

Chapter 1

INTRODUCTION TO COMPUTER SYSTEM

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1.3	Classification of Computers
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1.0 OBJECTIVES

After studying this chapter you will be able to:

- Learn the concept of a system in general and the computer system in specific.
- Learn and understand how the computers have evolved dramatically within a very short span, from very huge machines of the past, to very compact designs of the present with tremendous advances in technology.
- Understand the general classifications of computers.
- Study computer applications.
- Understand the typical characteristics of computers which are speed, accuracy, efficiency, storage capacity, versatility.
- Understand limitations of the computer.
- Discuss the similarities and differences between the human and the computer.
- Understand the Component of the computer.

1.1 INTRODUCTION- Computer

Today, almost all of us in the world make use of computers in one way or the other. It finds applications in various fields of engineering, medicine, commercial, research and others. Not only in these sophisticated areas, but also in our daily lives, computers have become indispensable. They are present everywhere, in all the devices that we use daily like cars, games, washing machines, microwaves etc. and in day to day computations like banking, reservations, electronic mails, internet and many more.

The word **computer** is derived from the word **compute**. Compute means to calculate. The computer was originally defined as a super fast calculator. It had the capacity to solve complex arithmetic and scientific problems at very high speed. But nowadays in addition to handling complex arithmetic computations, computers perform many other tasks like accepting, sorting, selecting, moving, comparing various types of information. They also perform arithmetic and logical operations on alphabetic, numeric and other types of information. This information provided by the user to the computer is **data**. The information in one form which is presented to the computer is the input information or **input data**.

Information in another form is presented by the computer after performing a process on it. This information is the output information or **output data**.

The set of instructions given to the computer to perform various operations is called as the **computer program**. The process of converting the input data into the required output form with the help of the computer program is called as **data processing**. The computers are therefore also referred to as data processors

Therefore a computer can now be defined as a fast and accurate data processing system that accepts data, performs various operations on the data, has the capability to store the data and produce the results on the basis of detailed step by step instructions given to it..

The terms **hardware and software** are almost always used in connection with the computer.

- **The Hardware:**

The hardware is the machinery itself. It is made up of the physical parts or devices of the computer system like the electronic Integrated Circuits (ICs), magnetic storage media and other mechanical devices like input devices, output devices etc. All these various hardware are linked together to form an effective functional unit. The various types of hardware used in the computers, has evolved from vacuum tubes of the first generation to Ultra Large Scale Integrated Circuits of the present generation.

- **The Software:**

The computer hardware itself is not capable of doing anything on its own. It has to be given explicit instructions to perform the specific task. The computer program is the one which controls the processing activities of the computer. The computer thus functions according to the instructions written in the program. Software mainly consists of these computer programs, procedures and other documentation used in the operation of a computer system. Software is a collection of programs which utilize and enhance the capability of the hardware

Check your Progress - 1.1

1. Fill in the blanks.

- a. The set of instructions to perform various operations is called
a
- b. Compute means to of the computer.
- c. Mechanical devices are a type of.....

2. Answer in brief.

- a. Define a computer.
.....
.....
- b. What is software?
.....
.....

1. 2 EVOLUTION OF COMPUTERS

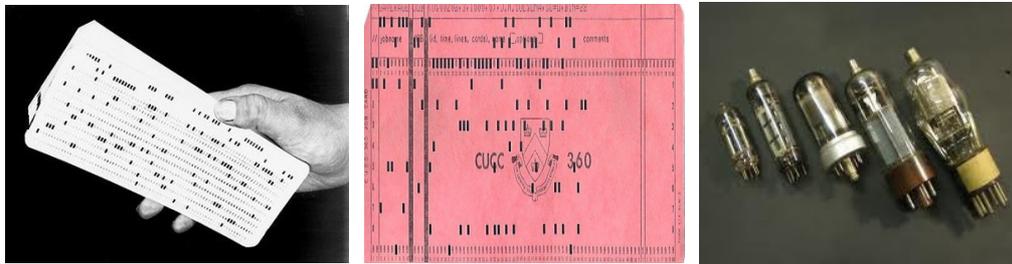
The computers of today are vastly different in appearance and performance as compared to the computers of earlier days. But where did this technology come from and Where is it heading? To fully understand the impact of computers on today's world and the promises they hold for the future, it is important to understand the evolution of computers.

1.2.1. The First Generation:

The first generation computers made use of:

- Vacuum tube technology,
- Punched cards for data input,
- Punched cards and paper tape for output,
- Machine Language for writing programs,
- Magnetic tapes and drums for external storage.

The computers of the first generation were very bulky and emitted large amount of heat which required air conditioning. They were large in size and cumbersome to handle. They had to be manually assembled and had limited commercial use. The concept of operating systems was not known at that time. Each computer had a different binary coded program called a machine language that told it how to operate.



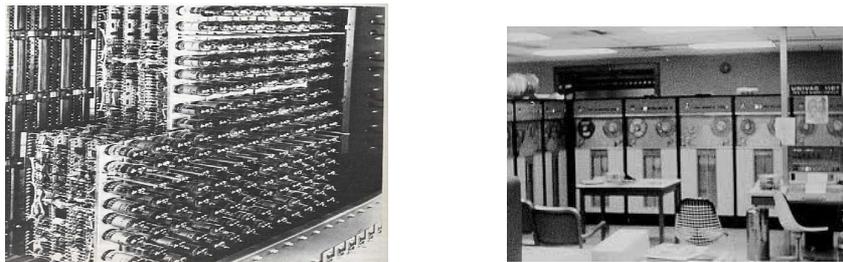
Punched cards

Paper tape

Vacuum tube

Fig. 1.1 The first Generation Computer technology

The **Abacus**, which emerged about 5000 years ago in Asia Minor and is still in use today, allows users to make computations using a system of sliding beads arranged on a rack. Early merchants used Abacus to keep trading transactions.



Abacus

Pascaline

Fig. 1.2 the first Generation Computers

Blaise Pascal, a French mathematician invented the first mechanical machine, a rectangular brass box, called **Pascaline** which could perform addition and subtraction on whole numbers. This was in the seventeenth century. **Colmar**, a Frenchman invented a machine that could perform the four basic arithmetic functions of addition, subtraction, multiplication and division. Colmar's mechanical calculator, "**Arithmometer**", presented a more practical approach to computing. With its enhanced versatility, the "Arithmometer" was widely used until the First World War, although later inventors refined Colmar's calculator, together with fellow inventors, Pascal and Leibniz, he helped define the age of mechanical computation.

Charles Babbage a British mathematician at Cambridge University invented the first **analytical engine or difference engine**. This machine could be programmed by instructions coded on punch cards and had mechanical memory to store the results. For his contributions in this field **Charles Babbage** is known as '**the father of modern digital computer**'.

Some of the early computers included:

Mark I –

This was the first fully automatic calculating machine. It was designed by Howard Aiken of Harvard University in collaboration with IBM. This machine was an electronic relay computer. Electromagnetic signals were used for the movement of mechanical parts. Mark I could perform the basic arithmetic and complex equations. Although this machine was extremely reliable, it was very slow (it took about 3-5 seconds per calculation) and was complex in design and large in size.

Atanasoff-Berry Computer (ABC) –

This computer developed by John Atanasoff and Clifford Berry was the world's first general purpose electronic digital computer. It made use of vacuum tubes for internal logic and capacitors for storage.

ENIAC (Electronic Numeric Integrator and Calculator) –

The first all electronic computer was produced by a partnership between the US Government and the University of Pennsylvania. It was built using 18,000 vacuum tubes, 70,000 resistors and 1,500 relays and consumed 160 kilowatts of electrical power. The ENIAC computed at speed about thousand times faster than Mark I. However, it could store and manipulate only a limited amount of data. Program modifications and detecting errors were also difficult.



Fig. 1.3 ENIAC

EDVAC –

In the mid 1940's Dr. John von Neumann designed the **Electronic Discrete Variable Automatic Computer** with a memory to store both program and data. This was the first machine which used the stored program concept. It had five distinct units - arithmetic, central control, memory, input and output. The key element was the central control. All the functions of the computer were co-ordinate through this single source, the central control. The programming of the computers was done in machine language

UNIVAC • I –

Remington Rand designed this computer specifically for business data processing applications. The **Universal Automatic Computer** was the first general purpose commercially available computer.



Fig 1.4 UNIVAC

1.2.2 The Second Generation:

In the second generation computers:

- Vacuum tube technology was replaced by transistorized technology,
- Size of the computers started reducing,
- Assembly language started being used in place of machine language,
- Concept of **stored program** emerged,
- High level languages were invented.

This was the generation of **Transistorized Computers**. Vacuum tubes were replaced by transistors. As a result, the size of the machines started shrinking. These computers were smaller, faster, more reliable and more energy efficient. The first transistorized computer was TX-0. The first large scale machines that took advantage of the transistor technology were the early supercomputers, Stretch by IBM and LARC by Sperry Rand. These machines were mainly developed for atomic energy laboratories. Typical computers of the second generation were the IBM 1400 and 7000 series, Honeywell 200 and General Electric.

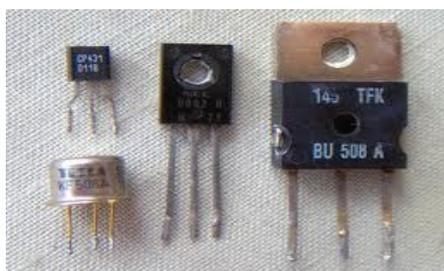


Fig 1.5 Transistors

IBM 1401 was universally accepted throughout the industry and most large businesses routinely processed financial information using second generation computers. The machine language was replaced by assembly language. Thus the long and difficult binary code was replaced with abbreviated programming code which was relatively easy to understand.

The stored program concept and programming languages gave the computers flexibility to finally be cost effective and productive for business use. The **stored program** concept implied that the instructions to run a computer for a specific task were held inside the computer's memory and could quickly be modified or replaced by a different set of instructions for a different function. High level languages like COBOL, FORTRAN and ALGOL were developed. Computers started finding vast and varied applications. The entire software industry began with the second generation computers.

1.2.3. The Third Generation:

The third generation computers were characterized by:

- Use of Integrated circuits,
- Phenomenal increase in computation speed,
- Substantial reduction in size and power consumption of the machines,
- Use of magnetic tapes and drums for external storage,
- Design of Operating systems and new higher level languages,
- Commercial production of computers.

This generation was characterized by the invention of **Integrated Circuits (ICs)**.

The IC combined electronic components onto a small chip which was made from quartz.

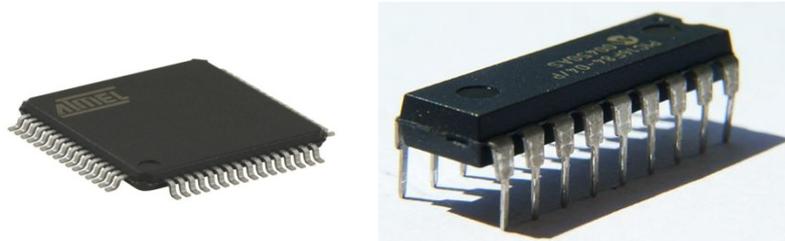


Fig 1.6 i) Integrated Circuit

ii) Integrated Circuit

Later, even more components were fitted onto a single chip, called a **semiconductor**. This reduced the size even further. The weight and power consumption of computers decreased and the speed increased tremendously. Heavy emphasis was given to the development of software. Operating systems were designed which allowed the machine to run many different programs at once. A central program monitored and co-ordinate the computer s memory. Multiprogramming was made possible, whereby the machine could perform several jobs at the same time. Computers achieved speeds of executing millions of instructions per second. Commercial production became easier and cheaper. Higher level languages like Pascal and Report Program Generator (RPG) were introduced and applications oriented languages like FORTRAN, COBOL, and PL/1 were developed.

1.2.4. The Fourth Generation:

The general features of the fourth generation computers were:

- Use of Very Large Scale Integration,
- Invention of microcomputers,
- Introduction of Personal Computers,
- Networking,
- Fourth Generation Languages.



Fig. 1.7 VLSI

The third generation computers made use of 'Integrated Circuits that had 10-20 components on each chip, this was **Small Scale Integration (SSI)**.

The Fourth Generation realized **Large Scale Integration (LSI)** which could fit hundreds of components on one chip and **Very Large Scale integration (VLSI)** which squeezed thousand of components on one chip. The Intel 4004 chip, located all the components of a computer (central processing unit, memory, input and output controls) on a single chip and microcomputers were introduced. Higher capacity storage media like magnetic disks were developed. Fourth generation languages emerged and applications software's started becoming popular.

Computer production became inexpensive and the era of Personal

Computers (PCs) commenced. In 1981, IBM introduced its personal computer for use in office, home and schools. In direct competition, the Macintosh was introduced by Apple in 1984. Shared interactive systems and user friendly environments were the features of these computers.

As the computers started becoming more and more powerful, they could be linked together or networked to share not only data but also memory space and software. The networks could reach enormous proportions with local area networks. A global web of computer circuitry, the Internet, links the computers worldwide into a single network of information.

1.2.5 The Fifth Generation:

Defining the fifth generation computers is somewhat difficult because the field is still in its infancy. The computers of tomorrow would be characterized by Artificial Intelligence (AI). An example of AI is Expert Systems. Computers could be developed which could think and reason in much the same way as humans. Computers would be able to accept spoken words as input (voice recognition).

