

Basic Computer Skills
Fundamentals of Computers

For

B.A./B.Sc./B.Com./B.B.A Semester-I/II
[Ability Enhancement Compulsory Course (AECC)]



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UNIVERSITY ARTS & SCIENCE COLLEGE (Autonomous)

KAKATIYA UNIVERSITY

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Ability Enhancement Compulsory Course (AECC)

Basic Computer Skills

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Unit-I: Introduction to Computers: what is a computer, characteristics of Computers, Generations of Computers, Classifications of Computers, Basic Computer organization, Applications of Computers. Input and Output Devices: Input devices, Output devices, Softcopy devices, Hard copy devices. Computer Memory and Processors: Introduction, Memory Hierarchy, Processor, Registers, Cache memory, primary memory, secondary storage devices, magnetic tapes, floppy disks, hard disks, optical drives, USB flash drivers, Memory cards, Mass storage devices, Basic processors architecture.

Unit-II: Number System and Computer Codes: Binary number system, working with binary numbers, octal number system, hexadecimal number system, working with fractions, signed number representation in binary form, BCD code, and other codes. Boolean algebra and logic gates: Boolean algebra, Venn diagrams, representation of Boolean functions, logic gates, logic diagrams and Boolean expressions using karnaugh map. Computer Software: Introduction to computer software, classification of computer software, system software, application software, firmware, middleware, acquiring computer software, design and implementation of correct, efficient and maintainable programs.

Text: ReemaThareja, Fundamentals of Computers.

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What is a Computer?

The term “Computer” is derived from the Latin word “Compute”, which means to calculate. A computer is an electronic machine, devised for performing calculations and controlling operations that can be expressed either in logical or numerical terms. In simple terms, a computer is an electronic device that performs diverse operations with the help of instructions to process the information in order to achieve the desired results. Computer application extends to cover huge area including education, industries, government, medicine, scientific research etc.

A computer is one of the most influential forces available in modern times. Due to its memory, high speed and perfection, its application can be extended to almost infinite levels. Millions of complex calculations can be done in mere fraction of time. Difficult decisions can be made with accuracy for comparatively little cost. Computers are widely seen as instruments for future progress and as tools to achieve substantiality by way of improved access to information by means of video conferencing and e-mail. Indeed computers have left such an impression on modern civilization that we call this era as the information age.

DEFINITION OF COMPUTER:

Computer is a device that transforms data into meaningful information. Data can be anything like marks obtained by you in various subjects. It can also be name, age, sex, weight, height, etc. of all the students in a class. Computer can also be defined in terms of functions it can perform. A computer can i) accept data, ii) store data, iii) process data as desired, and iv) retrieve the stored data as and when required and v) print the result in desired format.

Characteristics of Computers:

The following are the characteristics of computer:

a) Speed:

Computers are capable of carrying out the task with enormous speed. Today's computers, according to their class, can perform from 4 MIPS (Millions of instructions per second) to 100 MIPS. What may take days for manual calculations may take only a few hours for computers to perform. Inside the computer the information signal travels at incredible electronic speed.

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b) Storage:

Computers can store enormous quantity of information, which is expressed in terms of Kilobytes (or) Mega Bytes (MB) or Gega Bytes (GB). It is achieved through its 'Main memory' or 'Primary storage' and through 'auxiliary storage' or 'Secondary storage'. The Hard disks Floppy disk, Compact Disc (CD), Universal Serial Bus (USB) and Magnetic Tape storage are examples of secondary storages. These large volumes of storage occupy much lesser space compared to paper documents and this aspect of computers makes them more powerful.

c) Accuracy:

The accuracy of a Computer is consistently high. In fact, this quality of the computers make them indispensable in various fields such as Scientific Research, Space Research, Weather Predictions and many other areas where precision of a high order is required. The accuracy of the computer is best achieved by programming them in the most efficient manner. When it comes to very complex mathematical or scientific problem the computer's accuracy has no substitute.

d) Versatility:

Computers are versatile in that they can perform almost any task, provided they are given the appropriate logical steps. For example, they are capable of performing wide ranging tasks such as construction of a payroll, inventory management in a factory, hotel billing, hospital management, banking applications and any imaginable task in every walk of life.

e) Automation:

The biggest advantage of computers is that it is automatic in its operation. Once a programming logic is initiated the computer performs repeated operations without human interventions until program completion.

f) Diligence:

Computers are machines and that do not get tired or 'lose concentration' like human beings. If a large number of calculations say million calculations are to be performed the resultant output will remain exactly the same even if operations are repeated any number of times. But when a human being is asked to do the same job this consistency cannot be achieved. Thus for those who want consistent and continuous standard output, computer's 'diligence' is of great help.

g) Reliability:

The computers give very accurate results with predetermined values. They correct and modify the parameters automatically, giving suitable signals. They give formatted results with high degree of precisions.

Generations of Computers:

Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. But nowadays, generation includes both hardware and software, which together make up an entire computer system.

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There are totally five computer generations known till date. Each generation has been discussed in detail along with their time period, characteristics. We've used approximate dates against each generation which are normally accepted.

Following are the main five *generations* of computers:

FIRST GENERATION

The period of first generation was 1946-1959. First generation of computers started with using vacuum tubes as the basic components for memory and circuits for CPU (Central Processing Unit). These tubes like electric bulbs produced a lot of heat and were prone to frequent fusing of the installations, therefore, were very expensive and could be afforded only by very large organisations.

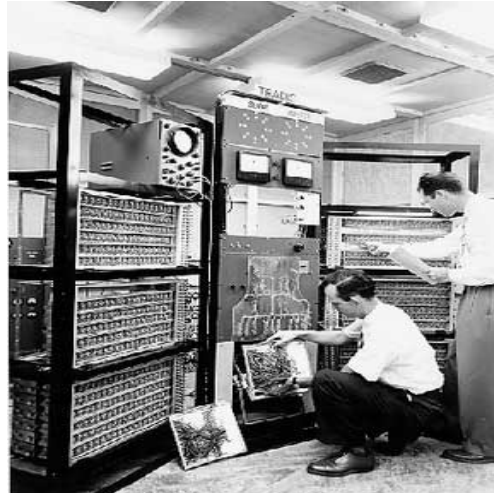
In this generation, mainly batch processing operating systems were used. In this generation, Punched cards, Paper tape, Magnetic tape Input & Output device were used. There were machine codes and electric wired board languages used.

The main features of First Generation are:

- Vacuum tube technology
- Unreliable
- Supported Machine language only
- Very costly
- Generate lot of heat
- Slow Input / Output device
- Huge size
- Need of A.C.
- Non-portable
- Consumes lot of electricity

Some computers of this generation were:

- ENIAC
- EDVAC
- UNIVAC
- IBM-701
- IBM-650



SECOND GENERATION

The period of second generation was 1959-1965. This generation using the transistor was cheaper, consumed less power, more compact in size, more reliable and faster than the first generation machines made of vacuum tubes. In this generation, magnetic cores were used as primary memory and magnetic tape and magnetic disks as secondary storage devices.

In this generation, assembly language and high-level programming language like FORTRAN, COBOL was used. There was Batch processing and Multiprogramming Operating system used.

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The main features are:

1. Use of transistors
2. Reliable as compared to First generation computers (FGC)
3. Smaller size as compared to FGC
4. Generate less heat as compared to FGC
5. Consumed less electricity as compared to FGC
6. Faster than FGC
7. Still very costly
8. A.C. needed
9. Support machine and assembly languages



Some computers of this generation were:

- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

THIRD GENERATION

The period of third generation was 1965-1971. The third generation of computer is marked by the use of Integrated Circuits (IC's) in place of transistors. A single IC has many transistors, resistors and capacitors along with the associated circuitry. The IC was invented by Jack Kilby. This development made computers smaller in size, reliable and efficient.

In this generation, Remote processing, Time-sharing, Real-time, Multi-programming Operating System were used.

High-level language (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68, etc.) were used during this generation.

The main features of Third Generation are:

- IC used
- More reliable
- Smaller size
- Generate less heat
- Faster
- Lesser maintenance
- Still costly
- A.C. needed
- Consumed lesser electricity
- Support high-level language



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Some computers of this generation were:

- IBM-360 series
- Honeywell-6000 series
- PDP(Personal Data Processor)
- IBM-370/168
- TDC-316

FOURTH GENERATION

The period of Fourth Generation was 1971-1980. The fourth generation of computers is marked by the use of Very Large Scale Integrated (VLSI) circuits. VLSI circuits having about 5000 transistors and other circuit elements and their associated circuits on a single chip made it possible to have microcomputers of fourth generation. Fourth Generation computers became more powerful, compact, reliable, and affordable. As a result, it gave rise to personal computer (PC) revolution.

