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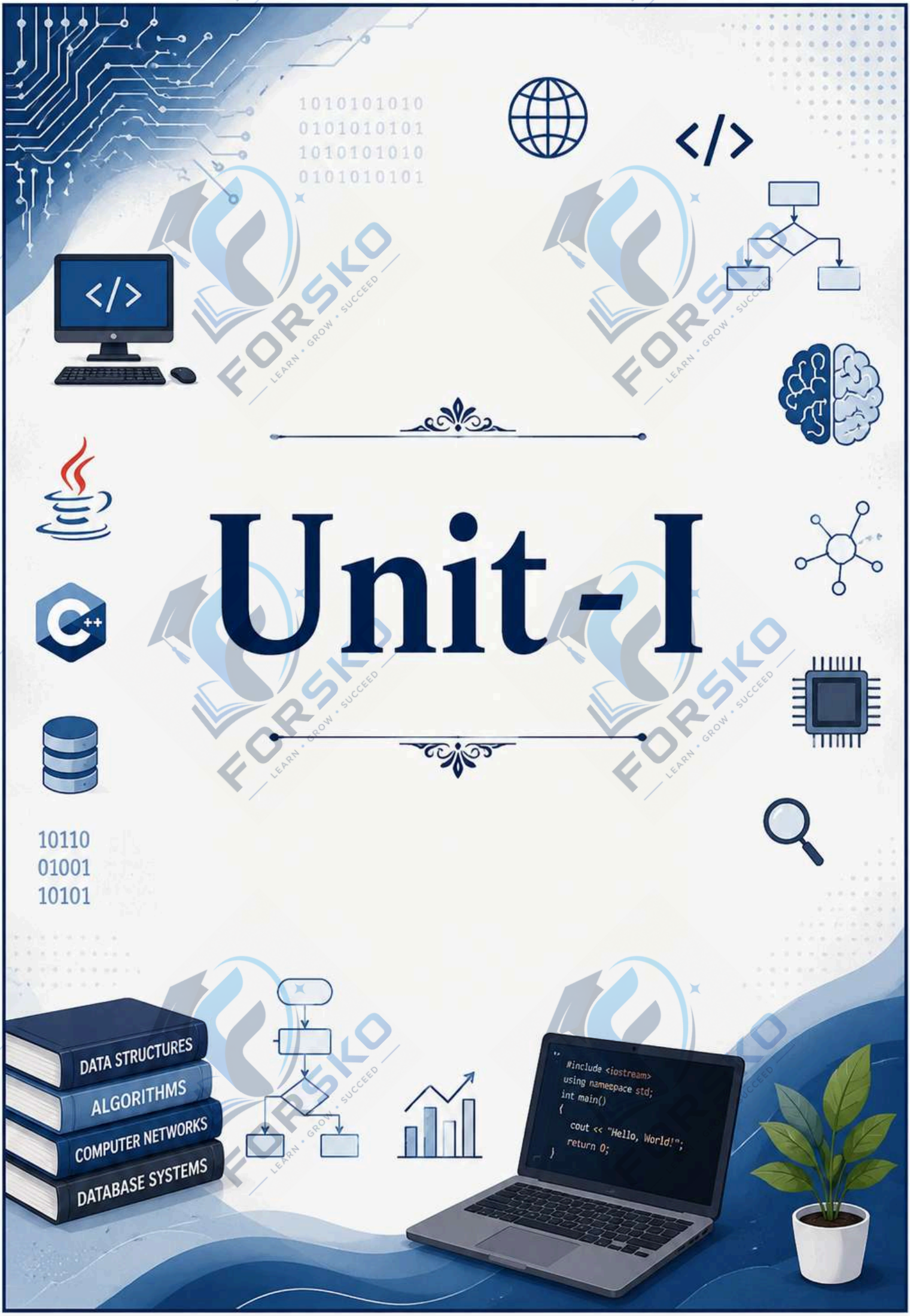
Infographics
Visual Learning
Better understanding through visual content.
Simplified Concepts
Complex topics explained in simple and visual form.
Quick Revision
Easy to revise important points and diagrams.
Exam Ready
Helps in faster revision and better exam preparation.
DATA STRUCTURES
ALGORITHMS
COMPUTER NETWORKS
DATABASE SYSTEMS

Unit-I

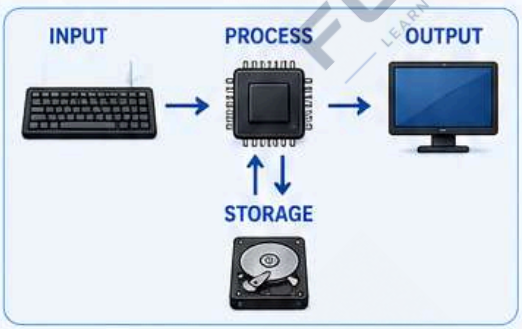

DATA STRUCTURES
ALGORITHMS
COMPUTER NETWORKS
DATABASE SYSTEMS
#include <iostream>
using nameepace std;
int main()
{
cout << "Hello, World!";
return 0;
}

INTRODUCTION TO COMPUTER

A computer is an electronic device that accepts data (input), processes it according to instructions, stores it and produces useful information (output).

WHAT IS A COMPUTER?

A computer is a fast, accurate, and diligent electronic device. It can store large amounts of data, perform complex calculations, follow instructions and produce results.



CHARACTERISTICS OF COMPUTER

- **Speed** — Computers can perform millions of operations in a few seconds.
- **Accuracy** — Computers are highly accurate and give correct results.
- **Diligence** — Computers can work continuously without getting tired.
- **Storage** — Computers can store large amounts of data.
- **Versatility** — Computers can be used for many different types of tasks.
- **Reliability** — Computers are reliable and consistent in their output.

USES OF COMPUTERS

Computers are used in almost every field today. They make work easy, fast and accurate.

1. EDUCATION

- Used for digital learning and e-learning.
- Helps in research and project work.
- Online exams and results.
- Educational software and simulations.

2. BUSINESS

- Used for accounting, payroll and billing.
- Helps in preparing reports and presentations.
- Used in marketing, sales and customer management.
- E-commerce and online banking.

3. COMMUNICATION

- Email, instant messaging and video conferencing.
- Social media and networking.
- Helps people to connect quickly from anywhere in the world.

4. BANKING & FINANCE

- Used for online banking and transactions.
- ATM services.
- Investment and stock market operations.
- Loan processing and account management.

5. HEALTH CARE

- Used in hospitals for patient records and appointments.
- Helps in diagnosis and treatment.
- Medical research and analysis.
- Telemedicine and online consultations.

6. SCIENCE & ENGINEERING

- Used for research, modeling and simulations.
- Helps in designing products (CAD/CAM).
- Data analysis and experiments.
- Weather forecasting and space research.

7. ENTERTAINMENT

- Used for watching movies, listening to music.
- Playing games.
- Animation and graphic designing.
- Video editing and special effects.

8. GOVERNMENT

- Used for maintaining records and databases.
- Online services to citizens (e-governance).
- Helps in planning, budgeting and decision making.
- Used in defense and security.

KEY POINTS

- A computer accepts data, processes it, stores it and gives useful information.
- It is fast, accurate, reliable and can be used in many fields.
- Computers save time, reduce human effort and improve productivity.
- Today, computers are an essential part of our daily life.

INTRODUCTION TO COMPUTER

A computer is an electronic device that accepts data, processes it according to instructions, stores it and produces meaningful information (output).

WHAT IS A COMPUTER?

A computer is a fast, accurate and reliable machine. It can perform complex calculations in a very short time. It works automatically under the control of programs.

MAIN FEATURES

- Speed
- Accuracy
- Diligence
- Storage Capacity
- Versatility
- Automation
- Reliability

USES OF COMPUTERS

1. Education

Used for e-learning, online classes, exams, research and educational content.

2. Business

Used for accounting, payroll, inventory management, data analysis and e-commerce.

3. Banking & Finance

Used for online banking, transactions, fund transfer, ATM, insurance and investment.

4. Communication

Helps in email, video conferencing, social media and instant messaging.

5. Healthcare

Used in hospitals for patient records, diagnosis, research and telemedicine.

6. Science & Research

Used for simulations, experiments, data analysis and scientific discoveries.

7. Entertainment

Used for gaming, music, movies, animation and digital art.

8. Government

Used for e-governance, data management, public services and citizen portals.

9. Others

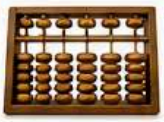
Used in travel booking, weather forecasting, news, and many more day-to-day tasks.

HISTORY OF COMPUTERS

The journey of computers from gigantic machines to smart devices.

1. Pre-Mechanical (Abacus and Counting Devices)

3000 BC – 1600 AD



Early counting tools like Abacus were used for basic calculations.

2. Mechanical Computers

17th – 19th Century

Devices like Pascaline (1642) and Analytical Engine (1837) were built to perform calculations using mechanical parts.

3. Electromechanical Computers

1930s – 1940s

Machines like Zuse Z3 (1941) and Harvard Mark I (1944) used relays and electromechanical components.

4. First Generation (Vacuum Tubes)

1946 – 1956

ENIAC (1946) is the first electronic general-purpose computer. Used vacuum tubes, large in size and consumed more power.

5. Second Generation (Transistors)

1956 – 1963

Used transistors instead of vacuum tubes. Smaller in size, faster, more reliable and less heat generation.

6. Third Generation (Integrated Circuits)

1964 – 1971

Integrated Circuits (ICs) were used. Computers became smaller, faster and more efficient.

7. Fourth Generation (Microprocessors)

1971 – Present

Microprocessors brought a revolution. Personal computers (PCs) were introduced. High speed, high storage and multitasking became possible.

8. Fifth Generation (AI & Beyond)

Present – Future

Focus on Artificial Intelligence, Machine Learning, Natural Lampuage Processing and Quantum Computing.

KEY MILESTONES

- 1946 – ENIAC (World's first electronic computer)
- 1947 – Transistor invented
- 1958 – Integrated Circuit invented
- 1971 – Microprocessor invented (Intel 4004)
- 1990s – Internet and World Wide Web
- 2000s – Smartphones and Cloud Computing
- 2010s – AI, Big Data, IoT
- 2020s – Quantum Computing (in progress)

FROM THEN TO NOW

From huge machines that filled rooms to smart devices that fit in our pockets.

DID YOU KNOW?

Computers have changed the world by making tasks easier, saving time, improving communication and opening endless possibilities for the future.

HISTORY OF COMPUTERS

A JOURNEY OF INNOVATION AND TECHNOLOGY

The computer has come a long way from huge room-sized machines to smart devices that fit in our pockets. It has transformed the world and the way we live, work and communicate.

EVOLUTION THROUGH GENERATIONS

1st GENERATION (1940–1956)

Vacuum Tube Computers

FEATURES
- Used vacuum tubes for circuitry.
- Very large in size, consumed huge power and generated a lot of heat.
- Programming was done in machine language.

EXAMPLES
ENIAC
EDVAC
UNIVAC I

2nd GENERATION (1956–1963)

Transistor Computers

FEATURES
- Used transistors instead of vacuum tubes.
- Smaller in size, less heat and more reliable.
- Used assembly language and early high-level languages.

EXAMPLES
IBM 1401
IBM 7094
CDC 1604

3rd GENERATION (1964–1971)

Integrated Circuit Computers

FEATURES
- Used Integrated Circuits (ICs).
- Smaller, faster, more efficient and more reliable.
- Supported high-level languages (FORTRAN, COBOL).

EXAMPLES
IBM System/360
PDP-8
Honeywell 6000

4th GENERATION (1971–2000)

Microprocessor Computers

FEATURES
- Used Microprocessors (VLSI technology).
- Very small in size, high speed, large storage.
- Rise of Personal Computers.

EXAMPLES
Intel 4004
IBM PC
Apple II
Macintosh

5th GENERATION (2000–Present)

Artificial Intelligence Computers

FEATURES
- Based on ULSI technology.
- Focus on Artificial Intelligence, Machine Learning, NLP, Robotics, etc.
- High speed, intelligent and multitasking systems.

