



GENERAL SCIENCE & TECHNOLOGY

For UPSC, State PSC Civil Services & other exams

Volume - 3

Computer and Technology



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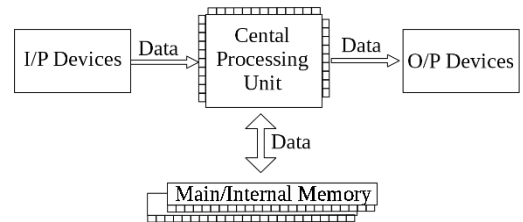
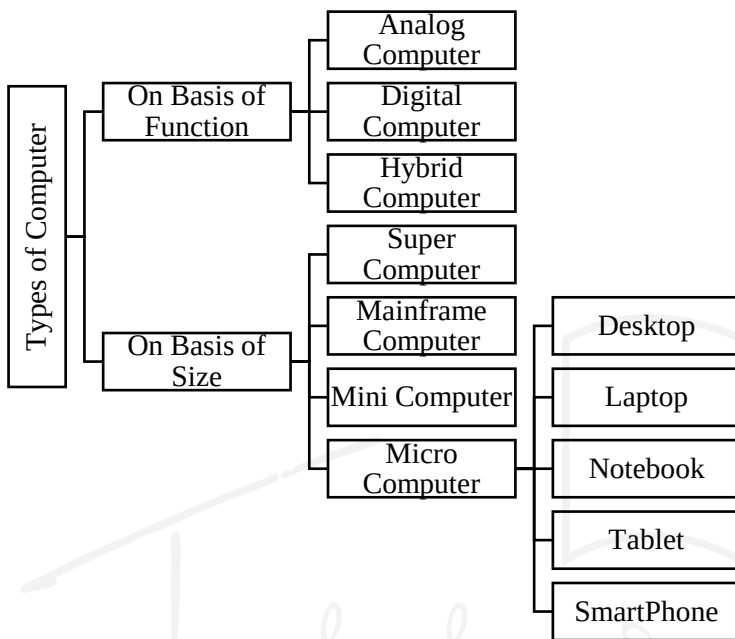
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CHAPTER

Basic of Computer

“A computer would deserve to be called intelligent if it could deceive a human into believing that it was human.” –Alan Turing (father of modern computers).

A **computer** is an electronic device that can be programmed to **accept data (input), process** it and **generate results (output)**. A computer along with additional hardware and software together is called a computer system.



Types of Computer: On Basis of Function:

- Analog Computer:** Analog computers process **continuous data** and work with **physical quantities** like voltage, temperature, speed, and pressure.
Ex: **Thermometer, Speedometer, Seismograph**
- Digital Computer:** Digital computers process **discrete (binary) data** using **0s and 1s**, performing calculations and logical operations.
Ex: Personal Computer (PC), Laptops, Supercomputers
- Hybrid Computer:** Hybrid computers combine **both analog and digital features**, processing continuous (analog) and discrete (digital) data.
Ex: ECG Machine (Electrocardiogram), Flight Simulators, Weather Prediction System

Types of Computers: On Basis of Size:

Mainframe Computer :

- Mainframes are a type of computer, which are made for **‘throughput’** as fast as possible. Throughput can be defined as **“the rate at which the data is processed”**.
- They are very large in size.
- They have greater processing power and memory as compared to minicomputers.
- Multiple users work at a time on these computers. They are expensive.
- They are generally used in railway reservations, insurance companies, research institutes and professional organizations.
- IBM 4300, IBM4381, UAX 8842 etc are examples of mainframe computers.

- **Historical Overview :**
 - ✓ First Mainframe Computer: Harvard Mark I (1944).
 - ✓ IBM 700 series (1950s-60s) revolutionized mainframes.
 - ✓ **Gene Amdahl** is widely considered the "**father of the mainframe computer**" and played a key role in the design of IBM's mainframe computers, including the IBM 704.

Mini computer :

- A Minicomputer is a mid-sized computing device that is more powerful than a microcomputer but less powerful than a mainframe. It is designed for multi-user operations
- They have more processing power and storage capability. They have more than one CPU. More than one person can work upon them at a given time.
- They are generally used in big offices, banks etc.
- **Historical Overview :**
 - ✓ **First Minicomputer: PDP-8** (1965) by **Digital Equipment Corporation (DEC)**.

- ✓ **1970s & 1980s:** Minicomputers became popular in **businesses, research institutions, and industry.**
- ✓ **Modern Minicomputers:** Still used in **networking, industrial automation, and cloud computing.**

Micro computer :

- A Microcomputer is the smallest and most commonly used type of computer designed for individual use.
- They are small in size and less costly.
- They are used at homes, in schools. A micro computer consists of a single CPU.
- They have comparatively less memory and working speed.
- A single person can work on it at a given time. They are also called personal computers.
- **Historical Overview :**
 - ✓ **First Microcomputer: Micral (1973)** – First commercially available microcomputer.
 - ✓ **Popularized by: Apple I (1976), IBM PC (1981).**
 - ✓ **Modern microcomputers:** Now include **desktops, laptops, notebooks, tablets, and smartphones.**

Types of Microcomputers		
Type	Description	Example
Desktop Computer	A stationary computer designed for office and home use, requiring an external monitor, keyboard, and mouse.	Dell OptiPlex, HP Pavilion, Apple iMac
Laptop	A portable computer with a built-in keyboard, display, and battery, used for personal and professional tasks.	MacBook Air, Lenovo ThinkPad, Dell XPS
Notebook	A thinner, lightweight version of a laptop with similar functionality but improved portability.	ASUS ZenBook, HP Spectre, Dell XPS 13
Tablet	A touchscreen-based, portable computing device that runs mobile operating systems.	Apple iPad, Samsung Galaxy Tab, Microsoft Surface
Smartphone	A mobile computing device with a touchscreen, calling features, and internet connectivity.	iPhone, Samsung Galaxy, Google Pixel
Personal Digital Assistant (PDA)	A small handheld device used for organizing personal information, now mostly replaced by smartphones.	Palm Pilot, BlackBerry PDA
Gaming Console	A microcomputer designed specifically for gaming and multimedia applications.	Sony PlayStation, Microsoft Xbox, Nintendo Switch
Embedded Computer	A specialized microcomputer embedded in electronic devices for a specific function.	Smart TVs, ATMs, Car GPS Systems

Supercomputer:

- Supercomputers are the largest in size. They are the most powerful in processing and memory.
- They process complex calculations with high accuracy.
- A Supercomputer is the most powerful and fastest type of computer, capable of performing trillions of calculations per second.
- It is used for complex computations in scientific research, artificial intelligence, and large-scale simulations.
- FLOPS [Floating Point Operation Per Second] is the unit of measurement for speed.
- **Historical Overview:**
 - ✓ **First Supercomputer: CDC 6600 (1964)**, developed by **Seymour Cray (Father of Super Computer)**.
 - ✓ **Cray-1 (1976)**: Introduced vector processing technology.
 - ✓ **Modern Supercomputers**: Use **parallel processing**, **AI**, and **quantum computing** to enhance speed.

