: Temperature in Celsius

Algorithm:
Step1: Start
Step 2: Read Temperature in Fahrenheit F
Step 3: C 5/9*(F32)
Step 4: Print Temperature in Celsius: C
Step5: End

Properties of Algorithm

Donald Ervin Knuth has given a list of five properties for algorithm, these properties are

- Finiteness
  - An algorithm must always terminate after a finite number of steps.
  - It means after every step one reach closer to solution of the problem and after a finite number of steps algorithm reaches to an end point.

- Definiteness
  - Each step of an algorithm must be precisely defined.
  - It is done by well thought actions to be performed at each step of the algorithm.
  - Also the actions are defined unambiguously for each activity in the algorithm.

- Input
  - Any operation you perform need some beginning value/quantities associated with different activities in the operation.
  - So the value/quantities are given to the algorithm before it begins.

- Output
  - One always expects output/result (expected value/quantities) in terms of output from an algorithm.
  - The result may be obtained at different stages of the algorithm. If some result is from the intermediate stage of the operation then it is known as intermediate result and result obtained at the end of algorithm is known as end result.
  - The output is expected value/quantities always have a specified relation to the inputs

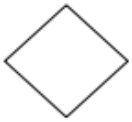
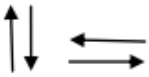
- Effectiveness
  - Algorithms to be developed/written using basic operations.
  - Actually operations should be basic, so that even they can in principle be done exactly and in a finite amount of time by a person, by using paper and pencil only.

Flowchart

- The flowchart is a diagram which visually presents the flow of data through processing systems.
- This means by seeing a flow chart one can know the operations performed and the sequence of these operations in a system.
- Algorithms are nothing but sequence of steps for solving problems.
- So a flow chart can be used for representing an algorithm.
- A flowchart, will describe the operations (and in what sequence) are required to solve a given problem.
- We can see a flow chart as a blueprint of a design you have made for solving a problem.
- For example suppose you are going for a picnic with your friends then you plan for the activities you will do there.
- If you have a plan of activities then you know clearly when you will do what activity.
- Similarly when you have a problem to solve using computer or in other word you need to write a computer program for a problem then it will be good to draw a flowchart prior to writing a computer program. Flowchart is drawn according to defined rules.

Flowchart Symbols

- There are 6 basic symbols commonly used in flowcharting of assembly language Programs
    - Terminal
    - Process
    - Input / Output
    - Decision
    - Connector
    - Predefined Process

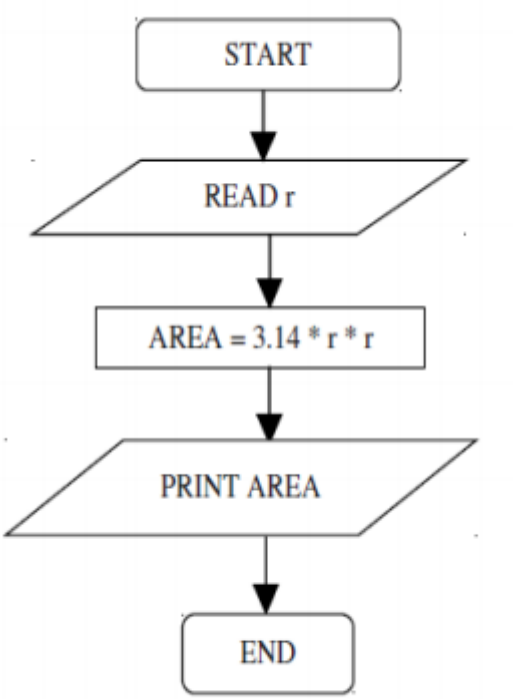
Symbol	Name	Function
	**Process**	Indicates any type of internal operation inside the Processor or Memory
	input/output	Used for any Input / Output (I/O) operation. Indicates that the computer is to obtain data or output results
	Decision	Used to ask a question that can be answered in a binary format (Yes/No, True/False)
	Connector	Allows the flowchart to be drawn without intersecting lines or without a reverse flow.
	Predefined Process	Used to invoke a subroutine or an Interrupt program.
	Terminal	Indicates the starting or ending of the program, process, or interrupt program
	Flow Lines	Shows direction of flow.

General Rules for flowcharting

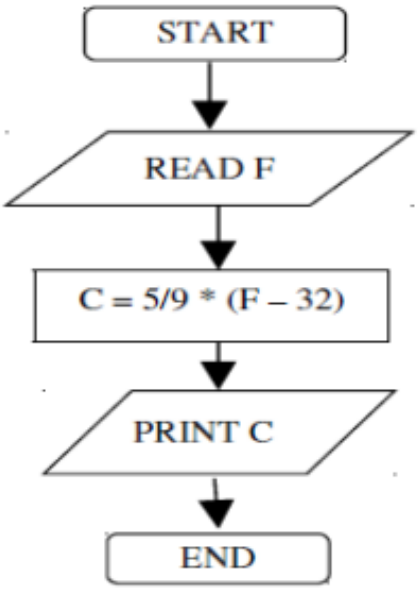
1. All boxes of the flowchart are connected with Arrows. (Not lines)
2. Flowchart symbols have an entry point on the top of the symbol with no other entry points. The exit point for all flowchart symbols is on the bottom except for the Decision symbol.
3. The Decision symbol has two exit points; these can be on the sides or the bottom and one side.
4. Generally a flowchart will flow from top to bottom. However, an upward flow can be shown as long as it does not exceed 3 symbols.
5. Connectors are used to connect breaks in the flowchart. Examples are: • From one page to another page. From the bottom of the page to the top of the same page. • An upward flow of more than 3 symbols
6. Subroutines and Interrupt programs have their own and independent flowcharts.
7. All flow charts start with a Terminal or Predefined Process (for interrupt programs or subroutines) symbol.
8. All flowcharts end with a terminal or a contentious loop. Flowcharting uses symbols that have been in use for a number of years to represent the type of operations and/or processes being performed. The standardised format provides a common method for people to visualise problems together in the same manner. The use of standardised symbols makes the flow charts easier to interpret; however, standardizing symbols is not as important as the sequence of activities that make up the process.