Many advances in the science of computer design and technology are coming together to enable the creation of fifth generation computers. Two such advances are **parallel processing** where many CPUs work as one and advance in **superconductor technology** which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow.

Check your Progress -1.2

1. Match the following.

A	B
a) Very Large scale Integration	I) Second Generation
b) Vacuum Tube Technology	II) Fifth Generation
c) Stored Program	III) Fourth Generation
d) Superconductor Technology	IV) First Generation
e) Semiconductor Technology	v) Third Generation

2. Write True or False

- A. Expert system is an example of artificial Intelligence.
- B. The world's first general purposes electronic digital computer was the Abacus.
- C. The first generation computers used machine language for programming.
- D. Charles Babbage designed the Analytical Engine .
- E. Personal Computer (PC) was developed in the first generations.

1. 3 CLASSIFICATION OF COMPUTERS

Computers are broadly classified into two categories depending upon the logic used in their design as:

1.3.1 Analog computers:

In analog computers, data is recognized as a continuous measurement of a physical property like voltage, speed, pressure etc. Readings on a dial or graphs are obtained as the output, ex. Voltage, temperature; pressure can be measured in this way.

1.3.2 Digital Computers:

These are high speed electronic devices. These devices are programmable. They process data by way of mathematical calculations, comparison, sorting etc. They accept input and produce output as discrete signals representing high (on) or low (off) voltage state of electricity. Numbers, alphabets, symbols are all represented as a series of 1s and 0s.

Digital Computers are further classified as General Purpose Digital Computers and Special Purpose Digital Computers. General Purpose computers can be used for any applications like accounts, payroll, data processing etc. Special purpose computers are used for a specific job like those used in automobiles, microwaves etc.

Another classification of digital computers is done on the basis of their capacity to access memory and size like:

- **Small Computers:**

I) **Microcomputers:** Microcomputers are generally referred to as **Personal Computers (PCs)**. They have Smallest memory and less power. They are widely used in day to day applications like office automation, and professional applications, ex. PC-AT, Pentium etc.

II) **Note Book and Laptop Computers:** These are portable in nature and are battery operated. Storage devices like CDs, floppies etc. and output devices like printers can be connected to these computers. Notebook computers are smaller in physical size than lap top computers. However, both have powerful processors, support graphics, and can accept mouse driven input.

Microcomputer



Notebook or Laptop



Handheld Computer

Fig. 1.8 Small Computers

III) **Hand Held Computers:**

These types of computers are mainly used in applications like collection of field data. They are even smaller than the note book computers.

• **Hybrid Computers:** Hybrid Computers are a combination of Analog and Digital computers. They combine the speed of analog computers and accuracy of digital computers. They are mostly used in specialized applications where the input data is in an analog form i.e. measurement. This is converted into digital form for further processing. The computers accept data from sensors and produce output using conventional input/output devices.

• **Mini Computers:** Mini computers are more powerful than the micro computers. They have higher memory capacity and more storage capacity with higher speeds. These computers are mainly used in process control systems. They are mainly used in applications like payrolls, financial accounting, Computer aided design etc. ex. VAX, PDP-11

• **Mainframe Computers:** Main frame computers are very large computers which process data at very high speeds of the order of several million instructions per second. They can be linked into a network with smaller computers, micro computers and with each other. They are typically used in large organizations, government departments etc. ex. IBM4381, CDC

• **Super Computers:** A super computer is the fastest, most powerful and most expensive computer which is used for complex tasks that require a lot of computational power. Super computers have multiple processors which process multiple instructions at the same time. This is known as **parallel processing**. These computers are widely used in very advanced applications like weather forecasting, processing geological data etc. ex. CRAY-2, NEC - 500, PARAM.

Check your Progress - 1.3

1. Fill in the blanks

- a. Personal computers are also called as
- b. Combination of Analog and Digital computers are called as
- c. In acomputer number and characters are represented as a series of 0's and 1's.

2. Answer in brief

- 1. What is parallel processing?

.....
.....

- 2. What is analog computer?

.....
.....

- 3. Write 1-2 lines on mainframe computers.

.....
.....

1.4 APPLICATIONS OF COMPUTERS

Today computers find widespread applications in all activities of the modern world. Some of the major application areas include:

1.4.1 Scientific, Engineering and Research:

This is the major area where computers find vast applications. They are used in areas which require lot of experiments, mathematical calculations,

weather forecasting, and complex mathematical and engineering applications. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) help in designing robotics, automobile manufacturing, automatic process control devices etc.

1.4.2 Business:

Record keeping, budgets, reports, inventory, payroll, invoicing, accounts are all the areas of business and industry where computers are used to a great extent. Database management is one of the major area where computers are used on a large scale. The areas of application here include banking, airline reservations, etc. where large amounts of data need to be updated, edited, sorted, searched from large databases.

1.4.3 Medicine:

Computerized systems are now in widespread use in monitoring patient data like , pulse rate, blood pressure etc. resulting in faster and accurate diagnosis. Modern day medical equipment are highly computerized today. Computers are also widely used in medical research.

1.4.4 Information:

This is the age of information. Television, Satellite communication, Internet, networks are all based on computers.

1.4.5 Education:

The use of computers in education is increasing day by day. The students develop the habit of thinking more logically and are able to formulate problem solving techniques. CDs on a variety of subjects are available to impart education. On line training programs for students are also becoming popular day by day. All the major encyclopedias, dictionaries and books are now available in the digital form and therefore are easily accessible to the student of today. Creativity in drawing, painting, designing, decoration, music etc. can be well developed with computers.

1.4.6 Games and Entertainment:

Computer games are popular with children and adults alike. Computers are nowadays also used in entertainment areas like movies, sports, advertising etc.

1.5 ADVANTAGES AND DISADVANTAGES OF COMPUTERS

Advantages of Computers:

1.5.1 Speed:

The speed of a computer is measured in terms of the number of instructions that it can perform or execute in a second. The speeds of computers are measured in milli-seconds (10⁻³ sec), micro-seconds (10⁻⁶ sec), and nano-seconds (10⁻⁹sec). Computers are superfast machines and can process millions of instructions per second. Smaller computers can execute thousands of instructions per second, while the more complex machines can execute millions of instructions per second.

1.5.2 Accuracy:

Computers are very accurate. They are capable of executing hundreds of instructions without any errors. They do not make mistakes in their computations. They perform each and every calculation with the same accuracy.

1.5.3 Efficiency

The efficiency of computers does not decrease with age. The computers

can perform repeated tasks with the same efficiency any number of times without exhausting themselves. Even if they are instructed to execute millions of instructions, they are capable of executing them all with the same speed and efficiency without exhaustion.

1.5.4 Storage Capability

Computers are capable of storing large amounts of data in their storage devices. These devices occupy very less space and can store millions of characters in condensed forms. These storage devices typically include floppy disks, tapes, hard disks, CDs etc, the data stored on these devices can be retrieved and reused whenever it is required in future

1.5.5 Versatility

Computers are very versatile. They are capable not only of performing complex mathematical tasks of science and engineering, but also other non-numerical operations fielding air-line reservation, electricity bills, data base management etc.

Limitations of Computers:

Although the computers of today are highly intelligent and sophisticated they have their own limitations. The computer cannot think on its own, since it does not have its own brain. It can only do what it has been programmed to do. It can execute only those jobs that can be expressed as a finite set of instructions to achieve a specific goal. Each of the steps has to be clearly defined. The computers do not learn from previous experience nor can they arrive at a conclusion without going through all the intermediate steps. However the impact of computers on today's society is phenomenal and they are today an important part of the society.

Check your Progress - 1.4 & 1.5

Select the appropriate option

- a. The number of instructions a computer can process in a given time is called its
- | | |
|------------------|---------------|
| (i) Versatility | (ii) Speed |
| (iii) Efficiency | (iv) Accuracy |

Answer the following:

- a) Give any one application of modern day computers

.....
.....

- b) State in brief one or two limitations of computers.

.....
.....

1.6 Similarities and Difference

between Human and Computer

Computer is a very effective and efficient machine which performs several activities in few minutes, which otherwise would have taken several days if performed naturally. Besides there would have been a doubt about the accuracy, finish etc. The computer may be faster; more accurate but it cannot compete with human brain. However there are some similarities between the human and the computer which would make the computer more understandable.

Human	Computer
# Like human beings has ears, nose, eyes etc.	Computers have input devices such as keyboard, scanner, touch screen, mouse etc to get information.
# Like we remember things	Computer also stores information.
#We recollect certain information as required.	The computer also retrieves information when times,
#We express ourselves by speech, writing etc	Computer expresses through screen, Printouts etc which We call as output.
#When we watch, hear, learn certain things and analyze.	with the help of software, computer also can analyze Information and draw conclusions.
#The place where we store, analyze,	The computer brain is known as CPU conclude information is known as the brain (Central Processing Unit) where it analyses information.

The computer has storage devices like floppies, hard disks, compact disks to store and retrieve information.

However computer does not understand emotions, it does not understand meaning beyond words, it cannot read between the lines like the human. We learn many things unknowingly, certain things knowingly; we call it as upbringing. But computers can learn everything only knowingly. We learn many things on our own, but computer has to be taught to do everything.

Check your Progress - 1.6

Select the appropriate option

- a. Keyboard is
- | | |
|---------------------|---------------------|
| (i) Input device | (ii) CPU |
| (iii) Output device | (iv) Storage device |
- b. The part of computer similar to the human brain is
- | | |
|-------------------------------|--------------|
| (i) Floppy disk | (ii) Printer |
| (iii) Central processing unit | (iv) Mouse |

1.7 A COMPUTER SYSTEM

Any system is defined as a group of integrated parts which are

designed to achieve a common objective. Thus, a system is made up of more than one element or part, where each element performs a specific function and where all the elements (parts) are logically related and are controlled in such a way that the goal (purpose) of the system is achieved.

A computer is made up of a number of integrated elements like

- The central processing unit,
- The input and output devices and
- The storage devices.

Each of these units performs a specific task. However, none of them can function independently on their own. They are logically related and controlled to achieve a specific goal. When they are thus integrated they form a fully fledged **computer system**.

1. 8 COMPONENTS OF A COMPUTER SYSTEM

The basic parts of computer system are:

- Input Unit
- The Central Processing Unit
- Output Unit

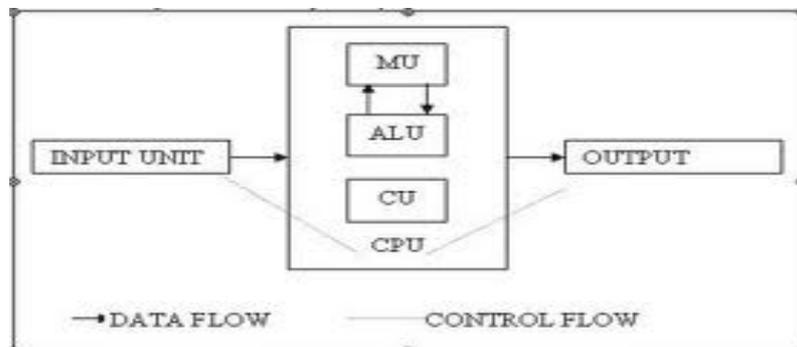


Fig. 1.9 Central Processing Unit

1.8.1 The Input Unit:

Input devices are the devices which are used to feed programs and data to the computer. The input system connects the external environment with the computer system. The input devices are the means of communication between the user and the computer system. Typical input devices include the keyboard, floppy disks, mouse, microphone, light pen, joy stick, magnetic tapes etc. The way in which the data is fed into the computer through each of these devices is different. However, a computer can accept data only in a specific form. Therefore these input devices transform the data fed to them, into a form which can be accepted by the computer. These devices are a means of communication and inter¹ station between the user and the computer systems.

Thus the functions of the input unit are :

- accept information (data) and programs.
- convert the data in a form which the computer can accept.
- provide this converted data to the computer for further processing.

1.8.2 The Central Processing Unit:

This is the brain of any computer system. The central processing unit or CPU is made of three parts:

- The control unit.
- The arithmetic logic unit
- Te primary storage unit

The Control Unit :

The Control Unit controls the operations of the entire computer system. The control unit gets the instructions from the programs stored in primary storage unit interprets these instruction an subsequently directs the other units to execute the instructions. Thus it manages and coordinates the entire computer system.

The Arithmetic Logic Unit:

The Arithmetic Logic Unit (ALU) actually executes the instructions and performs all the calculations and decisions. The data is held in the primary storage unit and transferred to the ALU whenever needed. Data can be moved from the primary storage to the arithmetic logic unit a number of times before the entire processing is complete. After the completion, the results are sent to the output storage section and the output devices.

The Primary Storage Unit:

This is also called as **Main Memory**. Before the actual processing starts the data and the instructions fed to the computer through the input units are stored in this primary storage unit. Similarly, the data which is to be output from the computer system is also temporarily stored in the primary memory. It is also the area where intermediate results of calculations are stored. The main memory has the storage section that holds the computer programs during execution. Thus the primary unit:

- Stores data and programs during actual processing
- Stores temporary results of intermediate processing
- Stores results of execution temporarily

1.8.3 Output Unit:

The output devices give the results of the process and computations to the outside world. The output units accept the results produced by the computer, convert them into a human readable form and supply them to the users. The more common output devices are printers, plotters, display screens, magnetic tape drives etc.