Supercomputer in India:

India has developed several high-performance supercomputers for scientific research, weather forecasting, artificial intelligence, and space exploration. These systems are developed by organizations like C-DAC (Centre for Development of Advanced Computing), ISRO, and IITs.

Historical Overview:

- India launched its own supercomputing program in 1988, under the leadership of Dr. Vijay Bhatkar (Father of supercomputers in India).
- The Centre for Development of Advanced Computing (C-DAC) was established in 1988 to develop indigenous supercomputers.
- **PARAM 8000 – India’s First Supercomputer (1991) :**
 - ✓ Developed by: C-DAC.
 - ✓ Processing Power: 1 GFLOP (Giga Floating Point Operations Per Second).
 - ✓ Significance: Marked India's entry into the global supercomputing race.
 - ✓ Impact: Led to technological self-reliance in high-performance computing.
- **National Supercomputing Mission (NSM) :**
 - ✓ Launched in 2015 to develop world-class supercomputing infrastructure in India.
 - ✓ **Objective:** Build indigenous supercomputers and deploy them in academic institutions for research.
 - ✓ **Implemented by:**
 - C-DAC (Centre for Development of Advanced Computing).
 - DST (Department of Science & Technology).
 - MeitY (Ministry of Electronics & Information Technology).
 - ✓ **Target:** Install **70+ supercomputers across India.**

List of Major Supercomputers in India			
Supercomputer Name	Institution	Processing Power	Application
PARAM Siddhi-AI (Top 100-150)	C-DAC (Pune)	5.267 PFLOPS	AI, Drug Discovery, Deep Learning
Pratyush	IITM Pune	4.0 PFLOPS	Weather & Climate Research
Mihir	NCMRWF, Noida	2.8 PFLOPS	Meteorological Simulations
EKA	CRL, Pune (Tata Group)	172 TFLOPS	AI & Scientific Computing
SAGA-220	ISRO	220 TFLOPS	Space Research & Aerospace Simulations
PARAM Yuva-II	C-DAC	500 TFLOPS	General Research & Data Analysis
PARAM Brahma	IISER Pune	850 TFLOPS	Scientific Research
PARAM Yukti	JNCASR (Bangalore)	450 TFLOPS	Molecular & Material Science
PARAM Shivay	IIT-BHU (Banaras Hindu University)	833 TFLOPS	Academic Research & Data Science

PARAM Sanganak	IIT Kanpur	1.6 PFLOPS	AI & Deep Learning
PARAM Pravega	IISc Bangalore	3.3 PFLOPS	Scientific Research & Cloud Computing
Flosolver MK6	NAL (National Aerospace Laboratories)	50 TFLOPS	Aerospace & Fluid Dynamics

Development of Computer

Year	Descriptions
1617 AD	<p>Napier's Bones</p> <ul style="list-style-type: none"> ➤ A manually operated calculating device. ➤ Invented by Scottish mathematician John Napier. ➤ Used for multiplication and division. ➤ A tool to simplify complex calculations, considered one of the most significant advancements in the study and practical applications of mathematics.
1642 AD	<p>Pascaline</p> <ul style="list-style-type: none"> ➤ Also known as the Adding Machine. ➤ Invented by Blaise Pascal. ➤ Used for addition and subtraction only. ➤ Operated based on the principles of a clock and odometer.
1694 AD	<p>Leibniz Wheel</p> <ul style="list-style-type: none"> ➤ Considered an improved version of Pascaline. ➤ Developed by Gottfried Wilhelm von Leibniz. ➤ Capable of performing basic mathematical operations (addition, subtraction, multiplication, and division).
1801–1805	<p>Punch Cards</p> <ul style="list-style-type: none"> ➤ Developed by Joseph Jacquard for use in mechanical looms. ➤ First mechanical loom that used punched cards to store weaving designs. ➤ Played a crucial role in the development of computers based on two key ideas: <ul style="list-style-type: none"> ✓ Information was coded using punch cards. ✓ Stored data and instructions on punch cards functioned as a program.
1822 AD	<p>Difference Engine</p> <ul style="list-style-type: none"> ➤ A gear, shaft, and steam-powered machine. ➤ Invented by Charles Babbage. ➤ The first error-free device for mathematical and statistical calculations. ➤ Used for creating mathematical tables and could perform 60 additions per minute. ➤ Had memory capability and operated based on programmed instructions.
1833 AD	<p>Analytical Engine</p> <ul style="list-style-type: none"> ➤ In 1833 AD, Charles Babbage developed an advanced version of the Difference Engine, known as the Analytical Engine. ➤ It was capable of operating based on instructions stored on punch cards. ➤ The punch cards were used not only to store instructions but also to record input and output data. ➤ A key feature of this machine was its ability to perform calculations up to the 50th decimal place. ➤ It could also compute the square root of whole numbers, and the results were automatically printed. ➤ Memory was used for data storage in this machine. ➤ It had separate devices for input and output operations.