In this generation, Time sharing, Real time, Networks, Distributed Operating System were used. All the higher level languages like C and C++, DBASE, etc., were used in this generation.

The main features of Fourth Generation are:

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PC's
- Very small size
- Pipeline processing
- No A.C. needed
- Concept of internet was introduced
- Great developments in the fields of networks
- Computers became easily available



Some computers of this generation were:

- DEC 10
- STAR 1000
- PDP 11
- CRAY-1 (Super Computer)
- CRAY-X-MP (Super Computer)

FIFTH GENERATION

The period of Fifth Generation is 1980-till date. In the fifth generation, the VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components.

This generation is based on parallel processing hardware and AI (Artificial Intelligence) software.

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AI is an emerging branch in computer science which interprets means and methods of making computers think like human beings.

All the higher level languages like C and C++, Java, .Net, etc., are used in this generation.

Artificial Intelligence includes:

- Robotics
- Neural networks
- Game Playing
- Development of expert systems to make decisions in real life situations.
- Natural language understanding and generation.



The main features of Fifth Generation are:

- ULSI technology
- Development of true artificial intelligence
- Development of Natural language processing
- Advancement in Parallel Processing & Superconductor technology
- More user friendly interfaces with multimedia features
- Availability of very powerful and compact computers at cheaper rates

Some computers types of this generation are:

- Desktop
- Laptop
- NoteBook
- UltraBook
- ChromeBook

Classifications of Computers:

The classification of computers is based on the following three criteria:

- (a) According to Purpose
- (b) According to Technology used
- (c) According to size and Capacity

According to Purpose

According to the utilization of computer for different uses, computers are of following two types:

1. **General Purpose Computers:** Computers that follow instructions for general requirements such as sales analysis, financial accounting, invoicing, inventory, management information etc. are called General Purpose Computers. Almost all computers used in offices for commercial, educational and other applications are general purpose computers.

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2. Special Purpose Computers: Computers designed from scratch to perform special tasks like scientific applications and research, weather forecasting, space applications, medical diagnostics etc. are called Special Purpose Computers.

According to Technology Used

According to the technology used, computers are of following three types:

1. Analog Computers: Analog computers are special purpose computers that represent and store data in continuously varying physical quantities such as current, voltage or frequency. These computers are programmed for measuring physical quantities like pressure, temperature, speed etc. and to perform computations on these measurements. Analog computers are mainly used for scientific and engineering applications. Some of the examples of analog computers are given below:

(i) **Thermometer:** It is a simple analog computer used to measure temperature. In thermometer, the mercury moves up or down as the temperature varies.

(ii) **Speedometer:** Car's speedometer is another example of analog computer where the position of the needle on the dial represents the speed of the car.

2. Digital Computers: Digital computers are mainly general purpose computers that represent and store data in discrete quantities or numbers. In these computers, all processing is done in terms of numeric representation (Binary Digits) of data and information. Although the user enters data in decimal or character form, it is converted into binary digits (0's and 1's).

3. Hybrid Computers: Hybrid computers incorporate the technology of both analog and digital computers. These computers store and process analog signals which have been converted into discrete numbers using analog-to-digital converters. They can also convert the digital numbers into analog signals or physical properties using digital-to-analog converters. Hybrid computers are mainly used in artificial intelligence (robotics) and computer aided manufacturing (e.g. process control).

According to Size and Capacity

According to the size and memory/storage capacity, computers are of following four types:

1. Supercomputer: Supercomputer is the biggest and fastest computer, which is mainly designed for complex scientific applications. It has many CPUs (Central Processing Units - main part of computer) which operate in parallel to make it as a fastest computer.

It is typically used for the following applications:

- Weather Forecasting
- Petroleum Exploration and Production
- Energy Management
- Defense
- Nuclear Energy Research
- Structural Analysis
- Electronic Design
- Real-time Animation
- Medicine

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Some of the examples of supercomputers are CRAY3, CRAY-XMP-14, NEC500, P ARAM 9000 and P ARAM 10000.

2. Mainframe Computer: Mainframe computers are very large and fast computers but smaller and slower than supercomputers. These are used in a centralized location where many terminals (input/output devices) are connected with one CPU and thus, allow different users to share the single CPU. They have a very high memory (several hundred Megabytes) and can support thousands of users. They are mainly used for following applications:

- Railway and Airline Reservations
- Banking Applications
- Commercial Applications of Large Industries/Companies

Some of the examples of mainframe computers are IBM 3090, IBM 4381, IBM 4300 and IBM ES-9000.

3. Minicomputer: Minicomputers are medium-scale, smaller and generally slower than mainframe computers. Like mainframes, they have many terminals which are connected with one CPU and can support many users. The cost of minicomputer is very less as compared to mainframe. Therefore, it is mainly used in applications where processing can be distributed among several minicomputers rather than using a mainframe computer.

Some of the examples of minicomputers are PDP-1, IBM AS/400 and DEC Micro VAX. IBM AS/400, which is actually a mini computer (computer with performance between a mainframe and minicomputer), is becoming very popular among minicomputers.

4. Microcomputer: A microcomputer is the smallest digital computer, which uses a microprocessor as its CPU. Microprocessor is a single chip (Integrated Circuit) CPU. Microcomputer is popularly called as Personal Computer (PC). It can be used both as a stand-alone machine and a terminal in a multi-user environment. Microcomputers are becoming very popular nowadays due to very high processing power and memory. Today, a powerful microcomputer may be used as a Computer – An Introduction substitute for mini or mainframe computer.

Microcomputers are either of desktop or portable model. Portable computers can be carried from one place to another. Some of the models are called as laptops while others as notebook computers. Notebook computers are smaller, lighter and costlier than laptops. Desktop computers fit on a desktop and are used widely in offices and homes.

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Basic Computer organization:

COMPONENTS OF A COMPUTER SYSTEM:



There are different types of computers, but all computers have these parts:

Monitor: It looks like a television screen and shows still or moving images in color. It is also called a display.

System Unit or Central Processing Unit (CPU): The computer case that holds all the electronic chips, memory storage areas and devices that make the computer work. It has openings or ports for other components to plug into. It is also called the computer console.

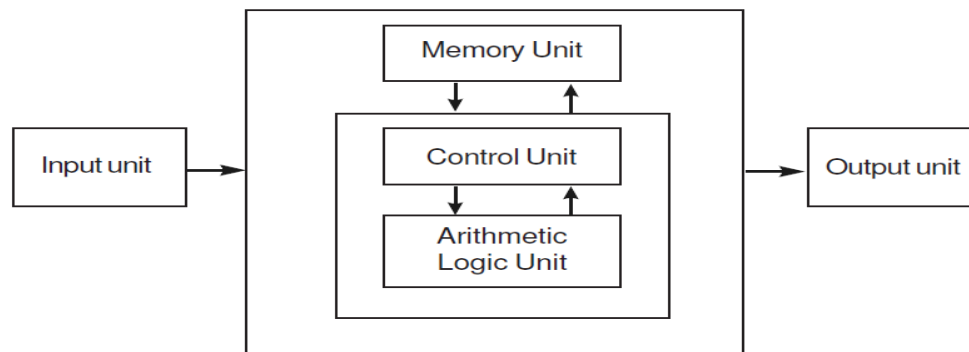
Key Board: Keyboard Used for typing text into your computer, but also has special keys i.e., number keys, arrow keys to move around the screen and function keys.

Mouse: A small tool for pointing and selecting items on the computer screen. Some mice plug into the computer and some are wireless. Laptops have a touch pad instead of a mouse.

CD/DVD drive: Separate removable storage drive in My Computer (D drive) for playing and saving music, pictures and videos. To burn CD or DVD, need R or RW not ROM style.

Speakers: Built-in source for sound or audio on your computer. Look for the volume icon to adjust the sound settings. A sound bar or external speakers can be added for better sound quality.

The block diagram of computer is shown in figure below:



The computer performs basically five major operations of functions irrespective of their size and make. These are:

- 1) It accepts data or instruction by way of input,

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- 2) It stores data,
- 3) It can process data as required by the user,
- 4) It gives results in the form of output, and
- 5) It controls all operations inside a computer.

We discuss below each of these operations.

Input Unit

This unit contains devices with the help of which we enter data into computer. This unit makes link between user and computer.

The input devices translate the human being information into the form understandable by computer.

CPU (Central Processing Unit)

CPU is considered as the brain of the computer. CPU performs all types of data processing operations. It stores data, intermediate results and instructions (program). It controls the operations of all parts of computer.

CPU itself has the following three components

- ALU (Arithmetic Logic Unit)
- Memory Unit
- Control Unit

Output Unit

Output unit consists of devices with the help of which we get the information from computer. This unit is a link between computer and users.

Output devices translate the computer's output into the form understandable by users.

CPU:

- CPU is considered as the brain of the computer.
- CPU performs all types of data processing operations.
- It stores data, intermediate result and instructions (program).
- It controls the operations of all parts of computer.

