UNIT – 1 : INTRODUCTION TO COMPUTERS

Points to be covered in this topic

1.1 INTRODUCTION TO COMPUTERS

A computer is one of the **most important electronic devices** used in the modern world for performing various tasks quickly, accurately and efficiently. It is designed to accept data from the user, **process that data according to a set of instructions,** store it for future use and produce meaningful information as output. Computers are capable of performing millions of calculations within a very short period of time, which makes them extremely useful in every field of life.

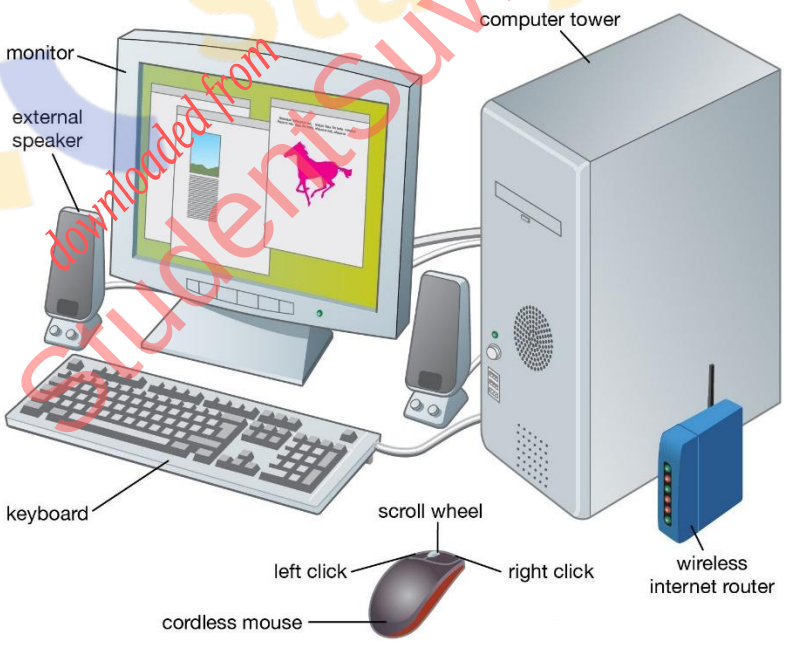
Today, computers are used in **homes, schools, hospitals, banks, industries, research centers**, **transportation systems, communication** networks and government organizations. From simple calculations to complex scientific operations, computers play a major role in increasing productivity and reducing human effort. The development of computers has completely transformed the way people work, communicate, learn and **store information**.

The word "**Computer**" is derived from the Latin word "**Computare**", which means "to calculate". Earlier computers were mainly used for numerical calculations, but modern computers can perform a wide variety of functions such as data processing, multimedia editing, internet browsing, online communication, gaming and artificial intelligence applications.

1.2 DEFINITION OF COMPUTER

A computer can be defined as an electronic programmable machine that accepts raw data as input, processes it according to **predefined instructions**, stores the processed data and produces meaningful information as output. A computer works under the control of programs and follows the instructions provided by the user or software.

The functioning of a computer is generally based on the IPO cycle, which stands for Input, Process and Output. In this cycle, data is first entered into the computer through input devices such as keyboard or mouse. **The Central Processing Unit** (CPU) processes the data according to instructions, and the processed information is then displayed to the user through output devices such as monitor or printer.



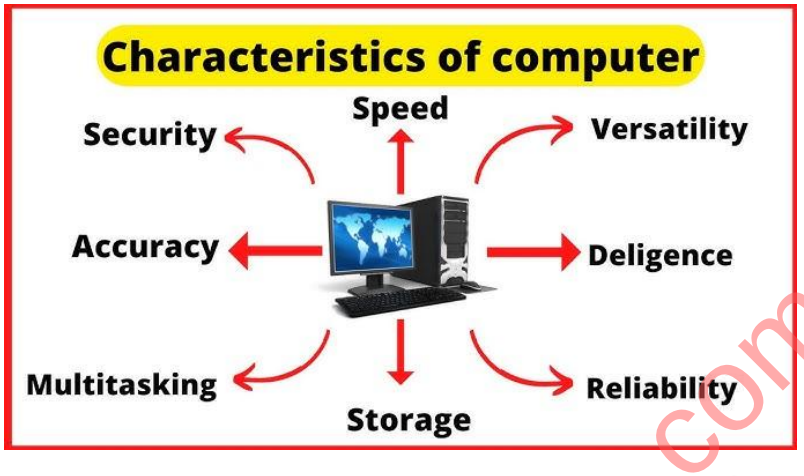
The basic operations performed by a computer include:

✓ **Inputting data**
✓ **Processing data**
✓ **Producing output**
✓ **Storing information**

Computers cannot think or make decisions on their own like humans. They simply follow the instructions provided to them and perform operations with great speed and accuracy.

1.3 CHARACTERISTICS OF COMPUTERS

Computers possess several unique characteristics that make them highly useful and reliable in different fields. These characteristics distinguish computers from human beings and other machines.



i. Speed

One of the most important characteristics of a computer is its extremely high speed. A computer can perform millions or even billions of calculations within a few seconds. Tasks that may take several hours for a human to complete can be finished by a computer in a fraction of a second. Due to this high processing speed, computers are widely used in scientific calculations, banking systems and data analysis.

ii. Accuracy

Computers are capable of producing highly accurate results if the input data and instructions are correct. Errors in computer output usually occur because of incorrect data entry or faulty programming rather than mistakes made by the computer itself. This high level of accuracy makes computers reliable for **important applications such as medical diagnosis**, financial accounting and engineering design.

iii. Storage Capacity

Computers have a very large storage capacity and can store huge amounts of data and information for a long period of time. Modern storage devices such as hard disks, SSDs and cloud storage systems can hold millions of files, documents, images and videos. Stored data can also be retrieved quickly whenever required.

iv. Diligence

Unlike human beings, computers do not become tired or bored after performing repetitive tasks for a long time. They can work continuously for many hours without any reduction in speed, efficiency or accuracy. This ability to work continuously without fatigue is known as diligence.

v. Versatility

Computers are versatile machines because they can perform different types of tasks in various fields. The same computer can be used for **education**, **business management, entertainment**, **communication, programming, designing** and scientific research depending upon the software installed in it.

vi. Automation

Computers can perform operations automatically once the instructions and programs are provided. After starting a task, the computer completes the entire operation without requiring continuous human intervention. **This characteristic helps in reducing manual effort and improving efficiency**.

vii. Reliability

Computers are highly reliable machines because they can consistently produce the same results for the same input and instructions. They are widely trusted in organizations where accuracy and consistency are very important.

1.4 HISTORY AND GENERATIONS OF COMPUTERS

The history of computers shows the continuous development of technology from simple mechanical devices to highly advanced modern computers. The evolution of computers is generally divided into five generations based on the technology used in their development.