1889–1890 AD	Hollerith Census Tabulator <ul style="list-style-type: none"> ➤ A punch card-based census machine. ➤ Developed by American mathematician Herman Hollerith. ➤ Introduced the concept of punch cards as a computing tool, pioneered by Herman Hollerith.
1939–1942	ABC Computer (Atanasoff-Berry Computer) <ul style="list-style-type: none"> ➤ Developed by: John Atanasoff and Clifford Berry. ➤ First fully automatic electronic digital computer. ➤ Work on this computer continued from 1939 to 1942, and in 1942, it was released in England by John Atanasoff and Clifford Berry.
1944 AD	MARK-I <ul style="list-style-type: none"> ➤ Inventors & Developers: Howard Aiken & IBM (International Business Machines). ➤ World's first fully automatic electro mechanical calculating machine. ➤ Used for performing complex mathematical calculations. ➤ Full name: Automatic Sequence Controlled Calculator (ASCC). ➤ Capabilities: <ul style="list-style-type: none"> ✓ Could perform multiplication in 6 seconds. ✓ Could perform division in 12 seconds.
1946 AD	ENIAC (Electronic Numerical Integrator and Computer) <ul style="list-style-type: none"> ➤ Developed by: A team of scientists at the University of Pennsylvania led by J. Presper Eckert and John William Mauchly. ➤ World's first fully electronic computer.
1947 AD	EDVAC (Electronic Discrete Variable Automatic Computer) <ul style="list-style-type: none"> ➤ Developed by: John von Neumann. ➤ Capable of storing data and instructions in binary form (0s and 1s). ➤ First stored-program digital computer.
Some Important Facts <ul style="list-style-type: none"> ➤ Lady Ada Augusta <ul style="list-style-type: none"> ✓ The first woman to program the Analytical Engine. ✓ She is known as the world's first programmer. ✓ She is also credited with the invention of the binary system. ➤ John von Neumann: <ul style="list-style-type: none"> ✓ Introduced the concept of logical design with stored programs. ✓ Credited with storing data and instructions in binary form. ✓ He is known as the Father of Modern Computers. <p>The concept of stored program states that a program and memory can be stored in the same memory.</p>	
1949 AD	EDSAC (Electronic Delay Storage Automatic Calculator) <ul style="list-style-type: none"> ➤ Developed by Professor Maurice Wilkes at Cambridge University. ➤ It was the first stored-program digital computer.
1951 AD	UNIVAC (Universal Automatic Computer) <ul style="list-style-type: none"> ➤ Developed by General Electric Corporation. ➤ Designed by John Mauchly and J. Presper Eckert. ➤ First commercial computer used for business and general-purpose applications.

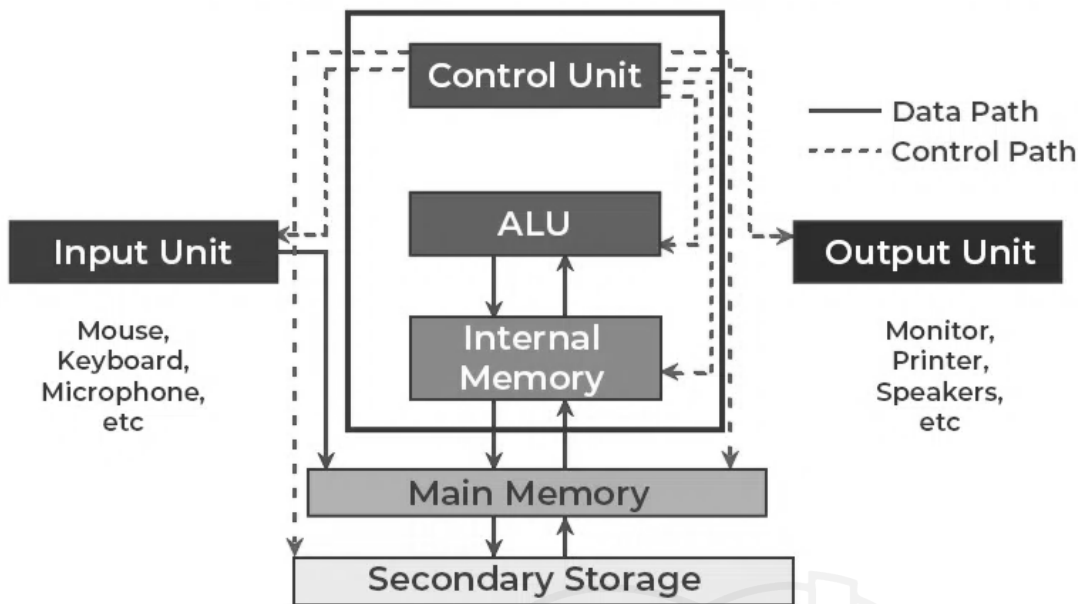
Generations of Computers							
Generation	Year	Processing Device	Storage Device	Speed	Operating Systems	Languages	Examples
First Generation	1940–1956	Vacuum Tubes	Magnetic Drums, Punch Cards	Milliseconds (10⁻³ sec)	No OS, Manual Programming	Machine Language (Binary 0 & 1)	ENIAC, UNIVAC, IBM 701
Second Generation	1956–1963	Transistors	Magnetic Tapes, Magnetic Core Memory	Microseconds (10⁻⁶ sec)	Batch Processing OS	Assembly Language	IBM 1401, UNIVAC 1108, CDC 1604
Third Generation	1964–1971	Integrated Circuits (ICs)	Semiconductor Memory (RAM, ROM), Magnetic Disks	Nanoseconds (10⁻⁹ sec)	Time-Sharing, Multiprogramming OS	FORTRAN, COBOL, BASIC, Pascal	IBM System/360, PDP-8, PDP-11
Fourth Generation	1971–Present	Microprocessors (Intel 4004, 8086, AMD Processors)	Hard Disks, Optical Disks, Flash Memory, SSD	Picoseconds (10⁻¹² sec)	Windows, macOS, UNIX, Linux	C, C++, Java, Python	IBM PC, Apple Macintosh, Laptops, Tablets
Fifth Generation	Present & Future	AI Processors, Quantum Computing, Neural Networks	Cloud Storage, AI Memory, Advanced RAM & SSDs	Femtoseconds (10⁻¹⁵ sec) and beyond	AI-Driven OS, Cloud OS	Python, R, AI-based Programming, Machine Learning	IBM Watson, Google DeepMind, Quantum Computers, AI-powered robots

Unleash the topper in you

Structure of Computer

A computer system primarily comprises a central processing unit (CPU), memory, input/output devices and storage devices. All these components function together as a single unit to deliver the desired output

Components of computer



Input Device

- The devices through which control signals are sent to a computer are termed as input devices.
- These devices convert the input data into a digital form that is acceptable by the computer system.