Examples of Flowcharts

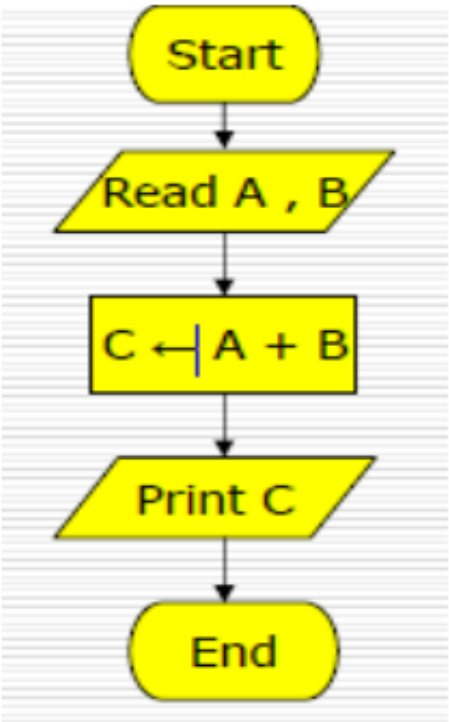
Problem1: Find the area of a circle of radius r.



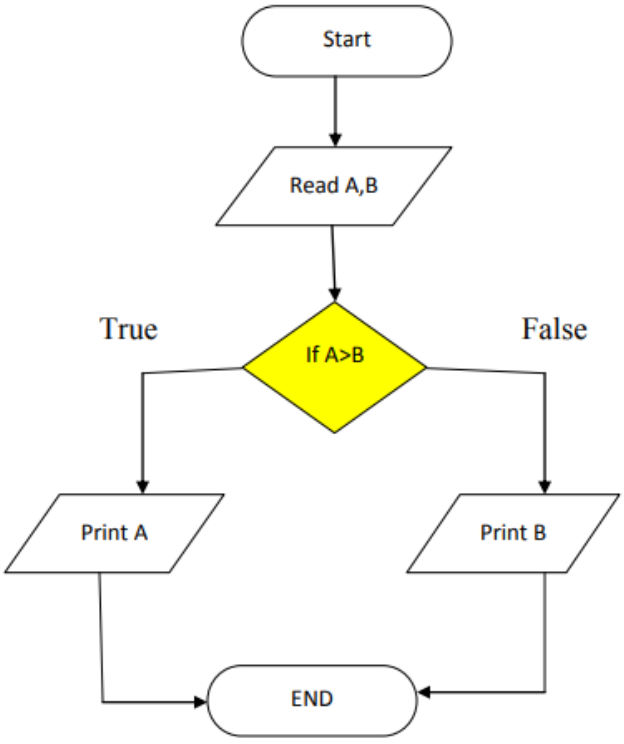
Problem 2: Convert temperature Fahrenheit to Celsius.



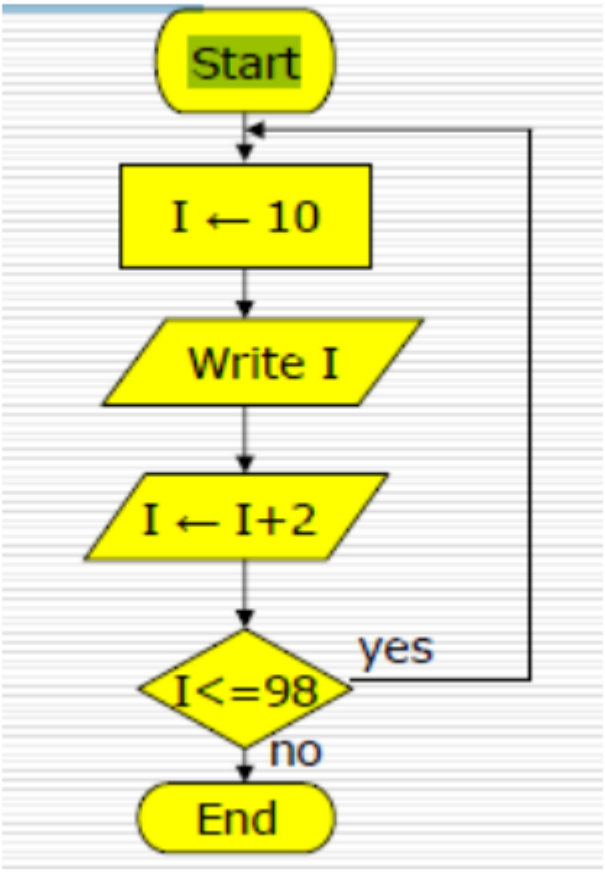
Problem3: Flowchart for an algorithm which gets two numbers and prints sum of their value



Problem4: Algorithm for find the greater number between two numbers.



Problem5: Flowchart for the problem of printing even numbers between 9 and 100



Advantages of using Flowcharts

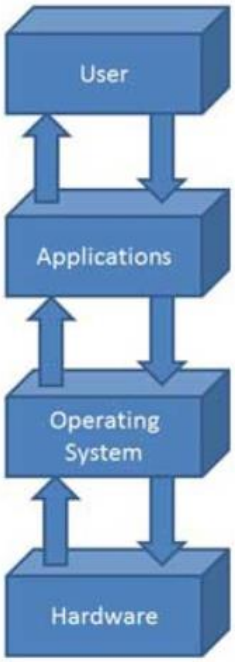
As we discussed flow chart is used for representing algorithm in pictorial form. This pictorial representation of a solution/system is having many advantages. These advantages are as follows

1. Communication: A Flowchart can be used as a better way of communication of the logic of a system and steps involve in the solution, to all concerned particularly to the client of system.
2. Effective analysis: A flowchart of a problem can be used for effective analysis of the problem.
3. Documentation of Program/System: Program flowcharts are a vital part of a good program documentation. Program document is used for various purposes like knowing the components in the program, complexity of the program etc.
4. Efficient Program Maintenance: Once a program is developed and becomes operational it needs time to time maintenance. With help of flowchart maintenance become easier.
5. Coding of the Program: Any design of solution of a problem is finally converted into computer program. Writing code referring the flowchart of the solution become easy.