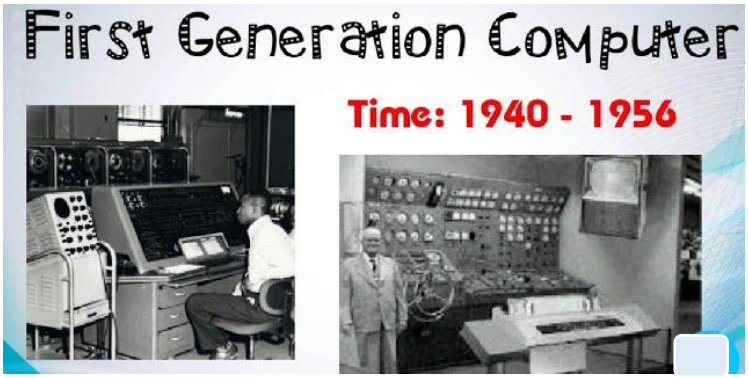
Generation of Computer

(1st to 5th)

1.4.1 FIRST GENERATION COMPUTERS (1940–1956)

The first generation computers used vacuum tubes as the main electronic component for processing data. These computers were extremely large in size and occupied entire rooms. They consumed a huge amount of electricity and generated excessive heat during operation.

Programming in first generation computers was done using machine language, which was difficult to understand and use. These computers were slow, expensive and less reliable compared to modern computers.



Characteristics of First Generation Computers

✓ **Used vacuum tubes**
✓ **Very large in size**
✓ **Consumed high power**
✓ **Produced excessive heat**
✓ **Used machine language**

Examples

✓ **ENIAC**
✓ **UNIVAC**

1.4.2 SECOND GENERATION COMPUTERS (1956–1963)

In the second generation, transistors replaced vacuum tubes. Transistors were much smaller, faster and more reliable than vacuum tubes. **As a result, second generation computers became smaller in size and consumed less electricity.**

During this period, assembly language and high-level programming languages such as COBOL and FORTRAN were introduced. These computers were more efficient and less expensive than first generation computers.

Characteristics of Second Generation Computers

✓ **Used transistors**
✓ **Smaller and faster**
✓ **Less heat generation**

✓ **More reliable**

✓ **Supported high-level languages**

Examples

✓ **IBM 1401**

✓ **IBM 7094**

1.4.3 THIRD GENERATION COMPUTERS (1964–1971)

The third generation computers used Integrated Circuits (ICs), which combined multiple electronic components on a single chip. The use of ICs greatly increased processing speed and reduced the size of computers.

These computers were more powerful, accurate and reliable. Operating systems also became popular during this generation, making computers easier to use.

Characteristics of Third Generation Computers

✓ **Used Integrated Circuits (ICs)**

✓ **High processing speed**

✓ **Smaller size**

✓ **Improved reliability**

✓ **Operating systems introduced**

Example

✓ **IBM System/360**

1.4.4 FOURTH GENERATION COMPUTERS (1971–PRESENT)

The fourth generation computers are based on microprocessor technology. A microprocessor contains thousands of integrated circuits on a single silicon chip. **This development led to the creation of personal computers** (PCs) that became affordable and widely available.

Modern desktop computers, laptops and mobile devices belong to the fourth generation. These computers are highly efficient, portable and capable of performing multiple tasks simultaneously.

Characteristics of Fourth Generation Computers

✓ **Used microprocessors**

✓ **Very small size**

✓ **High speed and accuracy**

✓ **Low maintenance cost**

✓ **User-friendly systems**

Examples

✓ **Desktop Computer**
✓ **Laptop**
✓ **Tablet**

1.4.5 FIFTH GENERATION COMPUTERS (PRESENT & FUTURE)

The fifth generation computers are based on **Artificial Intelligence** (AI) and advanced technologies such as robotics, machine learning and natural language processing. These computers are designed to simulate human intelligence and decision-making abilities.

Fifth generation computers are capable of understanding speech, recognizing patterns and solving complex problems intelligently. Modern AI systems, robots and smart assistants are examples of fifth generation computing technology.

Characteristics of Fifth Generation Computers

✓ **Artificial Intelligence based**
✓ **Natural language processing**
✓ **Advanced automation**
✓ **Intelligent decision making**
✓ **Extremely high processing capability**

Examples

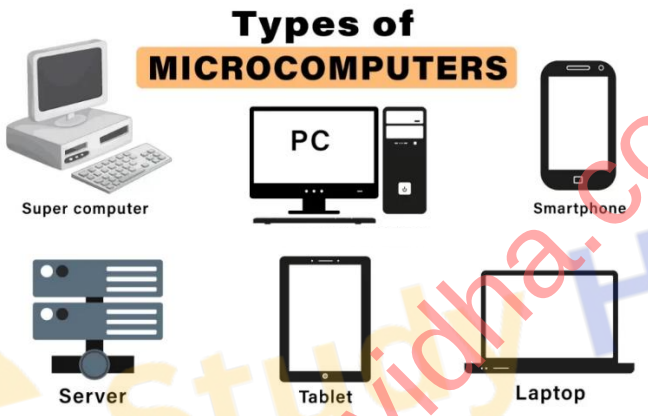
✓ **AI Robots**
✓ **Smart Assistants**
✓ **Expert Systems**

1.5 CLASSIFICATION OF COMPUTERS

Computers are classified into different categories on the basis of their size, processing power and purpose.

i. Micro Computer

Micro computers are small-sized computers designed for individual users. They are commonly used in homes, schools, offices and small businesses. These computers are affordable, easy to use and capable of performing various general-purpose tasks.



Examples

- ✓ **Desktop Computer**
- ✓ **Laptop**
- ✓ **Personal Computer (PC)**

ii. Mini Computer

Mini computers are medium-sized computers that can support multiple users simultaneously. They are more powerful than micro computers and are generally used in small organizations and industries.

Mini computers are suitable for managing databases, industrial operations and business applications.

iii. Mainframe Computer

Mainframe computers are large and powerful computers capable of processing massive amounts of data at very high speed. They are used by banks, railways, airlines and government organizations where thousands of users access data simultaneously.

These computers provide high reliability, security and storage capacity.

iv. Super Computer

Super computers are the fastest and most powerful computers available. They are specially designed for complex scientific and engineering applications that require extremely high processing speed.