EXAMPLES
Modern PCs
Laptops
Smartphones
Supercomputers

EVOLUTION AT A GLANCE

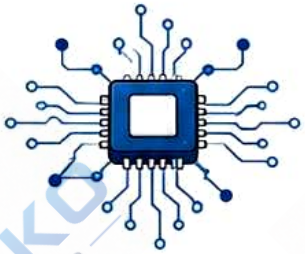
1950s	1960s	1970s	1980s–2000	2000–Present
Vacuum Tubes Huge Size	Transistors Smaller & Reliable	Integrated Circuits More Power	Microprocessors Personal Computers	AI & Advanced Tech Smart & Intelligent

> "From large machines that filled rooms to smart devices that fit in our hands, computers have truly changed the world."

KEY POINTS

- Computers have evolved through five major generations.
- Each generation introduced new technology and improvements.
- Computers are now an essential part of our daily life.
- The future holds smarter, faster and more intelligent computers.

CHARACTERISTICS OF COMPUTER



A computer is an electronic device that accepts data, processes it, stores it and produces useful information.

1 SPEED

- Computers can perform millions of calculations in a few seconds.
- They work very fast compared to humans.

Example: A computer can add thousands of numbers in seconds.

2 ACCURACY

- Computers give highly accurate results.
- The accuracy depends on the quality of data and instructions given.

Example: In banking, computers give exact calculations.

3 DILIGENCE

- Computers can work continuously for long hours without getting tired or bored.
- They can repeat the same task many times with the same speed and accuracy.

Example: Computers can work 24×7 in railway reservation systems.

4 STORAGE CAPACITY

- Computers can store large amounts of data and information.
- Stored data can be retrieved quickly whenever needed.

Example: A computer can store thousands of books, images and videos.

5 VERSATILITY

- Computers can be used for many different types of tasks.
- They can do many jobs such as calculations, drawing, typing, playing etc.

Example: A computer can be used in hospitals, schools, offices, banks and industries.

6 AUTOMATION

- Once instructions are given, the computer works automatically without human intervention.
- It follows instructions step by step.

Example: In payroll systems, salaries are calculated automatically.

7 RELIABILITY

- Computers are reliable and give consistent results.
- They rarely make mistakes.

Example: Computers are used in airlines, hospitals and banks where reliability is very important.

8 MULTITASKING

- Computers can perform many tasks at the same time.
- They can switch quickly from one task to another.

Example: You can listen to music, print a document and browse the internet at the same time.

9 NO IQ & NO FEELINGS

- Computers have no intelligence of their own.
- They do not feel emotions; they only follow instructions given by humans.

Example: A computer cannot think by itself; it depends on the user for instructions.

KEY POINTS

- Computers are fast, accurate, reliable and versatile machines.
- They can store large amounts of data and work continuously without getting tired.
- They follow instructions automatically and perform many tasks.
- These characteristics make computers very useful in our daily life.

BLOCK DIAGRAM OF COMPUTER

A computer system is made up of **Input Unit**, **CPU (Central Processing Unit)**, **Memory Unit** and **Output Unit**. These units work together to perform data processing.

INPUT UNIT

Accepts data and instructions from the user.

CPU (CENTRAL PROCESSING UNIT)

CONTROL UNIT (CU)

Controls all the operations of computer. It fetches instructions from memory, decodes them and directs execution.

ARITHMETIC AND LOGIC UNIT (ALU)

Performs arithmetic operations (+, −, ×, ÷) and logical operations (>, <, =, AND, OR, etc.) on data.

REGISTERS / CACHE MEMORY

Very small and very fast memory used by CPU to store data, instructions and intermediate results.

OUTPUT UNIT

Presents the processed information to the user.

MEMORY UNIT

Stores data, instructions and results permanently or temporarily.

PRIMARY MEMORY (Main Memory)	SECONDARY MEMORY (Auxiliary Memory)
RAM, ROM	Hard Disk, SSD, CD, DVD, etc.

FLOW OF OPERATION

1. Data / Instructions are given by the user to Input Unit.
2. Input unit sends data and instructions to CPU via memory.
3. CPU processes the data as per instructions.
4. Result is stored in memory.
5. Output unit displays the result to the user.

KEY POINTS

- All units work together.
- CPU is the brain of the computer.
- Memory stores data and instructions.
- Input gives data.
- Output shows the result.

CPU

(CENTRAL PROCESSING UNIT)

THE BRAIN OF YOUR COMPUTER

WHAT IS CPU?

The CPU (Central Processing Unit) is the main processor of a computer. It executes instructions from programs, performs calculations and controls all the operations of the system.

INSIDE A CPU

ALU
Performs arithmetic and logical operations

CONTROL UNIT (CU)
Controls and coordinates all operations

REGISTERS
Small, high-speed memory locations inside the CPU

CACHE MEMORY
Very fast memory that stores frequently used data

HOW CPU WORKS

1. FETCH
CPU fetches instructions from RAM.

2. DECODE
10110
01010
10101
CPU decodes the instruction to understand it.

3. EXECUTE
CPU executes the instruction (calculations, logic, data movement).

4. STORE
CPU stores the result back to RAM or another device.

5. REPEAT
CPU repeats this process billions of times per second.

KEY FEATURES / SPECIFICATIONS

CLOCK SPEED
Measured in GHz. Higher clock speed means more cycles per second.

CORES
More cores = better multitasking and performance.

CACHE MEMORY
CACHE
Small but super fast memory that speeds up data access.

TDP (Thermal Design Power)
The amount of heat (in watts) the CPU generates.

ARCHITECTURE
The design technology (e.g., x86, ARM) affects performance and efficiency.

TYPES OF CPU

SINGLE CORE
Has one core. Suitable for basic tasks.

DUAL CORE
Two cores. Better performance and multitasking.

MULTI CORE
(QUAD CORE, HEXA CORE, OCTA CORE...)
More cores = Higher performance.

USES / WHERE CPU IS USED

Computers & Laptops
Handling all computing tasks

Gaming
Runs games and handles complex graphics & physics

Smartphones
Powers apps and system operations

Servers
Handles requests and data processing

Embedded Systems
Used in cars, appliances, medical devices, etc.

FUN FACTS

Modern CPUs can execute billions of instructions per second!

CPUs can heat up to 70–100°C under heavy load!

A CPU contains billions of tiny transistors.

Moore's Law predicted the number of transistors doubles approximately every 2 years.

IN SIMPLE WORDS: CPU is the brain that thinks, calculates and controls everything in your computer.

Unit - II


DATA STRUCTURES
ALGORITHMS
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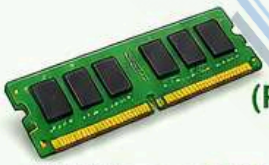
#include <iostream>
using namespace std;
int main()
{
cout << "Hello, World!";
return 0;
}

MEMORIES

Memories are used to **store** data, instructions and information in a computer.

PRIMARY MEMORIES

Primary memories are directly accessible by the CPU.
They are also called **Main Memory.**



1. RAM
(Random Access Memory)

RAM is a **volatile** memory used to store data and instructions temporarily while a program is running.

Features of RAM

- Volatile memory (data lost when power is off).
- Read and write operations.
- Stores data temporarily.
- Used to hold data and instructions that CPU is currently using.
- Faster than ROM.
- Examples: DRAM, SRAM.

2. ROM
(Read Only Memory)

ROM is a **non-volatile** memory used to store permanent instructions that are required to start the computer.

Features of ROM

- Non-volatile memory (data not lost when power is off).
- Read only (cannot be written by user).
- Stores permanent data/instructions.
- Contains instructions for booting and starting the system.
- Slower than RAM.
- Examples: PROM, EPROM, EEPROM.

RAM vs ROM

Feature	RAM	ROM
Full Form	Random Access Memory	Read Only Memory
Nature	Volatile	Non-volatile
Read/Write	Read and Write	Read Only
Data Retention	Data is lost when power is off	Data is not lost when power is off
Purpose	Stores data temporarily while processing	Stores permanent instructions for system booting
Speed	Faster	Slower
Examples	DRAM, SRAM	PROM, EPROM, EEPROM
User Access	Directly accessible by user/programs	Not directly accessible by user

KEY POINTS

- Primary memories are main memories and are accessed by CPU.
- RAM is temporary memory and allows read/write operations.
- ROM is permanent memory and stores essential instructions.
- RAM is fast but volatile, ROM is non-volatile but slower.

RAM

(RANDOM ACCESS MEMORY)

RAM is the primary memory of a computer that stores data, instructions and programs that are currently in use.

WHAT IS RAM?

RAM (Random Access Memory) is a type of volatile memory that can be read from and written to in any order. It temporarily holds data that the CPU needs quick access to while a program is running.

KEY FEATURES

- Volatile Memory
- High Speed
- Random Access
- Temporary Storage
- Improves System Performance

WHERE IS RAM USED?

- Running Applications
- Gaming
- Web Browsing
- Multitasking
- Video Editing & More

STRUCTURE OF A RAM MODULE

Notch
Helps in proper installation

Gold Contacts
Provide electrical connection to the memory slot

Key
Ensures RAM is inserted in the correct direction

TYPES OF RAM

1. SRAM (Static RAM)

- Uses flip-flops to store data
- Very fast and expensive
- Used in Cache Memory

2. DRAM (Dynamic RAM)

- Uses capacitors to store data
- Slower than SRAM but cheaper
- Used as main memory

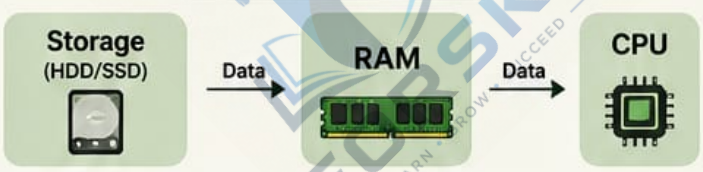
3. SDRAM (Synchronous DRAM)

- Works in sync with the system clock
- Faster than regular DRAM
- Commonly used in PCs

4. DDR SDRAM

- Double Data Rate SDRAM
- Transfers data on both rising and falling edges
- DDR, DDR2, DDR3, DDR4, DDR5 (latest)

HOW RAM WORKS?



When you run a program, data is loaded from storage (HDD/SSD) into RAM. The CPU accesses this data from RAM because it is much faster. When the program is closed or the computer is turned off, the data in RAM is lost.

IMPORTANT POINTS

- More RAM = Better Multitasking
- RAM is temporary. Data is lost when power is off.
- RAM works with CPU to improve overall system performance.
- Upgrading RAM can make your computer faster.

In simple terms: RAM is like your work table – the bigger it is, the more you can work at the same time, smoothly and quickly.

TYPES OF RAM

RANDOM ACCESS MEMORY

RAM (Random Access Memory) is a primary memory that stores data, instructions and programs temporarily while the computer is in use.
It is volatile, which means data is lost when power is turned off.

High Speed
RAM allows fast access to data.

Random Access
Any memory location can be accessed directly.

Temporary Storage
Stores data only while the system is running.

Improves Performance
More RAM = better multitasking and faster performance.

MAIN TYPES OF RAM

1. SRAM (Static RAM)

SRAM uses flip-flops to store each bit.
It is very fast and expensive.

- No need to refresh
- Very high speed
- Low capacity
- Used in cache memory

Speed	Very Fast
Cost	Very High
Storage Density	Low
Used In	Cache memory (L1, L2, L3)

2. DRAM (Dynamic RAM)

DRAM uses capacitors to store each bit.
It needs to be refreshed periodically.

- Needs refresh
- Slower than SRAM
- High capacity
- Used as main memory

Speed	Fast
Cost	Low
Storage Density	High
Used In	Main memory (RAM modules)

3. SDRAM (Synchronous DRAM)

SDRAM works in synchronization with the system clock.

- Faster than DRAM
- Synchronous operation
- Higher bandwidth
- Commonly used in PCs

Speed	Faster
Cost	Moderate
Storage Density	High
Used In	Older PCs and systems

4. DDR SDRAM (Double Data Rate SDRAM)

DDR SDRAM transfers data on both rising and falling edges of the clock signal.

- Higher data rate
- Better bandwidth
- More efficient
- Widely used today

Speed	Very Fast
Cost	Moderate
Storage Density	Very High
Used In	Modern PCs, Laptops, Servers

5. LPDDR (Low Power DDR)

LPDDR is a low power version of DDR used in portable devices.