CPU itself has the following three components.

- Memory or Storage Unit:
- Control Unit
- ALU (Arithmetic Logic Unit)

Memory or Storage Unit:

This unit can store instructions, data and intermediate results. This unit supplies information to the other units of the computer when needed. It is also known as internal storage unit or main memory or primary storage or Random access memory (RAM).

Its size affects speed, power and capability. There are primary memory and secondary memory, two types of memories in the computer.

Functions of Memory Unit are:

- It stores all the data to be processed and the instructions required for processing.
- It stores intermediate results of processing.

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- It stores final results of processing before these results are released to an output device.
- All inputs and outputs are transmitted through main memory.

Control Unit

This unit controls the operations of all parts of computer. It does not carry out any actual data processing operations.

Functions of Control unit are:

- It is responsible for controlling the transfer of data and instructions among other units of a computer.
- It manages and coordinates all the units of the computer.
- It obtains the instructions from the memory, interprets them and directs the operation of the computer.
- It communicates with Input/Output devices for transfer of data or results from storage.
- It does not process or store data.

ALU (Arithmetic Logic Unit)

This unit consists of two subsections namely:

- Arithmetic Section
- Logic Section

Arithmetic Section

Function of Arithmetic section is to perform arithmetic operations like addition, subtraction, multiplication and division. All complex operations are done by making repetitive use of above operations.

Logic Section

Function of logic section is to perform logic operations such as comparing, selecting, matching and merging of data.

Functions of ALU are:-

- (1) It operates on data available in main memory.
- (2) It carries out all arithmetic operations like addition, subtraction, multiplication and division.
- (3) It carries out all logic operations like comparison, selection and merging of data
- (4) After processing the data, it sends back the processed data to main memory.

Applications of Computers:

Computers have proliferated into various areas of our lives. For a user, computer is a tool that provides the desired information, whenever needed. You may use computer to get information about the reservation of tickets (railways, airplanes and cinema halls), books in a library, medical history of a person, a place in a map, or the dictionary meaning of a word. The information may be presented to you in the form of text, images, video clips, etc.

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Some of the application areas of the computer are listed below—

Education: Computers are extensively used, as a tool and as an aid, for imparting education. Educators use computers to prepare notes and presentations of their lectures. Computers are used to develop computer-based training packages, to provide distance education using the e-learning software, and to conduct online examinations. Researchers use computers to get easy access to conference and journal details and to get global access to the research material.

Entertainment: Computers have had a major impact on the entertainment industry. The user can download and view movies, play games, chat, book tickets for cinema halls, use multimedia for making movies, incorporate visual and sound effects using computers, etc. The users can also listen to music, download and share music, create music using computers, etc.

Sports: A computer can be used to watch a game, view the scores, improve the game, play games (like chess, etc.) and create games. They are also used for the purposes of training players.

Advertising: Computer is a powerful advertising media. Advertisement can be displayed on different websites, electronic-mails can be sent and reviews of a product by different customers can be posted. Computers are also used to create an advertisement using the visual and the sound effects. For the advertisers, computer is a medium via which the advertisements can be viewed globally. Web advertising has become a significant factor in the marketing plans of almost all companies. In fact, the business model of Google is mainly dependent on web advertising for generating revenues.

Medicine: Medical researchers and practitioners use computers to access information about the advances in medical research or to take opinion of doctors globally. The medical history of patients is stored in the computers. Computers are also an integral part of various kinds of sophisticated medical equipments like ultrasound machine, CAT scan machine, MRI scan machine, etc. Computers also provide assistance to the medical surgeons during critical surgery operations like laparoscopic operations, etc.

Science and Engineering: Scientists and engineers use computers for performing complex scientific calculations, for designing and making drawings (CAD/CAM applications) and also for simulating and testing the designs. Computers are used for storing the complex data, performing complex calculations and for visualizing 3-dimensional objects. Complex scientific applications like the launch of the rockets, space exploration, etc., are not possible without the computers.

Government: The government uses computers to manage its own operations and also for e-governance. The websites of the different government departments provide information to the users. Computers are used for the filing of income tax return, paying taxes, online submission of water and electricity bills, for the access of land record details, etc. The police department uses computers to search for criminals using fingerprint matching, etc.

Home: Computers have now become an integral part of home equipment. At home, people use computers to play games, to maintain the home accounts, for communicating

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with friends and relatives via Internet, for paying bills, for education and learning, etc. Microprocessors are embedded in house hold utilities like, washing machines, TVs, food processors, home theatres, security devices, etc.

The list of applications of computers is so long that it is not possible to discuss all of them here. In addition to the applications of the computers discussed above, computers have also proliferated into areas like banks, investments, stock trading, accounting, ticket reservation, military operations, meteorological predictions, social networking, business organizations, police department, video conferencing, telepresence, book publishing, web newspapers, and information sharing.

INPUT AND OUTPUT DEVICES

Input / Output devices are used to enter information and instructions into a computer for storage or processing and to deliver the processed data to a user. These are required for users to communicate with the computer. In simple terms, input devices bring information INTO the computer and output devices bring information OUT of a computer system. These input/output devices are also known as peripherals since they surround the CPU and memory of a computer system.

Input Devices:

An input device is any device that provides input to a computer. There are many input devices, but the two most common ones are a keyboard and mouse. Every key you press on the keyboard and every movement or click you make with the mouse sends a specific input signal to the computer. Input devices accept data and instructions from the user. Following are the examples of various input devices, which are connected to the computer for this purpose.

KEYBOARD:

A keyboard is the most common input device. Several kinds of keyboards are available, but they resemble each other with minor variations. The keyboard in most common use is the QWERTY board. Generally standard keyboard has 104 keys. In these keyboards, the cursor control keys are duplicated to allow easier use of the numeric pad.

Sr.No	Keys	Description
1	Typing Keys	These keys include the letter keys (A-Z) and digit keys (0-9) which generally give same layout as that of typewriters.
2	Numeric Keypad	It is used to enter numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
3	Function Keys	The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has unique meaning and is used for some specific purpose.
4	Control keys	These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
5	Special Purpose Keys	Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

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MOUSE

A mouse is an electro-mechanical, hand-held device. It is used as a pointer. It can perform functions like selecting menu commands, moving icons, resizing windows, starting programs, and choosing options. The most common mouse uses an internal, magnetically coated ball, to detect the movement of the mouse across a flat surface, usually a desktop. Now a day's Optical or laser mouse is used to detect the movement. All windows based applications today are designed to work with a mouse. A mouse is used to replace hard-to-remember key combinations with easier "Point and Click" actions. However, it cannot substitute all keyboard operations. It can be alternative for commands based operations.

Advantages

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of keyboard.

LIGHT PEN

An input device that utilizes a light-sensitive detector to select objects on a display screen. A light pen is similar to a mouse, except that with a light pen you can move the pointer and select objects on the display screen by directly pointing to the objects with the pen.

OPTICAL SCANNER

These devices are used for automatic data collection. The devices of this category completely eliminate manual input of data. For example, the bar-code reader is actually just a special type of image scanner. An image scanner translates printed images into an electronic format that can be stored in a computer's memory, and with the right kind of software, one can alter a stored image. Another example of scanner is optical character recognition (OCR) device, used by banks to convert the scanned image of a typed or printed page into text that can be edited on the computer.

TOUCH SCREEN

Touch panel displays and pads are now being offered as alternatives to keyboard. Here the input can be given through the computer screen, that accepts the input through monitor; users touch electronic buttons displayed on the screen or they may use light pen.

MICROPHONE

Microphone is an input device, which takes voice as input. The voice communication is more error-prone than information through keyboard. There are two types of microphones available:

1. Desktop Microphone
2. Hand held Microphone

TRACK BALL

Trackball, a pointing device, is a mouse lying on its back. To move the pointer, you rotate the ball with your thumb, your fingers, or the palm of your hand. There are usually one to three buttons next to the ball, which you use just like mouse buttons. The

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advantage of trackballs over mouse is that the trackball is stationary so it does not require much space to use it. In addition, you can place a trackball on any type of surface, including your lap. For both these reasons, trackballs are popular pointing devices for portable computers.

MAGNETIC INK CARD READER (MICR)

MICR input device is generally used in banks because of a large number of cheques to be processed everyday. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.

This reading process is called Magnetic Ink Character Recognition (MICR). The main advantage of MICR is that it is fast and less error prone.

OPTICAL CHARACTER READER (OCR)

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

BAR CODE READERS

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

OPTICAL MARK READER (OMR)

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

JOYSTICK

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



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OUTPUT DEVICES

Output devices return processed data that is information, back to the user. Some of the commonly used output devices are:

MONITOR

Out of all the output devices, monitor is perhaps the most important output device because people interact with this device most intensively than others. Computer information is displayed, visually with a video adapter card and monitor. Information processed within the CPU, that needs to be visually displayed, is sent to video adapter. The video adapter converts information from the format used, in the same manner as a television displays information sent to it by a cable service.