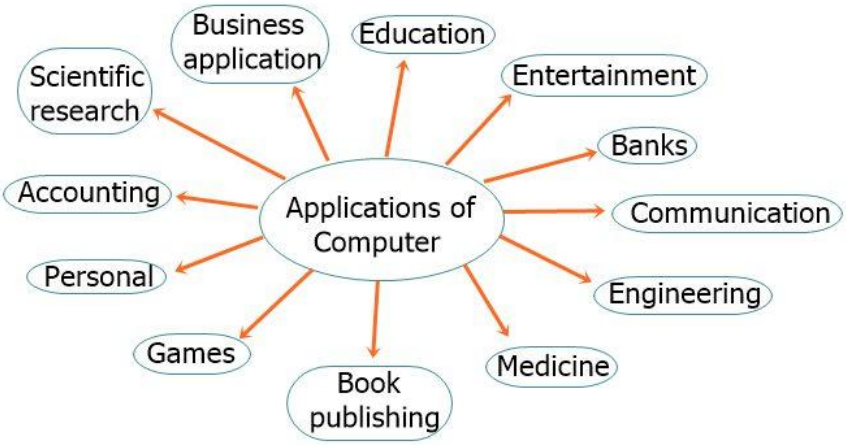
Super computers are used in weather forecasting, space research, nuclear simulations and scientific research.

Example

✓ **PARAM Supercomputer**

1.6 APPLICATIONS OF COMPUTERS

Computers are widely used in almost every field of modern life because of their speed, accuracy, storage capacity and reliability. They help individuals and organizations perform tasks more efficiently and reduce manual effort. The use of computers has increased rapidly due to technological advancements and internet connectivity.



i. Education

Computers have revolutionized the field of education by making learning more interactive, accessible and effective. Schools, colleges and universities use computers for teaching, preparing presentations, conducting examinations and maintaining student records. Students can access online learning platforms, digital libraries and educational videos to improve their knowledge and skills.

Computers also support e-learning and virtual classrooms, allowing students to study from any location through the internet.

Uses in Education

✓ **Online classes and virtual learning**
✓ **Preparation of assignments and projects**
✓ **Digital libraries and e-books**
✓ **Computer-based examinations**
✓ **Educational software and simulations**

ii. Banking

Banks use computers to manage customer accounts, perform financial transactions and maintain records securely. **Computers help banks process transactions quickly and accurately**. Services such as online banking, ATM operations, mobile banking and electronic fund transfer are all based on computer technology.

Computers have improved the efficiency and security of banking operations and reduced paperwork significantly.

Uses in Banking

✓ **Online banking services**
✓ **ATM transactions**
✓ **Account management**
✓ **Loan processing**
✓ **Digital payment systems**

iii. Healthcare

Computers play an important role in hospitals, clinics and medical research centers. They are used for maintaining patient records, diagnosing diseases, conducting medical tests and monitoring patients. Advanced medical equipment also depends on computer technology for accurate results.

Doctors use computers to access patient history, prepare medical reports and communicate with specialists across the world.

Uses in Healthcare

✓ **Patient record management**
✓ **Medical imaging and diagnosis**
✓ **Laboratory testing**
✓ **Online consultation**
✓ **Medical research and analysis**

iv. Business

In business organizations, computers are used for accounting, payroll management, inventory control, communication and decision-making. Businesses use computer software to maintain financial records, prepare reports and analyze market trends.

Computers help organizations improve productivity, reduce operational costs and manage data efficiently.

Uses in Business

✓ **Accounting and billing**
✓ **Payroll processing**
✓ **Inventory management**
✓ **Data analysis and reporting**
✓ **Online marketing and communication**

v. Communication

Computers have completely transformed communication systems by enabling fast and easy exchange of information across the world. Through internet services, people can send emails, make video calls, share files and communicate instantly.

Social media platforms, messaging applications and video conferencing tools are all based on computer and networking technologies.

Uses in Communication

✓ **Email services**
✓ **Video conferencing**
✓ **Social networking**

✓ **Instant messaging**
✓ **File sharing through internet**

vi. Entertainment

Computers are widely used in the entertainment industry for gaming, movie production, animation, music editing and multimedia applications. Modern computer graphics and editing software are used to create visual effects, animated movies and digital content.

People also use computers to watch movies, listen to music and play online games.

Uses in Entertainment

✓ **Gaming applications**
✓ **Video editing and animation**
✓ **Music production**
✓ **Watching movies and streaming**
✓ **Graphic designing**

vii. Science and Engineering

Scientists and engineers use computers for research, data analysis, simulations and designing complex systems. Computers help researchers solve scientific problems quickly and accurately.

Engineering applications such as **Computer-Aided Design** (CAD) and simulations depend heavily on computer systems.

Uses in Science and Engineering

✓ **Scientific research**
✓ **Weather forecasting**
✓ **Space exploration**
✓ **Engineering design and simulation**
✓ **Data analysis and modeling**

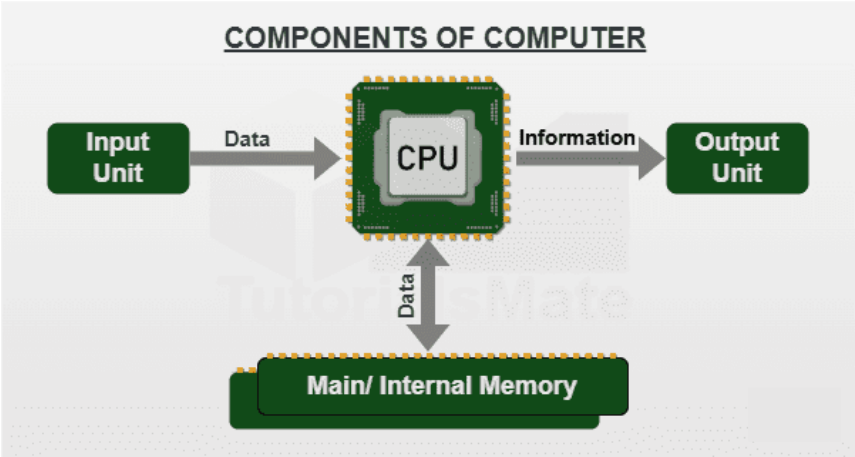
1.7 COMPONENTS OF A COMPUTER SYSTEM

A computer system consists of different hardware components that work together to perform various operations. Each component has a specific function and contributes to the overall functioning of the computer.