Unit III: Operating System Fundamentals

Operating System

- An operating system is a program that acts as an interface between the software and the computer hardware.
- It is an integrated set of specialized programs used to manage overall resources and operations of the computer.
- It is specialized software that controls and monitors the execution of all other programs that reside in the computer, including application programs and other system software.



Objectives of Operating System

- To make the computer system convenient to use in an efficient manner.
- To hide the details of the hardware resources from the users.
- To provide users a convenient interface to use the computer system.
- To act as an intermediary between the hardware and its users, making it easier for the users to access and use other resources.
- To manage the resources of a computer system.
- To keep track of who is using which resource, granting resource requests, and mediating conflicting requests from different programs and users.
- To provide efficient and fair sharing of resources among users and programs.

Characteristics of Operating System

Here is a list of some of the most prominent characteristic features of Operating Systems

- Memory Management
  Keeps track of the primary memory, i.e. what part of it is in use by whom, what part is not in use, etc. and allocates the memory when a process or program requests it.

- Processor Management
  Allocates the processor (CPU) to a process and deallocates the processor when it is no longer required.

- Device Management
  Keeps track of all the devices.
  This is also called I/O controller that decides which process gets the device, when, and for how much time.

- File Management
  Allocates and de-allocates the resources and decides who gets the resources.

- Security
  Prevents unauthorized access to programs and data by means of passwords and other similar techniques.

- Job Accounting
  Keeps track of time and resources used by various jobs and/or users.

- Control Over System Performance
  Records delays between the request for a service and from the system.

- Interaction with the Operators
  Interaction may take place via the console of the computer in the form of instructions. The Operating System acknowledges the same, does the corresponding action, and informs the operation by a display screen.

- Error-detecting Aids
  Production of dumps, traces, error messages, and other debugging and error-detecting methods.

- Coordination Between Other Software and Users
  Coordination and assignment of compilers, interpreters, assemblers, and other software to the various users of the computer systems.

Types of Operating System (OS)

Following are the popular types of OS (Operating System):

- Batch Operating System
- Multitasking/Time Sharing OS
- Multiprocessing OS
- Real Time OS
- Distributed OS
- Network OS
- Mobile OS

- Batch Operating System
  Some computer processes are very lengthy and time-consuming. To speed the same process, a job with a similar type of needs are batched together and run as a group.

  The user of a batch operating system never directly interacts with the computer. In this type of OS, every user prepares his or her job on an offline device like a punch card and submit it to the computer operator.

- Multi-Tasking/Time-sharing Operating systems
  Time-sharing operating system enables people located at a different terminal(shell) to use a single computer system at the same time. The processor time (CPU) which is shared among multiple users is termed as time sharing.

- Real time OS
  A real time operating system time interval to process and respond to inputs is very small. Examples: Military Software Systems, Space Software Systems are the Real time OS example.

- Distributed Operating System
  Distributed systems use many processors located in different machines to provide very fast computation to its users.

- Network Operating System
  Network Operating System runs on a server. It provides the capability to serve to manage data, user, groups, security, application, and other networking functions.

- Mobile OS
  Mobile operating systems are those OS which is especially that are designed to power smartphones, tablets, and wearables devices.
  Some most famous mobile operating systems are Android and iOS, but others include BlackBerry, Web, and watchOS.

Software

- Software is a set of instructions, data or programs used to operate computers and execute specific tasks.
- Opposite of hardware, which describes the physical aspects of a computer, software is a generic term used to refer to applications, scripts and programs that run on a device.
- Software can be thought of as the variable part of a computer and hardware the invariable part.

Software Characteristics

Software characteristics are classified into six major components.

- Functionality
  - Refers to the degree of performance of the software against its intended purpose.

- Reliability
  - Refers to the ability of the software to provide desired functionality under the given conditions.

- Usability
  - Refers to the extent to which the software can be used with ease.

- Efficiency
  - Refers to the ability of the software to use system resources in the most effective and efficient manner.

- Maintainability

  - Refers to the ease with which the modifications can be made in a software system to extend its functionality, improve its performance, or correct errors.

- Portability
  - Refers to the ease with which software developers can transfer software from one platform to another, without (or with minimum) changes.
  - In simple terms, it refers to the ability of software to function properly on different hardware and software platforms without making any changes in it.

Classifications of Software

- Software's are classified in to below two types as below.
- The classification criteria are on which the software is operating and end users.
  - Systems software
  - Application software

Systems software

- Systems software includes the programs that are dedicated to managing the computer itself, such as the operating system, file management utilities, and disk operating system (or DOS), translators like assemblers, complier and interpreters.
- System software is software that provides platform to other software's.
- Some examples can be operating systems, antivirus software's, disk formatting software's, Computer language translators etc.
- These are commonly prepared by the computer manufacturers.
- This software's consists of programs written in low-level languages, used to interact with the hardware at a very basic level. System software serves as the interface between the hardware and the end users.

The most important features of system software include

- Closeness to the system
- Fast speed
- Difficult to manipulate
- Written in low level language
- Difficult to design

Application Software

- An application is any program, or group of programs, that is designed for the end user.
- Application software is a term which is used for software created for a specific purpose.
- It is generally a program or collection of programs used by end users.
- It can be called an application or simply an app.
- Various examples of application software are as fallows
  - Word processing software(MS WORD,ATOM)
  - Database programs(MSSQL,MYSQL,COUCH BASE,MANGO DB)
  - Entertainment software(TICK TALK,YOU TUBE)
  - Business software(TALLY,SARAL TAX OFFICE)
  - Educational software(BYJUS,GLOBAL SHIKSHA)
  - Computer-aided design(CAD) software
  - Spread sheet software(MS EXCEL)

Difference between System and Application Software's

System Software	Application Software
System software is used for operating computer hardware	Application software is used by user to perform specific task.
System software's are installed on the computer when operating system is installed.	Application software's are installed according to user's requirements.
In general, the user does not interact with system software because it works in the background.	In general, the user interacts with application software's.
System software can run independently. It provides platform for running application software's.	Application software can't run independently. They can't run without the presence of system software.
Some examples of system software's are compiler, assembler, debugger, driver, etc.	Some examples of application software's are word processor, web browser, media player, etc.