Two basic types of monitors are used with microcomputers, which are as follows:

1. CRT
2. LCD

Cathode Ray Tube (CRT): CRT or Cathode Ray Tube Monitor is the typical monitor that you see on a desktop computer. It looks a lot like a television screen, and works the same way. This type uses a large vacuum tube, called cathode ray tube (CRT).

Liquid Crystal Displays (LCD): These types of monitors are also known as flat panel monitor. Most of these employ liquid crystal displays (LCDs) to render images. These days LCD monitor are very popular. When people talk about the capabilities of various monitors, one critical statistic is the resolution of the monitor. Most monitors have a resolution of at least 800 x 600 pixels. High-end monitors can have resolutions of 1024 x 768 pixels or even 1280 x 1024 pixels. Thus monitors are available either in low resolution or in high resolution.

PRINTER

After a document is created on the computer, it can be sent to a printer for a hard copy (printout). Some printers offer special features such as colored and large page formats. Some of the most commonly used printers are:

1. Laser Printer
2. Ink Jet Printer
3. Dot Matrix Printer
4. Line Printer

Laser Printer: A laser printer produces high quality print that one normally finds in publishing. It is extremely fast and quiet. Moreover, the operation of a laser printer is easy with automatic paper loading and no smudging or messing up of ink ribbons. The fastest laser printer can print up to 200 pages per minute in monochrome (black and white) and up to 100 pages per minute in colour.

Ink-Jet Printer: An ink-jet printer creates an image directly on paper by spraying ink through as many as 64 tiny nozzles. Although the image it produces is not generally quite as sharp as the output of a laser printer, the quality of ink-jet images is still high. In general, ink-jet printer offers an excellent middle ground between dot matrix and laser printer. Like laser printer, an ink-jet printer is quiet and convenient, but not particularly

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fast. Typically, an ink-jet printer is more expensive than a dot-matrix printer, but costs only half as much as a laser printer.

Dot Matrix Printer: The dot matrix printer was very popular at one point of time. It is a very versatile and inexpensive output device. In dot matrix printer the print head physically "hits" the paper through the ribbon and produces text (or images) by combinations of dots; hence the name dot matrix printer. Its speed is measured in characters per second (CPS). Although it is less expensive, it is louder, slower and produces lower print quality.

Line Printer: A line printer is generally used with large computer systems to produce text based data processing reports. Line printers are high-speed printers with speeds ranging anywhere from 100 to about 3800 lines per minute. In the past, print quality on line printers was not high. Developments in technology are improving the print quality on line printers. These are in the cost range of lakhs of Rupees.

PLOTTER: A plotter is a special kind of output device that, like a printer, produces images on paper, but does so in a different way. Plotters are designed to produce large drawings or images, such as construction plans for buildings or blueprints for mechanical objects. A plotter can be connected to the port normally used by a printer.

An array of different colored pens in a clip rack and a robotic arm is part of plotter. The instructions that a plotter receives from a computer consist of a color, and beginning and ending coordinates for a line. With that information, the plotter picks up the appropriate pen through its arm, positions it at the beginning coordinates drops the pen down to the surface of the paper and draws to the ending coordinates. Plotters draw curves by creating a sequence of very short straight lines. Plotters usually come in two designs:

1. Flat Bed: Plotters of small size to be kept on table with restriction of paper size.
2. Drum: These plotters are of big size using rolls of paper of unlimited length.

SPEAKER:

Speakers are another type of output device, which allow you to listen to voice like music, and conversation with people.

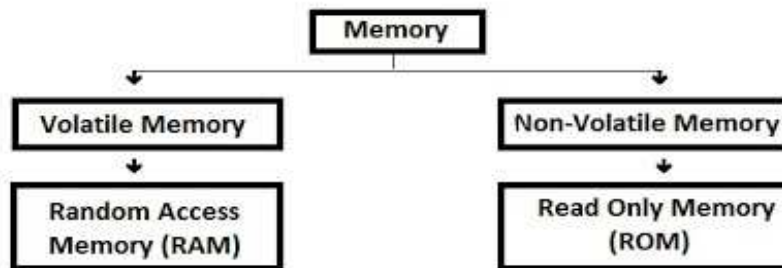


Computer Memory and Processors:

COMPUTER MEMORY:

Memory is an essential element of a computer. Without its memory, a computer is of hardly any use. Memory plays an important role in saving and retrieving data. The performance of the computer system depends upon the size of the memory. Memory is of following types:

1. **Primary Memory / Volatile Memory.**
2. **Secondary Memory / Non Volatile Memory.**



1. Primary Memory / Volatile Memory: Primary Memory is internal memory of the computer. RAM and ROM both form part of primary memory. The primary memory provides main working space to the computer. The following terms comes under primary memory of a computer are discussed below:

Characteristics of Main Memory/Primary Memory:

- These are semiconductor memories.
 - It is known as main memory.
 - Usually volatile memory.
 - Data is lost in case power is switched off.
 - It is working memory of the computer.
 - Faster than secondary memories.
 - A computer cannot run without primary memory.
- **Random Access Memory (RAM):** The primary storage is referred to as random access memory (RAM) because it is possible to randomly select and use any location of the memory directly store and retrieve data. It takes same time to any address of the memory as the first address. It is also called read/write memory. The storage of data and instructions inside the primary storage is temporary. It disappears from RAM as soon as the power to the computer is switched off. The memories, which lose their content on failure of power supply, are known as volatile memories .So now we can say that RAM is volatile memory.



Static RAM (SRAM)

The word **static** indicates that the memory retains its contents as long as power remains applied.

- Data is lost when the power gets down due to volatile nature.
- SRAM chips use a matrix of 6-transistors and no capacitors.
- Transistors do not require power to prevent leakage, so SRAM need not have to be refreshed on a regular basis.
- Because of the extra space in the matrix, SRAM uses more chips than DRAM for the same amount of storage space, thus making the manufacturing costs higher.
- Static RAM is used as cache memory needs to be very fast and small.

Characteristic of the Static RAM

- It has long data lifetime
- There is no need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

Dynamic RAM (DRAM)

- DRAM must be continually **refreshed** in order to maintain the data.
- This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second.
- DRAM is used for most system memory because it is cheap and small.
- All DRAMs are made up of memory cells.
- These cells are composed of one capacitor and one transistor.

Characteristic of the Dynamic RAM

- It has short data lifetime
- Need to refresh continuously
- Slower as compared to SRAM
- Used as RAM
- lesser in size

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- Less expensive
 - Less power consumption
- **Read Only Memory (ROM):** There is another memory in computer, which is called Read Only Memory (ROM). Again it is the ICs inside the PC that form the ROM. The storage of program and data in the ROM is permanent. The ROM stores some standard processing programs supplied by the manufacturers to operate the personal computer. The ROM can only be read by the CPU but it cannot be changed. The basic input/output program is stored in the ROM that examines and initializes various equipment attached to the PC when the power switch is ON.



The memories, which do not lose their content on failure of power supply, are known as non-volatile memories. ROM is non-volatile memory.

- **PROM:** There is another type of primary memory in computer, which is called Programmable Read Only Memory (PROM). You know that it is not possible to modify or erase programs stored in ROM, but it is possible for you to store your program in PROM chip. Once the programmers' are written it cannot be changed and remain intact even if power is switched off. Therefore programs or instructions written in PROM or ROM cannot be erased or changed.
- **EPROM:** This stands for Erasable Programmable Read Only Memory, which overcome the problem of PROM & ROM. EPROM chip can be programmed time and again by erasing the information stored earlier in it. Information stored in EPROM exposing the chip for some time ultraviolet light and it erases chip is reprogrammed using a special programming facility. When the EPROM is in use information can only be read.
- **EEPROM:** This stands for Electrically Erasable and Programmable Read Only Memory. It is programmed and erased electrically, can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (milli second). In this, any location can be selectively erased and programmed. This can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of re-programming is flexible but slow.
- **Cache Memory:** The speed of CPU is extremely high compared to the access time of main memory. Therefore the performance of CPU decreases due to the slow speed of main memory. To decrease the mismatch in operating speed, a small memory chip is attached between CPU and Main memory whose access time is

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very close to the processing speed of CPU. It is called CACHE memory. CACHE memories are accessed much faster than conventional RAM. It is used to store programs or data currently being executed or temporary data frequently used by the CPU. So each memory makes main memory to be faster and larger than it really is. It is also very expensive to have bigger size of cache memory and its size is normally kept small.