The major components of a computer system are:

✓ **Input Unit**
✓ **Output Unit**
✓ **Central Processing Unit (CPU)**
✓ **Memory Unit**

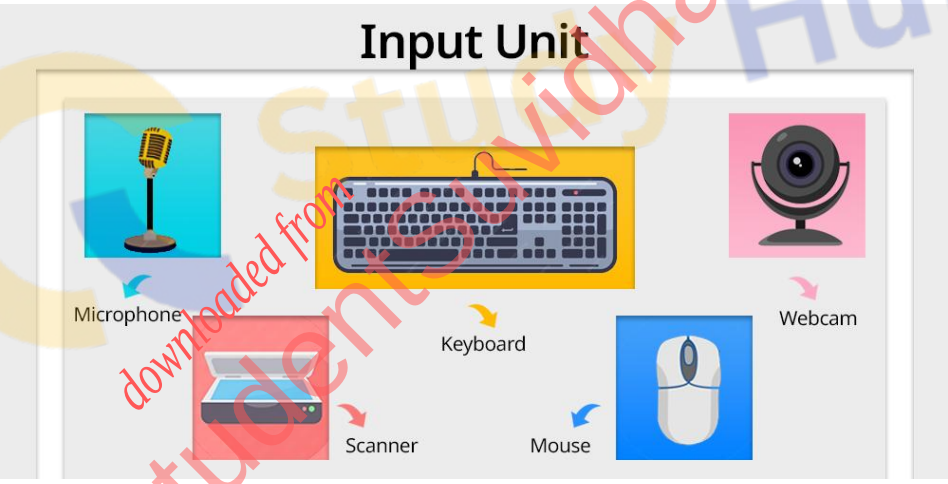
These components communicate with each other to process data and generate meaningful information.



1.7.1 INPUT UNIT

The input unit is the part of the computer system that is used to enter data and instructions into the computer. It acts as a communication link between the user and the computer system. Input devices convert human-readable data into machine-readable form so that the computer can process it.

Without input devices, the computer cannot receive instructions or data from the user.



Functions of Input Unit

i. Accepts data and instructions from the user.

ii. Converts data into machine-readable form.

iii. Transfers input data to the CPU for processing.

Common Input Devices

Keyboard: The keyboard is the most commonly used input device. It is used for typing text, numbers and commands into the computer.

Mouse: A mouse is a pointing device used to control the movement of the cursor on the screen. It helps users select items, open files and interact with graphical interfaces.

Scanner: A scanner is used to convert printed documents and images into digital form so that they can be stored in the computer.

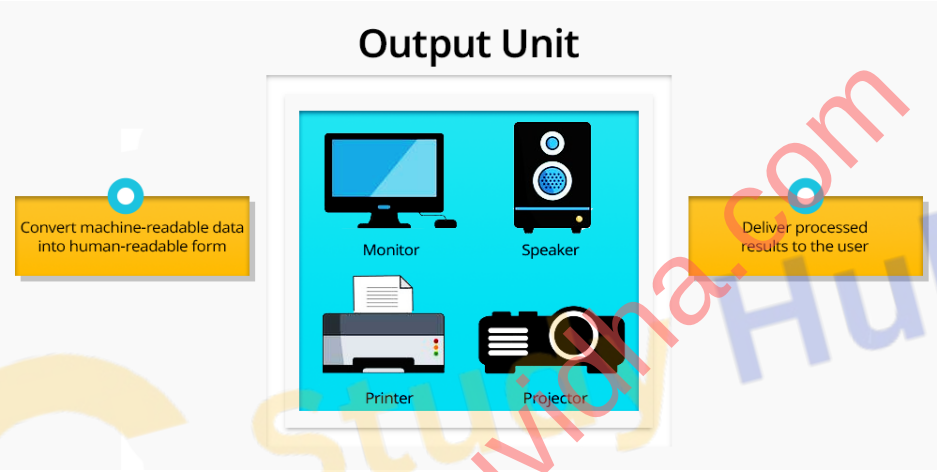
Microphone: A microphone is used to input sound or voice into the computer system.

Webcam: A webcam captures images and videos and is mainly used for video conferencing and online communication.

1.7.2 OUTPUT UNIT

The output unit is responsible for displaying the processed information to the user. It converts machine-readable data into human-readable form. Output devices allow users to view, hear or print the results generated by the computer.

The output produced by the computer is known as information because it is meaningful and useful to the user.



Functions of Output Unit

i. Receives processed data from the computer.

ii. Converts machine language into human-readable form.

iii. Displays or presents the final output to the user.

Common Output Devices

Monitor: A monitor is the most commonly used output device. It displays text, images and videos generated by the computer.

Printer: A printer produces a hard copy of documents and images on paper.

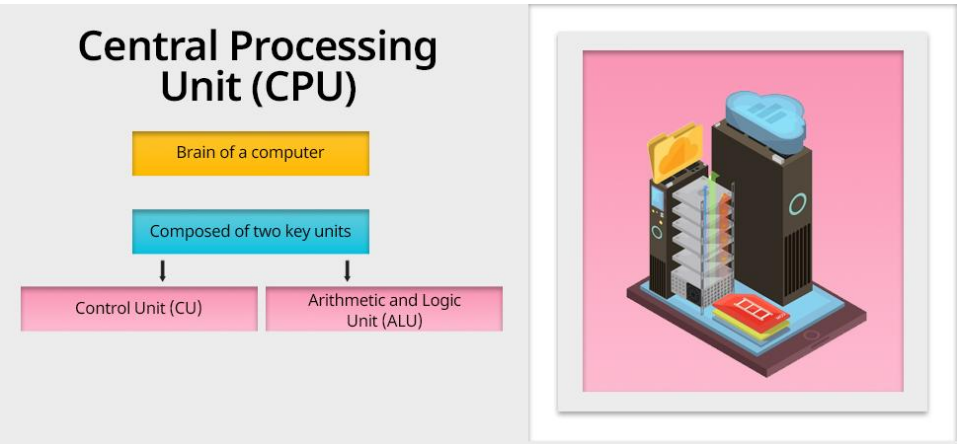
Speaker: Speakers are used to produce sound output from the computer.

Projector: A projector displays computer output on a large screen and is commonly used in classrooms and seminars.

1.7.3 CENTRAL PROCESSING UNIT (CPU)

The Central Processing Unit (CPU) is considered the “Brain of the Computer” because it controls and performs all operations within the computer system. It processes instructions, performs calculations and manages the activities of all hardware components.

The CPU receives input data, processes it according to instructions and sends the results to the output unit.



The CPU mainly consists of two important units:

✓ **Arithmetic Logic Unit (ALU)**
✓ **Control Unit (CU)**

i. Arithmetic Logic Unit (ALU)

The Arithmetic Logic Unit is responsible for performing all arithmetic and logical operations in the computer system. Arithmetic operations include addition, subtraction, multiplication and division, while logical operations include comparison and decision-making processes.

The ALU plays a major role in data processing and calculations.

Functions of ALU

✓ **Performs arithmetic calculations**
✓ **Performs logical comparisons**
✓ **Processes mathematical operations**
✓ **Helps in decision-making operations**

ii. Control Unit (CU)

The Control Unit controls and coordinates all operations of the computer system. It manages the flow of data between the input unit, output unit, memory unit and ALU.

The Control Unit does not perform calculations itself, but it directs all operations and ensures that instructions are executed correctly.