The Unix Operating

- UNIX is an operating system which was first developed in the 1960s, and has been under constant development ever since.
- By operating system, we mean the suite of programs which make the computer work. It is a stable, multi-user, multi-tasking system for servers, desktops and laptops.
- UNIX systems also have a graphical user interface (GUI) similar to Microsoft Windows which provides an easy to use environment.
- However, knowledge of UNIX is required for operations which aren't covered by a graphical program, or for when there is no windows interface available, for example, in a telnet session.

Types of UNIX

- The Linux PenguinThere are many different versions of UNIX, although they share common similarities.
- The most popular varieties of UNIX are Sun Solaris, GNU/Linux, and MacOS X. Linux in its turn is packaged in a form known as a Linux distribution. There are several Linux distributions, both free and commercial.
- ISU has a campus site subscription to Red Hat Enterprise Linux (RHEL), providing access for university-owned equipment as well as personal access to students, faculty, and staff. All our clusters are running RHEL.

BASIC UNIX / LUNIX COMMANDS

cal

- cal command is a calendar command in Linux which is used to see the calendar of a specific month or a whole year.
- cal : Shows current month calendar on the terminal with the current date highlighted.
- cal -y : Shows the calendar of the complete current year with the current date highlighted.

Syntax:
cal [[month] year]

date

- date command is used to display the system date and time.
- date command is also used to set date and time of the system.
- By default the date command displays the date in the time zone on which unix/linux operating system is configured.
- You must be the super-user (root) to change the date and time.

Syntax:
- date [OPTION]... [+FORMAT]
- date [-u|--utc|--universal] [MMDDhhmm[[CC]YY][.ss]]

bc

- bc command is used for command line calculator.
- It is similar to basic calculator by using which we can do basic mathematical calculations.

Syntax:
bc [-hlwsqv] [long-options] [file ...]

echo

- echo command in linux is used to display line of text/string that are passed as an argument .
- This is a built in command that is mostly used in shell scripts and batch files to output
- status text to the screen or a file.
  Syntax:
  echo [option] [string]
  Displaying a text/string :
  Syntax :
- echo [string]

who

- The who command is used to get information about currently logged in user on to system.
  Syntax:
  $who [options] [filename]

ls

- ls is a Linux shell command that lists directory contents of files and directories.
  Syntax:
  ls [options] [paths]

pwd

- pwd stands for Print Working Directory. It prints the path of the working directory, starting from the root.
  - pwd -L: Prints the symbolic path.
  - pwd -P: Prints the actual path.

  Synatx:
  pwd [-options]

cd

- cd command in linux known as change directory command. It is used to change current working directory.

  Syntax:
  $ cd [directory]
  To move inside a subdirectory : to move inside a subdirectory in linux we use
  $ cd [directory_name]

Mkdir

- The mkdir stands for 'make directory'. With the help of mkdir command, you can create
- a new directory wherever you want in your system.

  Syntax:
  mkdir [options...] [directories ...]

rmdir

- rmdir command is used remove empty directories from the filesystem in Linux.

  Syntax:
  rmdir [options...] [directories ...]

COMMANDS TO WORK WITH FILES

- Cat

Cat(concatenate) command is very frequently used in Linux. It reads data from the file and gives their content as output. It helps us to create, view, concatenate files.
Syntax:
$cat filename

- cp

cp stands for copy. This command is used to copy files or group of files or directory. It creates an exact image of a file on a disk with different file name. cp command require at least two filenames in its arguments.
Syntax:

cp [OPTION] Source Destination
cp [OPTION] Source Directory
cp [OPTION] Source-1 Source-2 Source-3 Source-n Directory

rm

- The 'rm' means remove. This command is used to remove a file.
- The command line doesn't have a recycle bin or trash unlike other GUI's to recover the files. Hence, be very much careful while using this command. Once you have deleted a file, it is removed permanently.
  Syntax:
  rm [OPTION]... FILE...

mv

- The mv command is one of the basic Linux commands that is used to move files and directories from one location to another. It is also used to rename files and directories.

  Syntax:
  mv [Option] source destination

file

- The file command is used to determine the type of file i.e. ASCII or MIME type. It doesn't care about the extension used for the file.
- The command simply is used to identify the file type. There are various other options used with the file command.

  Syntax:

  file [option] [filename]

wc

- Linux wc command helps in counting the lines, words, and characters in a file. It displays the number of lines, number of characters, and the number of words in a file.
  Syntax:
  wc [OPTION]... [FILE]...

head

- The head command, as the name implies, print the top N number of data of the given input.
- By default, it prints the first 10 lines of the specified files. If more than one file name is provided then data from each file is preceded by its file name.

  Syntax:
  head [OPTION]... [FILE]...

tail

- It is the complementary of head command.The tail command, as the name implies, print the last N number of data of the given input.
- By default it prints the last 10 lines of the specified files. If more than one file name is provided then data from each file is precedes by its file name.

  Syntax:
  tail [OPTION]... [FILE]...

Unit IV: Introduction to Database Management Systems

Database

Collection of data is called database, where as DBMS is a system that manages the data in efficient and convenient way.

Definition 1:

A database-management system (DBMS) is a collection of interrelated data and a set of programs to access those data. The collection of data, usually referred to as the database, contains information relevant to an enterprise.

Definition 2:

Database is a collection of related data and data is a collection of facts and figures that can be processed to produce information. Mostly data represents recordable facts. Data aids in producing information, which is based on facts.

Ex:

If we have data about marks obtained by all students, we can then conclude about toppers and average marks.

If we have data about blood donors with their blood group, we can then find donors at right time.

Conclusion:

The primary goal of a DBMS is to provide a way to store and retrieve database information that is both convenient and efficient.