- Low power consumption
- Smaller size
- Good performance
- Used in mobile devices

Speed	Fast
Cost	High
Storage Density	High
Used In	Smartphones, Tablets, Ultrabooks

EVOLUTION OF DDR RAM

DDR	DDR2	DDR3	DDR4	DDR5
Introduced first generation DDR.	Lower power, higher speed.	Better performance and efficiency.	Higher speed, lower power.	Highest speed, more bandwidth.
2.5 V 184 pins	1.8 V 240 pins	1.5 V (1.35 V*) 240 pins	1.2 V 288 pins	1.1 V 288 pins

*Some DDR3 modules use 1.35 V for low power.

HOW TO IDENTIFY RAM TYPE?

1. Check the Module
Look for labels on the RAM stick. It usually mentions DDR, DDR2, DDR3, DDR4 or DDR5.

2. Check the Notch
The position of the notch on the golden pins is different for each type.

3. Check Specifications
Use system information tools or BIOS to see the RAM type.

SRAM vs DRAM (Quick Comparison)

Feature	SRAM	DRAM
Full Form	Static RAM	Dynamic RAM
Cell Structure	Flip-Flop	Capacitor + Transistor
Refresh	Not Required	Required
Speed	Very Fast	Slower
Cost	Very High	Low
Used In	Cache Memory	Main Memory

IMPORTANT POINTS

- All types of RAM are volatile.
- More RAM allows better multitasking.
- RAM works with CPU to improve overall system performance.
- Choose the right RAM type compatible with your system.

IN SIMPLE WORDS

Think of RAM as your study table. The bigger and faster the table (RAM), the more books (data) you can keep open at the same time and work smoothly.

Remember: SRAM is faster but costly and used in small size (cache). DRAM and its types are used as main memory because they are cheaper and available in large capacity.

ROM

READ ONLY MEMORY

ROM (Read Only Memory) is a type of non-volatile memory that stores data and instructions permanently.
The data in ROM can only be read, not written or modified during normal operation.

WHAT IS ROM?

ROM is a non-volatile memory used in computers and electronic devices to store firmware and permanent instructions needed for the device to start and operate.
The data remains even when the power is turned off.

Non-volatile
(memory retains data without power)

KEY FEATURES

- **Non-volatile** — Data is retained even without power.
- **Read Only** — Data can only be read, not written.
- **Reliable** — Stores essential instructions permanently.
- **Used for Firmware** — Contains BIOS, device firmware, boot programs, etc.
- **Slower than RAM** — But stable and used for permanent storage.

WHERE IS ROM USED?

- BIOS / UEFI in computers
- Firmware in printers
- Firmware in routers and modems
- Game consoles
- Automobiles (ECU)
- Home appliances (microwave, AC, TV, etc.)

TYPES OF ROM

1. MASK ROM (MROM)

- Programmed during manufacturing.
- Data cannot be changed ever.
- Used in mass production.
- Low cost, high reliability.

2. PROM (Programmable ROM)

- User can program it once.
- Uses a special programmer.
- Once programmed, cannot be changed.

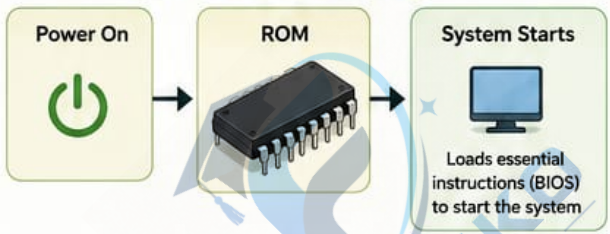
3. EPROM (Erasable PROM)

- Can be erased using UV light.
- Can be reprogrammed.
- Has a quartz window on the chip.

4. EEPROM (Electrically Erasable PROM)

- Can be erased electrically.
- Can be reprogrammed many times.
- Used in modern devices.
- Slower than RAM but faster than EPROM.

HOW ROM WORKS?



When a device is switched on, the CPU reads instructions from ROM (like BIOS). These instructions help in starting the hardware, checking devices and loading the operating system.

ROM vs RAM

	ROM	RAM
Full Form	Read Only Memory	Random Access Memory
Volatility	Non-volatile	Volatile
Access	Read Only	Read / Write
Data Retention	Retains data without power	Loses data when power is off
Use	Stores permanent instructions (BIOS, firmware)	Stores temporary data and running programs
Speed	Slower than RAM	Faster than ROM

IMPORTANT POINTS

- ROM is non-volatile and read-only.
- It stores permanent instructions required to boot and run the system.
- Types: Mask ROM, PROM, EPROM, EEPROM.
- Example: BIOS chip in a computer motherboard.

IN SIMPLE WORDS

ROM is like the memory of a device that remembers important instructions forever so that the device can start and work properly.

TYPES OF ROM

READ ONLY MEMORY

ROM (Read Only Memory) is a type of **non-volatile memory** that stores data and instructions permanently.
The data in ROM can only be read, not written or modified during normal operation.

- **Non-Volatile** — Retains data even when power is turned off.
- **Read Only** — Data can only be read, not written.
- **Reliable** — Stores essential instructions (firmware).
- **Used in Booting** — Helps in starting the system (BIOS/UEFI).
- **Low Cost** — Cheaper than RAM and used in large scale.

MAIN TYPES OF ROM

1 MASK ROM (MROM)

- Programmed during manufacturing.
- Data cannot be changed or modified.
- Used in mass production.
- Low cost and high reliability.

USED IN


Consumer Electronics


Calculators


Controllers

2 PROM (Programmable ROM)

- User can program it once.
- Requires a PROM programmer device.
- Once programmed, data cannot be changed.

USED IN


Prototyping


Industrial Devices


Communication Systems

3 EPROM (Erasable PROM)

- Can be erased using ultraviolet (UV) light.
- Can be reprogrammed multiple times.
- Has a quartz window on the chip.

USED IN


Development Boards


Microcontroller Systems


Testing Equipment

4 EEPROM (Electrically Erasable PROM)

- Can be erased electrically.
- Can be reprogrammed many times.
- No need for UV light.
- Slower than RAM but faster than EPROM.

USED IN


BIOS/UEFI Memory

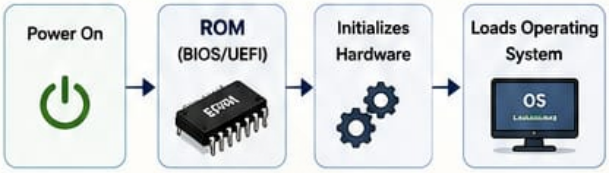

Automotive Systems


IoT & Smart Devices

COMPARISON: ROM TYPES AT A GLANCE

Feature	Mask ROM (MROM)	PROM	EPROM	EEPROM
Programmability	No	Once	Multiple Times	Multiple Times
Erasure Method	Not Possible	Not Possible	UV Light	Electrical
Reprogrammable	No	No	Yes	Yes
Speed	Fast	Fast	Slower	Slower
Cost	Low (in bulk)	Moderate	High	Moderate
Volatility	Non-Volatile	Non-Volatile	Non-Volatile	Non-Volatile
Typical Use	Mass Production	One-time Programming	Development & Testing	Frequent Updates

ROM HIERARCHY IN SYSTEM



HOW ROM WORKS?

When a computer is switched on, the CPU reads instructions from ROM (BIOS/UEFI). These instructions perform POST (Power-On Self Test), check hardware, and then load the operating system into RAM to start the system.

QUICK DIFFERENCE: ROM vs RAM

ROM

- Read Only Memory
- Non-volatile (data retained without power)
- Stores permanent data (firmware, BIOS)
- Slower than RAM
- Used for booting and permanent storage

VS

RAM

- Random Access Memory
- Volatile (data lost when power is off)
- Stores temporary data and programs
- Faster than ROM
- Used for running applications

IN SIMPLE WORDS

ROM is like the memory that remembers important instructions forever so that the computer can start and work properly.

CACHE MEMORY

The High-Speed Memory Between CPU and RAM

Cache Memory is a small, **very fast memory** that stores frequently used data and instructions to speed up the performance of the CPU.

Very Fast
Faster than RAM & Storage

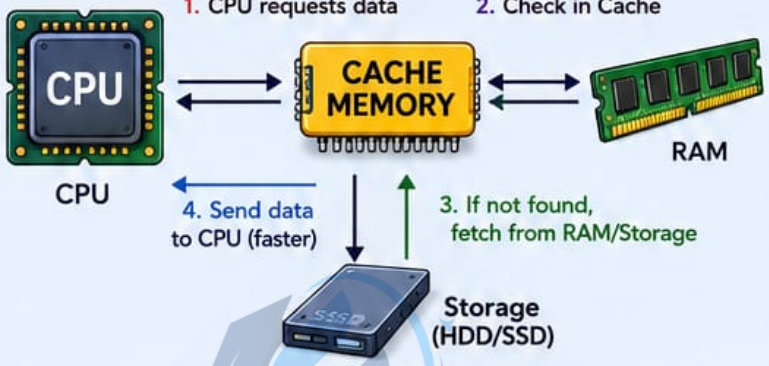
Small in Size
Smaller capacity than RAM

Stores Frequently Used Data
Keeps data that CPU uses often

Improves Performance
Reduces access time

Temporary
Data is lost when power off

HOW CACHE MEMORY WORKS?



- If data is found in Cache → CPU gets it instantly (very fast).
- If not found → data is taken from RAM → stored in Cache for future use.

TYPES OF CACHE MEMORY

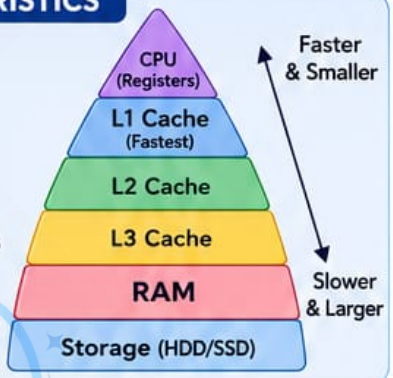
L1 Cache
(Level 1)
- Smallest in size
- Fastest
- Located inside the CPU

L2 Cache
(Level 2)
- Larger than L1
- Slightly slower than L1
- Close to CPU

L3 Cache
(Level 3)
- Largest among cache
- Shared by all cores
- Slower than L1 & L2 but faster than RAM

KEY CHARACTERISTICS

- **Temporary:** Works only when power is on.
- **High Speed:** Much faster than RAM and storage devices.
- **Small Capacity:** Usually in KB, MB (less than RAM).
- **Automatic:** Managed by hardware (no user control).



BENEFITS OF CACHE MEMORY

- Reduces CPU waiting time
- Improves overall system speed
- Increases efficiency of programs
- Less load on RAM
- Better performance in gaming and heavy software

CACHE vs RAM vs ROM

Feature	Cache Memory	RAM	ROM
Full Form	—	Random Access Memory	Read Only Memory
Speed	Very Fast (Fastest)	Fast	Slower
Size	Very Small (KB/MB)	Large (GB)	Small–Medium (MB/GB)
Volatility	Volatile	Volatile	Non-Volatile
Use	Stores frequently used data	Stores current programs & data	Stores permanent instructions
Location	Inside/near CPU	Main Memory	Chip (BIOS, Firmware)

REAL-LIFE ANALOGY

Think of Cache as the items you keep in your pocket (frequently used things), while RAM is your bag, and Storage is the big cupboard at home.

IN SIMPLE WORDS

Cache Memory acts as a super-fast storage between CPU and RAM that helps the computer work faster and smarter by keeping important data ready to use.

SECONDARY STORAGE DEVICES

Devices which are used to store data permanently.

WHAT IS SECONDARY STORAGE?

Secondary storage refers to **non-volatile** storage devices that store data and programs permanently. The data remains stored even when the power is switched off.

FEATURES

- Non-volatile – data is retained even when power is off.
- Large storage capacity.
- Used for long-term data storage.
- Slower than primary memory (RAM).
- Data can be easily transferred.
- Examples: Hard Disk, SSD, CD, DVD, Pen Drive, etc.

TYPES OF SECONDARY STORAGE DEVICES

1 HARD DISK DRIVE (HDD)

- Uses magnetic storage.
- Large storage capacity.
- Economical.
- Used in computers, laptops, servers, etc.

2 SOLID STATE DRIVE (SSD)

- Uses flash memory.
- Faster than HDD.
- No moving parts.
- More reliable and durable.
- Used in laptops, desktops.

