**Introduction to Computers**

**Definition**: A Computer is an electronic device that can perform activities that involve Mathematical, Logical and graphical manipulations. Generally, the term is used to describe a collection of devices that function together as a system.

It performs the following three operations in sequence.

1. It receives data & instructions from the input device.
2. Processes the data as per instructions.
3. Provides the result (output) in a desired form.

**Data**: It is the collection of raw facts, figures & symbols.

Ex: Names of students and their marks in different subjects listed in random order.

**Information**: It is the data that is processed & presented in an organized manner.

Ex: When the names of students are arranged in alphabetical order, total and average marks are calculated & presented in a tabular form, it is information.

**Program**: Set of instructions that enable a computer to perform a given task.

**Characteristics of computers:**

**High speed:** Computers have the ability to perform routine tasks at a greater speed than human beings. They can perform millions of calculations in seconds.

**Accuracy**: Computers are used to perform tasks in a way that ensures accuracy.

**Storage:** Computers can store large amount of information. Any item of data or any instruction stored in the memory can be retrieved by the computer at lightning speeds.

**Automation:** Computers can be instructed to perform complex tasks automatically (which increases the productivity).

**Diligence:** Computers can perform the same task repeatedly & with the same accuracy without getting tired.

**Versatility:** Computers are flexible to perform both simple and complex tasks.

**Cost effectiveness:** Computers reduce the amount of paper work and human effort, thereby reducing costs.

**Limitations of computers:**

1. Computers need clear & complete instructions to perform a task accurately. If the instructions are not clear & complete, the computer will not produce the required result.

2. Computers cannot think.

3. Computers cannot learn by experience.

**1.2. Classification of Digital Computers (Types of Computers)**

Computers can be classified by their size and power as follows:

1. Super Computers

2. Mainframe Computers

3. Mini Computers

4. Micro Computers/ Personal Computer

5. Network Computer

**a) Super Computers**

• They are the computers with the most processing power. The primary application of supercomputers has been in scientific and military work, but their use is growing in business as their prices decreases.

• They are especially valuable for large simulation models of real world phenomena, where complex mathematical representations and calculations are required or for image creation and processing.

•They are also used in weather prediction, design aircraft( Boeing 777), motion picture like star wars and Jurassic Park)

•They operate generally at 4 to 10 times faster than the next most powerful computer class; the mainframe.

**b) Mainframe Computers**

•They are less powerful and generally less expensive than supercomputers.

•Large corporate use mainframe computers for centralized data processing maintaining large databases.

•Application than run on a mainframe can be large and complex, allowing for data and information to be shared throughout the organization.

•Examples: Airline Reservation System, Corporate Payroll, Student Information etc.

•A mainframe system may have anywhere from 50megabytes to several gigabytes of primary storage.

•Secondary storage may use high capacity magnetic and optical storage media with capacities in the gigabytes to terabyte range.

•Typically, several hundreds or thousands or online computers can be linked to a mainframe.

•Advance mainframe performs more than 1,000 MIPS and can handle up to one billion transactions per day.

**c) Mini Computers**

•Also called midrange computers, are relatively small, inexpensive and compact computers that perform the same functions as mainframe computers but to limited extent.

•They are designed especially for accomplishing specific tasks such as process control, scientific research, and engineering applications.

•IBM is the market leader in minicomputers with its AS/400 series of computers.

•Larger companies gain greater corporate flexibility by distributing data processing with minicomputers in organizations units instead of centralization at one place.

•They form the network.

**d) Micro Computers**

These are also called PCs and are the smallest and least expensive category of general purpose computers. Micro computer ranges from palmtops to Desktop computers. Laptops/ Notebooks are very popular now a day. Microprocessor is the core part of the Micro computers which forms the CPU.

**e) Network Computers**

**1.3. Anatomy of Digital Computers**

*Functions and Components of a Computer:*

To function properly, the computer needs both hardware and software. Hardware consists of the mechanical and electronic devices, which we can see and touch. The different parts of the computer are Processor (CPU), Input devices, Output devices, Storage devices and Memory devices. The software consists of programs, the operating systems and the data that reside in the memory and storage devices.