Database-System Applications:

Databases are widely used. Here are some representative applications:

- Enterprise Information
    - Sales: For customer, product, and purchase information.
    - Accounting: For payments, receipts, account balances, assets and other accounting information.
    - Human resources: For information about employees, salaries, payroll taxes, and benefits, and for generation of pay checks.
    - Manufacturing: For management of the supply chain and for tracking production of items in factories, inventories of items in warehouses and stores, and orders for items.
    - Online retailers: For sales data noted above plus online order tracking, generation of recommendation lists, and maintenance of online product evaluations.
    -
- Banking and Finance
    - Banking: For customer information, accounts, loans, and banking transactions.
    - Credit card transactions: For purchases on credit cards and generation of monthly statements.

    - Finance: For storing information about holdings, sales, and purchases of financial instruments such as stocks and bonds; also for storing real-time market data to enable online trading by customers and automated trading by the firm.

- Universities: For student information, course registrations, and grades (in addition to standard enterprise information such as human resources and accounting).

- Airlines: For reservations and schedule information. Airlines were among the first to use databases in a geographically distributed manner.

- Telecommunication: For keeping records of calls made, generating monthly bills, maintaining balances on prepaid calling cards, and storing information about the communication networks.

Database system vs. File system

File System

- This typical file-processing system is supported by a conventional (Standard) operating system.
- The system stores permanent records in various files, and it needs different application programs to extract records from, and add records to, the appropriate files.

Before database management systems (DBMSs) were introduced, organizations usually stored information in such systems.

File-processing system has a number of major disadvantages, they are as below.

- Data redundancy (duplication or repetition) and inconsistency.
    - The same information may be duplicated in several places (files).
    - The duplication of data results in increase in size of the file and improper updating.
    - The improper updating of data causes in inconsistency.

- Difficulty in accessing (reading or retrieving) data.
    - File system not support data accessing flexibility.
    - Need to filter out the data manually or go for accessing programs newly.

- Data isolation (separation).
    - Data are scattered in various files, and files may be in different formats, writing new application programs to retrieve the appropriate data is difficult.

- Integrity (wholeness) problems.
    - There is need to maintain conditions while storing data, In file system maintaining such conditions results in problem, due to scattered data among different files.

- Atomicity problems.

- A computer system, like any other device, is subject to failure. In many applications, it is crucial that, if a failure occurs, the data be restored to the consistent state that existed prior to the failure.

- In file system the atomicity is difficult to achieve, where as in DBMS atomicity is achieved through transaction management.

- Concurrent (Simultaneously) access anomalies.

  - Accessing the data simultaneously results in improper incorrect results.
  - In multi user environment concurrent access is a essential service, need to meet it and DBMS is achieved it properly through.

- Security problems.

  - Security is the important for the vital data, since unauthorized accessing of data results in leakage of information.
  - DBMS loaded with good security mechanism with authorization and authentication.

View of Data:

A major purpose of a database system is to provide users with an abstract view of the data. That is, the system hides certain details of how the data are stored and maintained.

Note: Abstraction is hiding the complexity of the system from the end user.

The view of data is classified as follows.

- Physical level.
  - The lowest level of abstraction describes how the data are actually stored.
  - The physical level describes complex low-level data structures in detail.

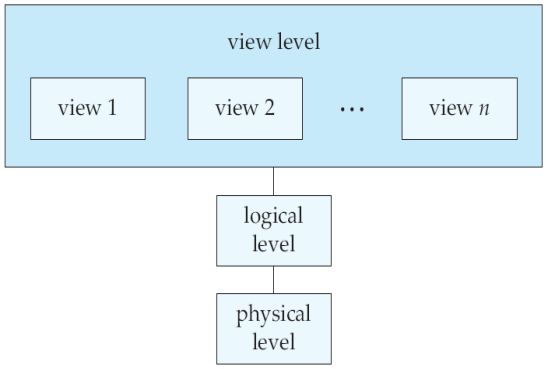
- Logical level.

  - The next-higher level of abstraction describes what data are stored in the database, and what relationships exist among those data.
  - The logical level thus describes the entire database in terms of a small number of relatively simple structures.
  - The user of the logical level does not need to be aware of this complexity physical-level structures, this is referred as physical data independence.

- View level.

  - This is the highest level of abstraction describes only part of the entire database.
  - The view level of abstraction exists to simplify their interaction with the system. The system may provide many views for the same database.

Below diagram shows the different levels of the views.



Instances and Schemas

Instances and Schemas

- The collection of information stored in the database at a particular moment is called an instance of the database.
- The overall design of the database is called the database schema.
- Self description of the database is called schema.

The schemas are classified as below.

- The physical schema describes the database design at the physical level.
- The logical schema describes the database design at the logical level.
- A database may also have several schemas at the view level, sometimes called subschema's, that describe different views of the database.

Database languages

- Database languages, also known as query languages or data query languages, are a classification of programming languages that developers use to define and access databases, which are collections of organized data that users can access electronically.
- Database languages allow users to complete tasks such as controlling access to data, defining, and updating data and searching for information within the database management system (DBMS).
- A DBMS is a piece of technology that interacts with users, applications and the database to record and analyse data while also manipulating the database to offer a way to store, access and retrieve data.
- A DBMS provides necessary database languages that allow users to express database updates and queries, which are requests for data.
- There are different examples of database languages available, including SQL, which is the standard programming language for many databases.
- Database languages comprise four sublanguages that serve different functions to execute tasks.

Database languages are classified into four types, they are discussed in below section

- Data definition language (DDL)

  - Data definition language (DDL) creates the framework of the database by specifying the database schema, which is the structure that represents the organization of data. Its common uses include the creation and alteration of tables, files, indexes and columns within the database.
  - This language also allows users to rename or drop the existing database or its components.
  - Below list consists of DDL statements

  - CREATE: Creates a new database or object, such as a table, index or column
  - ALTER: Changes the structure of the database or object
  - DROP: Deletes the database or existing objects
  - RENAME: Renames the database or existing objects

- Data manipulation language (DML)

  - Data manipulation language (DML) provides operations that handle user requests, offering a way to access and manipulate the data that users store within a database. Its common functions include inserting, updating and retrieving data from the database.
  - Here's a list of DML statements
    - INSERT: Adds new data to the existing database table
    - UPDATE: Changes or updates values in the table
    - DELETE: Removes records or rows from the table
    - SELECT: Retrieves data from the table or multiple tables

- Data control language (DCL)