- **Virtual Memory:** It is a method of using the computer hard drive to provide extra memory for the computer. Segments of memory are stored on the hard drive known as pages. When a segment of memory is requested that is not in memory it is moved from the virtual memory to an actual memory address.
- **Registers:** The CPU processes data and instructions with high speed; there is also movement of data between various units of computer. It is necessary to transfer the processed data with high speed. So the computer uses a number of special memory units called registers. They are not part of the main memory but they store data or information temporarily and pass it on as directed by the control unit.

2. Secondary Memory / Non-Volatile Memory: Secondary memory is external and permanent in nature. The secondary memory is concerned with magnetic memory. Secondary memory can be stored on storage media like floppy disks, magnetic disks, magnetic tapes, This memory can also be stored optically on Optical disks - CD-ROM. The following terms comes under secondary memory of a computer are discussed below:

Characteristics of Secondary Memory:

- These are magnetic and optical memories.
- It is known as backup memory.
- It is non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without secondary memory.
- Slower than primary memories.

Magnetic Storage:

- **Magnetic Tape:** Magnetic tapes are used for large computers like mainframe computers where large volume of data is stored for a longer time. In PC also you can use tapes in the form of cassettes. The cost of storing data in tapes is inexpensive. Tapes consist of magnetic materials that store data permanently. It can be 12.5 mm to 25 mm wide plastic film-type and 500 meter to 1200 meter long which is coated with magnetic material. The deck is connected to the central processor and information is fed into or read from the tape through the processor. It's similar to cassette tape recorder.

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- **Magnetic Disk:** You might have seen the gramophone record, which is circular like a disk and coated with magnetic material. Magnetic disks used in computer are made on the same principle. It rotates with very high speed inside the computer drive. Data is stored on both the surface of the disk. Magnetic disks are most popular for direct access storage device. Each disk consists of a number of invisible concentric circles called tracks. Information is recorded on tracks of a disk surface in the form of tiny magnetic spots. The presence of a magnetic spot represents one bit and its absence represents zero bit. The information stored in a disk can be read many times without affecting the stored data. So the reading operation is non-destructive. But if you want to write a new data, then the existing data is erased from the disk and new data is recorded. For Example-Floppy Disk.

Optical storage:

With every new application and software there is greater demand for memory capacity. It is the necessity to store large volume of data that has led to the development of optical disk storage medium. Optical disks can be divided into the following categories:

- **CD:** Compact Disc is a flat, round, optical storage medium invented by James Russell. The first CD was created at a Philips factory in Germany on August 17, 1982. The picture is an example of the bottom of a standard compact disc and is the side the disc player reads. The opposite side of the disc has a label to help indicate what is on the disc.
- **DVD:** Digital Versatile Disc or Digital Video Disc, a DVD or DVD-ROM is a disc capable of storing large amounts of data on one disc the size of a standard Compact Disc. CD/DVD drives were first sold in 1997. They are widely used for storing and viewing movies and other data.

Solid State Storage

- **Flash/Pen Drive:** USB flash drive, data stick, pen drive, memory unit, keychain drive and thumb drive, a jump drive is a portable storage device. It is often the size of a human thumb (hence the name), and it connects to a computer via a USB port. Flash drives are an easy way to store and transfer information. They are available in sizes ranging from 2 GB to 1 TB.

Unlike a standard hard drive, the flash drive has no movable parts; it contains only an integrated circuit memory chip that is used to store data. Flash drives usually have plastic or aluminum casings surrounding the memory chip and a USB connector for use with most modern computers.

- **Memory Card:** It is a type of storage media that is often used to store photos, videos, or other data in electronic devices. Devices that commonly use a memory card include digital cameras, digital camcorders, handheld computers, MP3 players, PDAs, cell phones, game consoles, and printers. The picture to the right is a MicroSD flash memory card, which is just one of the types of memory cards

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available. There are a handful of different types of memory cards on the market, each varying in size, compatibility, and storage capacity.

Computer Memory is measured as follows:

- Bit - All computers work on a binary numbering system, i.e. they process data in one's or zero's. This 1 or 0 level of storage is called a bit.
- Byte - A byte consists of eight bits.
- Kilobyte - A kilobyte (KB) consists of 1024 bytes.
- Megabyte - A megabyte (MB) consists of 1024 kilobytes.
- Gigabyte - A gigabyte (GB) consists of 1024 megabytes.
- Terabyte – A Terabyte (TB) consists of 1024 gigabytes.

BASIC PROCESSORS ARCHITECTURE:

A processor's instruction set is a determining factor in its architecture. On the basis of the instruction set, microprocessors are classified as—Reduced Instruction Set Computer (RISC), and Complex Instruction Set Computer (CISC). The *x86* instruction set of the original Intel 8086 processor is of the CISC type. The PCs are based on the *x86* instruction set.

CISC architecture hardwires the processor with complex instructions, which are difficult to create otherwise using basic instructions. CISC combines the different instructions into one single CPU.

- CISC has a large instruction set that includes simple and fast instructions for performing basic tasks, as well as complex instructions that correspond to statements in the high level language.
- An increased number of instructions (200 to 300) results in a much more complex processor, requiring millions of transistors.
- Instructions are of variable lengths, using 8, 16 or 32 bits for storage. This results in the processor's time being spent in calculating where each instruction begins and ends.
- With large number of application software programs being written for the processor, a new processor has to be backwards compatible to the older version of processors.
- AMD and Cyrix are based on CISC.

RISC has simple, single-cycle instructions, which performs only basic instructions. RISC architecture does not have hardwired advanced functions. All high-level language support is done in the software.

- RISC has fewer instructions and requires fewer transistors, which results in the reduced manufacturing cost of processor.
- The instruction size is fixed (32 bits). The processor need not spend time in finding out where each instruction begins and ends.
- RISC architecture has a reduced production cost compared to CISC processors.
- The instructions, simple in nature, are executed in just one clock cycle, which speeds up the program execution when compared to CISC processors.

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- RISC processors can handle multiple instructions simultaneously by processing them in parallel.
- Apple Mac G3 and PowerPC are based on RISC.
- Processors like Athlon XP and Pentium IV use a hybrid of both technologies.

Pipelining improves instruction execution speed by putting the execution steps into parallel. A CPU can receive a single instruction, begin executing it, and receive another instruction before it has completed the first. This allows for more instructions to be performed, about, one instruction per clock cycle.

Parallel Processing is the simultaneous execution of instructions from the same program on different processors. A program is divided into multiple processes that are handled in parallel in order to reduce execution time.

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Unit-II: Number System and Computer Codes: Binary number system, working with binary numbers, octal number system, hexadecimal number system, working with fractions, signed number representation in binary form, BCD code, and other codes. Boolean algebra and logic gates: Boolean algebra, Venn diagrams, representation of Boolean functions, logic gates, logic diagrams and Boolean expressions using karnaugh map. Computer Software: Introduction to computer software, classification of computer software, system software, application software, firmware, middleware, acquiring computer software, design and implementation of correct, efficient and maintainable programs.

Basics of Computers - Number System

Number System and Computer Codes: Binary number system, working with binary numbers, octal number system, hexadecimal number system, working with fractions, signed number representation in binary form, BCD code, and other codes.

The technique to represent and work with numbers is called **number system**. **Decimal number system** is the most common number system. Other popular number systems include **binary number system**, **octal number system**, **hexadecimal number system**, etc.

Decimal Number System

Decimal number system is a **base 10** number system having 10 digits from 0 to 9. This means that any numerical quantity can be represented using these 10 digits. Decimal number system is also a **positional value system**. This means that the value of digits will depend on its position. Let us take an example to understand this.

Say we have three numbers – 734, 971 and 207. The value of 7 in all three numbers is different–

- In 734, value of 7 is 7 hundreds or 700 or 7×100 or 7×10^2
- In 971, value of 7 is 7 tens or 70 or 7×10 or 7×10^1
- In 207, value of 7 is 7 units or 7 or 7×1 or 7×10^0

The weightage of each position can be represented as follows –

10^5	10^4	10^3	10^2	10^1	10^0
--------	--------	--------	--------	--------	--------

In digital systems, instructions are given through electric signals; variation is done by varying the voltage of the signal. Having 10 different voltages to implement decimal number system in digital equipment is difficult. So, many number systems that are easier to implement digitally have been developed. Let's look at them in detail.

Binary Number System

The easiest way to vary instructions through electric signals is two-state system – on and off. On is represented as 1 and off as 0, though 0 is not actually no signal but

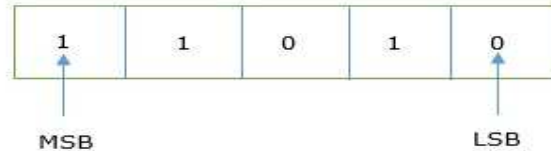
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signal at a lower voltage. The number system having just these two digits – 0 and 1 – is called **binary number system**.