Fig: Block Diagram of Computer

**A computer does mainly the following four functions:**

**Receive input**: Accept information from outside through various input devices like the keyboard, mouse, etc.

**Produce information**: Perform arithmetic or logical operations on the information.

**Produce output**: Communicate information to the outside world through output devices like monitor, printer etc.

**Store information**: Store the information in storage devices like hard disk, floppy disks, etc.

Computer hardware falls into two categories: processing hardware, which consists of the central processing unit (CPU), and the peripheral devices. The CPU, as its name implies, is where the data processing is done. Peripheral devices allow people to interact with the CPU. Together, they make it possible to use the computer for a variety of tasks.

***How CPU and memory does works?***

An instruction is fetched from primary storage by the Control Unit. The Control Unit decodes the instruction. The ALU receives the data and the instruction and performs the calculation or comparison. The result is stored in primary storage which is sent to the proper output device.

**1.4. Computer Architecture**

**History:**

**Pascaline**

In 1642, 19 year old French mathematician Blaise pascal invented a mechanical adding-machine called pascaline. The numbers were entered by means of add and subtract. It had 8 wheels and each wheel had 10 digits from 0 to 9.

**Stepped Recknor**

In 1671, German mathematician Gothfried von Leibnitsz invented an improved and strong computing machine called “stepped Recknor” which could multiply, divide and workout square roots apart from addition and subtraction. The machine also had handle and gear.

**Analytical Engine**

In 1833, Charles Babbage, (English mathematician) developed Analytical Engine which was a kind of a general purpose computer designed to solve any arithmetical problems. It was significant in a way that it had most of the elements present in today s digital computer systems, that’s why he is called “Father of Computer Science”. Lady Ada Augusta, student of Charles

Babbage, after his demise developed several programs for performing mathematical calculations on Analytical engine. She is considered as the first programmer in history and has to her credit a computer language called ADA named after her.

**Dr. Herman Hollerith**

In 1890AD, Herman Hollerith designed a system to record census data. The information was stored as holes in punched cards, which were interpreted by machines with electrical sensors.

**Mark-I**

In 1944 Howard Aiken completed mark I. It was an electromechanical computer which was 51ft.long, 8 ft. height, and 3 ft wide and consisted of 18000 vacuum tubes. This consisted of 7 lakh 50thousand parts and 500 miles long wire.

**Electronic Numerical integration and calculator (ENIAC):1946 A.D.**

ENIAC was the first electronic computer developed by John Mauchly and John presper Eckret in1946. It could do 5000 additions per second. It was extremely huge, used 19,000 vacuum tubes, occupied an area of 150 sq. meters, weighed about 30 tons and required about 130 kW of power.

**EDVAC:**

In 1952, Electronic Discrete Variable Automatic Computer (EDVAC) was developed by John Mauchly and John Presper Eckert with the help of A. Burks and Neumann. This machine was used to store the data and information as well as the instructions.

* John Mauchly and Eckert founded their own company in 1946 and began to work on Universal Automatic Computer (UNIVAC): general purpose commercial computer in 1951. It was the first commercially used electronic computer in the world.
* In 1958, the first computer to use the transistor as a switching device, the IBM 7090, was introduced.
* In 1964, the first computer to use Integrated circuits (IC), the IBM 360 was announced.
* In 1975, the first microcomputer, the Altair, was introduced. In the same year, the first Supercomputer, the Cray-1 was announced.

**Generations of computers:**

**Generation Components used**

First Generation

(1946-1954) Vacuum tubes

Second Generation

(1955-1964) Transistors

Third Generation

(1965-1974) Integrated Circuits (**IC**)

Fourth Generation

(1974-till today) Very Large Scale Integrated Circuits (**VLSI)**

Fifth Generation

(Under Development) Ultra Scale Integrated Circuits (**ULSI)**

**BIOCHIP**

**RISC/ CISC**

**RISC**

(Reduced Instruction Set Computer) processors are designed for speeding up the processing power of the computer making the chip as simple as possible so that it uses less space and shorter design cycle. It is possible to use the technique of pipelining using RISC processors which gives the immense processing power.

The advantages of RISC processors are as follows:

1. Speed: Due to simplified instruction set RISC processors are 2 to 4 times faster.

2. Simpler hardware- Because of simpler instruction set the RISC processor uses much less chip space, as a result extra functions are also placed in the same chip.