Check your Progress - 1.7 & 1.8

1. Fill in the blanks.

- The primary storage unit is also called as
- Arithmetic logic unit is a part of
- The unit of the computer which gives t h e results of the process and computations is the

2. Answer in brief

- Define a system.
.....
.....
- Write the functions of the input unit.
.....

1.9 SUMMARY

A computer is a fast and accurate data processing system which accepts data, performs various operations on the data, has the capacity to store data and process the data with the set of instructions given to it. The data is the information provided by the user to the computer and the set of instructions to perform the operation on data is the computer program.

The hardware of the computer is the physical parts of the machine like monitor, keyboard, disks etc. whereas the software is the various programs, procedures and other documentation which is used to operate the hardware efficiently.

Classification of computers done on the basis of the logic used in their design as analog and digital computers. Analog computers recognize data as a continuous movement of a physical property. Digital computers recognize data a series of discrete signals representing high or low voltage state of electricity. Hybrid computers are a combination of analog and digital computers. Digital computers are further classified according to their speed and capacity of memory and size as micro computers, notebook or laptops, Mini computers, Main frames and Super computers.

The typical characteristics of the computer are its superfast speed, the accuracy of each and every calculation, and its consistent efficiency. It has tremendous storage capacity and can store large volumes of data. It is versatile in the sense that it can be used in a vast range of applications from complex scientific problems to a child's game. A system is a group of integrated elements which are logically related to achieve the goal of the system each element performs a specific task assigned to it.

A computer system is made up of:

Input Unit: which accepts input data
The Central Processing Unit: This is made up of the Control unit, the Arithmetic and Logic Unit and the Primary Storage Unit. This unit controls the entire computer system.

Output Unit: This unit gives the results of the computation to the user. The evolution or development of computers is characterized by generations of computers. The first generation had very large and complex machines which made use of the vacuum tube technology. Invention of transistors in the second generation reduced the size of the computers and the concept of stored program emerged, as well as higher level languages were introduced. The third generation was characterized by Integrated Circuits and commercial production of computers. The fourth generation saw the invention of microcomputers with Very Large Scale Integration, Networking and introduction of personal computers. The fifth or the present generation has seen advances in parallel processing and superconductor technologies.

Computers today, find applications in vast and varying fields like scientific, engineering and research, medicine and business, education and games, entertainment. The computers however have a serious drawback that they can only do what they are programmed to do since they have no brain. They cannot arrive at a conclusion without going through all intermediate steps.

1.10 CHECK YOUR PROGRESS - ANSWERS

1.1

- 1 a) program
b) Calculate
c) Hardware

2. a) A computer can be defined as a fast and accurate data processing system that accepts data, performs various operations on the data, has the capability

to store the data and produce the results on the basis of detailed step by step instructions given to it

b) Software is a collection of programs which utilize and enhance the capability of the hardware. It consists of the various computer programs, procedures and other documentation used in the operation of a computer system.

1.2

1. a- (iii)
b- (iv)
c - (i)
d- (ii)
e- (v)

2.
 - a) True
 - b) False
 - c) True
 - d) True
 - e) False

1.3

1. a) Microcomputer b) Hybrid Computer c) Digital

2. a) Multiple processors multiple instructions at the same time. This is known as **parallel processing**.

b) **Analog computer** is a computer in which data (information) is recognized as a continuous measurement of a physical property like voltage, speed, pressure etc. Graphical output or readings on a dial are obtained, ex. voltage, speed, temperature, pressure can be measured in this way.

c) Mainframe computers are very large computers which process data at very high speeds. They can be linked into a network and are used in large organizations and government departments, ex. IBM 4381.

1.4 & 1.5

1 a) - ii) speed

2 **a) Applications of modern day computers** : Scientific, Engineering and Research : They are used in areas which require lot of experiments, mathematical calculations, weather forecasting, and complex mathematical and engineering applications.

b) Limitations of computers : Computers can only do what they have been programmed to do. They can execute only those jobs that can be expressed as a finite set of instructions to achieve a specific goal where each step has to be clearly defined.

1.6

1.
 - a) - i) input device
 - b) - iii) central Processing unit

1.7 & 1.8

1.
 - a) Main Memory
 - b) Central Processing Unit
 - c) Output Unit

2.

- a) A system is defined as a group of integrated parts which are designed to achieve a common objective. Thus, a system is made up of more than one element or part, where each element performs a specific function and where all the elements (parts) are logically related and are controlled in such a way that the goal (purpose) of the system is

achieved.

- b) The functions of the input unit are :
- i) Accept information (data) and programs.
 - ii) Convert the data in a form which the computer can accept.
 - iii) Provide this converted data to the computer for further processing.

1.11 QUESTIONS FOR SELF - STUDY

1. Define the terms: data, program, hardware and software.
2. List and explain in brief the characteristics of computers.
3. Define a System. What constitutes a computer system?
4. Write short notes on Fourth Generation of Computers, Limitations of computers.
5. Explain the classification of computers on the basis of their capacity to access memory and size.
6. List the applications of computers.

1.12 SUGGESTED READINGS

- **Computer Fundamentals**
Concepts, Systems & Applications – P.K Sinha

REFERENCE

- <http://www.tutorialspoint.com/>



Chapter-2

Input Devices and Output Devices

2.0	Objectives
2.1	Introduction
2.2	Input Devices
2.3	Output Device
2.4	Summary
2.5	Check Your Progress - <i>Answers</i>
2.6	Questions for Self - Study.
2.7	Suggested Readings

2.0 OBJECTIVES

After studying this chapter you will be able to:

- Explain the definitions of peripheral devices.
- Describe different types of input devices like punched cards, keyboards, mouse, digitizers and scanners and output devices like printers, plotters, video display terminals and microfilms, their broad design, their features advantages and disadvantages.
- Discuss the common peripheral devices, their physical appearances and the mode of operation of these devices. The student would be able to use these devices in the practical efficiently.

2.1 INTRODUCTION

As seen earlier, computer hardware is made up of the physical parts of the computer system like the electronic ICs, magnetic storage media and the mechanical devices.

The devices which are a means of communication between the computer and the outside world are called as **peripheral devices**.

Those peripheral devices which supply information i.e. data and programs from the outside world to the computer are the **input devices**. Those peripheral devices which give information from the computer to the user or store them in secondary storage devices, like floppy disks or tapes for future use are called **output devices**.

The processors which are required to convert the input data into machine readable form and to convert the output generated by the computer into human readable form are known as **input/output (I/O) interfaces**. There are two concepts related to the way in which data is input to the computer:

1. **On-line Data Input** : Here data is directly transferred to the computer
2. **Off-line Data Input** : - Here the data is not immediately transferred to the computer.

2.2 INPUT DEVICES

The various types of input devices most commonly used are :

2.2.1 Punch Cards :

Data is recorded onto punch cards or punch tapes using standard codes, like the Hollerith code. The pattern of these holes is interpreted by a card reader device and converted into machine readable form. A punch card machine is used to transcribe the data onto the card.

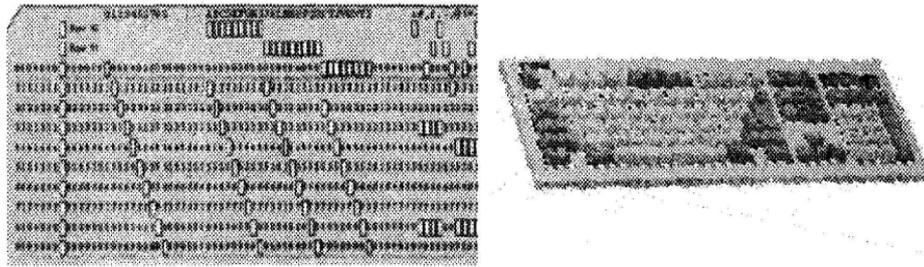


Fig. 2.1 Punch Card and a Keyboard

Characteristic of punch card

- they are cheaper
- they are reliable.

Disadvantage of punch card

The major drawback of these cards is that they cannot be reused. Also the cards have to be handled and stored carefully. Even if a single card is misplaced or the arrangement of the cards gets disturbed it becomes very difficult to rearrange them and to detect there problem. Punched cards require large storage space since they cannot be folded.

2.2.2 Keyboard

The keyboard is one of the most commonly used input device. The computer keyboard is similar to a typewriter keyboard. The keyboard has keys made up of letters, numbers, symbols and special function keys.

A display screen or monitor (Cathode Ray Tube) is used to display the data entered by the operator with the keyboard. This monitor can also display the results of processing as well as messages generated by the computer. A special symbol, called a cursor, indicates the position on the screen. There are special keys on the keyboard which allow the cursor to move in up, down, left and right directions. Other special keys on the keyboard include keys like Tab, Del, Ctrl, Ins, PgUp, PgDn etc.

The keys on the keyboard include :

A-Z : Used to enter alphabets

0-9 : Used to enter numbers

Up, Down, Left, Right(Arrow Keys): To Move the cursor in the specified direction

F1-F12 : Special Function Keys

PgUp/PgDn : To move cursor up or down by one page enter:

To move cursor to a new line

Shift : A Special key To Select the other option shown normal character on the same key

Num Lock : Activates the keypad on the right side of the keyboard. In the normal mode this numeric pad works as per the function written below the number on the key

Advantages of the keyboard :

- It is very easy to use a keyboard
- It offers a number of facilities
- Editing or changing the input data is very easy with the help of the keyboard
- It is relatively Inexpensive

2.2.3 Mouse

The mouse is a pointing device. The mouse is used to control and manipulate cursor movement on the monitor. The mouse usually has three or four buttons on it and a roller ball which signals the movements made by the mouse on a flat surface. These movements are transferred to the system. The mouse is rolled on a flat surface by the user. It can be used independently, but normally it is used in conjunction with the keyboard to improve the efficiency of the input operation. The mouse can be used to select data. Also the mouse makes it possible to move fast from one par of the screen to the other.

The various types of mouse in use are

- Mechanical mouse

- Optical mouse
- Opt mechanical mouse

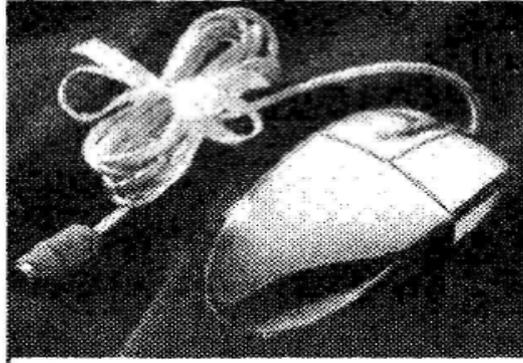


Fig. 2.2 Mouse

2.2.4 Light Pen

The light pen is a picking device. The light pen contains a photocell placed in a small tube. This photo-cell detects the presence of light on the CRT (monitor). The tip of the pen is moved on the surface of the screen to write or sketch data. The light pen is especially useful in Computer Aided Design (CAD) applications.



Fig 2.3 Light Pen

2.2.5 Joy Stick

The position and speed with which the joystick is moved is converted into digital signals by the use of a lever. These signals are then sent to the computer system. This in turn controls the movement of the cursor on the screen. The joystick is mainly used in video games applications.

2.2.6 Track Ball

The track ball uses a hard sphere to control cursor movement. The ball can be rotated in any direction by hand and this is translated into a digital signal to control the cursor movement on the screen.



Fig 2.4 Track ball

2.2.7 Touch screen:

A touch panel is a transparent plate which is fitted over the CRT. Input is registered when a finger or any other object comes in contact with the plate.

There are two types of touch panels:

- Optical touch panels
- Electric touch panels



Fig. 2.5 Touch Screen

2.2.8 Digitizer :

A digitizer converts a graphical or pictorial data into digital form which can be directly entered and stored in a computer. A digitizer is also called as a graphics tablet. There are two types of digitizers :

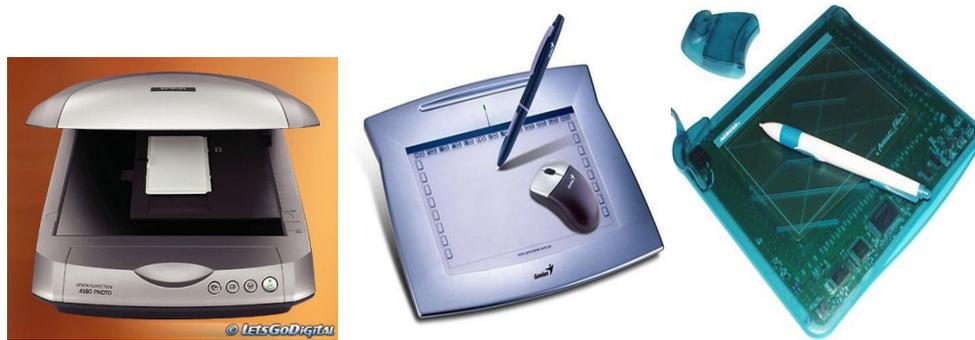


Fig 2.6 A Scanner, a Graphics tablet (digitizer)

• Image scan digitizer and flat bed digitizer

In the image scan digitizer the entire image is scanned and reproduced automatically. Therefore the image scan digitizers are more powerful as compared to flat bed digitizers. Flat bed digitizers are mainly used in simple drawings, graphs etc. whereas image scan digitizers are used for photographs and pictures.