3 CD (COMPACT DISC)

- Optical storage device.
- Stores up to 700 MB of data.
- Used to store music, data, software, etc.

4 DVD (DIGITAL VERSATILE DISC)

- Optical storage device.
- Stores up to 4.7 GB (single layer) and up to 8.5 GB (double layer).
- Used for movies, data, backup, etc.

5 PEN DRIVE (USB FLASH DRIVE)

- Small and portable.
- Uses flash memory.
- Easy to carry and use.
- Used to transfer and store data.

6 MEMORY CARD (SD CARD)

- Small flash memory card.
- Used in cameras, mobile phones, tablets, etc.
- Easy to remove and carry.

7 MAGNETIC TAPE

- Uses magnetic storage.
- Stores large amount of data.
- Used for backup in industries, banks, mainframes.

8 FLOPPY DISK (DISKETTE)

- Magnetic storage device.
- Stores up to 1.44 MB of data.
- Now rarely used.

COMPARISON OF SECONDARY STORAGE DEVICES

Device	Storage Capacity	Speed	Durability	Portability	Cost
HDD	500 GB – 20 TB	Medium	Medium (fragile)	Low	Low
SSD	128 GB – 4 TB	High	High (no moving parts)	Low	High
CD	Up to 700 MB	Low	High	High	Low
DVD	4.7 GB – 8.5 GB	Low	High	High	Low
Pen Drive	4 GB – 1 TB	High	High	Very High	Low
Memory Card	2 GB – 1 TB	High	High	Very High	Low
Magnetic Tape	100 GB – Several TB	Low	High	Low	Low
Floppy Disk	Up to 1.44 MB	Very Low	Low	Low	Very Low

KEY POINTS

- Secondary storage devices store data permanently.
- They are non-volatile and have large storage capacity.
- They are essential for data backup, transfer and long-term storage.

HARD DISK DRIVE (HDD)

High Capacity. Reliable Storage.

A Hard Disk Drive (HDD) is a **non-volatile** secondary storage device that stores data on rotating magnetic platters.
It has large storage capacity and is widely used in computers, laptops, servers and many other devices.

NON-VOLATILE
Data remains stored even when power is turned off.

LARGE CAPACITY
Stores from hundreds of GB to tens of TB of data.

RELIABLE
Designed for long-term storage with good durability.

COST EFFECTIVE
Low cost per GB compared to other storage devices.

WIDELY USED
Used in desktops, laptops, servers, DVRs, etc.

CONSTRUCTION OF HDD

1. **PLATTERS**
Circular disks coated with magnetic material where data is stored.
2. **SPINDLE**
Rotates the platters at high speed (RPM).
3. **READ/WRITE HEAD**
Reads data from and writes data to the platter surface.
4. **ACTUATOR ARM**
Moves the read/write head across the platters.
5. **ACTUATOR AXIS**
Moves the actuator arm inward or outward.
6. **CONTROLLER BOARD**
Controls all operations of the hard disk.
7. **CONNECTOR INTERFACE**
SATA / IDE interface connects HDD to the computer.

HOW DOES HDD WORK?

1. Data is sent from the computer to the HDD controller.
2. The actuator arm moves the read/write head to the correct track.
3. The head reads or writes data magnetically on the rotating platters.
4. Data is transferred between HDD and computer through the interface.
5. The data is stored and can be retrieved whenever required.

KEY SPECIFICATIONS

SPECIFICATION	DESCRIPTION
Storage Capacity	500 GB, 1 TB, 2 TB, 4 TB, 8 TB, 16 TB and above.
Speed (RPM)	5400 RPM, 7200 RPM, 10000 RPM, 15000 RPM.
Interface	SATA (Serial ATA) – most common. IDE (PATA) – older interface.
Form Factor	2.5 inch (laptops), 3.5 inch (desktops).
Buffer Size (Cache)	64 MB, 128 MB, 256 MB or more.

ADVANTAGES

- Very large storage capacity.
- Low cost per GB.
- Reliable for long-term storage.
- Suitable for bulk data storage.
- Widely compatible.

LIMITATIONS

- Slower than SSD.
- Contains moving parts, can be affected by shock.
- Consumes more power than SSD.
- Makes noise and generates heat.

TYPES OF HARD DISK DRIVES

1. INTERNAL HDD

Installed inside the computer.

- High capacity
- Performance for system use
- Requires installation

2. EXTERNAL HDD

Connected through USB or other ports.

- Portable
- Easy to connect
- Used for backup and data transfer

HDD vs OTHER STORAGE DEVICES (BY CAPACITY & SPEED)

Device	Capacity	Speed	Best For
HDD	500 GB – 20+ TB	★★☆☆☆ (Moderate)	Bulk storage, backups, multimedia, general use.
SSD	128 GB – 4 TB	★★★★☆ (Very Fast)	OS, applications, gaming, fast access.
Pen Drive	4 GB – 1 TB	★★★☆☆ (Fast)	Portability, file transfer, small data storage.
Optical Disc (CD/DVD/Blu-ray)	700 MB – 100 GB	★☆☆☆☆ (Slow)	Media storage, distribution, archives.

USES OF HDD

- Store OS, software and applications
- Store movies, music and photos
- Data backup and recovery
- Used in servers and data centers
- Used in DVRs, CCTV systems

TIPS TO TAKE CARE OF HDD

- Avoid physical shocks and vibrations.
- Keep the device away from heat, moisture and dust.
- Do not power off the system while HDD is working.
- Regularly backup important data.
- Defragment the drive for better performance (HDD only).

In Simple Words: A hard disk is like a big magnetic notebook where we write and store our data. It may be slower than SSD, but it gives us much more space at a lower cost.

SSD (SOLID STATE DRIVE)

FAST. RELIABLE. SILENT.

An SSD (Solid State Drive) is a **non-volatile** storage device that uses flash memory to store data. It has no moving parts, making it faster, more reliable and energy efficient than HDD.

VERY FAST
Faster boot, load and file transfer speeds.

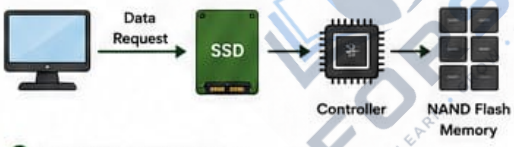
RELIABLE
No moving parts, resistant to shock and vibration.

SILENT
Works silently with no noise or heat.

ENERGY EFFICIENT
Consumes less power, increases battery life.

DURABLE
Longer life and better performance over time.

HOW SSD WORKS



1. Your computer requests data.
2. The SSD controller finds the data in NAND flash memory.
3. Data is sent back to the computer at high speed.
4. Data is stored using electronic signals in flash cells.

KEY SPECIFICATIONS

Storage Capacity	128 GB – 4 TB and above
Interface	SATA III, M.2 (SATA / NVMe PCIe)
Read Speed	Up to 550 MB/s (SATA) Up to 7000+ MB/s (NVMe)
Write Speed	Up to 520 MB/s (SATA) Up to 6500+ MB/s (NVMe)
Form Factor	2.5 inch, M.2 2280, mSATA
No. of Moving Parts	0 (No moving parts)

ADVANTAGES

- Very fast performance
- Shock and vibration resistant
- Silent operation
- Low power consumption
- Compact and lightweight
- More reliable and durable

LIMITATIONS

- Higher cost per GB
- Limited write cycles (TBW endurance)
- Data recovery can be complex and expensive

SSD vs HDD (COMPARISON)

Feature	SSD	HDD
Technology	Flash Memory	Magnetic Disk
Speed	Very Fast	Slow
Moving Parts	No	Yes
Durability	High	Low
Noise	Silent	Noisy
Power Consumption	Low	High
Weight	Lightweight	Heavier
Cost per GB	High	Low
Best For	OS, Apps, Gaming, Editing	Bulk Storage, Backup, Archives

TYPES OF SSD

1. SATA SSD (2.5 inch)

- Uses SATA III interface
- Speed up to 550 MB/s
- Compatible with most PCs and laptops

2. NVMe SSD (M.2)

- Uses PCIe NVMe interface
- Speed up to 7000+ MB/s
- Best performance for high end devices

USES OF SSD

- Operating System Drive
- Gaming
- Video Editing
- High Performance Computing
- Business & Professional Use

IN SIMPLE WORDS

An SSD is like a super fast digital storage box with no moving parts. It helps your computer start faster, run smoother and work better.

PEN DRIVE (USB FLASH DRIVE)

SMALL IN SIZE, BIG ON STORAGE

A Pen Drive is a portable, removable storage device that uses flash memory to store and transfer data. It connects to devices through a USB port.

PORTABLE
Easy to carry anywhere.

PLUG & PLAY
Connect and use immediately.

STORAGE ON THE GO
Store and transfer data easily.

DURABLE
Shock resistant and more reliable.

COST EFFECTIVE
Affordable and widely available.

HOW PEN DRIVE WORKS

When connected, the device detects the pen drive and allows you to read, write and transfer files.

KEY SPECIFICATIONS

Storage Capacity	4 GB – 512 GB and above
Interface	USB 2.0 / 3.0 / 3.1 / 3.2
Read Speed	Up to 20 – 400 MB/s (depends on USB version)
Write Speed	Up to 10 – 300 MB/s (depends on USB version)
Form Factor	Small, lightweight
Weight	5 – 20 grams (approx.)

USES OF PEN DRIVE

- Transfer files between computers
- Store photos, videos, music
- Backup important data
- Carry documents and presentations
- Install operating systems
- Share data securely

TYPES OF PEN DRIVE (BY USB VERSION)

USB 2.0	USB 3.0 / 3.1	USB 3.2
Speed up to 480 Mbps	Speed up to 5 Gbps	Speed up to 10 – 20 Gbps
Good for basic file transfer	Faster transfer of large files	Very high speed and performance

ADVANTAGES

- Easy to use
- Portable and lightweight
- No external power required
- Compatible with many devices
- Shock resistant and durable

PRECAUTIONS

- Do not remove while data is transferring
- Keep away from water and extreme heat
- Scan for viruses before opening files
- Backup important data regularly

IN SIMPLE WORDS

A pen drive is like a small pocket sized data carrier. It helps you carry your important files and memories wherever you go.

Unit - III


DATA STRUCTURES
ALGORITHMS
COMPUTER NETWORKS
DATABASE SYSTEMS


#include <iostream>
using namespace std;
int main()
{
cout << "Hello, World!";
return 0;
}

INPUT DEVICES

The First Step to Communication with a Computer

DEFINITION

Input devices are hardware devices used to enter data and instructions into a computer.

COMMON INPUT DEVICES

1. 

KEYBOARD

Used to type text, numbers, and commands.

2. 

MOUSE

Used to point, click, drag, and select.

3. 

SCANNER

Converts paper documents into digital form.

4. 

MICROPHONE

Inputs sound and voice.

5. 

WEBCAM

Captures images and videos.

6. 

JOYSTICK

Controls games and simulations.

7. 

LIGHT PEN

Used for drawing and selecting on compatible screens.

8. 

TOUCHSCREEN

Accepts input through touch.

9. 

BARCODE READER

Reads barcodes for billing and inventory.

10. 

OCR (OPTICAL CHARACTER RECOGNITION)

Converts printed text into editable digital text.

FEATURES

EASY DATA ENTRY
Helps in entering data quickly and easily.

IMPROVES ACCURACY
Reduces errors and improves correctness.

SAVES TIME
Speeds up work and increases productivity.

USER-FRIENDLY
Easy to use for all types of users.

Input devices allow users to communicate with computers efficiently.

KEYBOARD

THE KEYS TO COMMUNICATION BETWEEN YOU & YOUR COMPUTER

WHAT IS A KEYBOARD?

A keyboard is an input device that allows you to enter data, letters, numbers, and commands into a computer or other devices.

YOU TYPE → COMPUTER UNDERSTANDS

PARTS OF A KEYBOARD

Function Keys (F1–F12)
Perform special functions depending on the program.

Indicator Lights
Show status of Caps Lock, Num Lock and Scroll Lock.

Typing Keys (Alphanumeric)
Keys used to type letters, numbers and symbols.

Modifier Keys
Control, Alt, Shift, Windows keys – used with other keys to perform commands.

Navigation Keys
Help to move the cursor or scroll through documents.