Functions of CU

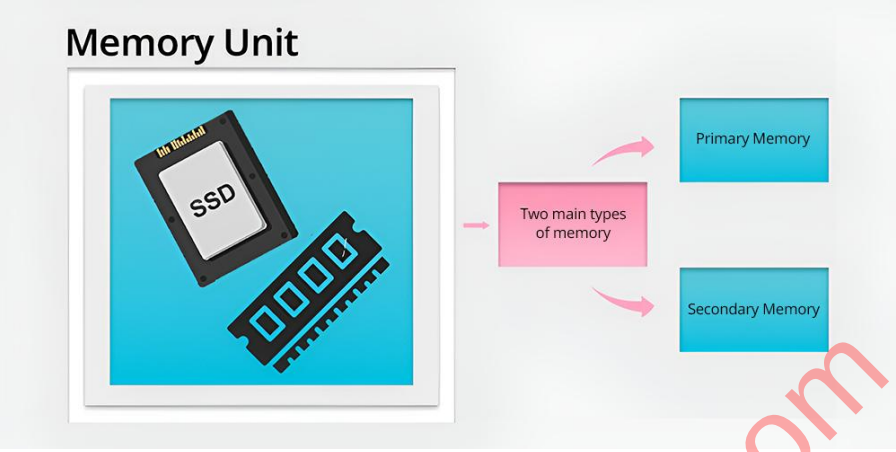
✓ **Controls all computer operations**
✓ **Coordinates hardware components**
✓ **Directs the execution of instructions**
✓ **Manages data flow inside the computer**

1.7.4 MEMORY UNIT

The memory unit is responsible for storing data, instructions and processed information in the computer system. It allows the computer to store information temporarily or permanently for future use.

Memory is an essential part of a computer because processing cannot take place without storage.

The memory unit is broadly classified into two types:



✓ **Primary Memory**

✓ **Secondary Memory**

i. Primary Memory

Primary memory is also known as main memory. It stores data and instructions that are currently being processed by the CPU. Primary memory is fast but has limited storage capacity.

Types of Primary Memory

RAM (Random Access Memory): RAM is a temporary memory used to store data while the computer is running. Data stored in RAM is lost when the computer is switched off.

ROM (Read Only Memory): ROM is permanent memory that stores important instructions required to start the computer system.

ii. Secondary Memory

Secondary memory is used for permanent storage of data and programs. It has a larger storage capacity compared to primary memory.

Examples of Secondary Memory

✓ **Hard Disk**

✓ **SSD**

✓ **Pen Drive**

✓ **CD/DVD**

✓ **Memory Card**

Secondary storage devices are used to store files, software, videos, images and documents for long-term use.

1.8 DATA, INFORMATION AND KNOWLEDGE

Data, information and knowledge are important concepts in computer science and information technology. These terms are closely related to each other, but each of them has a different meaning and purpose. Computers mainly work with data and convert it into meaningful information that can be used for decision-making and gaining knowledge.

i. Data

Data refers to raw facts and figures that do not have any specific meaning when considered individually. Data can consist of numbers, text, symbols, images or observations collected from different sources. Raw data alone is not useful unless it is processed and organized properly.

For example, marks obtained by students such as 85, 90 and 78 are simply raw facts and therefore represent data.

Data is entered into the computer through input devices and stored for processing. The computer processes the data according to instructions and converts it into meaningful information.

Characteristics of Data

✓ **Raw and unprocessed facts**

✓ **May not have meaning independently**

✓ **Used as input for processing**

✓ **Can exist in different forms such as numbers, text or images**

Examples of Data

✓ **Student marks**

✓ **Employee attendance records**

✓ **Temperature readings**

✓ **Product prices**

ii. Information

Information is processed and organized data that becomes meaningful and useful to the user. When data is analyzed, arranged and interpreted properly, it produces information.

For example, the statement "**The student scored 85 marks in the examination**" is meaningful and therefore represents information.

Information helps users understand situations, solve problems and make decisions. Computers are mainly used to process large amounts of data and generate useful information quickly and accurately.

Characteristics of Information

✓ **Processed and organized data**

✓ **Meaningful and useful**

✓ **Helps in decision-making**

✓ **Accurate and understandable**

Examples of Information

✓ **Examination result reports**
✓ **Bank account statements**
✓ **Salary reports**
✓ **Sales analysis reports**

iii. Knowledge

Knowledge refers to the understanding and awareness gained from information and experience. It is the ability to use information effectively for solving problems and making intelligent decisions.

For example, after analyzing a student's performance report, a teacher may conclude that the student is excellent in mathematics. This understanding represents knowledge.

Knowledge is considered more valuable because it helps individuals apply information in practical situations.

Characteristics of Knowledge

✓ **Derived from information and experience**

✓ **Helps in decision-making and problem-solving**

✓ **Involves understanding and interpretation**

✓ **Used for practical application**

Examples of Knowledge

✓ **Understanding business trends from sales reports**

✓ **Identifying weak subjects of students from exam results**

✓ **Predicting weather conditions from collected data**

Difference Between Data, Information and Knowledge

Basis	Data	Information	Knowledge
Meaning	Raw facts and figures	Processed data	Understanding gained from information
Nature	Unorganized	Organized	Applied understanding
Usefulness	Limited	Useful	Highly valuable
Example	85, 90, 78	Student scored 85 marks	Student performed well

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1.9 HARDWARE AND SOFTWARE

A computer system consists of two major elements known as hardware and software. Both hardware and software are essential for the proper functioning of a computer system. Hardware provides the physical structure of the computer, while software provides the instructions required to operate the hardware.

Hardware and software are interdependent, which means one cannot function properly without the other.

i. HARDWARE

Hardware refers to the physical components of a computer system that can be seen and touched. These components perform different operations such as input, processing, storage and output.

Hardware includes all electronic and mechanical parts connected to the computer system.

Examples of Hardware

✓ **Keyboard**
✓ **Mouse**
✓ **Monitor**

✓ **CPU**
✓ **Printer**
✓ **Hard Disk**

Hardware devices are classified into different categories depending upon their function.

Types of Hardware

a. Input Hardware

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

Examples

✓ Keyboard
✓ Mouse
✓ Scanner
✓ Microphone

b. Output Hardware

Output hardware devices display or present processed information to the user.

Examples

✓ Monitor
✓ Printer
✓ Speaker
✓ Projector

c. Storage Hardware

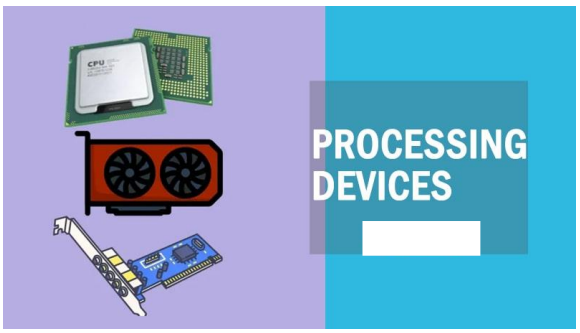
Storage hardware devices are used to store data and programs permanently or temporarily.