Each binary digit is also called a **bit**. Binary number system is also positional value system, where each digit has a value expressed in powers of 2, as displayed here.

2^5	2^4	2^3	2^2	2^1	2^0
-------	-------	-------	-------	-------	-------

In any binary number, the rightmost digit is called **least significant bit (LSB)** and leftmost digit is called **most significant bit (MSB)**.



And decimal equivalent of this number is sum of product of each digit with its positional value.

$$\begin{aligned} 11010_2 &= 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 \\ &= 16 + 8 + 0 + 2 + 0 \\ &= 26_{10} \end{aligned}$$

Computer memory is measured in terms of how many bits it can store. Here is a chart for memory capacity conversion.

- 1 byte (B) = 8 bits
- 1 Kilobytes (KB) = 1024 bytes
- 1 Megabyte (MB) = 1024 KB
- 1 Gigabyte (GB) = 1024 MB
- 1 Terabyte (TB) = 1024 GB
- 1 Exabyte (EB) = 1024 PB
- 1 Zettabyte = 1024 EB
- 1 Yottabyte (YB) = 1024 ZB

Octal Number System

Octal number system has eight digits – 0, 1, 2, 3, 4, 5, 6 and 7. Octal number system is also a positional value system with where each digit has its value expressed in powers of 8, as shown here –

8^5	8^4	8^3	8^2	8^1	8^0
-------	-------	-------	-------	-------	-------

Decimal equivalent of any octal number is sum of product of each digit with its positional value.

$$\begin{aligned} 726_8 &= 7 \times 8^2 + 2 \times 8^1 + 6 \times 8^0 \\ &= 448 + 16 + 6 \\ &= 470_{10} \end{aligned}$$

Hexadecimal Number System

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Octal number system has 16 symbols – 0 to 9 and A to F where A is equal to 10, B is equal to 11 and so on till F. Hexadecimal number system is also a positional value system with where each digit has its value expressed in powers of 16, as shown here –

16^5	16^4	16^3	16^2	16^1	16^0
--------	--------	--------	--------	--------	--------

Decimal equivalent of any hexadecimal number is sum of product of each digit with its positional value.

$$\begin{aligned} 27FB_{16} &= 2 \times 16^3 + 7 \times 16^2 + 15 \times 16^1 + 10 \times 16^0 \\ &= 8192 + 1792 + 240 + 10 \\ &= 10234_{10} \end{aligned}$$

Number System Relationship

The following table depicts the relationship between decimal, binary, octal and hexadecimal number systems.

HEXADECIMAL	DECIMAL	OCTAL	BINARY
0	0	0	0000
1	1	1	0001
2	2	2	0010
3	3	3	0011
4	4	4	0100
5	5	5	0101
6	6	6	0110
7	7	7	0111
8	8	10	1000
9	9	11	1001
A	10	12	1010
B	11	13	1011
C	12	14	1100
D	13	15	1101

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E	14	16	1110
F	15	17	1111

Table of the Numbers Systems with Base, Used Digits, Representation, C language representation:

Number system	Base	Used digits	Example
Binary	2	0,1	(11110000) ₂
Octal	8	0,1,2,3,4,5,6,7	(360) ₈
Decimal	10	0,1,2,3,4,5,6,7,8,9	(240) ₁₀
Hexadecimal	16	0,1,2,3,4,5,6,7,8,9, A,B,C,D,E,F	(F0) ₁₆

Number System Conversions

There are three types of conversion:

- **Decimal Number System to Other Base**
[For example: Decimal Number System to Binary Number System]
- **Other Base to Decimal Number System**
[For example: Binary Number System to Decimal Number System]
- **Other Base to Other Base**
[For example: Binary Number System to Hexadecimal Number System]

Decimal Number System to Other Base

To convert Number system from **Decimal Number System** to **Any Other Base** is quite easy; you have to follow just two steps:

A) Divide the Number (Decimal Number) by the base of target base system (in which you want to convert the number: Binary (2), octal (8) and Hexadecimal (16)).

B) Write the remainder from step 1 as a Least Signification Bit (LSB) to Step last as a Most Significant Bit (MSB).

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Decimal to Binary Conversion

Result

Decimal Number is : $(12345)_{10}$

2	12345	1	LSB
2	6172	0	
2	3086	0	
2	1543	1	
2	771	1	
2	385	1	
2	192	0	
2	96	0	
2	48	0	
2	24	0	
2	12	0	
2	6	0	
2	3	1	
	1	1	MSB

Binary Number is
 $(11000000111001)_2$

Decimal to Octal Conversion

Result

Decimal Number is : $(12345)_{10}$

8	12345	1	LSB
8	1543	7	
8	192	0	
8	24	0	
	3	3	MSB

Octal Number is
 $(30071)_8$

Decimal to Hexadecimal Conversion

Result

Example 1

Decimal Number is : $(12345)_{10}$

Hexadecimal Number is
 $(3039)_{16}$

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- Binary codes are suitable for the digital communications.
- Binary codes make the analysis and designing of digital circuits if we use the binary codes.
- Since only 0 & 1 are being used, implementation becomes easy.

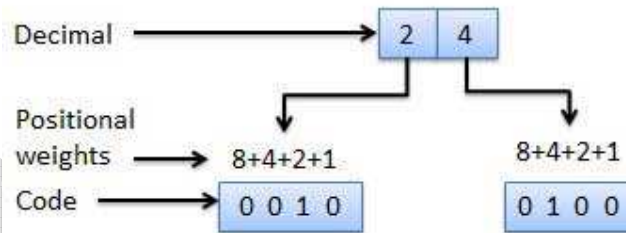
Classification of binary codes

The codes are broadly categorized into following four categories.

- Weighted Codes
- Non-Weighted Codes
- Binary Coded Decimal Code
- Alphanumeric Codes
- Error Detecting Codes
- Error Correcting Codes

Weighted Codes

Weighted binary codes are those binary codes which obey the positional weight principle. Each position of the number represents a specific weight. Several systems of the codes are used to express the decimal digits 0 through 9. In these codes each decimal digit is represented by a group of four bits.

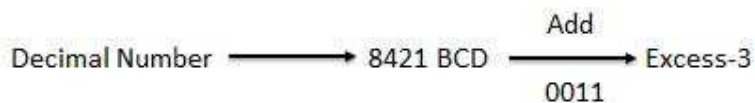


Non-Weighted Codes

In this type of binary codes, the positional weights are not assigned. The examples of non-weighted codes are Excess-3 code and Gray code.

Excess-3 code

The Excess-3 code is also called as XS-3 code. It is non-weighted code used to express decimal numbers. The Excess-3 code words are derived from the 8421 BCD code words adding $(0011)_2$ or $(3)_{10}$ to each code word in 8421. The excess-3 codes are obtained as follows –



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Example

Decimal	BCD	Excess-3
	8 4 2 1	BCD + 0011
0	0 0 0 0	0 0 1 1
1	0 0 0 1	0 1 0 0
2	0 0 1 0	0 1 0 1
3	0 0 1 1	0 1 1 0
4	0 1 0 0	0 1 1 1
5	0 1 0 1	1 0 0 0
6	0 1 1 0	1 0 0 1
7	0 1 1 1	1 0 1 0
8	1 0 0 0	1 0 1 1
9	1 0 0 1	1 1 0 0

Gray Code

It is the non-weighted code and it is not arithmetic codes. That means there are no specific weights assigned to the bit position. It has a very special feature that, only one bit will change each time the decimal number is incremented as shown in fig. As only one bit changes at a time, the gray code is called as a unit distance code. The gray code is a cyclic code. Gray code cannot be used for arithmetic operation.

Decimal	BCD	Gray
0	0 0 0 0	0 0 0 0
1	0 0 0 1	0 0 0 1
2	0 0 1 0	0 0 1 1
3	0 0 1 1	0 0 1 0
4	0 1 0 0	0 1 1 0
5	0 1 0 1	0 1 1 1
6	0 1 1 0	0 1 0 1
7	0 1 1 1	0 1 0 0
8	1 0 0 0	1 1 0 0
9	1 0 0 1	1 1 0 1

Application of Gray code

- Gray code is popularly used in the shaft position encoders.
- A shaft position encoder produces a code word which represents the angular position of the shaft.

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Binary Coded Decimal (BCD) code

In this code each decimal digit is represented by a 4-bit binary number. BCD is a way to express each of the decimal digits with a binary code. In the BCD, with four bits we can represent sixteen numbers (0000 to 1111). But in BCD code only first ten of these are used (0000 to 1001). The remaining six code combinations i.e. 1010 to 1111 are invalid in BCD.

Decimal	0	1	2	3	4	5	6	7	8	9
BCD	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

Advantages of BCD Codes

- It is very similar to decimal system.
- We need to remember binary equivalent of decimal numbers 0 to 9 only.