2.2.9 Scanner :

Scanner is able to directly enter text and images into the computer memory. Therefore the duplication work of entering data is eliminated and this also results in increased accuracy. The speed of data entry also increases. There are two types of scanners :

1. Optical Scanners
2. Magnetic Ink Character Recognition devices

a) Optical Scanner:

The optical scanner uses a light source and sensor for reading the information on the paper. It can read characters, pictures, graphics from the paper. The common types of optical scanners are:

1. **The Optical Mark Reader (OMR):** This is capable of reading pre specified marks made by pencils or pens with the help of light. Light is focused on the page that is to be scanned. The reflected light pattern is detected by the device. These types of scanners are normally used where the data is preprinted for applications. eg. answer papers of the objective tests where the answers are marked with pencils or preprinted forms.

2. **Optical Character Reader :**The Optical Character Reader (OCR) can read alphabets, characters and numbers printed on paper. These characters can be either handwritten or typed. However special fonts are required to be used while typing. In case of handwritten data, the characters have to be of standard predefined size. The OCR reads each character as a collection of pixels. The light which is reflected from the page to be scanned is converted into binary data. OCRs are available in various sizes and speeds. These devices are expensive and are mainly used in processing where the data volumes are large.

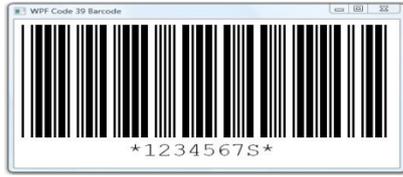


Fig 2.7 Bar Code Reader

Bar code reader is a device which reads bar coded data. Data which is coded in the form of light or dark lines (bars) is a bar code. Bar code readers are normally used in applications like labeling of products in retail shops, super markets etc. A laser beam scanner is used to read the bar code.

The most commonly used bar code is the Universal Product Code (UPC). In this code the bars are coded as 10 digits. The first five digits define the manufacturer or supplier, and the remaining five digits denote the actual product of the manufacturer.

b) Magnetic Ink Character Recognition (MICR):

A special type of input device, this mainly finds application in banking areas. A magnetic ink is used to encode the characters to be read. This ink contains iron oxide particles. When a cheque is presented in the bank, the amount is encoded by the bank employee in the lower right corner and the cheque is then processed with MICR. Special character sets like E13B and CMC7 are used by these devices to encode data. The E13B has four special character and the digits 0-9. The CMC7 has five special characters, digits 0-9, and all alphabets.

The advantages of using MICR are that they speed up data entry, and even roughly handled cheque can be processed relatively easily. However among the limitations are that special type of magnetic ink is required for encoding characters and only a limited number of digits and characters are available for encoding.

2.2.10 Voice Recognition Systems :

This system allows the user to talk with the computer. The Voice Recognition System consists of a microphone or telephone into which the operator speaks. The speech is converted into electrical signals. The signal is input as the voice of the operator. This is matched with an already entered pre-stored pattern of words called vocabulary. When the closest match is found the word is recognized. Since each operator may have a different style of speaking, all Voice Recognition systems are highly operator dependent. Also a separate vocabulary for each operator is required to be maintained. The advantages of the Voice Recognition systems are that they reduce the cost of data entry. Also the operator can move freely while talking into the computer.

Check your Progress- 2.1 & 2.2

1. Fill in the blanks

- a) is an example of a picking device.
- b) is an example of a pointing device.
- c) A digitizer is also as a

2. Give the full form of the following.

- a) MICR b) OCR c) OMR

3. Match the following.

- | | |
|---|---|
| <p>A</p> <ul style="list-style-type: none"> a) Punch card b) Bar code c) Joy stick d) Floppy Disk | <p>B</p> <ul style="list-style-type: none"> 1) Computer games 2) Output devices 3) Hollerith Code 4) Universal Product Code (UPC) |
|---|---|

2.3 OUTPUT DEVICES

The output device allows the computer to communicate with the outside world by accepting data from the computer and transforming it into user readable form.

The various types of output devices are :

2.3.1 Printers:

A printer produces the output from the computer on the paper. It is the most commonly used output device. The printers produce a hard copy i.e. a permanent copy of the results which can be stored and read later. **Printers are classified as :**

- a) Impact Printer
- b) Non Impact Printer

a) Impact Printer

Impact printers are similar to typewriters. They use hammer to strike a character against an inked ribbon and the impact of the hammer causes the image of the character to be printed on paper. E.g. Dot matrix printers, line printers, daisy wheel printers,

Advantages of impact printers:

- Their functioning is relatively easy
- Multiple copies can be produced at the same time with the help of carbon paper.
- Impact printers are noisy in operation and are subject to wear and tear of mechanical parts.

Types of impact printers :

1) Dot Matrix Printers

Dot matrix printer prints each character as a pattern of dots. The printer has a printer head with a matrix of pins (needles). Typical heads have a matrix of 7 rows and 9 columns. These pins produce a pattern of dots to form the individual characters.

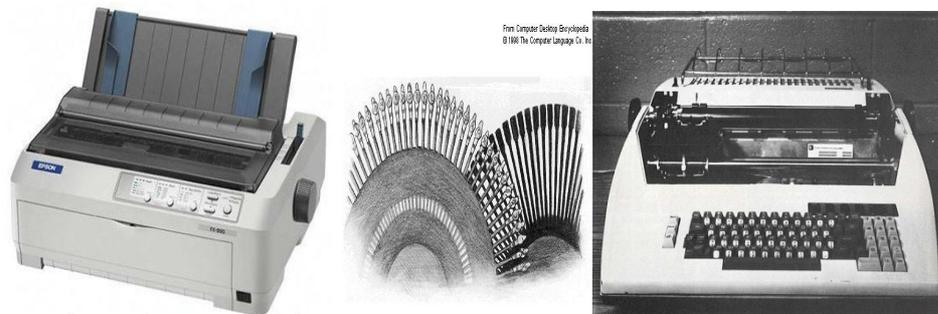


Fig. 2.8 A dot matrix printer, a daisy wheel and a daisy wheel printer

These printers are relatively low in cost and print at speeds of 50-500 characters per second. The programmer can also define the shape of characters for this printer. Therefore it is possible to print many special characters, characters in various sizes as well as charts and graphs on such printers. Dot matrix printers are very commonly used in most computer systems.

2) Daisy Wheel Printer :

These printers are also called as **letter quality printers**. These printers have a daisy wheel with a number of petals. A character is embossed on each wheel. There is a motor which spins the wheel at a fast rate. When the desired character is brought to the correct position, a hammer strikes the petal to produce the output. Thus these printers are impact printers. The letter quality of these printers is much superior as compared to the dot matrix printers. But they are slow and typically print in the range of 10-50 characters per second.

3) Line Printer:

Line printers are very fast printers which print at speed of 200-2500 lines per minute. These printers are impact printers and normally have 132 print positions per line. Different types of character set are available for different printers. Line printers are normally used in applications where large volumes of data are to be printed.



Fig 2.9 A Line printer

The two types of line printers are :

(i) Drum printers

This consists of a metallic cylinder. On the surface of this drum there are characters in bands. Each column or band on the drum contains all the characters. Opposite to each band there is a hammer located behind the paper. The drum rotates at a fast rate. The hammer strikes the paper along with the inked ribbon and produces the output. One line is printed in each revolution of the printer.

(ii) Chain printers

In the chain printers there is one print hammer for each print position on a line. There is a fast moving chain called the print chain. When this chain rotates, the print hammer and the inked ribbon strike the paper against the proper character on the chain.

b) Non Impact Printer

They use thermal, chemical, electrostatic and inkjet technologies for printing as against the hammer mechanism of impact printers. E.g. Laser printers, DeskJet printers.

Ink Jet Printer:

Ink jet printer is a non impact printer. It prints characters by spraying ink from tiny nozzles onto the paper. A special type of ink which has a high iron content is used. This ink is charged electrically when it comes out of the nozzle. This ink is absorbed by the paper and dries instantly. The output of the ink jet printer is of a superior quality. Also it is possible to obtain colored output. A number of character styles and sizes are available. However, being a non impact printer it is not possible to prepare carbon copies with this printer.



Fig 2.10 An Ink Jet Printer

Laser Printers : These printers are used where a very superior quality output is desired. The image is created on a photo sensitive drum ; with a laser beam. The laser is turned on and off when it moves back and forward across the drum. It leaves a negative charge on the drum to which a positively charged black toner powder sticks. When the paper rolls by the drum, the ink is transferred to the paper. Laser

printers have a buffer memory to store entire pages and hence their speed is very fast. The biggest advantage of these printers is that no mechanical movement is involved, therefore they are noiseless in operation. However they are comparatively expensive.

2.3.2 Plotter :

A plotter is an output device used in applications where printouts of graphs and drawings are required. Plotters are of two types :



Fig 2.11 plotter

1) Flat bed i.e. X-Y plotter:

This plotter plots on a paper which is fixed on a rectangular flatbed table. One recording pen moves in the x direction and one in the y direction to plot on the paper. Color plotting is also possible by using pens of different colors.

2) Drum Plotter:

In this plotter the paper on which the output is to be obtained, is placed over a drum. The drum rotates back and forth to produce motion. The pen is mounted horizontally across the drum and the horizontal motion of the pen is achieved with the help of the pen holder. The drum and the holder move simultaneously to produce output. Multi coloured printing is possible by changing the pens.

The speed of plotters is very slow. Therefore normally the output is first sent to some secondary storage device like a magnetic tape and then directed to the plotter.

2.3.3 Video Display Terminal:



Fig 2.12 : Screen - Flat Panel Display & Monitor

• CRT:

An electron beam is moved across a phosphor coated screen to produce the image. The CRT can be monochrome or colored. This screen normally has 25 lines and 80 characters.

• **Flat Panel Display :**

The most common flat panel display is the Liquid Crystal Display (LCD). This does not have a picture tube. The other type of display is the gas plasma screen.

• **The Video Display Terminal:**

The most popular output device in direct access processing is the Video Display Terminal. These terminals display information instantaneously. The monitor and the keyboard together are called a **terminal**. The types of terminals are :

Dumb Terminal:

This is a combination of a keyboard and monitor which can send or receive data, but cannot process the data.

Smart Terminal: A smart terminal has an inbuilt microprocessor. It can perform arithmetic, logic and control functions. They also have some memory capacity. So they can store the data before sending to the processor. They can also control the cursor movement.

Intelligent Terminal: This type of terminal also has an inbuilt microprocessor which can be programmed by the user. These terminals also have limited processing capability. They can communicate with other terminals and processors.

2.3.4 Computer Output Microfilm (COM):

This technology is used to record the computer output as microscopic filmed images. Information is recorded on a roll of microfilm. A microfilm recorder displays the information onto a screen. An inbuilt camera then takes pictures of this information. A microfilm reader is used to view this information. COM devices are normally used in application where there are large volumes of data.

COM devices are much faster than the normal printers. Also since the size of these films is very small the space required for storage is very less as compared to printed output. However since COM systems are highly sophisticated they are relatively expensive and are mainly used where there are high volumes of data.

Check your Progress - 2.3

Answer in brief.

a. What is a terminal? Name any two types of terminals.

.....
.....

b. What is an impact printer? Name one impact printer.

.....
.....

2.4 SUMMARY

The devices of the computer system which are a means of communication between the computer system and the outside world are called as peripheral devices. Those devices which accept data from the user are input devices, and those devices that give information from the computer to the user or store it in secondary storage devices for later use are output devices.

Input Output Interfaces are the processors which convert the data input by the user into a form which can be understood by the computer and also convert output generated by the computer into a human readable form. Data can be entered in the

computer directly i.e. online or after first preparing it and entering later i.e. offline.

The various input devices are:

1. **Punched cards** - data is first recorded into these cards using standard codes and then fed to the computer with a card punch machine. Though cheap, their major drawbacks are that they cannot be reused and require large storage space.
2. **Keyboard** - is the most commonly used device for on line data entry. It is very easy to use, inexpensive and allows on-line data editing.
3. **Mouse** - is a pointing device used along with a keyboard to control cursor movement, select data etc. Light pen, joystick and track ball are also similar devices used for cursor control.
4. **A digitizer** - This converts pictorial data into a digital form which can be directly entered and stored in a computer.
5. **A scanner** can directly enter text and images into computer memory using light source or magnetic ink recognition.
6. A voice recognition system converts the speech of the operator into electrical signals for data entry.

Output Devices:

The common output devices are :

- 1) **Printer** - these are of two types :

impact and non impact.

Impact printers produce output on paper and use a hammer to strike a character against a ribbon.

Non impact printers use thermal, chemical, electrostatic and inkjet technologies to produce output. Some of the commonly used printers are dot matrix, Line printers, Drum printers, Ink jet printers and laser printers.

- 2) **Plotter:** Plotters are mainly use for output of graphs and drawings. The common plotters are Flat Bed Plotters and Drum Plotters.

- 3) **Video Display Terminals** : Some of the popular video output devices are the monitor, Liquid Crystal Display, and a terminal which is a combination of a monitor and keyboard together.

- 4) **Computer Output Microfilm:** These are highly sophisticated output devices which record computer output as microscopic filmed images.