Examples

✓ Hard Disk
✓ SSD
✓ Pen Drive
✓ CD/DVD

d. Processing Hardware

Processing hardware performs calculations and controls computer operations.



Example

✓ CPU

ii. SOFTWARE

Software refers to a collection of programs, instructions and procedures that tell the computer what tasks to perform. Software acts as an interface between the user and the hardware.

Unlike hardware, software cannot be physically touched because it consists of programs and digital instructions.

Without software, hardware devices cannot function properly because computers require instructions to perform operations.

Types of Software

Software is mainly classified into two categories:

✓ **System Software**
✓ **Application Software**

a. System Software

System software is designed to manage and control computer hardware and provide a platform for running application software. It controls the internal operations of the computer system.

The operating system is the most important system software.

Functions of System Software

✓ Controls hardware devices

✓ Manages memory and files

✓ Provides security and user interface

✓ Supports execution of applications

Examples

✓ Windows
✓ Linux
✓ macOS

b. Application Software

Application software is designed to perform specific tasks for users. These programs help users complete activities such as typing documents, creating presentations and browsing the internet.

Examples

✓ MS Word
✓ MS Excel
✓ PowerPoint
✓ Web Browsers

Relationship Between Hardware and Software

Hardware and software work together to perform computer operations. Hardware alone cannot function without software because it requires instructions to operate. Similarly, software cannot run without hardware because physical devices are needed to execute programs.

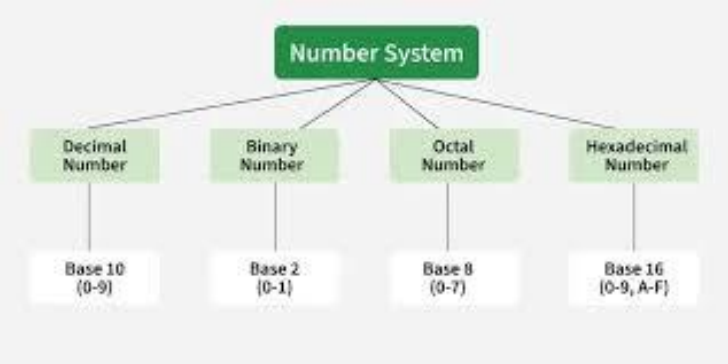
For example, when a user types using a keyboard, the hardware captures the input while the software processes and displays the result on the monitor.

Thus, hardware and software are dependent on each other and together form a complete computer system.

1.10 NUMBER SYSTEM

A number system is a method of representing numbers using specific digits or symbols. Number systems are very important in computers because computers understand and process data in binary form.

Different types of number systems are used in computer science and digital electronics for performing calculations and representing data.



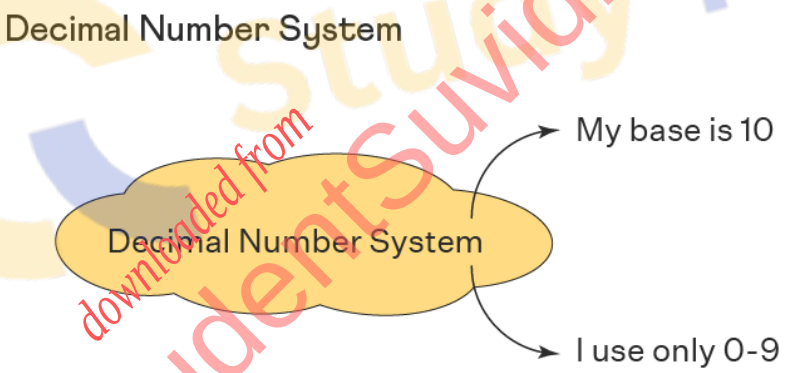
The commonly used number systems are:

✓ **Decimal Number System**
✓ **Binary Number System**
✓ **Octal Number System**
✓ **Hexadecimal Number System**

1.10.1 DECIMAL NUMBER SYSTEM

The decimal number system is the most commonly used number system in daily life. It consists of ten digits ranging from 0 to 9, and therefore its base or radix is 10.

In this number system, the value of each digit depends upon its position in the number. Each position represents a power of 10.



Example

$$(538)_10 = 5 \times 10^2 + 3 \times 10^1 + 8 \times 10^0$$

Characteristics of Decimal Number System

✓ Uses digits from 0 to 9

✓ Base value is 10

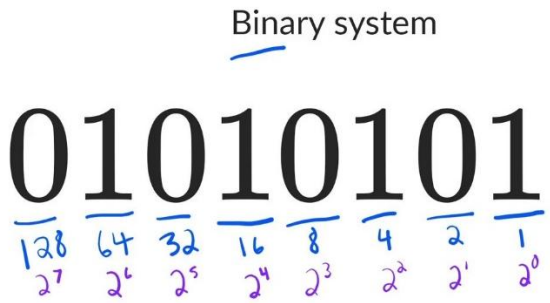
✓ Widely used in everyday calculations

✓ Positional value system

1.10.2 BINARY NUMBER SYSTEM

The binary number system is the fundamental number system used in computers. It uses only two digits, 0 and 1, and therefore its base is 2.

Each binary digit is called a “bit”. Computers operate internally using binary numbers because electronic circuits can easily represent two states such as ON/OFF or TRUE/FALSE.



Example

$$(1011)_2 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

Characteristics of Binary Number System

✓ Uses only 0 and 1

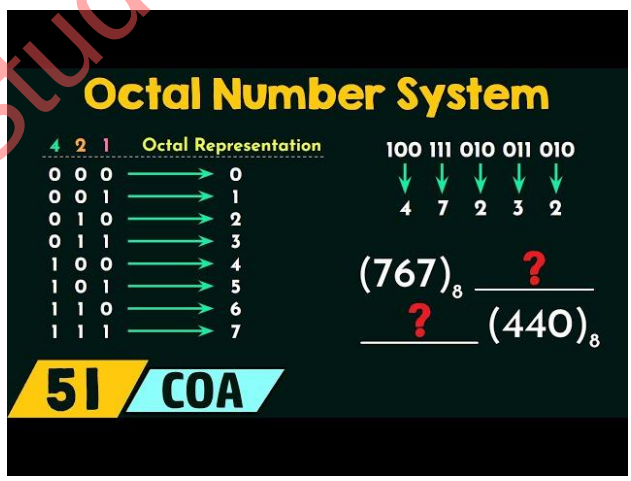
✓ Base value is 2

✓ Used internally by computers

✓ Easy representation in digital circuits

1.10.3 OCTAL NUMBER SYSTEM

The octal number system uses eight digits ranging from 0 to 7. Its base value is 8. Octal numbers are mainly used as a compact representation of binary numbers because one octal digit represents three binary digits.