Disadvantages of BCD Codes

- The addition and subtraction of BCD have different rules.
- The BCD arithmetic is little more complicated.
- BCD needs more number of bits than binary to represent the decimal number. So BCD is less efficient than binary.

Alphanumeric codes

A binary digit or bit can represent only two symbols as it has only two states '0' or '1'. But this is not enough for communication between two computers because there we need many more symbols for communication. These symbols are required to represent 26 alphabets with capital and small letters, numbers from 0 to 9, punctuation marks and other symbols.

The alphanumeric codes are the codes that represent numbers and alphabetic characters. Mostly such codes also represent other characters such as symbol and various instructions necessary for conveying information. An alphanumeric code should at least represent 10 digits and 26 letters of alphabet i.e. total 36 items. The following three alphanumeric codes are very commonly used for the data representation.

- American Standard Code for Information Interchange (ASCII).
- Extended Binary Coded Decimal Interchange Code (EBCDIC).
- Five bit Baudot Code.

ASCII code is a 7-bit code whereas EBCDIC is an 8-bit code. ASCII code is more commonly used worldwide while EBCDIC is used primarily in large IBM computers.

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Error Codes

There are binary code techniques available to detect and correct data during data transmission.

Error Code	Description
<u>Error Detection and Correction</u>	Error detection and correction code techniques

Boolean algebra and logic gates:

Boolean Algebra is used to analyze and simplify the digital (logic) circuits. It uses only the binary numbers i.e. 0 and 1. It is also called as **Binary Algebra** or **logical Algebra**. Boolean algebra was invented by **George Boole** in 1854.

Rule in Boolean Algebra

Following are the important rules used in Boolean algebra.

- Variable used can have only two values. Binary 1 for HIGH and Binary 0 for LOW.
- Complement of a variable is represented by an overbar (-). Thus, complement of variable B is represented as \bar{B} . Thus if $B = 0$ then $\bar{B} = 1$ and $B = 1$ then $\bar{B} = 0$.
- ORing of the variables is represented by a plus (+) sign between them. For example ORing of A, B, C is represented as $A + B + C$.
- Logical ANDing of the two or more variable is represented by writing a dot between them such as A.B.C. Sometime the dot may be omitted like ABC.

Boolean Laws

There are six types of Boolean Laws.

Commutative law

Any binary operation which satisfies the following expression is referred to as commutative operation.

$$(i) A.B = B.A \quad (ii) A + B = B + A$$

Commutative law states that changing the sequence of the variables does not have any effect on the output of a logic circuit.

Associative law

This law states that the order in which the logic operations are performed is irrelevant as their effect is the same.

$$(i) (A.B).C = A.(B.C) \quad (ii) (A + B) + C = A + (B + C)$$

Distributive law

Distributive law states the following condition.

$$A.(B + C) = A.B + A.C$$

AND law

These laws use the AND operation. Therefore they are called as **AND** laws.

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- (i) $A \cdot 0 = 0$ (ii) $A \cdot 1 = A$
 (iii) $A \cdot A = A$ (iv) $A \cdot \bar{A} = 0$

OR law

These laws use the OR operation. Therefore they are called as **OR** laws.

- (i) $A + 0 = A$ (ii) $A + 1 = 1$
 (iii) $A + A = A$ (iv) $A + \bar{A} = 1$

INVERSION law

This law uses the NOT operation. The inversion law states that double inversion of a variable results in the original variable itself.

$$\overline{\overline{A}} = A$$

Important Boolean Theorems

Following are few important boolean Theorems.

Boolean function/theorems	Description
<u>Boolean Functions</u>	Boolean Functions and Expressions, K-Map and NAND Gates realization
<u>De Morgan's Theorems</u>	De Morgan's Theorem 1 and Theorem 2

Logic Gates

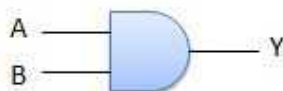
Logic gates are the basic building blocks of any digital system. It is an electronic circuit having one or more than one input and only one output. The relationship between the input and the output is based on a **certain logic**. Based on this, logic gates are named as AND gate, OR gate, NOT gate etc.

AND Gate

A circuit which performs an AND operation is shown in figure. It has n input ($n \geq 2$) and one output.

$$\begin{aligned} Y &= A \text{ AND } B \text{ AND } C \dots\dots N \\ Y &= A \cdot B \cdot C \dots\dots N \\ Y &= ABC \dots\dots N \end{aligned}$$

Logic diagram



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Truth Table

Inputs		Output
A	B	AB
0	0	0
0	1	0
1	0	0
1	1	1

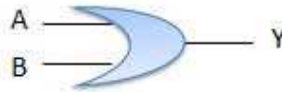
OR Gate

A circuit which performs an OR operation is shown in figure. It has n input ($n \geq 2$) and one output.

$$Y = A \text{ OR } B \text{ OR } C \dots\dots N$$

$$Y = A + B + C \dots\dots N$$

Logic diagram



Truth Table

Inputs		Output
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

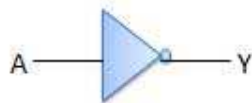
NOT Gate

NOT gate is also known as **Inverter**. It has one input A and one output Y.

$$Y = \text{NOT } A$$

$$Y = \overline{A}$$

Logic diagram



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Truth Table

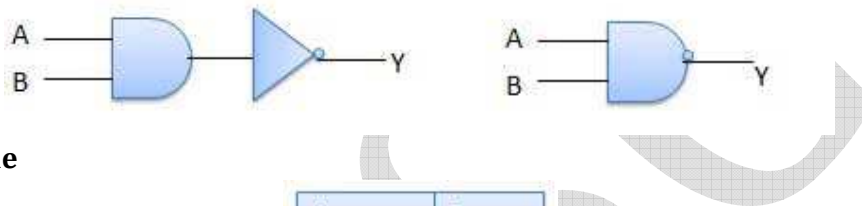
Inputs	Output
A	B
0	1
1	0

NAND Gate

A NOT-AND operation is known as NAND operation. It has n input ($n \geq 2$) and one output.

$$Y = A \text{ NOT AND } B \text{ NOT AND } C \dots\dots N$$
$$Y = A \text{ NAND } B \text{ NAND } C \dots\dots N$$

Logic diagram



Truth Table

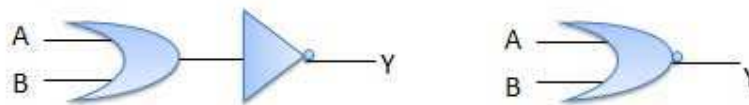
Inputs		Output
A	B	\overline{AB}
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

A NOT-OR operation is known as NOR operation. It has n input ($n \geq 2$) and one output.

$$Y = A \text{ NOT OR } B \text{ NOT OR } C \dots\dots N$$
$$Y = A \text{ NOR } B \text{ NOR } C \dots\dots N$$

Logic diagram



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Truth Table

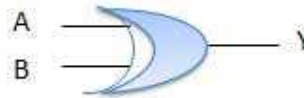
Inputs		Output
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

XOR Gate

XOR or Ex-OR gate is a special type of gate. It can be used in the half adder, full adder and subtractor. The exclusive-OR gate is abbreviated as EX-OR gate or sometime as X-OR gate. It has n input ($n \geq 2$) and one output.

$$\begin{aligned}
 Y &= A \text{ XOR } B \text{ XOR } C \dots\dots N \\
 Y &= A \oplus B \oplus C \dots\dots N \\
 Y &= \overline{AB} + \overline{AB}
 \end{aligned}$$

Logic diagram



Truth Table

Inputs		Output
A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

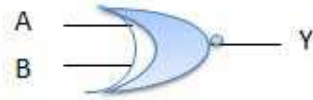
XNOR Gate

XNOR gate is a special type of gate. It can be used in the half adder, full adder and subtractor. The exclusive-NOR gate is abbreviated as EX-NOR gate or sometime as X-NOR gate. It has n input ($n \geq 2$) and one output.

$$\begin{aligned}
 Y &= A \text{ XOR } B \text{ XOR } C \dots\dots N \\
 Y &= A \ominus B \ominus C \dots\dots N \\
 Y &= \overline{\overline{AB} + \overline{AB}}
 \end{aligned}$$

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Logic diagram



Truth Table

Inputs		Output
A	B	$A \oplus B$
0	0	1
0	1	0
1	0	0
1	1	1

Karnaugh Maps

The Karnaugh map (K-map), introduced by Maurice Karnaugh in 1953, is a grid-like representation of a truth table which is used to simplify boolean algebra expressions. A Karnaugh map has zero and one entries at different positions. It provides grouping together Boolean expressions with common factors and eliminates unwanted variables from the expression. In a K-map, crossing a vertical or horizontal cell boundary is always a change of only one variable.