Keyboard :

- These are the most popular input devices for inputting into the computer.
- With the help of key-board, data and instructions can be entered on the computer.
- Keyboard is an input device based on a typewriter.
- Keyboard is a device acting like an encoder, which works to convert the input data into 0 or 1 binary digit.
- By pressing and holding a key on the keyboard for 0.5 seconds, the letter of the key is input evenly, this process is called typomatic.
- **Father of Keyboard : Kristopher Latham (1974) {Also Known as Father of Typewriter (1970)}**

Classification of keys in Keyboard

Part	Description
Alphanumeric Keys	Includes letters (A-Z) and numbers (0-9) for typing text and data entry.
Function Keys (F1-F12)	Perform specific tasks depending on the software, such as refreshing a page (F5) or opening help (F1).
Control Keys	Includes Ctrl, Alt, Shift, Windows key (Win), and Command (Mac) ; used for shortcuts and modifying functions.
Navigation Keys	Includes Arrow keys, Home, End, Page Up, Page Down ; used to move the cursor in documents and webpages.
Numeric Keypad	A separate set of number keys (0-9), including *, +, -, =, /, Enter, arranged like a calculator for quick data entry.
Modifier Keys	Used in combination with other keys to change input behavior (e.g., Shift + A = "A" instead of "a").
Enter Key	Confirms a command, moves to the next line in text editors, or submits input.

Backspace & Delete Keys	Backspace removes characters to the left, Delete removes characters to the right.
Escape (Esc) Key	Cancel an operation or closes a menu.
Print Screen (PrtSc), Scroll Lock, Pause/Break	Less commonly used; Print Screen captures the screen, Scroll Lock modifies scrolling behavior, Pause/Break is rarely used.
Specialized Keys	May include multimedia controls (volume, play/pause), programmable macro keys, and backlit LED keys in gaming or advanced keyboards.

Mouse :

- A **mouse** is a pointing device used to interact with a computer by moving a cursor on the screen.
- It allows users to perform actions such as selecting, dragging, clicking, and scrolling.
- The mouse typically has buttons and a scroll wheel for additional functionality.
- **Cursor** : That input device in which a pointer, called a cursor, is used to provide data and instructions.
- **Father of Mouse** : Douglas Engelbart (1964)

Function of Mouse :

1. **Pointing** - Moves the cursor to navigate the screen.
2. **Clicking** - Selects items, opens files, and executes commands using left-click.
3. **Right-Clicking** - Opens context menus for additional options.
4. **Double-Clicking** - Opens files and applications quickly.
5. **Scrolling** - Moves up and down through pages using the scroll wheel.
6. **Dragging & Dropping** - Moves files, selects text, or organizes desktop items by holding the mouse button while moving.
7. **Selecting Text** - Click and drag to highlight text or elements.
8. **Zooming** - Increases or decreases the view size (often with Ctrl + Scroll).
9. **Custom Button Functions** - Some mice have additional buttons that can be programmed for shortcuts or specific tasks.

Others Pointing device		
Pointing Device	Description	Usage
Touchpad (Trackpad)	A flat, touch-sensitive surface that detects finger movements for cursor control.	Commonly found in laptops as a built-in alternative to a mouse.
Trackball	A stationary device with a rotating ball for moving the cursor. Father of Trackball : 1957 - Tom Cranston and Fred Longsteff	Used in specialized applications like industrial controls and ergonomic setups.
Joystick	A stick that pivots on a base, used to control cursor movement. Father of Joystick : 1926 - C.B. Mirick	Mainly used for gaming and flight simulators.
Stylus (Pen Input Device)	A pen-like device used for precise input, often on touchscreens.	Used for digital drawing, writing, and touch gestures on tablets.
Light Pen	A pen-shaped device that detects light from a screen to select objects. Father of Light Pen : 1957 - Ben Gurely	Used in graphic design and interactive display systems.
Graphics Tablet (Digitizer)	A pressure-sensitive pad with a stylus for drawing and designing.	Used by artists and designers for digital artwork.
Eye Tracker	A device that tracks eye movement to control the cursor.	Used in assistive technology for users with disabilities.
Touchscreen	A display that detects touch gestures as input.	Used in smartphones, tablets, ATMs, and kiosks.

Digital camera :

- A digital device that captures images and videos electronically instead of using film.
- Converts light into digital signals to create photos and videos that can be stored, edited, and shared.
- Uses : Photography, videography, surveillance, live streaming, video conferencing, scientific research.

Microphone :

- A device that captures sound and converts it into electrical signals for recording or transmission.
- Picks up audio and transmits it to a computer, speaker, or recording device.
- **Uses :** Voice recording, online meetings, broadcasting, music production, security surveillance, speech recognition.

Scanner :

- A **scanner** is an input device used to convert physical documents, images, or text into a digital format.
- It works by capturing the image of a document and converting it into a computer-readable file.
- Scanners are widely used for digitization, document storage, and data extraction.

Types of Scanner			
Type of Scanner	Full Form	Description	Usage
MICR	Magnetic Ink Character Recognition	Uses magnetic ink to read and verify characters printed on documents, especially on bank checks . It reads unique fonts printed with special ink containing iron oxide.	Used primarily in banks for check processing and financial document verification.
OCR	Optical Character Recognition	Converts printed or handwritten text into editable digital text . The scanner recognizes letters and numbers, allowing conversion into word-processing documents.	Used in digitizing books, invoices, official records, passports, and ID cards .
OMR	Optical Mark Recognition	Detects filled-in bubbles or checkboxes on predefined forms. The scanner reads shaded marks and records them as data.	Used in exams, surveys, lotteries, and voting ballots .
OBR	Optical Barcode Recognition	Uses light sensors to scan and decode barcodes and QR codes for tracking and identification. It converts the scanned pattern into readable information.	Used in retail stores, warehouses, logistics, and inventory management for product tracking.

Biometric Sensor :

- A **biometric sensor** is a device that captures and measures biological data from a person to identify or authenticate them based on unique physical or behavioral traits.

Output Device:

- The function of the output device is to display the result for the user after having processed data, information and instructions.
- These devices translate the 0, 1 bit languages of computers into the human language and display the result on the monitor.

Monitor :

- A **monitor** is an output device that displays visual information generated by a computer.
- It acts as an interface between the user and the computer system, providing real-time feedback for operations.

Types of Monitor	
Types	Descriptions
Monochrome Monitor	<ul style="list-style-type: none"> ➤ Displays output in one color against a black background. ➤ Common colors: Green, White, or Amber. ➤ Used in early computers, terminals, and simple text-based applications.
GreyScale Monitor	<ul style="list-style-type: none"> ➤ Displays multiple shades of grey (from black to white). ➤ No color but offers better contrast than monochrome. ➤ Used in medical imaging, photography, and specialized applications.
Colour Monitor	<ul style="list-style-type: none"> ➤ Displays output in multiple colors using the RGB (Red, Green, Blue) model. ➤ Common in modern computing, gaming, video editing, and design. ➤ Can produce millions of colors depending on resolution and bit depth.