Numeric Keypad
Used for quick number entry and calculations.

HOW A KEYBOARD WORKS

1. **YOU PRESS A KEY**
When you press a key, a signal is generated.

2. **SIGNAL SENT**
The keyboard's controller scans the key and converts it into a digital code.

3. **DATA TO COMPUTER**
The code is sent to the computer via USB or wireless connection.

4. **COMPUTER PROCESSES**
The computer decodes the signal and performs the action on screen.

TYPES OF KEYBOARDS

MEMBRANE KEYBOARD

Quiet and affordable. Uses a thin membrane layer under the keys.

Best for: General use, offices, students

MECHANICAL KEYBOARD

Uses individual mechanical switches for each key.

Best for: Gaming, typing, professionals

WIRELESS KEYBOARD

Connects without wires (Bluetooth / 2.4 GHz receiver).

Best for: Minimal setup, smart TVs, laptops

ERGONOMIC KEYBOARD

Designed for comfort and to reduce strain on hands and wrists.

Best for: Long typing hours, offices

GAMING KEYBOARD

Built for gaming with faster response, RGB lighting & extra keys.

Best for: Gamers

COMMON KEY GROUPS (AT A GLANCE)

- **A** — **Alphanumeric Keys**: A–Z, 0–9 and symbols used for typing.
- **F1** — **Function Keys**: F1–F12 for special commands.
- **Ctrl** — **Modifier Keys**: Ctrl, Alt, Shift, Windows key.
- **Navigation Keys**: Arrow keys, Home, End, Page Up/Down.
- **Esc** — **Special Keys**: Enter, Backspace, Esc, Spacebar, Tab.

IMPORTANT KEYS & THEIR USES

Enter	Executes a command or moves to next line.
Backspace	Deletes the character to the left of the cursor.
Spacebar	Inserts a space.
Tab	Moves cursor to next tab stop.
Shift	Types uppercase / Access second function.
Caps Lock	Turns on uppercase typing.
Ctrl	Used with other keys to perform shortcuts.
Esc	Cancels or stops the current task.

KEYBOARD SHORTCUTS (VERY USEFUL!)

Ctrl + C	Copy
Ctrl + V	Paste
Ctrl + X	Cut
Ctrl + Z	Undo
Ctrl + Y	Redo
Ctrl + S	Save
Ctrl + P	Print
Alt + Tab	Switch between open apps
Windows + D	Show desktop

FUN FACTS

- The first keyboard-like device was used in typewriters around the 1860s.
- A typical keyboard has between 104 to 108 keys.
- The fastest typist ever typed 216 words per minute!
- Mechanical keyboards can last up to 50 million key presses per key.
- Keyboards support over 100+ languages with different layouts.

IN SIMPLE WORDS: A keyboard is your way of talking to the computer. Each key you press tells the computer what to do!

MOUSE

A pointing device that controls the movement of the pointer on a computer screen and helps us interact with the computer easily.

QUICK FACT

The computer mouse was invented by Douglas Engelbart in 1964.

PARTS OF A MOUSE

- **Left Button** — Used for select, drag and drop.
- **Right Button** — Opens context menu (shortcut menu).
- **Scroll Wheel** — Used to scroll up and down pages.
- **Sensor** — Detects movement on the surface.

TYPES OF MOUSE

1. Wired Mouse
Connects to the computer using a cable. It is reliable and lag-free.

2. Wireless Mouse
Connects using Bluetooth or USB receiver. It is portable and easy to use.

3. Gaming Mouse
Specially designed for gamers with high precision, extra buttons and better DPI.

4. Trackball Mouse
Has a ball on top which is rotated with fingers to move the pointer.

HOW DOES A MOUSE WORK?

When we move the mouse on a surface, its sensor detects the movement and sends signals to the computer. The computer processes these signals and moves the pointer on the screen in the same direction.

USES OF MOUSE

- Moving the pointer on the screen
- Selecting and opening items (click)
- Dragging and dropping files/folders
- Scrolling web pages and documents
- Drawing and design work
- Playing games

MOUSE POINTER MOVEMENTS

Point	Click	Double Click	Drag	Scroll
Normal position	Press and release	Click twice quickly	Hold and move	Move wheel up or down

DID YOU KNOW?

Earlier mice had a ball inside them. When the ball moved, it detected movement. Now, optical and laser sensors are used instead of the ball.

CARE TIPS

- Keep the mouse clean
- Use on a smooth surface
- Don't pull the wire
- Store properly when not in use

HISTORY

1964 — Doug Engelbart invented the first mouse.

1970s — Ball mouse became popular.

1990s — Optical mouse replaced ball mouse.

Today — Advanced mice with more features and precision.

MOUSE SHORTCUTS

Left Click	Select / Open
Right Click	Open shortcut menu
Scroll Wheel	Scroll up / down
Ctrl +	Zoom In / Out
Middle Click	Open link in new tab

★ Small Device, Big Impact – Mouse makes everything easy!

SCANNER

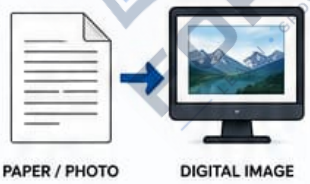
CAPTURING IMAGES, CREATING POSSIBILITIES

A scanner is an input device that captures text, images or graphics from paper or other sources and converts them into a digital format.

- Convert Physical to Digital
- Store, Edit & Share Easily
- Save Space & Preserve Documents

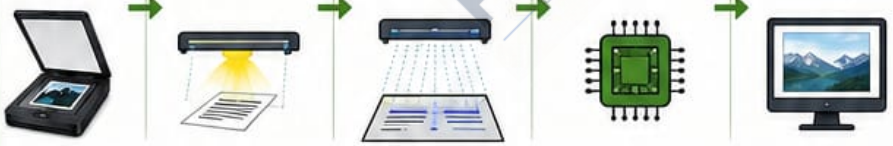
WHAT IS A SCANNER?

A scanner captures information from documents, photos, or objects and converts it into digital data that a computer can understand.



HOW DOES A SCANNER WORK?

1. **Place** – Place the document or photo on the scanner glass.
2. **Light Source** – A light (usually LED) shines on the document.
3. **Sensor** – The reflected light is detected by the image sensor.
4. **Conversion** – The analog signals are converted into digital data.
5. **Output** – The digital image is sent to the computer and saved.



TYPES OF SCANNERS

1. FLATBED SCANNER

The most common type. Document is placed on a flat glass surface.

Best for:
Photos, books, documents

2. SHEET-FED SCANNER

Scans pages by pulling them through the scanner automatically.

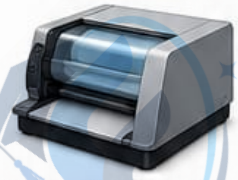
Best for:
Multi-page documents

3. HANDHELD SCANNER

Small, portable and moved by hand over the document.

Best for:
Portable use, receipts, small documents

4. DRUM SCANNER



Uses a rotating drum for very high-quality scanning (mostly in professional use).

Best for:
High-end publishing, graphic arts

5. OVERHEAD SCANNER

Captures images from above without touching the document.

Best for:
Books, delicate materials, archives

KEY FEATURES

- **Resolution (DPI) –** Determines the clarity and detail of the scanned image.
- **Color Depth –** Determines the number of colors captured.
- **Scan Speed –** The time taken to scan a document.
- **Scan Area –** The maximum size the scanner can scan.
- **File Formats –** Saves in formats like JPEG, PNG, PDF, TIFF, etc.

USES / APPLICATIONS

- **Document Management** – Digitize documents for easy storage and organization.
- **Education** – Scanning notes, books, assignments and learning materials.
- **Photography** – Digitizing printed photos and slides.
- **Healthcare** – Scanning medical reports, X-rays and patient records.
- **Business** – Invoices, receipts, ID cards and legal documents.
- **Archiving** – Preserving old and important documents.

SCANNER SPECIFICATIONS (EXAMPLE)

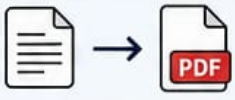
Type	Flatbed Scanner
Optical Resolution	1200 x 1200 DPI
Color Depth	48-bit
Scan Area	A4 / 216 x 297 mm
Scan Speed	10 sec per page (300 DPI)
Connectivity	USB 2.0 / USB 3.0
File Formats	JPG, PNG, PDF, TIFF, BMP

Connection

FUN FACTS

- The first image scanner was invented in 1957 by Russel A. Kirsch.
- High-end scanners can capture tiny details as small as 0.01 mm!
- Some scanners can scan in 3D!
- Scanning saves paper and helps the environment.

IN SIMPLE WORDS: A scanner is like a digital camera for documents. It captures what you see on paper and turns it into something your computer can use.



WEBCAM

SEE. CONNECT. SHARE.

A webcam is a digital camera that captures video and images in real time and sends them to a computer or network.

Real-time Video | Stay Connected | Capture & Share | Stream Live

COMMONLY USED FOR

- **Video Calls & Meetings** — Connect with family, friends or colleagues.
- **Online Classes** — Attend live classes and interact easily.
- **Live Streaming** — Stream your gameplay, events or webinars.
- **Recording** — Record videos, tutorials, vlogs and more.

HOW DOES A WEBCAM WORK?

1. **Light Enters Lens** — Light from the scene enters the webcam lens.
2. **Image Sensor Captures** — The image sensor converts the light into an electrical signal.
3. **Signal Processed** — The internal processor improves image quality.
4. **Data Sent to Computer** — The processed data is sent to the computer via USB.
5. **Video Shown on Screen** — The computer displays live video on the screen.

MAIN PARTS OF A WEBCAM

- **LENS** — Captures the video and focuses the image.
- **MICROPHONE** — Captures your voice for clear audio.
- **INDICATOR LIGHT** — Shows the webcam status (on/active).
- **BODY** — Holds all the internal components.
- **MOUNT / CLIP / STAND** — Helps to attach or place the webcam on a monitor, laptop or table.

TYPES OF WEBCAMS

1. BUILT-IN WEBCAM
Comes pre-installed in laptops, tablets or monitors.
Best for: General use, online classes, video calls

2. USB WEBCAM
Connects via USB port. Easy to install and use.
Best for: Video calls, streaming, recording

3. PTZ WEBCAM
Pan, Tilt, Zoom capabilities. Can be controlled remotely.
Best for: Conferences, webinars, large rooms

4. 4K WEBCAM
Ultra HD video quality for professional use.
Best for: Content creators, pro streamers

5. DOCUMENT WEBCAM
Focuses on documents, books or whiteboards instead of faces.
Best for: Teachers, presentations, document scanning

KEY FEATURES (WHAT TO LOOK FOR)

- **RESOLUTION (HD / FULL HD / 4K)** — Higher resolution gives clearer and sharper video.
- **FRAME RATE (FPS)** — 30 FPS is good for smooth video. 60 FPS is better.
- **AUTO FOCUS** — Keeps your image clear even when you move.
- **LOW LIGHT CORRECTION** — Improves video quality in dim lighting.
- **BUILT-IN MICROPHONE** — Captures clear audio without needing an external mic.
- **WIDE ANGLE** — Covers more area – useful for group meetings.
- **PRIVACY SHUTTER / COVER** — Protects your privacy when the webcam is not in use.

USES / APPLICATIONS

- **PERSONAL USE** — Video calls with family and friends
- **EDUCATION** — Online learning and virtual classrooms
- **BUSINESS** — Meetings, interviews and presentations
- **CONTENT CREATION** — YouTube videos, vlogs and tutorials
- **HEALTHCARE** — Teleconsultation and online check-ups
- **GAMING** — Live streaming your gameplay
- **SECURITY** — Surveillance and monitoring systems

WEBCAM CONNECTION

1. USB CONNECTION (MOST COMMON)

Plug and Play – No extra setup needed in most cases.

2. WIRELESS CONNECTION (SOME MODELS)

Useful for flexible placement without cables.

WEBCAM SPECIFICATIONS (EXAMPLE)

Resolution	1080p (Full HD)
Frame Rate	30 fps
Field of View	78°
Focus	Auto Focus
Microphone	Built-in Noise Reduction Mic
Connection	USB 2.0 / USB 3.0
Compatibility	Windows, macOS, Linux
Cable Length	1.5 Meter (Approx.)