3. Shorter design cycle- Because of simple hardware and less instruction per task, the RISC processor uses very short machine cycles.

**CISC**

(Complex Instruction Set Computer) processors use microcode, build rich instruction sets and build high-level instruction sets and these were the building blocks until the late 1980s and are still in major use today.

**Some characteristics are:**

1. Complex instruction-decoding logic, driven by the need for a single instruction to support multiple addressing modes.

2. A small number of general purpose registers.

3. Several special purposes register.

**Advantages of CISC:**

1.Microprogramming is as easy as assembly language to implement, and much less expensive than hardwiring a control unit.

2. The ease of micro-coding new instructions allowed the designers to make CISC machines upwardly compatible, i.e. a new computer could run the same programs as earlier computers.

3. As each instruction became more capable, fewer instructions could be used to implement a given task.

4. Because micro-program instruction sets can be written to match the constructs of high-level languages, the compiler does not have to be complicated.

**The disadvantages of CISC:**

1.The instruction set and chip hardware became more complex with each generation of computers.

2. The instructions set were lengthy and took more time to execute, slowing down the overall performance of the machine.

3. Many specialized instructions are not used frequently enough to justify their existence.

**Memory Units:**

Memory units are the internal storages areas in a computer. These are in the form of chips. Usually we classify the computer s memory into two categories: RAM and ROM.

**RAM (Random Access Memory):**

This is the main memory of the computer. This is also found in other devices like printers. This memory holds data as long as the electricity is supplied and therefore referred to as volatile memory. There are two basic types of RAM: (i) Dynamic RAM (DRAM) and (ii) Static RAM (SRAM). Dynamic RAM needs to be refreshed thousands of times per second. Static RAM needs to be refreshed less often, which makes it faster; but it is more expensive than dynamic RAM.

**ROM (Read Only Memory)**

It is a non-volatile memory. The data is pre-recorded in ROM. The program stored in ROM is known as Firmware and is programmed by the manufacturer. Once data has been written onto a ROM chip, it cannot be removed and can only be read. Most personal computers contain a small amount of ROM that stores critical programs such as the program that boots the computer.

**1.6. Auxiliary Storage Units**

**Hard Disk:**

•A Hard disk is internal hardware which stores and provides access to large amounts of information.

•Hard disks have much greater data capacity and are much faster to use than floppy disks.

•Usually, it is a fixed disk, permanently sealed in the drive.

•Most new computers include an internal hard disk that contains several gigabytes or terabytes of storage capacity.

•The head of hard disk that reads the data floats over the hard disk’s surface, while the head of the floppy disk touches the disk s surface while reading or writing data.

•Hard disk is a flat, circular, rigid plate with a magnetisable surface on one or both sides of which data can be stored.

•Hard disks are rigid aluminium or glass disks about 3.5” in diameter in a personal computer, and smaller in a laptop.

•Data is transferred magnetically by a read/write head.

•A hard disk is made of metallic disk coated with metallic oxide on both sides.

•To increase the storing capacity, several disks (platter) are packed together and mounted on a common drive to form a disk pack.

•A hard disk can have more than 1000 tracks per surface and contain 17 sectors per track.

**Optical Disk**

•An emerging technology that many expect will have a profound impact on mass storage strategies in the 1990s is the Optical Disk.

•With this technology becomes laser beams to wrote and read data at incredible densities.

•Thousand of times finer than the density of a typical magnetic disk.

•Data are placed onto optical disks with high-intensity laser beams that burn tiny holes into the disk s surface.

•Optical disk systems have recently started to become widely used on microcomputer systems.

•So, it is a storage medium from which data is read and to which it is written by lasers. It Stores much more data than in portable magnetic media.

***•There are three basic types of optical disks.***

* •CD-ROM (compact disk read only memory)
* •WORM (write once read many)
* •ERASABLE

•These three are not compatible with one another.

•WORM (Write-one Read-many)

* With a WORM disk, you can write data, but only once and then you can read number of times.

•ERASABLE Optical (rewritable & erasable)

* Can be read to, written to and erased just like magnetic disk.