Types of Monitor : Based on Display				
Monitor Type	Description	Advantages	Disadvantages	Common Uses
CRT (Cathode Ray Tube)	<p>Uses electron beams to excite phosphor-coated screen, producing images.</p> <p>Invention : 1897 (Karl Ferdinad Barun)</p>	<ul style="list-style-type: none"> ➤ Wide viewing angles ➤ Good color accuracy (for its time) ➤ Low input lag 	<ul style="list-style-type: none"> ➤ Bulky and heavy ➤ High power consumption ➤ Flickering issues, eye strain 	Older televisions, vintage gaming, scientific applications (now obsolete)
LCD (Liquid Crystal Display)	<p>Uses liquid crystals to control light passage and display images, and requires a CCFL backlight.</p> <p>Invention : 1960 (George H. Helimier)</p>	<ul style="list-style-type: none"> ➤ Slimmer & lighter than CRT ➤ Lower power consumption ➤ No flickering 	<ul style="list-style-type: none"> ➤ Limited viewing angles ➤ Slower response time than CRT ➤ Requires a constant backlight 	Office computers, older laptops, budget-friendly displays
TFT (Thin Film Transistor LCD)	<p>An advanced version of LCD that uses thin-film transistors for better color accuracy and response time.</p> <p>Invention : 1971 (Bernaud Lechnaur)</p>	<ul style="list-style-type: none"> ➤ Improved image quality over LCD ➤ Faster refresh rate ➤ Reduced ghosting effect 	<ul style="list-style-type: none"> ➤ Still requires a backlight ➤ Consumes more power than LED 	Laptops, smartphones, mid-range monitors
LED (Light Emitting Diode)	<p>A type of LCD monitor that uses LED backlighting instead of CCFL, offering better brightness, contrast, and energy efficiency.</p> <p>Invention : 1960 (Nick Holoneik)</p>	<ul style="list-style-type: none"> ➤ Thinner & lighter than LCD ➤ Best contrast & color accuracy ➤ Lower power consumption ➤ Faster response time 	<ul style="list-style-type: none"> ➤ Higher cost (compared to LCD) ➤ Can suffer from screen burn-in (OLED) 	Gaming monitors, smart TVs, professional displays, HDR content

Projector :

- A **projector** is an output device that takes images or video from a computer or media source and projects them onto a large screen or surface.
- **Invention** : 1895 (Lumeire Brothers and Augste and Luce)

Speaker :

- A **speaker** is an output device that converts digital or analog audio signals into sound waves, allowing users to hear audio from computers, TVs, or other electronic devices.

Printer :

- A **printer** is an output device that produces **hard copy** output by printing text, images, or graphics onto paper or other materials.
- **Father of Printer** : Chester Carlson (1938)

Types of Printer	
Impact Printer	Impact printers physically strike the paper to form characters or images. They are mainly used for business and industrial applications where carbon copies or multipart forms are required.
	Line Printer <ul style="list-style-type: none">➤ Prints a full line of text at a time, making it very fast.➤ High-speed printing, durable.➤ Uses : Large-scale industrial and business printing
	Drum Printer <ul style="list-style-type: none">➤ Uses a rotating drum with fixed characters.➤ Moderate (slower than chain printers).➤ Fixed character set (cannot be changed).➤ Good for text, but no graphics.➤ Uses : Payroll, reports, industrial printing.
	Chain Printer <ul style="list-style-type: none">➤ Uses a rotating chain with embossed characters.➤ Faster printing speed.➤ Character set can be changed by replacing the chain.➤ Better print clarity than drum printers.➤ Uses : High-volume document printing in banks & businesses.
	Serial Printer (Dot Matrix Printer) <ul style="list-style-type: none">➤ Prints characters one at a time using a matrix of small pins that strike the ink ribbon.➤ Can print carbon copies, low operating cost.➤ Uses : Billing machines, banks, railway tickets, and invoices.
Non-Impact Printers	Non-impact printers do not physically strike the paper; instead, they use electronic, laser, or thermal technology for faster and quieter printing.
	Laser Printer <ul style="list-style-type: none">➤ Uses a laser beam and toner to print high-quality text and images.➤ Fast printing speed, high-quality output, cost-efficient in the long run.➤ Uses : Offices, businesses, professional document printing.
	Inkjet Printer <ul style="list-style-type: none">➤ Sprays tiny droplets of liquid ink directly onto the paper.➤ Produces high-quality color prints, affordable for home users.➤ Uses : Home printing, photo printing, small offices.
	Thermal Printer <ul style="list-style-type: none">➤ Uses heat-sensitive paper that changes color when exposed to heat.➤ No need for ink or toner, low maintenance.➤ Uses : Receipts, billing systems, ATM slips, barcode printing.

Plotter :

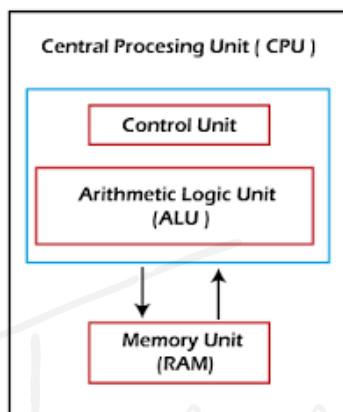
- A **plotter** is a specialized output device used for printing **large-scale vector graphics, technical drawings, and high-precision designs**.

➤ **Features :**

- ✓ Used for **engineering, CAD drawings, architectural blueprints, circuit diagrams, and large posters.**
- ✓ Offers **high precision, accuracy, and large format printing.**
- ✓ Can handle **various materials** like paper, vinyl, plastic, and cloth.

Processing Unit:

System Unit: It is the main component of the computer and it consists of the Central Processing Unit (CPU). System unit is a box in which there are CPU, other devices and circuits and they are connected to the main circuit board called Mother Board. In this way the main circuit of the computer lies in the system unit.



Central Processing Unit :

- **The CPU is the brain of a computer.**
- To execute instructions, it reads them, interprets them, controls and calculates. In fact whatever instructions are given to the computer they first go to CPU and CPU takes action on given instructions and shows outputs (results) on the monitor.
- **CPU has three components:**
 1. Control Unit (CU)
 2. Arithmetic Logic Unit (ALU)
 3. Memory or Storage Unit
- There are the following components in the internal structure of CPU- **C.U, ALU, Registers, internal bus.**

1. Control Unit (CU) :

- ✓ The **Control Unit (CU)** is responsible for **fetching, decoding, and executing instructions.** It acts as the **brain of the CPU**, directing how data moves within the system.