FUN FACTS

- The first webcam was used to watch a coffee pot in 1991 at Cambridge University!
- Webcams are now used in space missions, wildlife cameras and even smart homes!
- Some webcams can detect faces, gestures and even background blur!

WEBCAM CARE TIPS

- Keep the lens clean for clear video.
- Place the webcam at eye level for best angle.
- Ensure good lighting in front of you.
- Unplug or cover the webcam when not in use.
- Use genuine drivers for better performance.

IN SIMPLE WORDS: A webcam is your window to the world. It helps you connect, communicate and create from anywhere! ♥

JOYSTICK

CONTROL IN YOUR HANDS!

A joystick is an input device that allows the user to control the direction of something on a screen by moving a stick in different directions.

DIRECTION
Detects movement in multiple directions.

CONTROL
Provides precise and smooth control.

INTERACTIVE
Enhances gaming and simulation experience.

VERSATILE
Used in games, machines, robots, and more.

WHERE IS IT USED?

GAMING
Used to control characters, vehicles and actions in games.

FLIGHT SIMULATION
Controls the movement of aircraft in simulators.

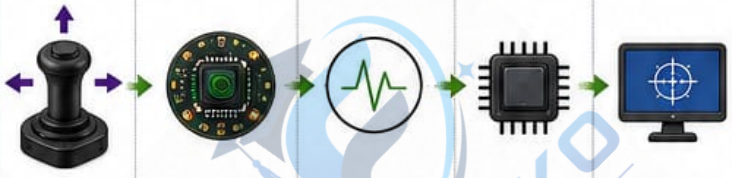
INDUSTRIAL MACHINES
Helps in operating cranes, robots and heavy machinery.

MEDICAL EQUIPMENT
Assists in controlling wheelchairs and devices.

ROBOTICS & AUTOMATION
Used to move robots and remote-controlled systems.

HOW DOES A JOYSTICK WORK?

1. **MOVE** — You move the stick in any direction.
2. **SENSOR DETECTS** — Sensors inside detect the direction and position.
3. **SIGNAL GENERATED** — The position is converted into electrical signals.
4. **DATA SENT** — The signals are sent to the connected device.
5. **ACTION PERFORMED** — The device performs the corresponding action.



PARTS OF A JOYSTICK

STICK / HANDLE
The part held and moved by the user.

BUTTON(S)
Perform additional actions like fire, select, etc.

GIMBAL
Allows the stick to move in multiple directions.

PIVOT
The point around which the stick tilts.

SENSOR
Detects the movement and direction of the stick.

BASE
Provides support and holds all the components.

TYPES OF JOYSTICKS

1. ANALOG JOYSTICK

Provides smooth and proportional control. Used in modern game controllers.

2. DIGITAL JOYSTICK

Detects movement in fixed directions only. Simple and durable.

3. FLIGHT JOYSTICK

Designed for flight simulators. Offers precise control.

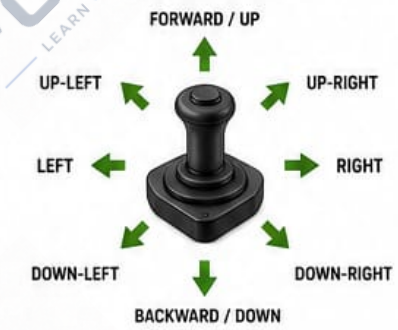
4. INDUSTRIAL JOYSTICK

Built for industrial use. Strong and reliable for machines.

5. THROTTLE JOYSTICK

Controls speed and thrust. Common in planes and racing.

JOYSTICK MOVEMENTS



KEY FEATURES

- **Multi-Directional Control** — Move in 2, 4 or 8 directions.
- **Precise Input** — Offers accurate and smooth control.
- **Ergonomic Design** — Comfortable grip for better use.
- **Durable & Reliable** — Built to withstand heavy usage.
- **Wide Compatibility** — Works with games, PC, robots, simulators and more.

BENEFITS

- Enhances user control and experience.
- Improves accuracy in games and machines.
- Easy to use and learn.
- Increases efficiency in industrial tasks.
- Useful in entertainment and professional fields.

HOW TO USE

- Hold the joystick handle comfortably.
- Move the stick in the desired direction.
- Use buttons (if any) for extra actions.
- The device will respond according to your input.

FUN FACTS

- The first joystick-like device was used in aircraft in the early 1900s!
- Joysticks are used in space missions to control robots and rovers.
- Game controllers with joysticks make gaming more exciting and realistic.
- Some wheelchairs use joysticks for easy movement.

IN SIMPLE WORDS

A joystick is like a magic stick that turns your movement into action. It gives you the power to control, play, create and explore!

SPEECH RECOGNITION SYSTEM

Turning Your Speech into Text & Commands

A Speech Recognition System allows computers to identify spoken words and convert them into text or perform actions.

HOW IT WORKS – THE PROCESS FLOW

1 SPEECH INPUT
You speak into a microphone.

2 AUDIO CAPTURE
Microphone captures the sound and converts it into electrical signals.

3 PREPROCESSING
Noise is removed and the audio is enhanced for better accuracy.

4 FEATURE EXTRACTION
Important features are extracted from the processed audio.

5 PATTERN MATCHING
Features are matched with stored patterns in the acoustic model and language model.

6 OUTPUT
The recognized speech is converted into text or used to perform a task.

Text Output | Action / Command

COMPONENTS OF SPEECH RECOGNITION SYSTEM

- **Microphone** – Captures the user's voice.
- **Signal Processing Unit** – Digitizes the audio and removes background noise.
- **Feature Extractor** – Extracts unique features like pitch, energy and frequency.
- **Acoustic Model** – Contains data about different sounds (acoustic units).
- **Language Model** – Understands the structure of words and sentences.
- **Decoder** – Combines results from models and finds the best match.
- **Output Module** – Displays the recognized text or executes the command.

SYSTEM ARCHITECTURE

User (Speaks) → Microphone → Signal Processing (Noise Removal & Enhancement) → Feature Extraction → Acoustic Model (Sound Patterns) → Decoder (Search & Match) → Language Model (Words & Grammar) → Output (Text / Command) → Text Output or Action Performed

APPLICATIONS

- **Voice Assistants** (Siri, Google Assistant, Alexa)
- **Dictation & Transcription** – Converts speech into written text.
- **Automotive Systems** – Hands-free control of navigation, calls, etc.
- **Assistive Technology** – Helps people with disabilities communicate.
- **Smart Home Devices** – Control devices using voice commands.
- **Customer Support** – Voice-based IVR and automated responses.

TYPES OF SPEECH RECOGNITION

1. Speaker Dependent
Recognizes only a specific person's voice.
Example: Voice unlock on mobile.

2. Speaker Independent
Recognizes voices of many people.
Example: Voice search, call center systems.

3. Continuous Speech
Recognizes natural flowing speech.
Example: Dictation, voice assistants.

CHALLENGES

- Background noise and poor audio quality
- Different accents, languages & dialects
- Similar sounding words
- Real-time processing requirements
- Privacy and security of voice data

KEY FEATURES

- High Accuracy
- Real-time Processing
- Noise Robustness
- Multi-language Support
- Adaptability & Learning
- Hands-free Interaction

EXAMPLE – VOICE COMMAND TO TEXT

You Speak	System Listens	Processing & Matching	Recognized Text	Action / Response
"What is the weather today?"	Capturing Audio..."	Analyzing & Matching...	"What is the weather today?"	"Today's weather is sunny 28°C."

BENEFITS

Increases Productivity | Hands-free Operation | Better User Experience | Accessible & Inclusive | Saves Time & Effort

> "Your Voice, Your Command, Technology That Understands You."

BARCODE READER

THE SMART WAY TO READ DATA

A Barcode Reader is an input device that reads barcodes, decodes the data and sends it to a computer or system.

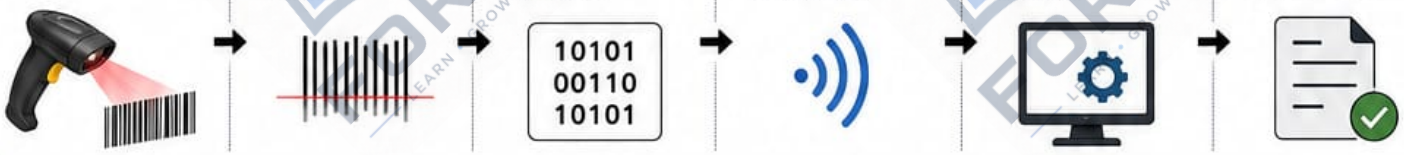
WHAT IS A BARCODE?

A barcode is a pattern of vertical lines (and spaces) that represents data such as numbers, letters or symbols.

Products · Price · Inventory · Healthcare

HOW DOES IT WORK?

1. **Scan** – The scanner emits light on the barcode.
2. **Capture** – The reflected light is captured by the sensor.
3. **Decode** – The data is decoded into readable characters.
4. **Transmit** – The decoded data is sent to the device or computer.
5. **Process** – The system processes the data as per the application.
6. **Output** – Useful information is displayed or stored for further use.



TYPES OF BARCODE READERS

1. Handheld Barcode Reader
Most scanmon type.
Portable and easy to use.
Connected via USB/Bluetooth.

2. Fixed Mount Barcode Reader
Mounted in one place.
Ideal for assembly lines and kiosks.

3. Wireless Barcode Reader
Connects via Bluetooth or Wi-Fi. Offers more mobility and flexibility.

4. Omnidirectional Barcode Reader
Reads barcodes from any direction. Used in retail checkouts.

COMPONENTS OF BARCODE READER

- **Light Source** – Illuminates the barcode.
- **Sensor** – Captures the reflected light.
- **Decoding Circuit** – Decodes the captured data.
- **Indicators** – LEDs / Beeps show success or error.
- **Interface** – Transfers data to computer or POS.
- **Trigger** – Activates the scanner.

TYPES OF BARCODES

1D BARCODES (Linear)

Data is represented in horizontal lines.

Examples: EAN, UPC, Code 39, Code 128, Codabar

2D BARCODES

Data is represented in both horizontal and vertical directions.

Examples: QR Code, Data Matrix, PDF417, Aztec Code

APPLICATIONS

- Retail & Supermarkets – Billing, Inventory, Price Check
- Warehouses & Logistics – Tracking, Sorting, Inventory
- Healthcare – Patient ID, Medicine Tracking
- Manufacturing – Parts Tracking, Quality Control
- Libraries – Book Issuing & Management
- Ticketing – Events, Travel, Boarding Passes
- Banks & Finance – Cheque Processing, Document Tracking

BENEFITS

- High Accuracy
- Fast Data Entry
- Reduces Human Errors
- Improves Productivity
- Cost Effective
- Easy to Use
- Works with Various Systems

COMMON FEATURES

- High Speed Scanning
- Reads 1D & 2D Barcodes
- Durable & Reliable
- Plug & Play Installation
- Long Battery Life (Wireless)
- Compatible with Multiple OS (Windows, Linux, Android, iOS)

BARCODE READER – FROM SCAN TO SOLUTION!

Barcode → Scan → Decode → Transmit → Process → Output / Use

FUN FACT

The first barcode was scanned in 1974 on a pack of Wrigley's gum in a supermarket!

DID YOU KNOW?

Barcodes can store a lot of information in a small space and can **be read in** a fraction of a second.

COMMON INTERFACES

USB · Bluetooth · Wi-Fi · RS232 · Keyboard Wedge

CARE TIPS

- Keep the scanner lens clean.
- Avoid exposure to water and extreme heat.
- Store in a safe place when not in use.

OUTPUT DEVICES

Devices that Present Information to the User

DEFINITION

Output devices are hardware devices that receive data from the computer and present the results to the user in a meaningful form.

TYPES OF OUTPUT

VISUAL
Information in visual form (text, images, videos, etc.)

AUDIO
Information in the form of sound.

HARD COPY
Information on paper.

COMMON OUTPUT DEVICES

1 MONITOR

Displays text, images, videos and graphics on the screen.

2 PRINTER

Produces output on paper. Used for documents, reports, photos, etc.

3 SPEAKERS

Produces sound or audio output (music, voice, alerts, etc.).

4 HEADPHONES

Provides private audio output through ears.

5 PLOTTER

Produces large size and high quality graphs and drawings (used in CAD, etc.).

6 PROJECTOR

Projects the output on a large screen or wall.