Example 1

An arbitrary truth table is taken below –

A	B	A operation B
0	0	w
0	1	x
1	0	y
1	1	z

Now we will make a k-map for the above truth table –

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		B	
		0	1
A	0	w	x
	1	y	z

Example 2

Now we will make a K-map for the expression – $AB + A'B'$

		B	
		0	1
A	0	1	0
	1	0	1

Simplification Using K-map

K-map uses some rules for the simplification of Boolean expressions by combining together adjacent cells into single term. The rules are described below –

Rule 1 – Any cell containing a zero cannot be grouped.

		BC			
		00	01	11	10
A	0	1	0	1	0
	1	0	1	1	1

Wrong grouping

Rule 2 – Groups must contain 2^n cells (n starting from 1).

		BC			
		00	01	11	10
A	0	1	0	1	0
	1	0	1	1	1

Wrong grouping

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Rule 3 – Grouping must be horizontal or vertical, but must not be diagonal.

		BC			
		00	01	11	10
A	0	1	1	1	0
	1	0	0	1	1

Wrong diagonal grouping

		BC			
		00	01	11	10
A	0	1	1	1	0
	1	0	0	1	1

Proper vertical grouping

		BC			
		00	01	11	10
A	0	1	1	1	0
	1	0	0	1	1

Proper horizontal grouping

Rule 4 – Groups must be covered as largely as possible.

		BC			
		00	01	11	10
A	0	1	0	1	0
	1	1	1	1	1

Insufficient grouping

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		BC			
A		00	01	11	10
0		1	0	1	0
1		1	1	1	1

Proper grouping

Rule 5 – If 1 of any cell cannot be grouped with any other cell, it will act as a group itself.

		BC			
A		00	01	11	10
0		1	0	1	0
1		0	1	0	1

Proper grouping

Rule 6 – Groups may overlap but there should be as few groups as possible.

		BC			
A		00	01	11	10
0		0	0	1	1
1		1	1	1	1

Proper grouping

Rule 7 – The leftmost cell/cells can be grouped with the rightmost cell/cells and the topmost cell/cells can be grouped with the bottommost cell/cells.

		BC			
A		00	01	11	10
0		1	0	0	1
1		1	0	0	1

Proper grouping

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Problem

Minimize the following Boolean expression using K-map –

$$F(A,B,C)=A'BC+A'BC'+AB'C'+AB'CF(A,B,C)=A'BC+A'BC'+AB'C'+AB'C$$

Solution: Each term is put into k-map and we get the following –

		BC			
		00	01	11	10
A	0	0	0	1	1
	1	1	1	0	0

K-map for F (A, B, C)

Now we will group the cells of 1 according to the rules stated above –

		BC			
		00	01	11	10
A	0	0	0	1	1
	1	1	1	0	0

K-map for F (A, B, C)

We have got two groups which are termed as $A'BA'B$ and $AB'AB'$. Hence, $F(A,B,C)=A'B+AB'=A\oplus B$. It is the minimized form.

Computer Software:

Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a particular problem.

There are two types of software –

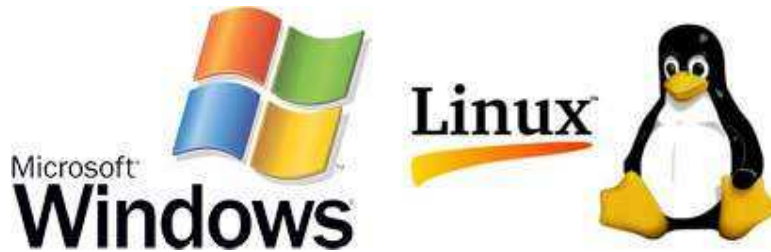
- System Software
- Application Software

System Software

The system software is a collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. System software is generally prepared by the computer manufacturers. These software products comprise of programs written in low-level languages, which interact with the hardware at a very basic level. System software serves as the interface between the hardware and the end users.

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Some examples of system software are Operating System, Compilers, Interpreter, Assemblers, etc.



Here is a list of some of the most prominent features of a system software –

- Close to the system
- Fast in speed
- Difficult to design
- Difficult to understand
- Less interactive
- Smaller in size
- Difficult to manipulate
- Generally written in low-level language

Application Software

Application software products are designed to satisfy a particular need of a particular environment. All software applications prepared in the computer lab can come under the category of Application software.

Application software may consist of a single program, such as Microsoft's notepad for writing and editing a simple text. It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as a spreadsheet package.

Examples of Application software are the following –

- Payroll Software
- Student Record Software
- Inventory Management Software
- Income Tax Software
- Railways Reservation Software
- Microsoft Office Suite Software
- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint



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Features of application software are as follows –

- Close to the user
- Easy to design
- More interactive
- Slow in speed
- Generally written in high-level language
- Easy to understand
- Easy to manipulate and use
- Bigger in size and requires large storage space

Firmware:

The firmware is a block of program instructions for specific purposes, recorded in non-volatile memory (ROM, EEPROM, flash, etc.), which establishes the lowest level logic that controls the electronic circuits of a device of any type. Being integrated into the electronics of the device is partly hardware, but it is also software, as it provides logic and is available in some type of programming language. Functionally, the firmware is the intermediary (interface) between the external commands that the device receives and its electronics, since it is in charge of controlling the latter to execute correctly said external orders. We find firmware in ROMs of systems of various peripheral devices, such as video monitors, disk drives, printers, etc., but also in the microprocessors themselves, main memory chips and in general in any integrated circuit. Many of the firmwares stored in ROM are protected by Copyright.

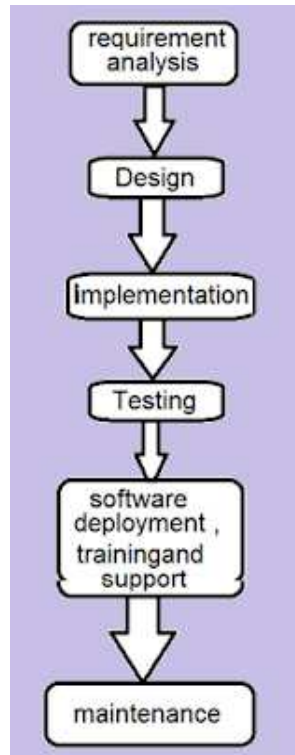
Middleware:

Middleware is software that assists an application to interact or communicate with other applications, software, networks, hardware and / or operating systems. This simplifies the work of programmers in the complex task of generating the connections that are needed in distributed systems. This process is also called middleware engineering. This provides a solution that improves the quality of service, security, message sending, service directory, etc. It functions as a distributed software abstraction layer, which sits between the application layers and the lower layers (operating system and network). The middleware abstracts from the complexity and heterogeneity of the underlying communications networks as well as the operating systems and programming languages, providing an API for easy programming and management of distributed applications. Depending on the problem to be solved and the necessary functions, different types of middleware services will be useful. Generally the client-side middleware is implemented by the Operating System, which has the libraries that execute all the functionalities for the communication through the network.

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Design and Implementation of Correct Efficient and Maintainable Programs

The entire program or software (collection of programs) development process is divided into a number of phases, where each phase performs a well-defined task.



Phases in Software development Life cycle.

Requirements analysis:

In this phase, the user's expectations are gathered to understand why the program or software has to be developed. Then, all the gathered requirements are analysed and the scope or objective of the overall software product is pinned down. The last activity in this phase involves documenting every identified requirement of the user in order to avoid any doubts or uncertainty regarding the functionality of the program. The functionality, capability, performance, and availability of hardware and software components are all analysed in this phase.

Design:

The requirement documented in the previous phase act as the input to the design phase. In this phase, a plan of actions is made before the actual development process starts. This plan will be followed throughout the development process. Moreover, in the design phase, the core structure of the software or program is broken down into modules. The solution of the program is then specified for each module in the form of algorithms or flow charts. The design phase therefore specifies how the program or software will be developed.

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Implementation:

In this phase, the designed algorithms are converted into program code using any of the high-level languages. The particular choice of language will depend on the type of program such as whether it is a system or an application program. C is preferred for writing system programs, whereas Visual Basic might be preferred for an application program. The program codes are tested by the programmer to ensure their correctness.

Testing:

In this phase, all the modules are tested together to ensure that the overall system works well as a whole product. In this phase, the software is tested using a large number of varied inputs, also known as test data, to ensure that the software is working as expected by the user's requirements identified in the requirements analysis phase.

Software deployment, training, and support:

After the code is tested and the software or the program is approved by the user, it is then installed or deployed in the production environment. Software training and support is a crucial phase. Program designers and developers spend a lot of time creating the software, but if nobody in the organization knows how to use it or to fix certain problems, then no one will want to use it.

Maintenance:

Maintenance and enhancements are ongoing activities that are done to cope with newly discovered problems or new requirements. Such activities may take a long time to complete.