Example

$$(725)_8 = 7 \times 8^2 + 2 \times 8^1 + 5 \times 8^0$$

Characteristics of Octal Number System

✓ Uses digits from 0 to 7

✓ Base value is 8

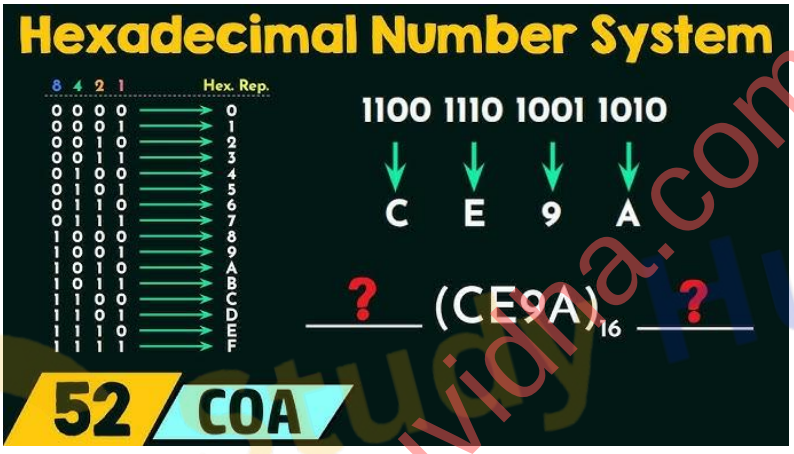
✓ Compact representation of binary numbers

✓ Used in computer systems and programming

1.10.4 HEXADECIMAL NUMBER SYSTEM

The hexadecimal number system uses sixteen symbols consisting of digits 0–9 and letters A–F. Here, A represents 10, B represents 11, and so on up to F which represents 15.

The hexadecimal system is widely used in computer programming and memory addressing because it provides a shorter representation of binary numbers.



Example

$$(2AF)_{16} = 2 \times 16^2 + 10 \times 16^1 + 15 \times 16^0$$

Characteristics of Hexadecimal Number System

✓ Uses digits 0–9 and letters A–F

✓ Base value is 16

✓ Compact representation of binary numbers

✓ Widely used in programming and digital systems

1.11 CONVERSION BETWEEN NUMBER SYSTEMS

Conversion between number systems is an important concept in computer science because computers use different number systems for processing and storing data. Sometimes it becomes necessary to convert numbers from one system to another in order to perform calculations, programming or digital operations.

The most common conversions include:

✓ Decimal to Binary
✓ Binary to Decimal
✓ Decimal to Octal
✓ Decimal to Hexadecimal
✓ Binary to Octal
✓ Binary to Hexadecimal

Understanding these conversions helps students understand how computers internally represent and manipulate data.

1.11.1 DECIMAL TO BINARY CONVERSION

The decimal to binary conversion is performed by repeatedly dividing the decimal number by 2 and writing the remainders. The binary number is obtained by reading the remainders from bottom to top.

Steps for Conversion

i. Divide the decimal number by 2.

ii. Write down the remainder.

iii. Continue dividing the quotient by 2 until the quotient becomes 0.

iv. Read the remainders in reverse order.

Example

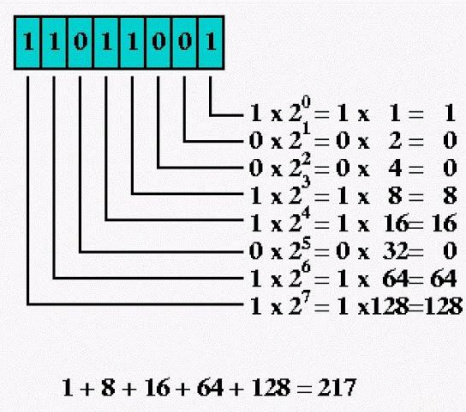
Convert $(25)_{10}$ into binary.

Division	Quotient	Remainder
25 ÷ 2	12	1
12 ÷ 2	6	0
6 ÷ 2	3	0
3 ÷ 2	1	1
1 ÷ 2	0	1

Therefore,

$$(25)_{10} = (11001)_2$$

1.11.2 BINARY TO DECIMAL CONVERSION



Binary to decimal conversion is performed by multiplying each binary digit with the corresponding power of 2 and then adding the results.

Steps for Conversion

i. Write the powers of 2 from right to left.

ii. Multiply each binary digit by its corresponding power.

iii. Add all the products.

Example

Convert $(1011)_2$ into decimal.

$$(1011)_2 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 11$$

Therefore,

✓ $(1011)_2 = (11)_{10}$

1.11.3 DECIMAL TO OCTAL CONVERSION

Decimal to octal conversion is performed by repeatedly dividing the decimal number by 8 and writing the remainders.

Example

Convert $(125)_{10}$ into octal.

Division	Quotient	Remainder
125 ÷ 8	15	5
15 ÷ 8	1	7
1 ÷ 8	0	1

Reading the remainders from bottom to top:

$$(125)_{10} = (175)_8$$

1.11.4 DECIMAL TO HEXADECIMAL CONVERSION

Decimal to hexadecimal conversion is performed by repeatedly dividing the decimal number by 16 and writing the remainders.

Example

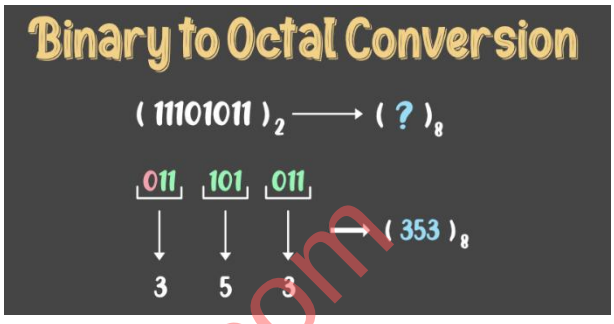
Convert $(255)_{10}$ into hexadecimal.

Division	Quotient	Remainder
255 ÷ 16	15	15 (F)
15 ÷ 16	0	15 (F)

Therefore,

$$(255)_{10} = (FF)_{16}$$

1.11.5 BINARY TO OCTAL CONVERSION



Binary numbers can easily be converted into octal numbers by grouping binary digits into sets of three starting from the right side.

Each group of three binary digits corresponds to one octal digit.

Example

Convert $(101101)_2$ into octal.