7 LED DISPLAY

Displays information using LED technology.

8 TOUCHSCREEN

Allows output to be displayed and also enables interaction.

9 BRAILLE DISPLAY

Outputs information in Braille for visually impaired users.

10 3D PRINTER

Creates three-dimensional objects as output.

IMPORTANCE / BENEFITS

Better Understanding
Presents data in a clear and effective manner.

Improved Communication
Helps in effective communication of information.

Saves Time
Quick results and outputs help in saving valuable time.

Increases Productivity
Helps users make better decisions and work efficiently.

User Satisfaction
Enhances user experience and satisfaction.

Output devices turn computer data into useful information for the user.

OUTPUT DEVICES

Devices that display or present processed information from a computer to the user.

1 TOUCH SCREEN

- Acts as both an input and output device.
- Displays information and accepts touch input.
- Used in smartphones, ATMs, kiosks, POS systems and more.

- Smartphones
- ATMs
- Kiosks
- POS Systems

2 MONITORS – TYPES

A. VDU
(Visual Display Unit)

- Traditional CRT monitor.
- Bulky and heavy.
- Higher power consumption.
- Lower picture quality compared to modern displays.

B. LCD
(Liquid Crystal Display)

- Thin and lightweight.
- Uses liquid crystals with backlight.
- Low power consumption.
- Better image quality than CRT.

C. LED
(Light Emitting Diode)

- Advanced form of LCD.
- Uses LED backlighting.
- Brighter display and better contrast.
- Energy efficient.
- Slim design with vibrant colors.

COMPARISON TABLE

Feature	VDU	LCD	LED
Thickness	Thick	Thin	Very Thin
Power Usage	High	Low	Very Low
Image Quality	Basic	Good	Excellent
Brightness	Low	Good	High
Technology	CRT	Liquid Crystal	LED Backlight

KEY POINTS

- Output devices present information to the user.
- Touch Screen works as both input and output.
- LED monitors are the most energy-efficient and provide the best display quality.

VDU
(VISUAL DISPLAY UNIT)
An Output Device

A Visual Display Unit (VDU) is an electronic output device that displays text, graphics, images, video and other information in a visual (human readable) form.

TYPES OF VDU

CRT (Cathode Ray Tube)
Traditional bulky monitors that use electron beams to produce images.

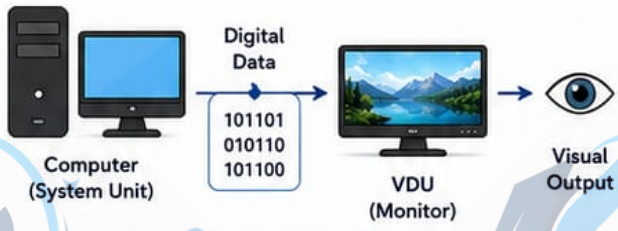
LCD (Liquid Crystal Display)
Uses liquid crystals to produce clear images with low power consumption.

LED Monitor
A type of LCD that uses LED backlight for better brightness and efficiency.

OLED Monitor
Uses Organic LEDS to provide better contrast, true colors and wider viewing angles.

Touch Screen VDU
Allows users to interact directly with the screen by touching it.

HOW VDU WORKS



The computer sends digital data to the VDU. The VDU processes this data and displays it on the screen in the form of text, images or videos.

PARTS OF VDU

1. **Display Screen** – Shows the output.
2. **Bezel (Frame)** – Surrounds and protects the screen.
3. **Control Buttons** – To adjust display settings (brightness, contrast, etc.).
4. **Stand** – Supports the monitor.
5. **Base** – Provides stability.

CHARACTERISTICS OF VDU

High Resolution
Provides clear and sharp images and text.

Good Color Quality
Displays accurate and vibrant colors.

Large Screen Size
Available in various sizes for better viewing.

Low Power Consumption
Modern VDUs consume less power.

Wide Viewing Angle
Images can be seen clearly from different positions.

USES OF VDU

- Used in computers for viewing results, documents, and multimedia.
- Used in schools, colleges and training centers for teaching and learning.
- Used in offices and businesses for productivity and communication.
- Used in entertainment for gaming, movies and videos.

BENEFITS OF USING VDU

- Easy to view information.
- Speeds up work and productivity.
- Displays graphics and data effectively.
- Supports multimedia applications.
- User friendly and interactive.

TIPS FOR HEALTHY USE OF VDU

- Keep the screen at least 20–28 inches away from your eyes.
- The top of the screen should be at or slightly below eye level.
- Take regular breaks (20-20-20 rule: Every 20 minutes, look at something 20 feet away for 20 seconds).
- Adjust brightness and contrast for comfortable viewing.
- Maintain good posture and proper lighting.

DID YOU KNOW?

The term "VDU" is commonly used in ergonomics and workplace safety to include any screen-based device that displays visual information.

PRINTER

Bringing Digital to Paper

A printer is an **output device** that produces text, images or graphics on paper or other media from digital data stored in a computer or other device.

KEY FUNCTIONS

- Produces hard copy (output) on paper.
- Used for text documents, images, reports, invoices and more.
- Increases productivity and organization.
- Available in various types for different needs.

HOW DOES A PRINTER WORK?

1. **DATA SENT** — The computer sends the print command and data to the printer.
2. **DATA PROCESSING** — The printer processes the data and prepares it for printing.
3. **PRINTING PROCESS** — Ink or toner is applied to the paper using print technology.
4. **PAPER HANDLING** — Paper is fed through the printer for printing.
5. **OUTPUT** — The final output is printed on paper or other media.

COMMON USES

- Documents & Reports
- Photos & Graphics
- Invoices & Bills
- School & College Projects
- Business Presentations
- Tickets & Receipts
- Labels & Packaging

TYPES OF PRINTERS

1. INKJET PRINTER
Uses liquid ink sprayed onto the paper. Best for color printing and photos.
- Low initial cost
- Good for home use

2. LASER PRINTER
Uses toner (powder) and heat to print on paper. Fast and high quality.
- High speed
- Ideal for offices

3. DOT MATRIX PRINTER
Uses pins to strike an ink ribbon to make dots on paper.
- Good for multi-part forms
- Durable and low running cost

4. THERMAL PRINTER
Uses heat to print on special thermal paper.
- Quiet and fast
- Used in receipts, tickets

5. MULTIFUNCTION PRINTER (All-in-One)
Combines printing, scanning, copying and sometimes faxing.
- Space saving
- Multi-purpose

PARTS OF A PRINTER

- **Paper Input Tray** — Holds the paper before printing.
- **Control Panel** — Buttons and display to operate the printer.
- **Cartridge / Toner** — Contains ink or toner used for printing.
- **Print Head / Laser Unit** — Transfers ink/toner on paper.
- **Paper Guide** — Keeps the paper aligned properly.
- **Output Tray** — Collects printed pages.
- **Paper Feed Roller** — Pulls the paper into the printer.

PRINTING TECHNOLOGIES

- **Inkjet Technology** — Sprays tiny droplets of ink on the paper.
- **Laser Technology** — Uses laser beam and toner to print images.
- **Dot Matrix Technology** — Uses pins to print characters as a pattern of dots.
- **Thermal Technology** — Uses heat to produce an image on thermal paper.

CONNECTION TYPES

USB	Wi-Fi	Ethernet	Bluetooth
Wired connection for fast and stable printing.	Wireless printing from computers, phones, tablets.	Network cable connection for shared use.	Wireless short-range connection for mobile devices.

PRINTER SPECIFICATIONS TO CONSIDER

- **Print Quality (DPI)** — Higher DPI gives better quality.
- **Print Speed (PPM)** — Pages Per Minute – more is better.
- **Paper Size Support** — A4, A3, Letter, Legal, etc.
- **Connectivity Options** — USB, Wi-Fi, Ethernet, Bluetooth.
- **Cost of Ink / Toner** — Check running cost, not just initial cost.

ADVANTAGES

- Provides permanent hard copy.
- Helps in documentation and record keeping.
- Useful for both personal and professional work.
- Improves presentation and communication.
- Available in various types for different needs.

DISADVANTAGES

- Ink or toner can be expensive.
- Requires regular maintenance.
- Uses paper and other supplies.
- Some printers are slow for large jobs.
- Takes up space.

CARE TIPS

- Keep the printer clean and dust-free.
- Use good quality paper and ink/toner.
- Do not use incompatible cartridges.
- Update drivers and software regularly.
- Print test pages regularly to avoid clogging.

DID YOU KNOW?

The first computer printer was invented in 1953 by Remington Rand. It weighed over 1 ton!

Black ink is not always black. It is usually a mixture of colors!

Use duplex (double-sided) printing to save paper and protect the environment.

A good printer makes your work look better on paper!

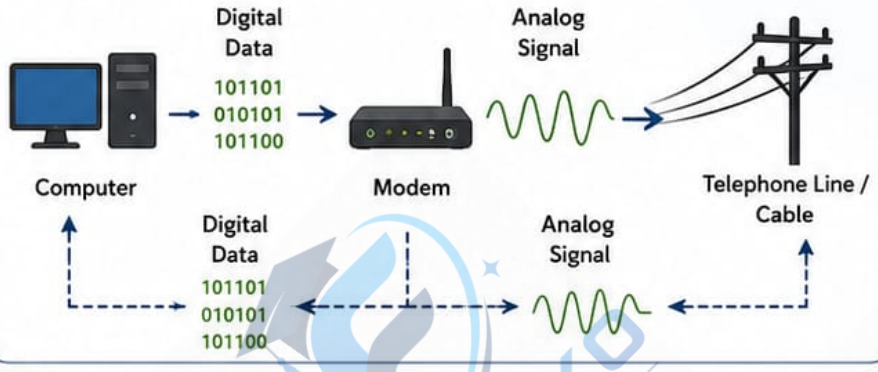
From documents to memories, printers make every page count!

MODEM

MODULATOR – DEMODULATOR

A modem is a device that converts digital data from a computer into analog signals for transmission over communication lines and converts incoming analog signals back into digital data.

HOW DOES A MODEM WORK?



TYPES OF MODEMS

Dial-up Modem
Uses telephone line to connect at low speed.

DSL Modem
Uses DSL (Digital Subscriber Line) for higher speed internet.

Cable Modem
Uses cable TV network to provide internet.

Fiber Modem (ONT)
Uses fiber optic connection for very high speed internet.

Wireless Modem (4G/5G)
Uses mobile network (4G/5G) to provide internet access.

FUNCTIONS OF MODEM

- **Modulation**
  Converts digital data into analog signals for transmission.
- **Demodulation**
  Converts received analog signals back into digital data.
- **Error Control**
  Detects and corrects errors in data transmission.
- **Compression**
  Reduces data size for faster and efficient transmission.

USES

- Provides internet access to homes and offices.
- Used in banks, schools, hospitals and businesses for online communication.
- Enables online activities like browsing, streaming, gaming, video calls, etc.
- Essential for data transfer in wide area networks (WAN).

KEY FEATURES

- Provides internet connectivity
- Supports data transmission both ways
- Ensures reliable and stable connection
- Varies in speed based on type and technology
- Easy to install and use

DID YOU KNOW?

The word "Modem" is derived from **MO**dulator – **DEM**odulator.

TIP

A modem is the **bridge** between your device and the internet.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10110
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DATA STRUCTURES
ALGORITHMS
COMPUTER NETWORKS
DATABASE SYSTEMS
#include <iostream>
using namespace std;
int main()
{
cout << "Hello, World!";
return 0;
}

OPERATING SYSTEM

Definition, Functions of Operating System

1 DEFINITION

"An Operating System (OS) is system software that acts as an interface between the user and computer hardware. It manages computer resources and provides common services for computer programs."

HOW OPERATING SYSTEM WORKS?

The OS manages all resources (CPU, Memory, Devices, Files, etc.) and provides services to programs and users.

EXAMPLES OF OPERATING SYSTEMS

2 FUNCTIONS OF OPERATING SYSTEM

01 PROCESS MANAGEMENT
The OS creates, schedules, and terminates processes. It handles multitasking and ensures smooth execution of programs.

02 MEMORY MANAGEMENT
It allocates and deallocates memory to programs as needed and keeps track of memory usage.

03 FILE MANAGEMENT
The OS organizes files and folders on storage devices. It allows creating, deleting, reading, writing, and searching files.