  - Data control language (DCL) controls access to the data that users store within a database. Essentially, this language controls the rights and permissions of the database system.
  - It allows users to grant or revoke privileges to the database.
  - Below list consists of DCL statements
    - GRANT: Gives a user access to the database
    - REVOKE: Removes a user's access to the database

- Transaction control language (TCL)

  - Transaction control language (TCL) manages the transactions within a database. Transactions group a set of related tasks into a single, executable task.
  - All the tasks must succeed in order for the transaction to work.
  - Below list consists of TCL statements:
    - COMMIT: Carries out a transaction
    - ROLLBACK: Restores a transaction if any tasks fail to execute
    - SAVEPOINT: Sets a point in a transaction to save

Internet Basics

Introduction

- A computer network is a set of computers sharing resources located on or provided by network nodes.
- The computers use common communication protocols over digital interconnections to communicate with each other.
- These interconnections are made up of telecommunication network technologies, based on physically wired, optical, and wireless radio-frequency methods that may be arranged in a variety of network topologies.
- The Internet (or internet) is the global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to communicate between networks and devices. It is a network of networks that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies.
- The Internet carries a vast range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing.

Basics of Internet Concepts

- Basics of Computer Networks
  Computer network is an interconnection between two or more hosts/computers. Different types of networks include LAN, WAN, MAN, etc.

- Internet Architecture
  Internet is called the network of networks. It is a global communication system that links together thousands of individual networks. Internet architecture is a meta-network, which refers to a congregation of thousands of distinct networks interacting with a common protocol

- Services on Internet
  Internet acts as a carrier for numerous diverse services, each with its own distinctive features and purposes.

- Communication on Internet
  Communication can happens through the the Internet by using Email, Internet Relay Chat, Video Conference etc.

- Web Browsing Software
  "World Wide Web" or simple "Web" is the name given to all the resources of internet. The special software or application program with which you can access web is called "Web Browser".

- Search Engines
  Search Engine is an application that allows you to search for content on the web. It displays multiple web pages based on the content or a word you have typed.

- Search for the content
  Search Engine helps to search for content on web using the different stages

- Accessing Web Browser
  There are several ways to access a web page like using URLs, hyperlinks, using navigating tools, search engine, etc.

Features of Internet

The features are described below

- Accessibility
  An Internet is a global service and accessible to all. Today, people located in a remote part of an island or interior of Africa can also use Internet.

- Easy to Use
  The software, which is used to access the Internet (web browser), is designed very simple; therefore, it can be easily learned and used. It is easy to develop.

- Interaction with Other Media
  Internet service has a high degree of interaction with other media. For example, News and other magazine, publishing houses have extended their business with the help of Internet services.

- Low Cost
  The development and maintenance cost of Internet service are comparatively low.

- Extension of Existing IT Technology
  This facilitates the sharing of IT technology by multiple users in organizations and even facilitates other trading partners to use.

- Flexibility of Communication
  Communication through Internet is flexible enough. It facilitates communication through text, voice, and video too. These services can be availed at both organizational and individual levels.

- Security
  Internet facility has to a certain extent helped the security system both at the individual and national level with components such as CCTV camera, etc.

Internet Applications

- Electronic Mail (email)
  The first major use of the internet is Email. People thronged to Email for sharing information, data files, Photos, Videos, Business communications, and any other files instantaneously with others. This had enabled faster communication between people and improve business efficiency. An email has reduced the usage of paper considerably and reduced the load on physical mail systems.

  Though other latest collaboration tools provide many rich features, they are not able to de-popularize Email, and it still rules official and personal communication. There are

many free Email websites offering mail services, and practically every individual has an Email address and connected by Email. Email concepts paved the way for developing many innovative tools for improved collaboration.

- FTP File Transfer
  This is the second major use case for the internet in the early days. FTP is the file transfer protocol that enables data exchange between two stakeholders over internet media in a secure way. The data exchange may occur between two business entities or customers with business and vice versa. Normally E-mail restricts the size of a file that can be shared, and also, it is not secured to share sensitive and confidential data across public networks. FTP concept is still in use even today in mobile apps for files downloading.

- Search Engines
  These engines locate the information one seeks, available in whichever server across the globe (world wide web). Google, Yahoo, and MSN are the renowned search engines in use today. One can search on anything on this site, and the search question can be in any format. In fact, People have started using the word Google as a generic verb synonymous to search.

- E-Commerce
  The Internet enables the selling of goods and services in online mode. There are many e-commerce platform vendors like Amazon, Ola who aggregate several products/services available in the market and sell them through their portal to customers. Products are procured by platform vendors, stored in their warehouses, packed and distributed by them in their own brand. Customers get a good discount, and they don't have to visit physical stores.

- Online Banking
  Called as Net banking, it allows doing banking transactions at ease sitting at home or while on mobile. Footfalls in the bank branches have come down appreciably with almost all the services are available in net banking 24×7. Any amount of money can be transferred instantaneously through this facility. E-Banking supports Electricity bills, Telephone bills, and other services payment.

- Cashless Transactions
  Bill Payment at merchandise outlets through debit cards, credit cards, UPI gateway are on the increase. Cash circulation gets reduced in the system to the extent of the growth of these transactions. It's growing by more than 50% every year, and it is expected to grow by 10 times over the next 5 years.

- Education
  The Internet offers a wealth of educational material on any subject with structured navigation and search facilities. One can seek any reading material, and the internet will get it for them from any server in any part of the world, and people need not have to go to libraries to go through books. Those who cannot attend physical (face to face) class can take an online course where they get connected to the teacher, in the other part of the world, in video mode and get taught on the subject backed up other audiovisual tools.

- Collaboration

  Online chat tools like messenger, Skype, and other video conferencing tools help people to get connected 24 x7 and have a hassle-free business and personal discussion. This avoids unwanted travel by people and saves their time for productive use. The Internet has also facilitated work from home with seamless connectivity to the office and avoid daily commuting.