2.5 CHECK YOUR PROGRESS - ANSWERS

2.1 & 2.2

1.
 - a) Light pen
 - b) Mouse
 - c) Graphics tablet
2.
 - a) Magnetic Ink Character Recognition
 - b) Optical Character Reader
 - c) Optical Mark Reader
3.
 - a - 3
 - b - 4
 - c - 1
 - d - 2

2.3

1.
 - a) The monitor and the keyboard together are called a terminal e.g. Dumb Terminal, Smart Terminal.
 - b) Impact printers are printers which use a hammer to strike a character against an inked ribbon, the impact of which causes the image of the character to be printed on the paper, eg. dot matrix printers,

2. 6 QUESTIONS FOR SELF - STUDY

1. Define : Peripheral Devices, Input Devices, Output Devices
2. Write Short notes on: Punched Cards, Keyboard, Optical Scanner, Plotter.
3. What are impact printers? Describe any two types of impact printers.
4. What is COM?
5. Describe the various types of computer terminals.

2.7 SUGGESTED READINGS

- **Computer Fundamentals**
Concepts, Systems & Applications – P.K Sinha

References

- <http://www.tutorialspoint.com/>



NOTES

Primary Storage and Secondary Storage Devices

3.0	Objectives
3.1	Introduction
3.2	Primary Storage
3.3	Secondary Storage Devices
3.4	Summary
3.5	Check Your Progress- Answers
3.6	Questions for Self – Study
3.7	Suggested Readings

3.0 OBJECTIVES

This chapter “Primary Storage and Secondary Storage Devices” will enable you to

- Explain what is a storage unit and the criteria according to which the different types of storage are ranked.
- Describe various types of storage devices and their storage capacities.
- Discuss various concepts related to memory of the computer

3.1 INTRODUCTION

Storage Unit: A **storage unit** is that part of the computer system which is used to store the data and instructions to be processed. There are two types of storage:

- 1) Primary storage
- 2) Secondary storage.

Primary memory is also known as **internal memory**. This is a section of the CPU which holds program instructions, input data and intermediate results. Primary memory is also known as main memory.

Secondary storage is a memory that is stored external to the computer. It is used mainly for permanent and long term storage of programs and data.

3.1.1 Characteristics of Storage units:

The storage units have special characteristics which decide the :

- Speed of operation of the computer,
- Its efficiency,
- Cost and
- The amount of data which the computer can store.

The storage unit of the computer is graded according to the following characteristics (whether primary or secondary):

• Access time:

This is the time required to locate and retrieve a particular data from the storage unit. A fast access to data and programs always yields higher efficiency.

• Storage Capacity:

Storage capacity is the amount of data that can be stored by a storage unit. Large capacity of data storage is always desirable.

As seen earlier, the smallest unit of data which the computer understands is the bit. A group of 8 bits forms a byte. The storage capacity of a computer system is defined in

terms of bytes or words. One kilobyte (1 KB) is 2^{10} or 1024 bytes, eg. 4 KB memory implies that it can store 4×1024 bytes or characters. Storage capacities of primary and secondary units are measured in Kilobytes, megabytes, gigabytes.

- **Cost:**

Low cost storage media are always desirable.

Thus, storage units with faster access time, higher storage capacity and low costs are the ones which are considered to be of a superior nature.

3.2 PRIMARY STORAGE

Primary storage is characterized by faster access time, less storage capacity and higher costs as compared to secondary storage units. Primary storage or main memory is that part of the computer system which stores the programs, data and intermediate results during the program execution.

A primary storage comes as an integral part of all computer systems. It comprises of a number of small locations. Each location has a unique number assigned to it. This is called as the **address** of the location and it is used to identify the location. Each location has a capacity to store a fixed number of bits. The number of bits that a location can store is called as **word length**. Each location contains the same number of bits.

Normally, primary memory size ranges from a few kilobytes on small computers to several thousand kilo bytes and megabytes on larger machines.

The primary storage is **volatile**. Whenever the power is turned off the data is lost. Primary storage is also called **Random Access Memory (RAM)**. RAM means it is possible to randomly select and use any storage location for storage and retrieval of data. RAM is also called a **read/write** memory because data can both be read from and written onto these units. When the power is switched off the data stored in the RAM is lost.

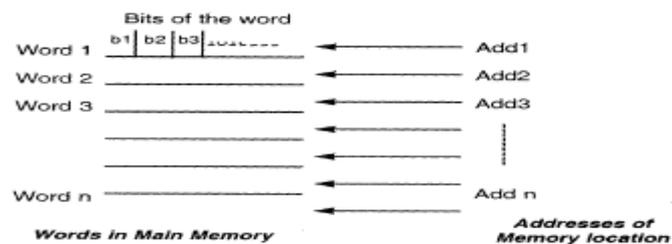


Fig 3.1 Organization of Primary storage unit

- **ROM:** ROM is Read Only Memory. In this type of memory the data is permanently stored. The information can only be read and new data cannot be written onto this memory. However the contents of the ROM are not lost even when the power is turned off i.e. this memory is **non-volatile**. Such memories are also called as **field stores**, or **permanent stores**.

There are a number of high level functions which are required to be performed by the computer system. Such functions are performed by writing special programs called **micro programs**. Micro programs generally execute the low level machine functions. These programs are mainly used as a substitute for hardware. Such programs can be stored on ROMs and be used again and again. This results in reducing the hardware of the system. ROM helps to increase the efficiency of the CPU as it can perform specialized tasks. ROM comes in the form of a **chip**. Once information is stored on a ROM chip it cannot be changed or altered.

- **PROM:** PROM is Programmable Read Only Memory. These are ROMs which can be programmed. A special PROM programmer is used to enter the program on the PROM.

Once the chip has been programmed, information on the PROM cannot be altered. PROM is non volatile i.e. data is not lost when power is switched off.

- **EPROM** : Another type of memory is the Erasable Programmable Read Only Memory.

It is possible to erase the data which has been previously stored on an EPROM and write new data onto the chip.

- **Cache Memory:**

This is a very special type of high speed memory. This memory cannot be accessed by the user. The main function of this cache memory is to make the programs and data available to the CPU very fast.

Access time of memory is generally very high as compared to the execution time of the CPU. Therefore a cache, which is a very small but fast memory, is used between the CPU and the main memory. This memory also called a high speed buffer. A cache stores those segments of programs and data which are frequently needed. It makes available this data to the CPU at a very fast rate thus increasing the efficiency.

- **Registers :**

Registers are used to retain information temporarily. These are special memory units which are not actual parts of the main memory, but allow efficient movement of information between the various units of the computer system. The registers receive information, hold it temporarily and make it available as and when required.

A computer uses a number of registers, where each register performs a specific function. Some of the common registers are :

1. **Memory Address Register (MAR):** The function of this register is to hold the address of the current or active memory location.
2. **Memory Buffer Register (MBR):** This register holds the contents of the address from which data is read or to which data has been written.
3. **Program Control Register :** It holds the address of the next instruction to be executed.

Accumulator Register: It holds the initial data, the intermediate results and the final data of the program under execution.

4. **Instruction Register:** This register holds the current instruction being executed.

Input/output Register: The function of this register is to communicate with the Input/output devices.

The storage capacity of primary storage is limited. It is normally not sufficient to accommodate all the data. Therefore secondary storage medium is used to store large volumes of data. The cost of secondary memory is much less as compared to primary memory, however access time of primary memory is very fast. The data stored on secondary storage is transferred to the primary storage as and when required. Secondary storage is also called auxiliary memory. Secondary storage is used for storing copies of data and programs. This is a non volatile memory and is stored external to the computer.

Check your Progress - 3.1 & 3.2

1. Answer in 1-2 words:

- a. Name the two types of storage:

.....

- b. Name the characteristics according to which the storage devices are ranked

.....

- c. Give the names of any two registers used by the computer:

.....

2. Give the full form of:

- a. RAM b.ROM c. PROM d. EPROM

3.3 SECONDARY STORAGE DEVICES

Information stored on secondary storage devices can be accessed in two ways:

- **Sequential Access and**
- **Direct Access:**

3.3.1 Sequential Access Devices:

Sequential or serial access

In **sequential access** data can be accessed only in the sequence in which it has been stored. Typical sequential access storage device is the magnetic tape. These types of devices are useful in applications like pay slip printing where the data is to be accessed one after the other.

Types of Access Devices:

a) **Punch Paper Tape:**

Punched paper tapes were the early devices of data storage. Data is coded onto a paper tape as a combination of punched holes across the width of the tape. Each row on the tape represents one character. The data has to be coded on the tapes using special coding systems. The punched paper tapes are a low cost storage medium and their storage capacity is unlimited. However, the paper is susceptible to wear and tear and mishandling. Nowadays, punched paper tapes are rarely being used wear and tear and mishandling. Nowadays, punched paper tapes are rarely being used.

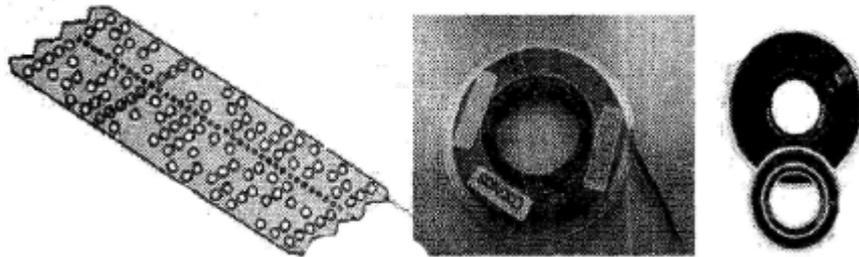


Fig. 3.2 Sequential Access Devices: Paper tape, magnetic tapes

b) **Magnetic Tape:**

A magnetic tape is a ribbon of Mylar which is coated with a thin layer of iron oxide material on one side. This tape is stored on a cassette or cartridge, or reel. The iron oxide material can be magnetized and the data is recorded on the tape in the form of magnetized and non-magnetized spots. A magnetic tape drive is used to read data from the tape or write information to the tape. The tape drive has a read/write head to access or store information respectively.

Magnetic tape is a read write device where the data can be written as well as erased and new data recorded on the same area. The tape is divided into vertical columns and horizontal rows. The columns are called **frames** and the rows are called **tracks**. Special computer codes are used for recording data on the tape. One character is recorded on each frame. Most modern tapes have 9 tracks, and use the EBCDIC code for data representation. The actual number of characters that can be stored on an inch of a tape is known as the **density** of the tape.

The storage capacity of magnetic tapes is very large. This capacity is measured in terms of bytes per inch. Most common tape densities are 800 bpi, 1600 bpi. Nowadays tapes with much higher densities of the order of 6000 bpi are also available.

The records in a tape can be of any size. Also all the records in a given file need not be same in length. Thus the tapes can store fixed length and variable length records. In between two consecutive records the computer automatically keeps a fraction of the tape blank. This blank space is called the Interlock gap, While reading from the tape, the drive takes a finite amount of time to physically stop when the end of

the record is reached. Therefore this interlock gap is created to avoid loss of any data of the subsequent record that may have been stored while the drive mechanism comes to a halt.

Advantages of Magnetic Tapes:

- High data density and virtually unlimited storage
- Low in cost
- Easy to handle and portable from one computer to another.

Limitations are:

- Support only Sequential access
- Tapes are sensitive to dust; humidity and temperature, hence require proper storage facilities.

3.3.2 Direct Access Storage Devices

Random or direct access

In **random access** the data at any location on the storage unit can be accessed directly without having to follow the sequence in which it has been stored. Typical devices that support direct access are the magnetic disk and magnetic drum.

a) Magnetic Disk: A magnetic disk is a thin metallic/Mylar platter circular in shape. It is coated on both sides with magnetic material. A number of these disks are mounted on a disk pack, on a central shaft. Thus all the disks in the disk pack move at the same speed, simultaneously in the same direction. These disks are also called as hard disks or fixed disks. Hard disk can be permanently installed in the drive or can also be in the form of a removable cartridge. The data are recorded as magnetic spots on the coating of the disk. The presence of a magnetic spot represents 1 and the absence represents a 0. The standard binary code, 8-bit EBCDIC is used for recording data on the disk. Information is stored on both the surfaces of the disk. Each disk is divided into a number of concentric circles called **tracks**. All the corresponding tracks in all the surfaces are together called a **cylinder**. Information is not stored on the outer surface of the upper plate and the lower surface of the bottom plate.

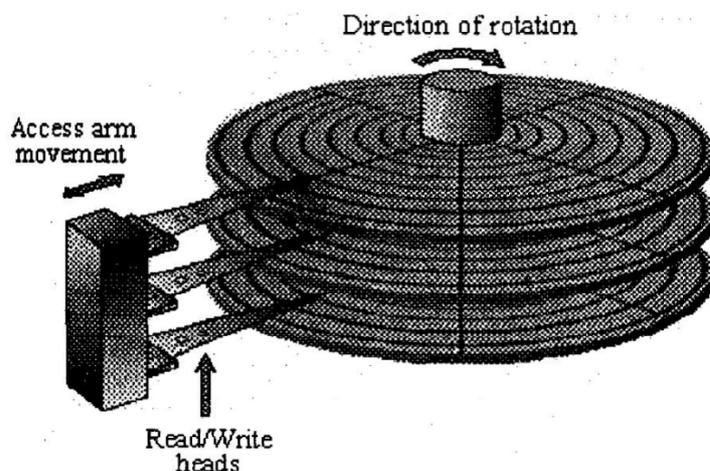


Fig. 3.3 Arrangement of a Magnetic Disk

In some of the disks the outer tracks contain more data bits since the outer circumference is greater. However, in most of the disks each **track stores** the same number of characters. This means that the inner tracks, with a smaller circumference are more densely packed than the outer tracks.