✓ **Functions :**

- **Instruction Fetching:** Retrieves instructions from memory.
- **Decoding:** Interprets what the instruction means.
- **Execution Control:** Directs ALU and memory on how to process data.
- **Managing Data Flow:** Controls input/output operations and ensures instructions are executed in order.

✓ **Importance :**

- Ensures the **smooth execution of instructions.**
- Synchronizes all components of the CPU.

2. Arithmetic and Logic Unit (ALU) :

- ✓ The **Arithmetic and Logic Unit (ALU)** is responsible for **performing mathematical calculations and logical operations** in a computer system.

✓ **Functions :**

- **Arithmetic Operations:** Addition, subtraction, multiplication, division.
- **Logical Operations:** AND, OR, NOT, XOR (used in decision-making).
- **Comparisons:** Less than, greater than, equal to.
- **Bitwise Operations:** Bit shifting, complementing, etc.

✓ **Importance :**

- **Handles all data processing tasks within the CPU.**
- **Supports decision-making operations in programs.**

3. Memory Unit :

- ✓ A computer has the capacity to store data and information and it is known as the memory of a computer.
- ✓ Computer's memory is that location where data, information, and programs are stored and are available when they need to be.
- ✓ Memory is a very important part of computers. Computers cannot work without memory.
- ✓ There are many locations in memory for storage memory capacity and memory size depends on the number of these locations. There is an identity number for each location and it is called **address.**

- ✓ When the term 'memory' is used it means **main memory**. It is also called internal memory or primary memory. It is a part of the CPU. Main memory has high speed and it calculates primary facts according to the instructions given in the program. It is used to store intermediate and last results. Memory is a **semiconductor chip**.

Registers:

- i. Registers are **small, high-speed storage locations** within the CPU used for **temporary data storage** during processing.
- ii. **Types :**
 - 1. **Instruction Register (IR):** Stores the current instruction being executed.
 - 2. **Program Counter (PC):** Holds the address of the next instruction.
 - 3. **Accumulator (ACC):** Stores intermediate arithmetic and logic results.
- iii. **Importance :**
 - 1. Registers are **the fastest memory** inside the processor.
 - 2. Essential for CPU operations and instruction execution.

Cache Memory :

- i. Cache memory is a **high-speed memory** that stores frequently used data to reduce CPU access time to RAM.
- ii. **Importance:**
 - 1. Improves **CPU speed and efficiency**.
 - 2. Reduces **bottlenecks between CPU and RAM**.

RAM:

- i. RAM is the **main memory** that temporarily stores data and instructions while a computer is running.
- ii. The data, after having been fed by keyboard or other input devices and before the process, gets stored in RAM and it is retrieved from there via CPU. The data stored in RAM can

be accessed anytime and can be read from as well as written to. The Information stored in RAM can be retrieved within one tenth of a second.

iii. Types :

- 1. **SRAM (Static RAM):** Faster, used in cache memory.
- 2. **DRAM (Dynamic RAM):** Slower but cheaper, used in main memory.

iv. Importance:

- 1. RAM is **volatile** (data is lost when power is off).
- 2. More RAM allows **better multitasking and performance**.

Rom :

- i. ROM is **non-volatile memory** that permanently stores essential system instructions.
- ii. Programs stored in this memory cannot be changed or destroyed and they can be only read. This memory is called permanent or non-volatile.
- iii. It does not come to an end when electricity fails or the computer is switched off.
- iv. This memory is used to store basic instructions. The best example of ROM is BIOS (Basic Input Output System) in which the booting program is stored.
- v. **Types :**
 - 1. **PROM (Programmable ROM):** Can be programmed once.
 - 2. **EPROM (Erasable Programmable ROM):** Can be erased and reprogrammed using UV light.
 - 3. **EEPROM (Electrically Erasable PROM):** Can be rewritten multiple times electronically.
- vi. **Importance :**
 - 1. Stores **BIOS (Basic Input/Output System)**, firmware, and boot instructions.
 - 2. Data **remains even when power is turned off**.

Other Terminologies

Terminology	Definition	Function	Key Features
Motherboard	The main circuit board that connects and allows communication between all components of a computer.	Provides slots for CPU, RAM, storage, and expansion cards.	- Houses the CPU socket, RAM slots, and chipset.
			- Includes PCIe slots for GPU and expansion cards.
			- Connects input/output devices via USB, HDMI, and other ports.

System Bus	A set of wires or pathways that carry data and signals between different computer components.	Facilitates communication between CPU, memory, and input/output devices.	- Data Bus: Transfers actual data between components.
			- Address Bus: Specifies the memory location to access.
			- Control Bus: Sends control signals (e.g., read/write operations).
Computer Clock	A timing device that generates electrical pulses to synchronize all computer operations.	Maintains the timing and execution speed of instructions in the CPU.	- Measured in Hertz (Hz) (e.g., 3.5 GHz means 3.5 billion cycles per second).
			- Higher clock speed = faster processing.
			- Works with the clock generator and crystal oscillator .
Power Unit (PSU - Power Supply Unit)	Converts AC power from the wall into DC power required by computer components.	Supplies stable and regulated voltage to motherboard, CPU, GPU, and storage devices.	- Power rating in Watts (e.g., 500W, 750W, 1000W).
			- Converts 110V/220V AC to 12V, 5V, 3.3V DC .
			- Includes cooling fan, connectors for motherboard & peripherals.

Storage unit of Computer

A **Storage Unit** is a hardware component that stores **data, instructions, and files** permanently or temporarily. It allows computers to **retrieve and process information efficiently**.

Volatile vs. Non-Volatile Memory		
Feature	Volatile Memory	Non-Volatile Memory
Definition	Memory that loses data when power is turned off.	Memory that retains data even when power is off.
Examples	RAM (Random Access Memory), Cache, Registers	ROM (Read-Only Memory), HDD, SSD, USB Drive, CD/DVD, Flash Memory
Speed	Faster (directly accessed by CPU).	Slower (requires I/O operations to access).
Storage Type	Temporary storage used for active processing.	Permanent storage for data and programs.
Data Loss	Data is erased when power is lost.	Data remains stored even without power.
Usage	Used for running applications, buffering, caching .	Used for long-term file storage, firmware, OS, backups .
Cost	More expensive per GB (e.g., RAM).	Cheaper per GB (e.g., HDD, SSD).