- Social Networking

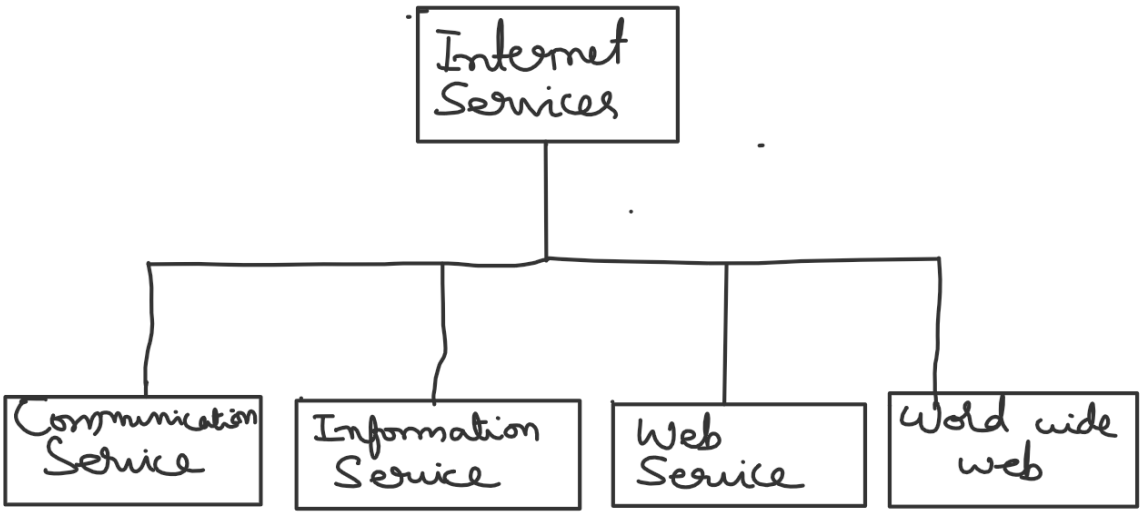
  Internet connects people online and enables them to form social groups. Information, Ideas, views, and opinions on any social/political issues are exchanged. The political and social organization makes use of this platform in promoting their interest among the public.

- Applications of Internet
  With the evolution of IOT, Artificial Intelligence technologies, supported by computing resources in the cloud, more and more new applications are being developed over the internet layer, and a few of them are:

  - Tracking the Vehicle – Fleet Management system
  - Monitoring the health of the moving vehicle – Telematics
  - Autonomous and Driverless vehicle – 5G networks
  - Remote diagnostics and triggering preventive maintenance of equipment
  - Monitoring Children in the home from outside
  - Online streaming of events
  - Entertainment – Contents sharing platform (OTT), Internet TV, Web Serials
  - Connected Machines – Manufacturing

Internet Services

Internet Services allows us to access huge amount of information such as text, graphics, sound and software over the internet. Following diagram shows the four different categories of Internet Services.



- Communication Services
  - There are various Communication Services available that offer exchange of information with individuals or groups.
  - The following table gives a brief introduction to these services

S.N.	Service Description
1	**Electronic Mail** Used to send electronic message over the internet.
2	**Telnet** Used to log on to a remote computer that is attached to internet.
3	**Newsgroup** Offers a forum for people to discuss topics of common interests.
4	**Internet Relay Chat (IRC)** Allows the people from all over the world to communicate in real time.
5	**Mailing Lists** Used to organize group of internet users to share common information through e-mail.
6	**Internet Telephony (VoIP)** Allows the internet users to talk across internet to any PC equipped to receive the call.
7	**Instant Messaging** Offers real time chat between individuals and group of people. Eg. Yahoo messenger, MSN messenger.

- Information Retrieval Services
    - There exist several Information retrieval services offering easy access to information present on the internet.
    - The following table gives a brief introduction to these services

S.N.	Service Description
1	**File Transfer Protocol (FTP)** Enable the users to transfer files.
2	**Archie** It's updated database of public FTP sites and their content. It helps to search a file by its name.
3	**Gopher** Used to search, retrieve, and display documents on remote sites.
4	**Very Easy Rodent Oriented Netwide Index to Computer Achieved (VERONICA)** VERONICA is gopher based resource. It allows access to the information resource stored on gopher's servers.

- Web Services
    - Web services allow exchange of information between applications on the web. Using web services, applications can easily interact with each other.
    - The web services are offered using concept of Utility Computing.
- World Wide Web (WWW)
    - WWW is also known as W3. It offers a way to access documents spread over the several servers over the internet. These documents may contain texts, graphics, audio, video, hyperlinks. The hyperlinks allow the users to navigate between the documents

Logical and Physical Address

- In computer networking IP address called a "logical" address, and the MAC address is called a "physical" address.

Logical Address (IP Address)

- An IP address is also known as a logical address and it can change over time as well as from one network to another. The Internet Service Provider will be in charge of assigning it. When a device connects to a different network, it receives a different IP address as a result of a change in Internet Service Provider.
- With the help of Dynamic Host Configuration Protocol (DHCP), even in the same network, when a device wants to connect to the internet, it will acquire different addresses from the pool. There is no assurance that the device always has the same IP address. The IP address is not directly linked to any devices. As a result, it is referred to as a logical address.

Physical Address (MAC Address)

- MAC address provided by the hardware interface vendor. It never changes when a device is attached to any network. As a result, it is referred to as a physical address.
- IP address is, for example, like school register no, university register no and corporate employee id. When a person transfers from school to college and then to the workplace, he or she is assigned a new Identification Number, which is used to uniquely identify the individual inside that organization. At different periods, the same individual was recognized with a different identification number. Similarly, when one machine connects to a different network, it receives a new IP address each time. Thus it is called a logical address.
- However, that address is unique inside that network. But MAC address is like an Aadhar number, it never changes to any business. It's like an original identity.
- In the same way, the MAC address will be the same for the device's (NIC), for any network on which the device is associated. Thus it is called a physical address. A MAC address is also a unique address. There won't be the same address for two devices.

Conclusion

The Logical/IP Address identifies a device in a network. But to reach and deliver data to the device, we need a MAC/Physical address.