•CD-R (Compact Disk Recordable)

•CD-RD (Compact Disk Rewritable)

•DVD (Digital Versatile Disc)

* Initial storage capacity of 4.7GB digital information on a single sided, single layer.
* Diameter & thickness is same as CD-ROM.

**Magnetic Tape:**

•Magnetic tape is a plastic tape with a magnetic surface for storing data as a series of magnetic spots.

•Magnetic tape has been one of the most prominent secondary storage alternatives.

•Magnetic tape is the most commonly used sequential access secondary storage medium.

•It is available in the form of cassettes, real & cartridges.

•Among these three, Reels are the most popular storage secondary media.

•Magnetic tape is a plastic ribbon coated on one side with iron oxide that can be magnetized

**Floppy Disk:**

Floppy disk is a soft magnetic disk. Floppy disks are being replaced by pen drives nowadays.

Floppy disks are slower to access than hard disks and have very less storage capacity. 

**1.7. Input Devices**

**How does a Keyboard Work?**

**Layout**

Computer keyboards are an input device. They put the information a person types into a program on the computer. Most keyboards have 80 to 110 keys. The numbers and letters on the keyboard are displayed keycaps--these are the buttons that are pressed when a person types. The layout of the numbers and letters are the same on every keyboard and they are referred to as the QWERTY.



**Key matrix**

The inside of the keyboard is like a mini-computer and consists of a processor and circuits. These transfer the information to the processor inside of the computer. Inside of the keyboard's processor resides the key matrix. The key matrix is a grid of circuits. These circuits are individually placed under each key. When a key is pushed, it pushes the switch on the circuit board underneath the key causing an electrical current to pass through the circuit and into the processor. When the current passes through, the switch vibrates, signalling the processor to read it. Depending upon the working principle, there are two main types of keys, namely, capacitive and hard-contact.

**Capacitive Key**

On the underside of a capacitive key, a metal plunger is fixed which helps in activating the circuit flow. When a capacitive key is pressed, the metal plunger applies a gentle pressure to the circuit board. The pressure is identified by the computer and the circuit flow is initiated, resulting in the transfer of information from the circuit to the currently installed software.

**Hard Contact Key**

A hard contact key is attached with a metallic plate that helps in connecting the circuit board. When the hard contact key is pressed, it pushes a metallic plate, which in turn touches the metallic portion of the circuit plate. This overall process of completing a circuit results in a circuit flow, allowing the transfer of the message to the central processing unit (CPU), which is further transmitted to the software.

**Working principles of mouse**



The mouse is a pointing device which helps us to operate the computer. Unlike the complicated hardware such as Mother board, RAM, Hard disk, Processor of the computer, the mouse is designed with a simple circuit to process. Nowadays, we get varieties of mouse with different technologies in the market. In recent days, the optical mouse had overcome the old ball mouse, because of its 'easy to use' function. The main components of the optical mouse are:

* Inbuilt optical sensor
* High speed camera which can take 1000 pictures at a time
* LED

The optical mouse does have an inbuilt optical sensor. The optical sensor reads the movements of the optical mouse (moved by the user) with the help of the light rays which comes out from the bottom. When the user moves the optical mouse, the LED (Light Emitting Diode) present inside the mouse emits the light according the minute movements. These movements are sent to the camera as light rays.

The camera captures the difference in light rays as images. When the camera captures the images, each and every picture and compared to one another with the digital technology. With the comparison, the speed of the mouse and the direction of the movement of the mouse are rapidly calculated. According to the calculation, the pointer moves on the screen.

**Working principles of scanner**

The basic principle of a scanner is to analyze an image and process it in some way. Image and text capture (optical character recognition or OCR) allow saving information to a file on user computer. User can then alter or enhance the image, print it out or use it on their Web page.

**Types of Scanners:**

1. Flatbed Scanners

2. Hand Held Scanners

**How a Flatbed Scanner Works**

A light source underneath the picture or document illuminates the image. Spaces white or blank reflect more light than do inked and colored areas.



A motor moves the scan head underneath the page. When the scan head is moving, it captures light that was reflected from individual areas of the page about 1/90,000 of an inch. Light from this page is bounced through an intricate system of mirrors that must continually pivot to keep the light beams aligned with a lens.