Magnetic disk is a random or direct access storage device. The data is read from or written onto the disk surface with the use of read/write heads. These heads are of flying type. They do not come in actual contact with the surface of the disk.

There are two types of disk systems:

1) Moving head System:

This consists of one read/write head for each disk surface. This head is mounted on an

access arm which moves in and out. Thus each head moves horizontally across the surface of the disk and can access each track individually.

2) Fixed head System:

In this system the access arm does not move. A large number of read/write heads one for each track are distributed over the surface of the disk. In this system the data access becomes very fast. However, extra space is needed to accommodate all the heads. The time required to access the data stored on the disk depends upon the following factors:

- The seek time - the time required for positioning the read/write head over the appropriate track
- The latency time - the time required to spin the required data under the head. This time is also called the search time.

b) Floppy Disks :

Floppy disks are made up of flexible Mylar coated with iron oxide. This disk is enclosed in a square plastic jacket to protect the surface of the disk from dust. A floppy disk is to be inserted in the floppy disk drive of the computer system to read or write information. The read/write head of the drive makes a direct contact with the floppy disk.

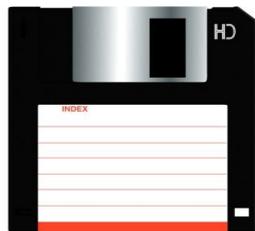


Fig 3.4

While accessing or storing data, Floppy disks come in various sizes

- 8 inch floppy disks
- 5^{1/4} inch floppy disks
- 3^{1/2} inch floppy disks

A floppy disk can be single sided or double sided i.e data can be written on a single side or on both the sides. A double sided disk drive is required to read data from

a double sided disk. This disk drive has two heads, one for each side. A single sided drive has only one head. Floppy disks can also be single side double density and double side double density depending upon their storage capacity.

Floppy disks are a very popular storage medium since they are small in size, relatively cheap and can store data on line. Floppy disks are also very portable. They can be carried from one place to another very easily.

c) Winchester Disk: In a Winchester, the disks are permanently enclosed in a sealed container. The disks are coated with a special lubricant to reduce friction with the read/write head. This technology allows for an increase in the number of tracks on the disk, and higher storage density. Winchester disks are fast and highly reliable. They are used extensively in micro computers.

d) Magnetic Drum: This is a cylinder whose outer surface is coated with a thin layer of magnetic material. A motor rotates on the cylinder at a constant speed. Data is recorded on the tracks of the drum as magnetized spots. A set of stationary read/write heads are positioned slightly away from the surface of the drum. Data is read from and written onto this drum with the help of these heads. The drum rotates at relatively fast speeds of the order of a several thousand rotations per minute. Magnetic drums have faster data transfer rates as compared to disks. However their storage capacity is limited. Magnetic drums are rarely used today.

3.3.3 Optical Devices

a) Optical Disk: An optical disk is made up of a rotating disk which is coated with a thin reflective metal. To record data on the optical disk, a laser beam is focused on the surface of the spinning disk. The laser beam is turned on and off at varying rates! Due to this, tiny holes (pits) are burnt into the metal coating along the tracks. When data stored on the optical disk is to be read, a less powerful laser beam is focused on the disk surface. The storage capacity of these devices is tremendous; the *Fig. 3.5 Optical disk* access time is relatively fast. The biggest drawback of the optical disk is that it is a permanent storage device. data once written cannot be erased. Therefore it is a read only storage medium. A typical example of the optical disk is the CD-ROM.



Fig 3.5

- **Optical Card :**

The optical card has an optical laser encoded strip which can store approximately 2 megabytes of data. These cards are the size of a credit card. Optical cards find use only in specific areas like storing credit records or medical histories of people.

- **Optical Tape :**

Optical tapes are similar to magnetic tapes in appearance. However optical laser techniques are used to write data on the tapes. Like optical disks optical tapes too are read only storage devices.

Check your Progress - 3.3

Answer in 1-2 Sentences:

a. What are the methods with which the data on the secondary storage devices can be accessed?

.....
.....
....

b. Name any two sequential access devices.

.....
.....
....

c. Name any two direct access storage devices.

.....
.....
....

d. Name any two optical devices. Name the factors which determine the time required to access data stored on the disk.

.....
.....

3.4 SUMMARY

The storage unit is that part of the computer system which stores the data and instructions. The two types of storage are primary storage and secondary storage. The characteristics of the storage unit are access time, storage capacity and cost.

Primary storage is an integral part of all computer systems. Primary storage is also called as Random Access Memory. This memory is volatile. The data stored on this memory is lost when the power is turned off. There are special types of memories which come in the form of chips. Micro programs which perform low level machine functions and which are used as a substitute for hardware are stored on such chips. Such memories are called field stores or permanent stores or Read Only Memory (ROM). Data can be permanently stored in this type of memory. Other similar memories are PROM, EPROM. Cache memory is a special type of high speed memory. Special memory units are used in computers which are not a part of the main memory. These units hold data temporarily. These units are called registers, eg. Memory Address Register, Instruction Register etc.

Secondary storage devices are used to store large amounts of data. Secondary storage devices are cheaper as compared to primary storage. However their data access time is less. Secondary storage is non volatile and stored external to the computer. There are two ways in which data can be accessed from the secondary devices: sequential access and random access. Punched paper tape, magnetic tape is sequential access devices. Punched paper tapes are nowadays rarely being used. Magnetic tapes can store unlimited data and have a high data density. They are also low in cost and portable. But since information can be accessed only sequentially, they are slow.

Direct access or random access devices allow the access of data from any storage location randomly, without having to follow the sequence in which it has been stored. Magnetic disk is made of a thin Mylar platter and coated on both sides by magnetic material. Data is recorded as magnetic spots on this disk. A number of such disks are mounted on a disk pack. Each disk is divided into a number of concentric circles called tracks. All the corresponding tracks in all the surfaces together are called as a cylinder. These disks are also called hard disks and can be permanently installed in a disk drive in the computer. Floppy disks are made of flexible mylar coated with iron oxide. The floppy disks come in various sizes like 8 inch, 5 inch, 3 inch. Floppy disks are relatively cheap and can store data online. They are also very portable. Winchester disks are permanently enclosed in a sealed container. A magnetic drum is a cylinder whose outer surface is coated with magnetic material. The drums have faster data transfer rate as compared to disks. However their storage capacity is limited.

Optical laser techniques are used to write data onto optical devices like optical disks, optical tapes and optical cards. The storage capacities of these devices are tremendous. But these are permanent storage devices.

3.5 CHECK YOUR PROGRESS – ANSWERS

3.1 & 3.2

- 1 a) Primary storage and secondary storage.
 - b) Access time, storage capacity and cost.
 - c) Accumulator Register, Instruction Register.
- 2 a) Random Access Memory
 - b) Read Only Memory
 - c) Programmable Read Only Memory
 - d) Erasable Programmable Read Only Memory.

3.3

- 1a) Sequential Access, Direct or Random Access
- b) Magnetic tape, punched paper tape
- c) Winchester disk, floppy disk
- d) Optical tape, optical card
- e) Seek time and latency or search time.

3.6 QUESTIONS FOR SELF - STUDY

1. Discuss what storage units are. What are the types of storage units? Describe the characteristics of the storage units.
2. Discuss what is volatile and non-volatile memory.
3. Define registers. Write in short about the most commonly used registers in the computer systems.
4. Explain the methods by which data on a secondary storage device can be accessed.
5. Describe any two sequential access devices.
6. Describe any two direct access storage devices.
7. What are moving head systems and fixed head systems?
8. Discuss any two types of optical storage devices.

3.7 Suggested Readings

- **Computer Fundamentals**

Concepts, Systems & Applications – P.K Sinha

References

- <http://www.tutorialspoint.com/>

Number Systems

4.0	Objectives
4.1	Introduction
4.2	Non Positional Number System
4.3	Positional Number System
4.4	Conversion
4.5	Shortcut Methods
4.6	Summary
4.7	Check Your Progress-Answers
4.8	Questions for Self-Study
4.9	Suggested Readings

4.0 OBJECTIVES

Friends, after studying this you will be able to explain various number systems. The main features of this chapter are as follows

- Non Positional Number System
- Positional Number System
- Number Systems
- Conversion
- Shortcut Methods

4.1 INTRODUCTION

We saw in the previous chapter that a computer stores data internally in a format that is not easily readable by human beings. This is the reason why input and output (I/O) interfaces are required. Every computer stores numbers, letters, and other special characters in coded form. Before going into the details of these codes, it is essential to have basic understanding of number system. Hence, this chapter familiarizes you with the fundamentals of number system. It also introduces some commonly used number system by computer professionals and relationship among them.

Number systems are two types – non-positional and positional.

4.2 NON POSITIONAL NUMBER SYSTEM

In early days, human beings counted on fingers. When counting beyond ten fingers, they used stones, pebbles, or sticks to indicate values. This method of a counting uses an additive approach or non-positional number system. IN this system, we have symbols such as I for 1, II for 2, III for 3, IIII for 4, IIIII for 5, etc. Each symbol represents the same value regardless of its position in a number, and to find the value of a number, one has to count the number of symbols present in the number. Since it is very difficult to perform arithmetic with such a number system, positional number system was developed.

4.3 POSITIONAL NUMBER SYSTEM

In a positional number system, there are only a few symbols called digits. These symbols represent different values, depending on the position they occupy in a number. The value of each digit in such a number is determined by three considerations.

1. The digit itself,
2. The position of the digit in the number, and
3. The base of the number system (where base is defined as the total number of digits available in the number system).

In our day-to-day life, we use decimal number system. In this system, base is equal to 10 because there are altogether ten symbols or digit (0,1,2,3,4,5,6,7,8, and 9).

You know that in decimal number system. Successive positions to the left of the decimal point represent units, tens, hundreds, thousands, etc. However, notice that each position represents a specific power of the base (10). For example, decimal number 2586 (written as 2586) consists of digit 6 in units position, 8 in tens position, 5 in hundreds position, and 2 in thousands position, and its value can be written as:

$$(2 \times 10^3) + (5 \times 10^2) + (8 \times 10^1) + (6 \times 10^0) = 2000 + 500 + 80 + 6 = 2586$$

Observe that the same digit signifies different values, depending on the position it occupies in the number. For example,

In 2586_{10} the digit 6 signifies $6 \times 10^0 = 6$

In 2568_{10} the digit 6 signifies $6 \times 10^1 = 60$

In 2658_{10} the digit 6 signifies $6 \times 10^2 = 600$

In 6258_{10} the digit 6 signifies $6 \times 10^3 = 6000$

Hence, we can represent any number by using the available digits and arranging them in various positions.

The principles that apply to decimal number system, also apply to any other positional number system. It is important to keep track of only the base of the number system in which we are working.

The value of the base in all positional number systems suggests the following characteristics:

1. The value of the base determines the total number of different symbols or digits available in the number system. The first of these choices is always zero.
2. The maximum value of a single digit is always equal to one less than the value of the base.

4.3.1 Binary Number System

Binary number system is like decimal number system, except that the base is 2, instead of

10. We can use only two symbols or digits (0 and 1) in this number system. Note that the largest single digit is 1 (one less than the base). Each position in binary number represents a power of the base (2). Hence, in this system, the rightmost position is units (2^0) position, the second position from the rights 2's (2^1) position, and proceeding in this way, we have 4's (2^2) position, 8's (2^3) position, 16's (2^4) position, and so on. Therefore, decimal equivalent of binary number 10101 (written as 10101_2) is :

$$(1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) = 16 + 0 + 4 + 0 + 1 = 21$$

In order to be specific about which system we are referring to, it is a common practice to indicate the base as a subscript. Hence, we write"

$$10101_2 = 21_{10}$$

The sort form of "binary digit" is bit. Hence, "bit" in computer terminology means either a 0 or 1.

An n-bit number is binary number consisting of 'n' bits. Below table lists all 3-bits numbers along with number can have not one of the 8 values in range 0 to 7. In fact, any decimal number in the range 0 to $2^n - 1$ can be represented in binary form as an n-bit number.

Binary	Decimal Equivalent
000	0
001	1
010	2

011	3
100	4
101	5
110	6
111	7

Table No 4.1 3-bit numbers with their decimal values.

Every computer stores numbers, letters, and other special characters in binary form. There are several occasions when computer professionals need to know the raw data contained in a computer's memory. A commonly used way to doing this is to print memory contents on a printer. This printout is called a memory dump. Memory dumps, which are in binary numbers, would have many pages of 0s and 1s. Working with these numbers would be very difficult and error prone for computer professionals. Hence, two number systems – octal and hexadecimal, are often used as shortcut notations for binary. These number systems and their relationship with binary number system are explained below.