Internet Service Provider

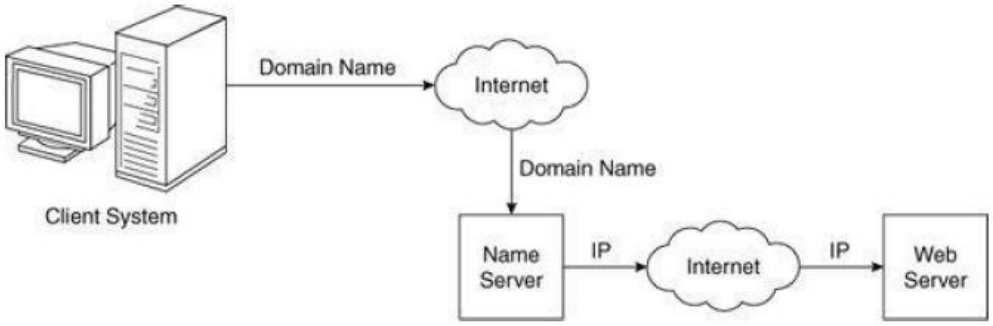
- An ISP (Internet service provider) is a company that provides individuals and other companies access to the Internet and other related services such as Web site building and virtual hosting.
- An ISP has the equipment and the telecommunication line access required to have a point-of-presence on the Internet for the geographic area served.
- The larger ISPs have their own high-speed leased lines so that they are less dependent on the telecommunication providers and can provide better service to their customers. Among the largest national and regional ISPs are Airtel, Jio, Hatway,Idea.
- An ISP is also sometimes referred to as an IAP (Internet access provider). ISP is sometimes used as an abbreviation for independent service provider to distinguish a service provider that is an independent, separate company from a telephone company.

Domain Name System

The Domain Name System (DNS) is the Internet's system for mapping alphabetic names to numeric Internet Protocol (IP) addresses like a phone book maps a person's name to a phone number.
Ex: when a Web address (URL) is typed into a browser, a DNS query is made to learn an IP address of a Web server associated with that name.

Using the **www.example.com** URL, **example.com** is the domain name, and **www** is the hostname. DNS resolution maps www.example.com into an IP address (such as 192.0.2.1). When a user needs to load a webpage, a conversion must occur between what a user types into their web browser (www.example.com) into an IP address required to locate the www.example.com site.

Below figure shows how fully qualified domain names requested by a browser are translated into IPs before they are routed to the appropriate Web server.



Web Basics

Introduction to web

- The World Wide Web (WWW), commonly known as the Web, is an information system where documents and other web resources are identified by Uniform Resource Locators which may be interlinked by hyperlinks, and are accessible over the Internet.
- The resources of the Web are transferred via the Hypertext Transfer Protocol (HTTP), may be accessed by users by a software application called a web browser, and are published by a software application called a web server.
- The World Wide Web is not synonymous with the Internet, which pre-dated the Web in some form by over two decades and upon the technologies of which the Web is built.

Note:
English scientist Tim Berners-Lee invented the World Wide Web in 1989.

Difference between Web and Internet

- The Internet and the Web are not the same thing.
- The Internet is a collection of computers and other devices connected by equipment that allows them to communicate with each other.
- The Web is a collection of software and protocols that has been installed on most, if not all, of the computers on the Internet.
- Some of these computers run Web servers, which provide documents, but most run Web clients, or browsers, which request documents from servers and display them to users.
- The Internet was quite useful before the Web was developed, and it is still useful without it. Most users of the Internet now use it through the Web.

Web Browser

- A web browser (commonly referred to as a browser) is a software application for retrieving, presenting and traversing information resources on the World Wide Web.
- An information resource is identified by a Uniform Resource Identifier (URI/URL) that may be a web page, image, video or other piece of content.
- Hyperlinks present in resources enable users easily to navigate their browsers to related resources.
- Although browsers are primarily intended to use the World Wide Web, they can also be used to access information provided by web servers in private networks or files in file systems.

- The most popular web browsers are Chrome, Edge (preceded by Internet Explorer),Safari, Opera and Firefox.
- The first web browser was invented in 1990 by Sir Tim Berners-Lee.
- Berners-Lee is the director of the World Wide Web Consortium (W3C), which oversees the Web's continued development, and is also the founder of the World Wide Web Foundation and his browser was called Worldwide Web and later renamed Nexus.

Web Servers

- Web servers are programs that provide documents to requesting browsers.
- Servers are slave programs: They act only when requests are made to them by browsers running on other computers on the Internet.
- The most commonly used Web servers are Apache, which has been implemented for a variety of computer platforms.
- Microsoft's Internet Information Server (IIS), which runs under Windows operating systems.

Introduction to Protocol

- A Protocol is a set of rules and conventions for communication. In the current scenario, when we are talking about protocols, it is about communication- the way we talk to each other. For instance, a newsreader speaks in English and because you understand English, you are able to understand. English is the protocol.
- In web, in particular, multiple protocols are used to communicate. Primarily for end users, the most important and visible protocols are HTTP and HTTPS. Though there are many other protocols as well, HTTP and HTTPS protocols cater to most of the population.

HTTP and HTTPS Protocols

- HTTP URL in your browser's address bar is http:// and the HTTPS URL is https://.
- HTTP is unsecured while HTTPS is secured.
- HTTP sends data over port 80 while HTTPS uses port 443.
- HTTP operates at application layer, while HTTPS operates at transport layer.
- No SSL certificates are required for HTTP, with HTTPS it is required that you have an SSL certificate and it is signed by a CA.
- HTTP doesn't require domain validation, where as HTTPS requires at least domain validation and certain certificates even require legal document validation.
- No encryption in HTTP, with HTTPS the data is encrypted before sending.

URL (Uniform Resource Locator)

- A URL (Uniform Resource Locator) is a unique identifier used to locate a resource on the Internet. It is also referred to as a web address.
- URLs consist of multiple parts -- including a protocol and domain name -- that tell a web browser how and where to retrieve a resource.
- End users use URLs by typing them directly into the address bar of a browser or by clicking a hyperlink found on a webpage, bookmark list, in an email or from another application.
- The URL contains the name of the protocol needed to access a resource, as well as a resource name. The first part of a URL identifies what protocol to use as the primary access medium. The second part identifies the IP address or domain name -- and possibly subdomain -- where the resource is located.