A lens focuses the beams of light into light sensitive diodes that translate the amount of light into an electric current. The amount of the current depends on the amount of light reflected, the greater the amount of light reflected the greater the current. The analog to digital (A-D) converter stores each analog reading of voltage as a digital pixel representing either a black or white area. Scanners that are more sophisticated can translate the voltage into shades of gray. In a color scanner, the scan head makes 3 passes under the image and the light on each pass is directed through a red, green or blue filter before it strikes the original image. The digital information is sent to the pc where it is translated into a format that a graphics program can read.

**How a Hand-Held Scanner Works?**

On the majority of handheld scanners when you press the scan button a light-emitting diode (sometimes called a LED) illuminates the image below the scanner. An inverted, angled mirror that sits right above the scanner's window reflects the image onto a lens in the back of the scanner.

The lens focuses a single line of the image onto a CCD (known as a charge coupled device), which is a component designed to detect subtle changes of voltage. As the light shines onto sever rows of light detectors located on the CCD, each registers the amount of light as a voltage level that equals to black, white or gray. Special analog chips receive light voltage generated by the CCD for gamma correction. This process enhances the black tones into an image that is that the eye will have been able to recognize the shades of the image easier.

The line of the image now is moved to the analog-digital converter. In a gray scale scanner, the converter assigns 8 bits to each pixel, or 256 shades of gray. As the disk turns, a light shines through the slits and is detected by a photo micro sensor on the other side of the disk. When light strikes the sensor it throws a switch that sends a signal to the A-D converter. This signal tells the converter to send the line of bit generated to the computer. Then the converter clears itself of the old data. The computer then moves to the next line.



**Working principles of Track Ball**

Trackball mice don't have a sensor at the bottom to take a picture of the desk indeed, they don't move across the desk at all, but they do use the same principle. Instead of taking pictures of the desk to detect movement as a mouse does, a trackball will be taking continual pictures of the ball itself, which usually has many tiny dots on the surface and when these dots move, the small processor inside responds by moving user cursor accordingly. In track ball spherical ball is mounted in a base with only a portion projecting above the surface. The ball is free to rotate in any direction. Two valuators either potentiometers or shaft encoders mounted in the base sense the rotation of the ball and provides results proportional to its relative position.



In addition to feedback from the normal tracking symbol users obtain tactile feedback from the rotation rate momentum of the ball. Trackball are frequently equipped with buttons in order they can be substituted for a mouse and are more ergonomically acceptable than mouse.

**Working principles of Graphic Tablets (Digitizing Tablet)**

Graphic tablet also referred to as a digitizing tablet, graphics pad, or drawing tablet, a tablet is an alternate type of input device that can be used in place of, or in conjunction with, a mouse, trackball, or other pointing device. The tablet consists of two parts, a flat surface for drawing, and a pen, stylus, or puck thatis programmed to work with the tablet.



The tablet cores to be film coated make continual orbital motions within the closed rotating drum under the action of a streamlined guide plate. During the motion, coating medium automatically sprays according to the technological process and rational technological parameters, at the same time hot air is supplied under a negative pressure. The hot air penetrates through the tablet core layers and is discharged from the bottom of the layers, so that the coating medium sprayed on the surface will dry rapidly and evenly, thus forming a solid and smooth surface film. Most tablets these days have a USB interface which is ideal since most computers in use today support USB.

**1.8. Output Devices**

An **output device** is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system to the outside world. Outputs are the signals or data sent by the system to the outside.

**Examples of output devices:**

* Speakers
* Plotters
* Printer
* Monitor

**Plotters**

A plotter is a graphics printer that uses a pen or pencil to draw images. Plotters use continuous lines to create images. Plotters are connected to computers and are used to produce complete images and text. However, plotters are much slower than printers because of the mechanical motion necessary to draw detailed graphics using continuous lines. Architects and product designers use plotters for technical drawings and computer-aided design purposes since plotters have the ability to create large images on oversized sheets of paper.

**How Plotters Work?**

The first step in using a plotter is to enter the appropriate coordinates for where user wants the image to appear on the paper. Once the schematics for the image are complete, the computer downloads the coordinates to the plotter, which interprets the code and calculates the most efficient path for the pen and paper.