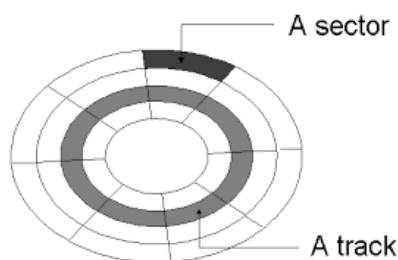
1. **Magnetic Tape :**

- ✓ **Invention :** 1928 - Fritz pelumier
- ✓ Magnetic Tape is a sequential access storage device that uses a thin plastic ribbon coated with a magnetic material to store data. It is primarily used for backup, archival storage, and large-scale data recording.
- ✓ **Features :**
 - **Storage Type** -Sequential (Reads/Writes data in order).

- **Material** -Plastic strip coated with magnetic material (Iron Oxide, Chromium Dioxide).
- **Capacity** -Ranges from **40 MB to 100 MB**.
- 7 or 9 bits are used to store data. A 1/2 inch wide strip is coated with a layer of ferromagnetic material.
- **Usage** - Used for data backup, archival, large-scale storage.

2. Floppy Disk:

- ✓ **Invention** : 1976 - IBM
- ✓ Floppy disk is a platter made of Mylar plastic and is round in shape.
- ✓ Its surface is coated with **iron-oxide** and like a hard disk it has **concentric tracks** and **sectors**.
- ✓ Data is stored in these tracks and sectors.
- ✓ For its safety it is kept in a plastic jacket which saves it from rub or scrub.
- ✓ A part of the jacket remains open so that the read/write head can accept or store data on disk. This open part is called access windows.

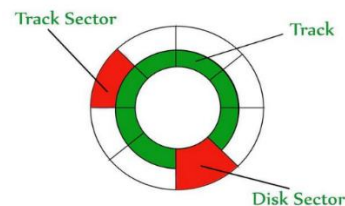


- ✓ There is a hole in the floppy disk and its envelope which is called an **index hole**. When the index hole comes under the photo sensor it means the read/write head is placed on the first sector of the present track.
- ✓ A part of the floppy is cut and it is called '**write protect notch**'. This is used to save data from writing or storing in the disk when this notch is open we can read and write data but when this notch is closed with some sticker or tape we can only read and cannot write data.
- ✓ **Key Features** :
 - **Storage Type** - Sequential storage (Data is accessed in order).
 - **Material** -Plastic ribbon coated with magnetic material (Iron Oxide or Chromium Dioxide).
 - **Data Access Speed** -Slow (Must scan from start to find data).
 - **Capacity** -High (Ranging from **hundreds of GBs to TBs per tape**).
 - **Usage** -Used for **backups, archiving, and large-scale data storage**.

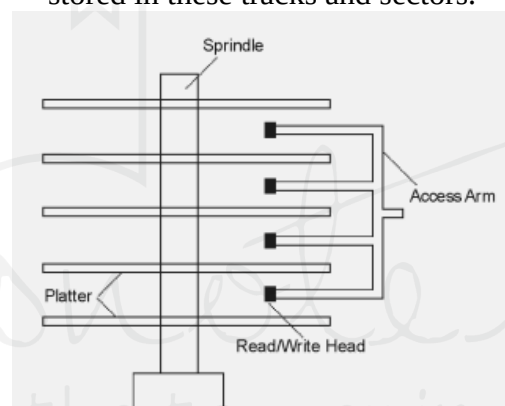
3. Hard Disk :

- ✓ **Invention** : 24 dec 1954 - Ray Johnson (IBM)
- ✓ Hard disks are used to store data in minicomputers and Microcomputers.

- ✓ This stays inside the system unit. It has enormous storage capacity and for this it is known as a mass storage device and because it is inside the system unit it is called **online storage device**.
- ✓ Hard disk can store numerous pieces of information permanently. Operating System, Compiler, Assembler, Database, Application program are also stored in it. So hard disks are the most popular, essential and permanent storage device.



- ✓ Hard disk is a pack of platters made of **aluminium or some other metal**. Each platter is coated with **iron-oxide**.
- ✓ On both surfaces of the platter there are **concentric tracks and sectors**. Data is stored in these tracks and sectors.



- ✓ All the disk platters are arranged in a **spindle**; each platter consists of a read/writer head.
- ✓ All the read/write heads are fitted with an arm in a comb like structure. This arm is called an **access arm**.
- ✓ **Features** :
 - **Storage Type** -Secondary storage (Permanent, non-volatile).
 - **Access Type**-Direct access (Faster than Magnetic Tape).
 - **Capacity**-Ranges from **250GB to 20TB** (or more).
 - **Data Transfer Rate** - Varies between **100 MB/s to 250 MB/s**.
 - **Connection Interface** -SATA (Common in PCs), NVMe & PCIe (Faster alternatives), SAS (Enterprise storage).

Types of Hard Disk Drive		
Type	Description	Common Uses
SATA HDD	Standard hard drive with Serial ATA interface , commonly used in desktops & laptops.	General storage, budget-friendly PCs.
SAS HDD	High-speed enterprise-grade HDD , used in servers & data centers .	Enterprise storage, large-scale applications.
External HDD	Portable hard drives that connect via USB.	Backup storage, file transfers.
Hybrid HDD (SSHD)	Combines HDD + SSD features for better speed.	Gaming & high-performance systems.

4. Optical Disk :

- ✓ It is an optical storage device.
- ✓ Data can be read or written with a laser beam.
- ✓ This disk is made up of resin like material- **polycarbonate**. Its surface is covered with **aluminium compounds** with which the disk reflects light.
- ✓ During the process of data storage on the reflected surface of CD Rom high power (25 megawatt) laser beam is aimed.

- ✓ The beam causes a **small pit**. This pit **represents binary '0'**. The place on the surface without a pit is called **land** and it **represents '1'** of binary code.
- ✓ **Features :**
 - Storage Type- Secondary storage (Permanent, non-volatile).
 - Access Type -Direct access (Can retrieve data instantly).
 - Capacity -CD: 700MB, DVD: 4.7GB - 17GB, Blu-ray: 25GB - 128GB.

Types of Optical Disk			
Type	Definition	Storage Capacity	Common Uses
CD (Compact Disc)	First-generation optical disk.	700 MB	Music, software, small files.
DVD (Digital Versatile Disc)	Enhanced version of CD with more storage.	4.7 GB - 17 GB	Movies, games, software installations.
Blu-ray Disc (BD)	High-definition video and large storage.	25 GB - 128 GB	4K movies, PS5/Xbox gaming, backups.