Grouping the digits:

101 101

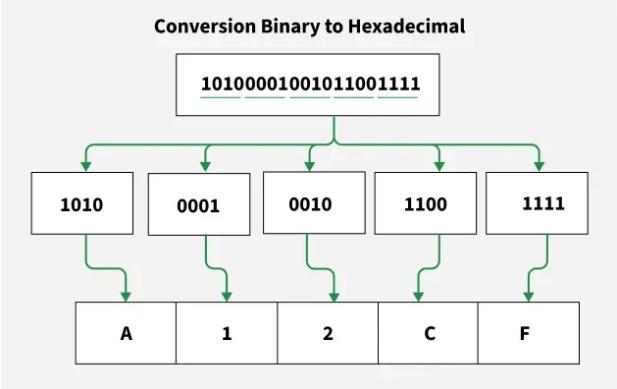
Now convert each group:

101 = 5
101 = 5

Therefore,

$$(101101)_2 = (55)_8$$

1.11.6 BINARY TO HEXADECIMAL CONVERSION



Binary numbers are converted into hexadecimal numbers by grouping binary digits into sets of four starting from the right side.

Each group of four binary digits corresponds to one hexadecimal digit.

Example

Convert $(11111111)_2$ into hexadecimal.

Grouping the digits:

1111 1111

Now convert each group:

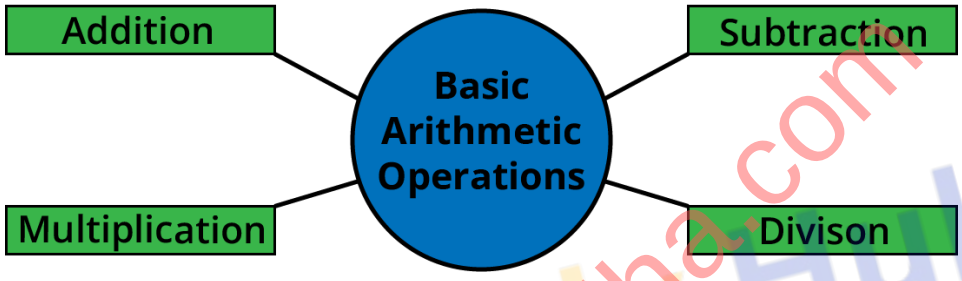
1111 = F
1111 = F

Therefore,

$$(11111111)_2 = (FF)_{16}$$

1.12 BINARY ARITHMETIC

Binary arithmetic refers to arithmetic operations performed on binary numbers. Since computers work internally with binary digits (0 and 1), binary arithmetic forms the basis of computer calculations and digital electronics.



The main binary arithmetic operations are:

✓ Binary Addition
✓ Binary Subtraction
✓ Binary Multiplication
✓ Binary Division

1.12.1 BINARY ADDITION

Binary addition is similar to decimal addition, but it uses only two digits: 0 and 1.

Rules of Binary Addition

Binary Addition	Result
0 + 0	0
0 + 1	1
1 + 0	1
1 + 1	10

In binary addition, when 1 is added to 1, the result becomes 10. Here, 0 is written and 1 is carried to the next position.

Example

Add $(1011)_2$ and $(1101)_2$

$$1011_2 + 1101_2 = 11000_2$$

Therefore,

✓ $(1011)_2 + (1101)_2 = (11000)_2$

1.12.2 BINARY SUBTRACTION

Binary subtraction is performed similarly to decimal subtraction using borrowing whenever necessary.

Rules of Binary Subtraction

Binary Subtraction	Result
0 − 0	0
1 − 0	1
1 − 1	0
10 − 1	1

In binary subtraction, if the upper digit is smaller than the lower digit, borrowing is performed from the next higher position.

Example

Subtract $(1010)_2$ from $(1101)_2$

$$1101_2 - 1010_2 = 0011_2$$

Therefore,

✓ $(1101)_2 - (1010)_2 = (0011)_2$

1.12.3 BINARY MULTIPLICATION

Binary multiplication is simpler than decimal multiplication because it involves only two digits.

Rules of Binary Multiplication

Binary Multiplication	Result
0 × 0	0
0 × 1	0
1 × 0	0

Binary Multiplication	Result
1 × 1	1

Example

Multiply $(101)_2$ by $(11)_2$

$$101_2 \times 11_2 = 1111_2$$

Therefore,

✓ $(101)_2 \times (11)_2 = (1111)_2$

1.12.4 BINARY DIVISION

Binary division is performed in the same way as decimal division. The divisor is repeatedly subtracted from the dividend until the operation is completed.

Example

Divide $(1110)_2$ by $(10)_2$

$$1110_2 \div 10_2 = 111_2$$

Therefore,

✓ $(1110)_2 \div (10)_2 = (111)_2$

1.13 COMPLEMENT REPRESENTATION

Complement representation is an important concept used in computer systems for representing negative binary numbers and performing subtraction operations efficiently.

The two commonly used complement methods are:

✓ 1's Complement
✓ 2's Complement

These methods simplify arithmetic operations inside digital computers.

1.13.1 1's COMPLEMENT

The 1's complement of a binary number is obtained by changing every 0 into 1 and every 1 into 0.

In other words, all bits are inverted.

Example

Find the 1's complement of $(1010)_2$

$$1010_2 \rightarrow 0101_2$$

Therefore,

✓ 1's complement of $(1010)_2$ is $(0101)_2$

Uses of 1's Complement

✓ Representation of negative numbers

✓ Simplification of subtraction operations

✓ Digital circuit operations

1.13.2 2's COMPLEMENT

The 2's complement of a binary number is obtained by adding 1 to the 1's complement of the number.

The 2's complement method is widely used in computer systems because it simplifies binary subtraction and negative number representation.

Steps to Find 2's Complement

i. Find the 1's complement of the binary number.

ii. Add 1 to the least significant bit.

Example

Find the 2's complement of $(1010)_2$

Step 1: Find 1's complement

$$1010_2 \rightarrow 0101_2$$

Step 2: Add 1

$$0101_2 + 1_2 = 0110_2$$

Therefore,

✓ 2's complement of $(1010)_2$ is $(0110)_2$

ADVANTAGES OF USING COMPLEMENTS

✓ Simplifies subtraction operations

✓ Helps represent negative numbers in binary form

✓ Reduces complexity in digital circuits

✓ Widely used in computer processors and arithmetic logic units

SUMMARY

✓ A computer is an electronic device used for processing and storing data efficiently.

✓ Computers are classified into Micro, Mini, Mainframe and Super Computers according to size and processing capability.

✓ The CPU is known as the brain of the computer because it controls and processes all operations.

✓ Data refers to raw facts, information is processed data and knowledge is understanding gained from information.

✓ Hardware consists of physical components while software consists of programs and instructions.

✓ The binary number system is the fundamental number system used by computers.

✓ Conversion between number systems is important for computer operations and programming.

✓ Binary arithmetic operations include addition, subtraction, multiplication and division.

✓ Complement representation is used for representing negative numbers and simplifying binary calculations.