4.3.2 Octal Number System

In octal number system, the base is 8. Hence, there are only eight symbols or digits:

0,1,2,3,4,5,6, and 7 (8 and 9 do not exist in this system). The largest single digit is 7 (one less than the base 8). Each position in an octal number represents a power of the base (8). Therefore, decimal equivalent of octal number 2057 (written as 2057) is:

$$(2 \times 8^3) + (0 \times 8^2) + (5 \times 8^1) + (7 \times 8^0) = 1024 + 0 + 40 + 7 = 1071$$

Observe that since there are only 8 digits in octal number system, 3 bits ($2^3 = 8$) are sufficient to represent any number in binary (see the above table-4.1)

4.3.2 Hexadecimal Number System

In hexadecimal number system, the base is 16. Hence, there are 16 symbols or digits. The first 10 digits are the same digits of decimal number system – 0, 1, 2,3,4,5,6,7,8, and 9. The remaining six digits are denoted by the symbols A,B,C,D,E, and F, representing decimal values 10,11,12,13,14 and 15, respectively. Hence, the largest single digit is F or 15 (one less than the base 16). Each position in hexadecimal number system represents a power of

the base (16). Therefore, decimal equivalent of hexadecimal number 1AF (written as $1AF_{16}$)

is

$$1 \times 16^2 + (A \times 16^1) + (F \times 16^0) = (1 \times 256) + (10 \times 16) + (15 \times 1) = 256 + 160 + 15 = 431$$

Hence, $1AF_{16} = 431_{10}$

Observe that since there are only 16 digits in hexadecimal number 4 bits ($2^4 = 16$) are sufficient to represent any hexadecimal number in binary.

Check Your Progress - 4.2 & 4.3

Fill in the blanks

1. Binary System consists of digitand
2. Every Computer Store letters, Symbols and numbers in format.
3. The principles that apply to decimal number system, also apply to any other..... number system.
4. In number system, the base is 16. Hence, there are 16 symbols or digits.
5. In 2658_{10} the digit 6 signifies

4.4 CONVERSION

Numbers expressed in decimal number system are much more meaningful to us, than are numbers expressed in any other number system. This is because we have been using decimal numbers in our day-to-day life, right from childhood. However, we can represent any number system in any other number system. Because the input and final output values are to be in decimal, computer professionals are often required to convert numbers in other number system to decimal and vice-versa. Many methods can be used to convert numbers from one base to another. A method of converting from another base to decimal, and a

method of converting from decimal to another base are described below.

4.4.1 Converting from another Base to Decimal

The following steps are used to convert a number in any other base to a base 10 (decimal) number.

Step 1 : Determine the column (positional) value of each digit (this depends on the position

of the digit and the base of the number system).

Step 2 : Multiply the obtained column values (in Step 1) by the digits in the corresponding columns.

Step 3 : Sum up the products calculated in Step 2. The total is the equivalent value in decimal.

Example 4.1.

$$1100_2 = ?_{10}$$

Solution:

Step 1: Determine Column values

Column Number (from right)	Column Value
1	$2^0 = 1$
2	$2^1 = 2$
3	$2^2 = 4$
4	$2^3 = 8$
5	$2^4 = 16$

Step 2: Multiply the column values by the corresponding column digits

16	8	4	2	1
x1	x1	x0	x0	x1

16	8	0	0	1
----	---	---	---	---

Step 3: Sum up the products

$$16 + 8 + 0 + 0 + 1 = 25$$

Hence, $11001_2 = 25_{10}$

Example 4.2.

$$4706_8 = ?_{10}$$

Solution:

Step 1: Determine Column values

Column Number(from right)	Column Value
1	$8^0 = 1$
2	$8^1 = 8$
3	$8^2 = 64$
4	$8^3 = 512$

Step 2: Multiply the column values By the corresponding column Digits

$$\begin{array}{rcccc}
 512 & 64 & 8 & 1 \\
 \times 4 & \times 7 & \times 0 & \times 6 \\
 \hline
 2048 & 448 & 0 & 6
 \end{array}$$

Step 3: Sum up the products

$$2048 + 448 + 0 + 6 = 2502$$

Hence, $4706_8 = 2502_{10}$

Example 4.3.

$$1AC_{16} = ?_{10}$$

Solution :

$$\begin{aligned}
 1AC_{16} &= 1 \times 16^2 + A \times 16^1 + C \times 16^0 \\
 &= 1 \times 256 + 10 \times 16 + 12 \times 1 \\
 &= 256 + 160 + 12 \\
 &= 428_{10}
 \end{aligned}$$

Example 4.4.

$$4052_7 = ?_{10}$$

Solution :

$$\begin{aligned}
 4052_{16} &= 4 \times 7^3 + 0 \times 7^2 + 5 \times 7^1 + 2 \times 7^0 \\
 &= 4 \times 343 + 0 \times 49 + 5 \times 7 + 2 \times 1 \\
 &= 1372 + 0 + 35 + 2 \\
 &= 1409_{10}
 \end{aligned}$$

Example 4.5.

$$4052_6 = ?_{10}$$

Solution :

$$\begin{aligned}
 4052_6 &= 4 \times 6^3 + 0 \times 6^2 + 5 \times 6^1 + 2 \times 6^0 \\
 &= 4 \times 216 + 0 \times 36 + 5 \times 6 + 2 \times 1 \\
 &= 864 + 0 + 30 + 2 \\
 &= 896_{10}
 \end{aligned}$$

Comparing this result with the obtained in Example 4.4, we find that although the digits (4052) are the same for both the numbers, their decimal equivalents are different.

This is because the number in Example 4.4 is represented in base 7 number system, whereas the number in Example 4.5 is represented in base 6 number system.

Solution :

$$\begin{aligned}4052_6 &= 4 \times 6^3 + 0 \times 6^2 + 5 \times 6^1 + 2 \times 6^0 \\ &= 4 \times 216 + 0 \times 36 + 5 \times 6 + 2 \times 1 \\ &= 864 + 0 + 30 + 2 \\ &= 896_{10}\end{aligned}$$

Example 4.6.

$$4052_7 = ?_{10}$$

Solution :

$$\begin{aligned}11001_4 &= 1 \times 4^4 + 1 \times 4^3 + 0 \times 4^2 + 0 \times 4^1 + 1 \times 4^0 \\ &= 1 \times 256 + 1 \times 64 + 0 \times 16 + 0 \times 4 + 1 \times 1 \\ &= 256 + 64 + 0 + 0 + 1 \\ &= 321_{10}\end{aligned}$$

Example 4.7.

$$1AC_{13} = ?_{10}$$

Solution :

$$\begin{aligned}1AC_{13} &= 1 \times 13^2 + A \times 13^1 + C \times 13^0 \\ &= 1 \times 169 + 10 \times 13 + 12 \times 1 \\ &= 311_{10}\end{aligned}$$

Compare the result with the result obtained In Example 4.3

4.4.2 Converting from Decimal to Another Base (Division- Remainder Technique)

The Following steps are used to convert a have 10 (decimal) number to a number in another base.

Step 1 : Divide the decimal number by the value of the new base.

Step 2 : Record the remainder from Step 1 as the rightmost digit (least significant digit) of the new base number.

Step 3 : Divide the quotient of the previous division by the new base.

Step 4: Record the remainder from Step 3 as the next digit (to the left) of the new number. Repeat Steps 3 and 4, recording remainders from right to left, until the quotient becomes zero in Step 3. Note that the last remainder, thus obtained, will be most significant digit of the new base number.

Example 4.8.

$$25_{10} = ?_3$$

Solution :

$$\begin{aligned}\text{Steps 1 and 2 : } &25/2 = 12 \text{ and remainder } 1 \\ \text{Steps 3 and 4 : } &12/2 = 6 \text{ and remainder } 0 \\ \text{Steps 3 and 4 : } &6/2 = 3 \text{ and remainder } 0 \\ \text{Steps 3 and 4 : } &3/2 = 1 \text{ and remainder } 1 \\ \text{Steps 3 and 4 : } &1/2 = 0 \text{ and remainder } 1\end{aligned}$$

As mentioned in Steps 2 and 4, the remainders are now arranged in the reverse order, making the first remainder the least significant digit (LSD) and the last remainder the most significant digit (MSD).

$$\text{Hence, } 25_{10} = 11001_2$$

Compare the result with the result obtained in Example 4.1.

Example 4.9.

$$42_{10} = ?_2$$

Solution :

2	42	Remainders
	21	0
	10	1
	5	0
	2	1
	1	0
	0	1

Hence, $42_{10} = 101010_2$

Example 4.10.

$$952_{10} = ?_8$$

Solution :

8	952	Remainders
	119	0
	14	7
	1	6
	0	1

Hence, $952_{10} = 1670_8$

Example 4.11.

$$42_{10} = ?_{16}$$

Solution : Remainders in hexadecimal

16	428	
	26	12 = C
	1	10 = A
	0	1 = 1

Hence, $428_{10} = 1AC_{16}$

Compare the result with the result obtained in Example 4.3.

Example 4.12.

$$100_{10} = ?_5$$

Solution :

5	100	Remainders
	20	0
	4	7
	0	6

Hence, $100_{10} = 400_5$

Example 4.13.

$100_{10} = ?_4$
Solution :

4	100	Remainders
	25	0
	6	1
	1	0
	0	1

Hence, $100_{10} = 1210_4$
 Compare the result with the result obtained in Example 4.12.

Example 4.14.

$1715_{10} = ?_{12}$
Solution :

Remainders in Base 12

12	1715	
	142	11 = B
	11	10 = A
	0	11 = B

Hence, $1715_{10} = BAB_{12}$
 Compare the result with the result obtained in Example 4.3.

4.4.3 Converting from a Base Other than 10 to Another Base Other Than 10

The following steps are used to convert a number in a base other than 10, to a number in

another base than 10:

Step 1 : Convert the original number to a base 10 (decimal) number.

Step 2 : Convert the decimal number obtained in Step 1 to the new base number.

Example 4.15.

$545_6 = ?_4$

Solution :

Step 1: Convert from base 6 to base 10

$$\begin{aligned}
 545 &= 5 \times 6^2 + 4 \times 6^1 + 5 \times 6^0 \\
 &= 5 \times 36 + 4 \times 6 + 5 \times 1 \\
 &= 180 + 24 + 5 \\
 &= 209_{10}
 \end{aligned}$$

Step 2: Convert 209_{10} to base 4

4	209	Remainders
	52	1
	13	0
	3	1
	0	3

$$209_{10} = 3101_4$$

Therefore, $545_6 = 209_{10} = 3101_4$

Hence, $546_6 = 3101_4$

Example 4.16.

$$101110_2 = ?_8$$

Solution :

Step 1: Convert 101110_2 to base 10

$$\begin{aligned} 101110_2 &= 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + \\ &= 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 \\ &= 32 + 0 + 8 + 4 + 2 + 0 \\ &= 46_{10} \end{aligned}$$

Step 2: Convert 46_{10} to base 8

8		46	Remainders
		5	6
		0	5
		46_{10}	$= 56_8$

$$\text{Therefore, } 101110_2 = 46_{10} = 56_8$$

$$\text{Hence, } 101110_2 = 56_8$$

Example 4.17.

$$11010011_2 = ?_{16}$$

Solution:

Step 1 : Convert 11010011_2 to base 10

$$\begin{aligned} 11010011_2 &= 1 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 \\ &= 1 \times 128 + 1 \times 64 + 0 \times 32 + 1 \times 16 + 0 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 \\ &= 128 + 64 + 0 + 16 + 0 + 0 + 2 + 1 \\ &= 211_{10} \end{aligned}$$

Step 2: Convert 211_{10} to base 16

16		211	Remainders
		13	3 = 3 in Hexadecimal
		0	13 = D in Hexadecimal

$$\text{Therefore, } 11010011_2 = 211_{10} = D3_{16}$$

$$\text{Hence, } 11010011_2 = D3_{16}$$

Example 4.16 illustrates the method of converting a binary number to an octal number,

Similarly, Example 4.17 shows how to convert a binary number to a hexadecimal number.

However, these are lengthy procedures and we can use shortcut methods when we desire

such conversions. The shortcut methods are described below.

4.5 SHORTCUT METHODS

4.5.1 Shortcut Method for Binary to Octal Conversion

The following steps are used in this method:

Step1 : Divide the binary digits into groups of three (starting from the right).

Step 2 : Convert each group of three binary digits to one octal digit. Since there are only 8 digits (0 to 7) in octal number system, 3 bits ($2^3 = 8$) are sufficient to represent any octal number in binary. Moreover, since decimal digits 0 to 7 are equal to the octal digits 0 to 7, we use binary to decimal conversion method in this step.

Example 4.18.
 $101110_2 = ?_8$

Solution:

Step 1: Divide the binary digits into groups of 3, starting from the right (LSD)

101 110

Step 2: Convert each group into one digit of octal (use binary-to-decimal Conversion method).

$$\begin{aligned}101_2 &= 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\ &= 4 + 0 + 1 \\ &= 5_8\end{aligned}$$

$$\begin{aligned}110_2 &= 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 \\ &= 4 + 2 + 0 \\ &= 6_8\end{aligned}$$

Hence, $101110_2 = 56_8$

Compare the result with the result obtained in Example 4.16.

Example 4.19.

$1101010_2 = ?_8$

Solution:

$1101010_2 = \underline{001} \quad \underline{101} \quad \underline{010}$

(Group of 3 digits from the right)

$= 152_8$ (Convert each group to an octal digit)

Hence, $1101010_2 = 152_8$

4.5.2 Short Method for Octal to Binary Conversion

The following steps are used in this method:

Step 1 : Convert each octal digit to a 3 digit binary number (the octal digits may be treated as a decimal numbers for this conversion).