1. **emiconductor Memory** : Semiconductor Memory is a non-volatile or volatile memory that uses semiconductor-based electronic circuits (NAND flash or DRAM) to store data. It is used in RAM, SSDs, USB flash drives, and memory cards for high-speed data access and storage.

a. Pendrive :

- ✓ **Invention** : 1996 - Dov Moran
- ✓ A **Pendrive (USB Flash Drive)** is a **portable storage device** that uses **flash memory (NAND chips)** and a **USB interface** for fast data transfer.
- ✓ Features :
 - Storage Type- Non-volatile, secondary storage.
 - Capacity-Ranges from **2GB to 2TB**.
 - Speed -USB 2.0 (60 MB/s), USB 3.0 (600 MB/s), USB 3.1 (1000 MB/s).

- Usage -File transfer, backups, bootable OS installation.

b. Memory Card :

- ✓ A Memory Card is a small semiconductor storage device used in smartphones, cameras, tablets, and gaming consoles. It provides portable, removable storage.
- ✓ **Features :**
 - **Storage Type** -Non-volatile, flash memory storage.
 - **Technology** -Uses **NAND flash memory**.
 - **Capacity**-Ranges from **2GB to 1TB**.
 - **Size** -Small & compact (MicroSD, SD Card).

c. SSD

- ✓ A **Solid State Drive (SSD)** is a **non-volatile storage device** that uses **flash memory (NAND chips)** instead of mechanical parts to store data.

- ✓ It is much **faster, more durable, and power-efficient** compared to traditional **Hard Disk Drives (HDDs)**.
- ✓ **Features :**
 - Storage Type -Secondary storage (Permanent, non-volatile).
 - Access Type - Direct access (Ultra-fast data retrieval).
 - Technology - Uses **NAND Flash Memory** (No moving parts).
 - Speed -Read/Write speeds range from **500 MB/s to 7000 MB/s**.

Data Representation:

A computer is primarily for processing data. A computer system considers everything as data, be it instructions, pictures, songs, videos, documents, etc. Data can also be raw and unorganised facts that are processed to get meaningful **information**.

Data Representation refers to the way **data (numbers, text, images, and sounds)** is **stored, processed, and transmitted** in a computer system. Computers use **binary (0s and 1s)** to represent all types of data.

Types of Number System			
Types	Definition	Example	Uses
Binary Number System (Base-2)	The Binary Number System uses only two digits (0 and 1) . Every digit in binary is called a bit .	1010 ₂ (Binary) = 10 (Decimal). 1101 ₂ (Binary) = 13 (Decimal).	Computers, digital logic
Decimal Number System (Base-10)	The Decimal Number System is the most commonly used system in daily life. It consists of ten digits (0 to 9) .	25 ₁₀ (Decimal) = 11001 ₂ (Binary). 100 ₁₀ (Decimal) = 64 ₈ (Octal) = 64 ₁₆ (Hex).	Daily life, mathematics
Octal Number System (Base-8)	The Octal Number System uses eight digits (0 to 7) . It is often used to represent binary numbers in a shorter form .	1010 ₂ (Binary) = 12 ₈ (Octal). 100110 ₂ (Binary) = 46 ₈ (Octal).	Short binary representation
Hexadecimal Number System (Base-16)	The Hexadecimal Number System uses sixteen symbols (0-9 and A-F) , where: A = 10, B = 11, C = 12, D = 13, E = 14, F = 15.	1010 ₂ (Binary) = A ₁₆ (Hex). 1111 ₂ (Binary) = F ₁₆ (Hex).	Memory addressing, color codes

Computer Coding:

At a Glance : Computer Coding				
Code Type	Bit Size	Description	Characters Support	Common Usage
Binary Coded Decimal (BCD)	4-bit per digit	Represents decimal numbers (0-9) in binary format .	Decimal digits (0-9)	Used in digital clocks, calculators, and financial applications.
Extended Binary Coded Decimal Interchange Code (EBCDIC)	8-bit	8-bit code developed by IBM to store text.	Mainframe text encoding	Used in mainframe computers and older systems.
ASCII (American Standard Code for Information Interchange)	7-bit / 8-bit	7-bit/8-bit character encoding system for English text.	English letters, numbers, symbols	Used in modern computers, emails, and programming .
Unicode (Universal Character Set - UCS)	16-bit / 32-bit	A universal character set supporting all world languages .	All world languages, emojis, special characters	Used in websites, databases, emojis, and multilingual systems .

Language of Computer

Language means by which we can understand each other easily. The language used to complete the task with Machine or computer is called **user language or computer language**. The language which can be understood by computer machines is called **binary or machine language**.

Types of Language : Based on Generations			
Generation	Type	Example Languages	Usage
1st Generation	Machine Language (Binary Code)	Machine Code (0s & 1s)	Direct CPU Instructions
2nd Generation	Assembly Language	Assembly (x86, ARM)	OS Development, Embedded Systems
3rd Generation	High-Level Languages	C, Java, Python, FORTRAN, BASIC	General Programming, System Development
4th Generation	Very High-Level Languages	SQL, MATLAB, Prolog, LISP	AI, Data Science, Database Management
5th Generation	AI & Logic-Based Languages	Prolog, LISP, Python,	Artificial Intelligence, Machine Learning

Machine Level Language :

- Machine Language is a computer Language which is understandable by computer machine.
- It is also called Binary (0,1) Language.
- It is called machine Language because it directly works with machines. Working in this language is very difficult
- Instructions given in machine language work very fast, because no translation is required. Output also comes in the form of machine language.
- Machine language was introduced in 1833 by **Ada Augusta**, which is why she is known as the **mother of programming languages**.
- A **string** consists of a group of characters, including spaces and numbers.
- **Strings are used in programming**, but they primarily represent **text rather than numbers**.
- It is the **native language of a CPU** and does not require translation.
- Examples: 10110000 01100001

Assembly Language :

- The language that allows instructions or storage locations to be represented using **letters or symbols instead of numbers** is called **Assembly Language**.
- It was invented in **1952 by Grace Hopper**.
- **Assembly Language** is a **human-readable version** of Machine Language, using **mnemonic codes** instead of binary.
- It requires an **Assembler** to convert **Assembly code into Machine code**.
- Example:

MOV AL, 61h ; Move value 61h into register AL

ADD AL, 02h ; Add 2 to AL

High level Language

- In the language the user provides the instructions like English language in place of mnemonic code.
- English-like statements are used in High level language, due to this understanding and writing became simple.
- This language is not dependent on machines.
- Compiler or Interpreter is used to translate high level language into machine language.
- The examples of high level languages are C, C++, Java etc.