04 DEVICE MANAGEMENT
The OS manages input/output devices like printer, keyboard, mouse, display, and ensures efficient communication.

05 SECURITY MANAGEMENT
It protects data and resources from unauthorized access. It provides user authentication and access control.

06 USER INTERFACE
The OS provides an interface (Graphical or Command Line) so that users can interact with the system easily.

07 RESOURCE ALLOCATION
The OS allocates CPU time, memory, device access, and other resources to different programs and users efficiently.

08 COMMUNICATION
It enables communication between different software programs, processes, and users through shared resources.

09 ERROR DETECTION & HANDLING
The OS detects errors in hardware or software and takes appropriate actions to prevent system failure.

10 PERFORMANCE MONITORING
The OS monitors system performance and keeps track of resource usage to ensure maximum efficiency.

In simple words, an Operating System is the backbone of a computer system. Without OS, no program can run and no user can interact with the computer.

OPERATING SYSTEM

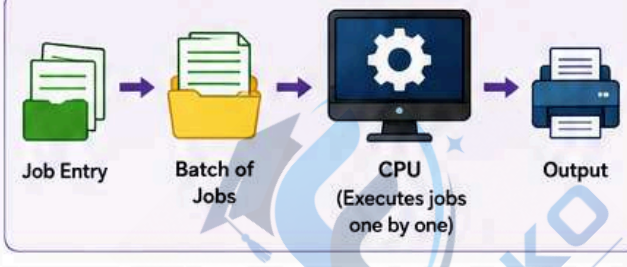
TYPES: BATCH MODE & MULTIPROGRAMMING

Operating Systems can be of many types depending on how they handle jobs (processes) and manage system resources.

1 BATCH MODE

In Batch Mode, jobs having similar needs are collected together and given to the computer as a batch. The OS executes them one by one without any interaction from the user during execution.

HOW IT WORKS



FEATURES

- Jobs are collected in batches.
- No user interaction during execution.
- Jobs are executed sequentially (one at a time).
- Suitable for large, non-interactive jobs.
- High turnaround time.

EXAMPLE

- Payroll processing
- Billing systems
- Bank statement generation
- End-of-day reports

ADVANTAGES & LIMITATIONS

Advantages

- Simple to operate.
- Good resource utilization for long, similar jobs.
- No user waiting for execution (after submission).

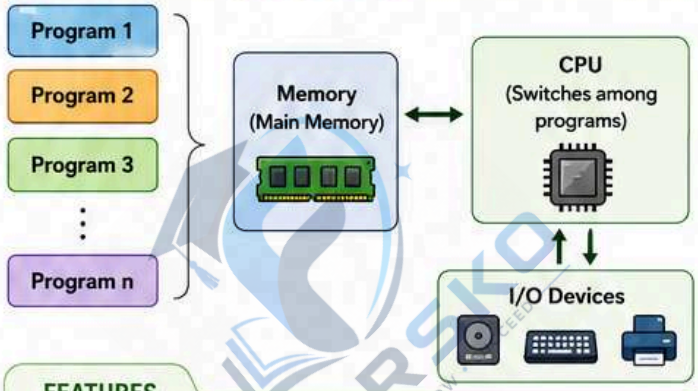
Limitations

- No user interaction during execution.
- High turnaround time.
- Difficult to debug errors.

2 MULTIPROGRAMMING

In Multiprogramming, multiple programs are kept in memory at the same time. The OS switches the CPU among these programs so that when one program waits for I/O, another program can use the CPU. This increases CPU utilization and system efficiency.

HOW IT WORKS



FEATURES

- Multiple programs are loaded into memory.
- CPU is allocated to programs in turns (CPU scheduling).
- When one program waits for I/O, another gets the CPU.
- Increases CPU utilization and system throughput.
- Provides better response time.

EXAMPLE

- Text editor + Compiler + Printer Spooler
- Web browser + Media player + Download manager
- OS running background services while you work

ADVANTAGES & LIMITATIONS

Advantages

- High CPU utilization.
- Better throughput.
- Reduces CPU idle time.
- Allows multiple jobs to make progress together.

Limitations

- More complex than batch systems.
- Needs more memory.
- Proper CPU scheduling is required.

In Simple Words

Batch Mode : Do one job at a time from a group (like a queue).

Multiprogramming : Do many jobs together by sharing the CPU smartly.

OPERATING SYSTEM

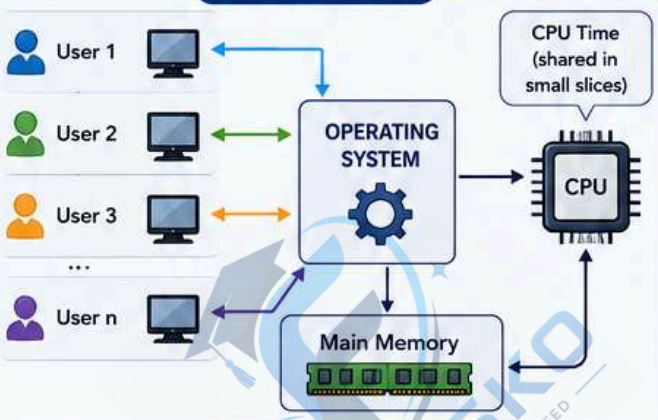
TYPES: TIMESHARING & ONLINE REAL TIME

Operating Systems can be of many types depending on how they handle jobs (processes) and manage system resources.

1 TIMESHARING SYSTEM

In a Timesharing System, many users can interact with the system simultaneously through terminals. The OS shares CPU time in small time slices (time quantum) among active users/processes, giving each user the illusion of having a dedicated computer.

HOW IT WORKS



The CPU switches from one user to another so quickly that every user gets the response in real-time.

FEATURES

- Many users can work simultaneously.
- CPU time is shared in small time slices.
- Provides quick response (interactive).
- Requires multiprogramming.
- Needs more memory.
- Fairness among users.

EXAMPLE

- Multi-user systems (Universities, Banks, Offices)
- UNIX/Linux multi-user environment
- Cloud computing platforms

ADVANTAGES & LIMITATIONS

Advantages

- Efficient CPU utilization
- Quick response for users
- Good for interactive applications
- Supports many users at once

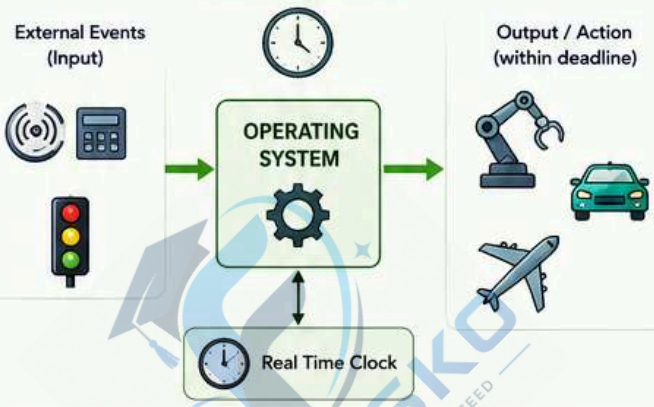
Limitations

- More complex than batch systems
- Requires more memory.
- Overhead due to context switching

2 ONLINE REAL TIME SYSTEM

In an Online Real Time System, the OS must respond to inputs and produce outputs within a strict time limit (deadline). Correctness depends not only on the logical result but also on the time at which the result is produced.

HOW IT WORKS



The system monitors time and ensures that every task is completed within its deadline.

FEATURES

- Strict timing constraints.
- Fast and predictable response.
- Reliability and accuracy are critical.
- High priority to time-critical tasks.
- Used in embedded systems.
- Hard real time and Soft real time.

EXAMPLE

- Industrial control systems (Robots, PLCs)
- Medical devices (Heart monitors, Ventilators)
- Air traffic control systems
- Automobile systems (ABS, Airbag)

ADVANTAGES & LIMITATIONS

Advantages

- Predictable and reliable
- High accuracy
- Essential for time-critical tasks
- Improves safety and performance

Limitations

- Very strict timing constraints
- Complex to design and test
- Expensive hardware/software
- Not suitable for non-critical jobs

IN SIMPLE WORDS

Timesharing System : Many users work at the same time. The OS shares CPU time among them so that everyone feels they have their own system.

Online Real Time System : The system must respond within a fixed time limit. If it is late, the result may be wrong or even dangerous.

OPERATING SYSTEM

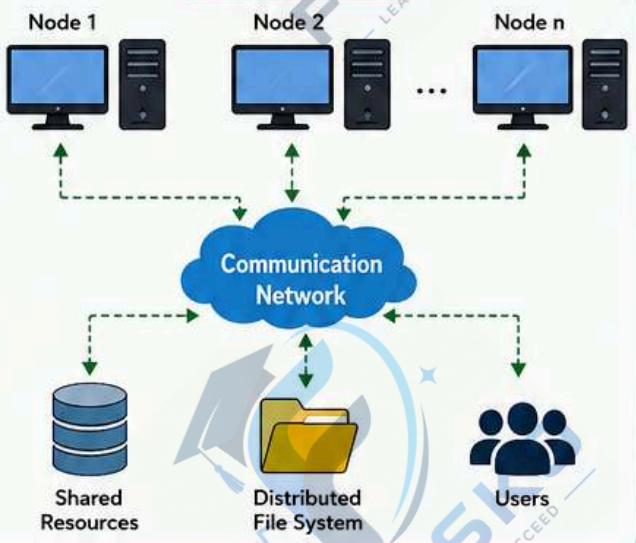
TYPES: DISTRIBUTED O.S. & BOOTING PROCESS

Operating Systems come in different types and work in different ways to manage resources, users and processes efficiently.

1 DISTRIBUTED OPERATING SYSTEM

A Distributed Operating System (DOS) manages a group of independent computers and makes them appear to users as a single coherent system. It shares resources, balances the load and provides high reliability and scalability.

HOW IT WORKS



FEATURES

- Resource sharing (hardware, software, data).
- Transparency – users are unaware of distribution.
- Scalability – system can grow by adding more nodes.
- High reliability and availability.
- Load balancing for better performance.
- Supports concurrent users and processes.

EXAMPLES

- Google Distributed File System (GFS)
- Amoeba
- Plan 9 from Bell Labs
- Hadoop Distributed File System (HDFS)

ADVANTAGES

- High availability
- Better fault tolerance
- Resource sharing
- Scalability
- Cost effective

LIMITATIONS

- Complex to design and manage
- Network dependency
- Security is more challenging
- Debugging is difficult

IN SIMPLE WORDS

A Distributed OS makes multiple computers work together as one system, sharing resources and workload over a network.

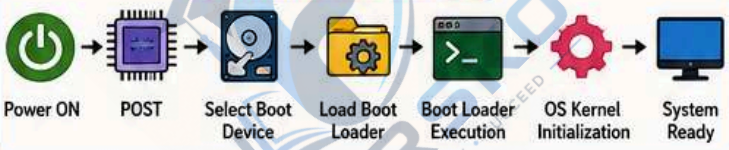
2 BOOTING PROCESS

Booting is the process of starting or restarting a computer. It loads the Operating System into main memory (RAM) and prepares the system for use.

STEPS IN BOOTING PROCESS

1. **Power ON**
   The user presses the power button. The system receives power.
2. **POST (Power-On Self Test)**
   BIOS/UEFI performs hardware check (CPU, RAM, keyboard, etc.). If all is well, it looks for boot device.
3. **Boot Device Selection**
   BIOS/UEFI selects the boot device (HDD/SSD, USB, CD/DVD, Network) as per the boot order.
4. **Load Boot Loader**
   The boot sector (MBR/GPT or EFI System Partition) is loaded into memory.
5. **Boot Loader Execution**
   Boot loader (e.g., GRUB, Windows Boot Manager) loads the kernel of the Operating System.
6. **OS Kernel Initialization**
   The kernel initializes system components, drivers, memory management and services.
7. **System Ready**
   The OS is fully loaded and control is given to system services. Login screen / desktop appears.

BOOTING PROCESS FLOW



IMPORTANCE

- Ensures correct startup of the system.
- Loads the OS safely and efficiently.
- Detects hardware faults early.
- Essential for system stability and security.

IN SIMPLE WORDS

Booting is like waking up a computer. It checks hardware, loads the OS and makes the system ready to use.