Early plotters contained two separate pens, one that moved vertically and one that moved horizontally. These plotters were limited in terms of the complexity of the images they could produce as well as the speed at which they could operate. Modern plotters use a sliding roller, which moves the paper against a stationary pen. A plotter pen is usually a hollow fiber rod with a sharpened end. The ink supply runs through the center of the rod and dispenses through the sharpened tip. The paper moves horizontally and vertically against the pen until the drawing is complete.

**Printer**

A printer is a peripheral which produces a text and/or graphics of documents stored in electronic form, usually on physical print media such as paper or transparencies. Many printers are primarily used as local peripherals and are attached by a printer cable or in most new printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as network printers, have built-in network interfaces, typically wireless and/or Ethernet based, and can serve as a hard copy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.

Types of printers

1. Impact Printer
2. Non-impact Printer

**Impact Printer**

To create text or image by physically make the print head to press the ink ribbon and cause the ink deposition on the paper in desired form is called impact type. Normally it is quite louder in nature when compared to other types of printers. The well-known example f or impact type is Dot Matrix and Daisy wheel. Some of the latest impact based in the market is Line printer (high speed impact printer), IBM electromagnetic table printing machine.

**Non-Impact printer**

This produce text or images on paper without striking the paper physically are called as non-impact Printer. These are not louder when compared to other types of printers.

**Dot matrix printer**

**How do dot matrix printers work?**

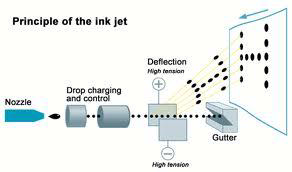
A dot matrix printer print head contain clusters of pins. The printer can push the pins out to form pattern in rapid sequence. The pins pressed an inked ribbon against the paper creating an image. Lower resolution printer have 9 pins, higher resolution have 24 pins. Speed is measured in character per second (CPS).some dot matrix printer print 500cps.



**Inkjet printer**

**How do inkjet matrix printers work?**

Inkjet printer sprays tiny droplets of ink onto the paper. Inkjet printer does not physically touch the paper. A print head scans the page in horizontal stripes, using the printer's motor assembly to move it from left to right and back again, while the paper is rolled up in vertical steps, again by the printer. A strip (or row) of the image is printed, then the paper moves on, ready for the next strip. To speed things up, the print head doesn‘t print just a single row of pixels in each pass, but a vertical row of pixels at a time. Inkjet printer’s print head takes about half a second to print the strip across a page. Inkjet printer offers speed of 2-4 pages per minute (ppm). Inkjet printers are inexpensive and low operating cost.



**Laser printer**

**How does laser printer work?**

Laser printer is a non-impact high-resolution printer which uses a rotating disk to reflect Laser beams to form an electrostatic image on a selenium imaging drum. The developer drum transfers toner from the toner bin to the charged areas of the imaging drum, which then transfers it onto the paper into which it is fused by heat. Toner is dry ink powder, generally a plastic heat-sensitive polymer. Laser printers using chemical photo reproduction techniques can produce resolutions of up to 2400 DPI .The photoconductive drum is given a positive or negative charge by the charge Corona wire. When the drum starts to revolve, a laser beam is shone on it. This laser beam consists of light photons. The laser assembly shines the laser beam on a mirror which is then reflected off the mirror. As a result, the drum that is made up of photoconductive material is discharged. The areas of the drum that are touched by the laser develop charge that is opposite to the charge of the drum.



The laser sketches figures and characters on the surface of the photoconductive drum. The figures or characters are actually a pattern of electric charges. In this case let us assume that the drum is positively charges. Therefore, the laser etched areas will be negatively charged. Thereafter, a fine ink powder called toner is sprinkled on the paper. This powder has to be positively charged. As the drum rolls, the toner adheres to the laser-etched area of the drum. It is repelled from the positively charged area of the drum. Thus, the laser pattern is etched on the drum with the toner. After this, the drum rolls over the paper. The paper passes along a belt under the drum. The paper is given a negative e charge. This negative charge must be stronger than the charge of the laser sketched electric image. This will aid the toner to leave the negative area on the drum for the negatively charged paper.

The paper is discharged as it moves out. This will prevent the paper from getting attached to the positively charged drum.