Step 2 : Combine all the resulting binary groups (of 3 digits each) into a single binary number.

Example 4.20.

$562_8 = ?_2$

Solution :

Step 1: Convert each octal Digit to 3 binary digits

$$5_8 = 101_2$$

$$6_8 = 110_2$$

$$2_8 = 010_2$$

Hence, $562_8 = 101110010_2$

Example 4.21.

$6751_8 = ?_2$

Solution : $6751_8 = \frac{110}{6} \quad \frac{111}{7} \quad \frac{101}{5} \quad \frac{001}{1}$

Hence, $6751_8 = 110111101001_2$

4.5.3 Shortcut Method for Binary to Hexadecimal Conversion

The following steps are used in this method:

Step 1 : Divide the binary digits into groups of four (starting from the right).

Step 2 : Convert each group of four binary digits to one hexadecimal digit. Remember that hexadecimal digits 0 to 9 are equal to decimal digits 0 to 9 and hexadecimal digits A to F are equal to decimal values 10 to 15. Hence, for this step, we use binary to decimal conversion procedure and represent decimal values 10 to 15 as hexadecimal A to F

Example 4.22.

$11010011_2 = ?_{16}$

Solution:

Step 1: Divide the binary digits into groups of 4, starting from the right (LSD) 1101 0011

Step 2: Convert each group into one digit of octal (use binary-to-decimal Conversion method).

$$1101_2 = 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$= 8 + 4 + 0 + 1$$

$$= 13_{10}$$

$$= D_{16}$$

$$0011_2 = 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

$$= 0 + 0 + 2 + 1$$

$$= 3_{10}$$

Hence, $11010011_2 = D3_{16}$

Compare the result with the result of Example 4.17.

Example 4.23.

$10110101100_2 = ?_{16}$

Solution:

$$10110101100_2 = \underline{0101} \quad \underline{1010} \quad \underline{1100}$$

(Group 4 digits from the right)

$$= 5AC \text{ (Convert each group to a hexadecimal digit)}$$

Hence, $10110101100_2 = 5AC_{16}$ **Shortcut Method for Hexadecimal to Binary Conversion**

The following steps are used in this method:

Step 1: Convert decimal equivalent of each hexadecimal digit to 4 binary digits.

Step 2: Combine all resulting binary groups (of 4 digits each) into a single binary number.

Example 4.24:

$2AB_{16} = ?_2$

Solution:

Step 1: Convert decimal equivalent of Each hexadecimal digit to 4 binary digits

$$5_{16} = 5_{10} = 0010_2$$

$$A_{16} = 10_{10} = 1010_2$$

$$B_{16} = 11_{10} = 1011_2$$

Step 2: Combine the binary groups.

$$1AB_{16} = \underline{0010} \quad \underline{1010} \quad \underline{1011}$$

$$\quad \quad \quad 2 \quad \quad A \quad \quad B$$

Hence, $2AB_{16} = 001010101011_2$ **Example 4.25.**

$ABC_{16} = ?_2$

Solution:

$$ABC_{16} = \underline{1010} \quad \underline{1011} \quad \underline{1100}$$

$$\quad \quad \quad A \quad \quad B \quad \quad C$$

$$= 101010111100_2$$

Hence, $ABC_{16} = 101010111100_2$

We have summarized the relationship among decimal, hexadecimal, binary, and octal number system. Note that the maximum value for a single digit of octal (7) is equal to the maximum value of three digits of binary. The value range of one digit of octal duplicated the value range of three digits of binary. If we substitute octal digits for binary digits, the substitution is on a one-to-three basis. Hence, computer that print octal numbers instead of binary, while taking memory dump, save one-third of printing space and time.

Similarly, note that the maximum value of one digit in hexadecimal is equal to the maximum value of the four digits in binary. Hence, the value range of one digit of

hexadecimal is equivalent to the value range of four digits of binary. Therefore, hexadecimal shortcut notation is one-to-four reduction in space and time required for memory dump.

Decimal	Hexadecimal	Binary	Octal
0	0	0	0
1	1	1	1
2	2	10	2
3	3	11	3
4	4	100	4
5	5	101	5
6	6	110	6
7	7	1000	7
8	8	1001	10
9	9	1010	11
10	A	1011	12
11	B	1100	13
12	C	1101	14
13	D	1101	15
14	E	1110	16
15	F	1111	17
16	10	10000	20

Relationship among Decimal, Hexadecimal, Binary, and Octal number systems.

Check Your Progress - 4.4 & 4.5

Fill in the Blanks

1. Decimal Equivalent for FF in Hexadecimal System is
2. Binary equivalent for 16 is
3. LSD is forand MSD is for
4. The symbols used in octal are
5. Hexadecimal equivalent for 10110101100 is

4.6 SUMMARY

- 1) Number systems are of two types – non-positional and positional.
- 2) In a non-positional number system. Each symbol represents the same value regardless of its position in the number and to find the value of a number, one has to count the number of symbols present in the number. It is very difficult to perform arithmetic with such a number system.
- 3) In a positional number system, there are only a few symbols called digits. These symbols represent different values depending on the position they occupy in a number. The value of each digit in such a number is determined by the three considerations:
 - The digit itself,
 - The position of the digit in the number, and
 - The base of the number system (where base is defined as the total number of digits available in the number system).
- 4) In our day-to-day life, we use the decimal number system. In this system, base is equal to 10 because there are altogether ten symbols or digits. (0,1,2,3,4,5,6,7,8 and

9).

5) Some positional number system that are used in computer design and by computer professionals are binary (having base 2), octal (having base 8), and hexadecimal (having base 16).

4.7 CHECK YOUR PROGRESS-ANSWERS

4.2 & 4.3

1. 0 and 1 2. Binary 3. Positional 4. Hexadecimal 5. $6 \times 10^2 = 600$

4.4 and 4.5

1. 255 2. 1000_2

3. Least Significant Digit & Most Significant Digit.

4. 0,1,2,3,4,5,6,7 5. $5AC_{16}$

4.8 QUESTIONS FOR SELF - STUDY

- 1) Differentiate between positional and Non positional number systems.
- 2) What is base of a number system? Write examples to illustrate the role of base in positional number system.
- 3) What is the value of base for decimal, hexadecimal, binary and octal number system?
- 4) Find decimal equivalent of
 - a) 1101011
 - b) 10110001100
 - c) 1010101100
 - d) 1110101
- 5) Find octal equivalent of following binary numbers
 - a) 1010011
 - b) 1001001101
 - c) 1010101100
 - d) 11001010
- 6) Find hexadecimal equivalent of above mentioned binary numbers
- 7) Convert following numbers into decimal numbers
 - a) 110110_2
 - b) $2A3B_{16}$
 - c) 2573_8
- 8) Convert following decimal numbers into binary numbers
 - a) 435
 - b) 32
 - c) 1694
 - d) 135

4.9 Suggested Readings

- **Computer Fundamentals**

Concepts, Systems & Applications – P.K Sinha



Chapter - 5

Boolean algebra and Logic Circuits

5.0	Objectives
5.1	Introduction
5.2	Boolean Algebra
5.3	Principle of Duality
5.4	Logic Gates
5.5	Logic Circuits
5.6	Design of Combinational Circuit
5.7	Summary
5.8	Check Your Progress - Answers
5.9	Questions for Self – Study
5.10	Suggested Readings

5.0 OBJECTIVES

Friends, This chapter deals with Boolean algebra and logic gates. After learning this chapter you will be able to explain-

- Boolean Algebra
- Logic Gates
- Logic Circuits
- Design of Combinational Circuit

5.1 INTRODUCTION

Boolean algebra deals with binary number system. It is very useful in designing logic circuits used in processors of computer system. In this chapter, you will learn about this algebra and elementary logic gates used to build up logic circuits of different types for performing necessary arithmetic operations. These logic gates are the building blocks of all logic circuits in a computer. You will also learn how to use Boolean algebra for designing simple logic circuits used frequently by arithmetic logic unit and almost all computers.

5.2 BOOLEAN ALGEBRA

In mid 1800, George Boole (1815-1864), an English mathematician, developed algebra for simplifying the representation and manipulation of propositional logic. It is known a Boolean algebra after its developer's name. Later, in the year 1938. Claude E. Shannon proposed the use of Boolean algebra in the design of relay switching circuits. The basic techniques described Shannon were adopted almost universally for the design and analysis of switching circuits. Owing to analogous relationship between the action of relays and modern electronic circuits, the same techniques are still used in the design of modern computers.

Boolean algebra provides an economical and straightforward approach to the design of relay and other types of switching circuits. Just as an ordinary algebraic expression is simplified by using basic theorems, the expression describing a given switching circuit network is also simplified by using Boolean algebra. Today, Boolean algebra is used extensively in designing electronic circuitry of computers.

Fundamental concepts of Boolean Algebra

Boolean algebra is based on the fundamental concepts described below.

Use of Binary Digits

In a normal algebraic expression, a variable can take any numerical value. For example, in the expression $3A + 7B = C$, each of the variables. A, B, and C may have from the entire

field of real numbers. Since, Boolean algebra deals with binary number system, the variables used in Boolean equations may have only possible values (0 or 1). For example, in the Boolean equation $A + B = C$, each of the variables A, B, and C may have only the values 0 or 1.

5.2.1 Logical Addition

The symbol '+' is used for logical addition operator. It is also known as 'OR' operator. We can define the + symbol (OR operator) by listing all possible combinations of A and B with the resulting value of C for each combination in the equation $A + B = C$. Since the variables A and B can have only two possible values (0 or 1). Only four (2^2) combinations of inputs are possible (see the table 5.1). The resulting output values for each of the four input combinations are given in the table. Such a table is known as a truth table. Hence, the below figure is the truth table for logical OR operator.

Inputs		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

Truth table logical OR (+) operator.

Table 5.1

Observe that the result is 0 only when both input variables are 0. It is 1 when any one or both of the input variables are 1. This is the reason why the + symbol does not have the "normal" arithmetic meaning, but is a logical addition operator. This concept of logical addition may be extended to any number of variables. For example, in the equation $A + B + C + D = E$, even if A,B,C and D, all had the value of 1, the sum of the values (the result E) would be 1 only. The equation $A + B = C$ is normally read as "A or B equals C".

5.2.2 Logical Multiplication

The symbol '.' is used for logical multiplication operator. It is also known as 'AND' operator. We can define the symbol (AND operator) by listing all possible combinations of A and B with the resulting value of C for each combination in the equation. $A . B = C$. table 5.2 shows the truth table for logical AND operator. Observe that the result C is equal to 1 only when both input variables A and B are 1, otherwise it is 0. The equation $A . B = C$ is normally read as "A and B equals C".

Inputs		Output
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Truth table for logical AND (.) operator.

Table 5.2

5.2.3 Complementation

Truth table for logical AND (.) operator. OR and AND are binary operations because they operate on two variables. Complementation is a unary operation defined on a single variable.

The symbol '-' is used for complementation operator. It is also known as 'NOT' operator. Hence, we write \bar{A} meaning "complement" of A, or $(A + B)$ meaning of $A + B$. Complementation of a variable is the reverse of its value. Hence, if $A = 0$, the $\bar{A} = 1$ and if $A = 1$. Then $\bar{A} = 0$. Below table 5.3 shows the truth table for logical NOT (-) operator. A is read as "complement of A" or "not of A".

Input	Output
A	\overline{A}
0	1
1	0

Truth table for logical NOT (-) operator.

Table 5.3

5.2.4 Operator Precedence

Does $A + B \cdot C$ mean $(A + B) \cdot C$ or $A + (B \cdot C)$? The two generate different values for $A = 1$, $B = 0$, and $C = 0$ because we have $(1 + 0) \cdot 0 = 0$ and $1 + (0 \cdot 0) = 1$. Hence, operator precedence rules are needed to correctly evaluate Boolean expressions. The precedence rules for Boolean operators are as follows:

1. The expression is scanned from left to right.
2. Expression enclosed within parentheses are evaluated first.
3. All complement (NOT) operations are performed next.
4. All ' \cdot ' (AND) operations are performed after that.
5. Finally, all '+' (OR) operations are performed in the end.

According to these rules, $A + B \cdot C$ should be evaluated as $A + (B \cdot C)$. Similarly, for the expression $A \cdot B$, complement of A and B are both evaluated first and the results are then AND ed. Again, for the expression $\overline{(A + B)}$, the expression inside the parenthesis $(A + B)$ is evaluated first and the result is then complemented.

5.3 Principle of Duality

- When value and operations can be paired up in a way that leaves everything important unchanged when all pairs are switched simultaneously, we call the member of each pair dual to each other.

Thus 0 and 1 are dual, \wedge and \vee are dual.

The duality principle asserts that Boolean.

Algebra is unchanged, when all dual pairs are interchanged.

- Dual of one expression is obtained by replacing AND (\cdot) with OR ($+$) and OR with AND together with replacement of 1 with 0 and 0 with 1.

5.4 Logic Gates

All operations within a computer are carried out by means of combinations of signals passing through standard blocks of built-in circuits known as logic gates. In other words, a logic gate is an electronic circuit that operates on one or more input signals to produce standard output signals. These logic gates are the building blocks of all electronic circuits in a computer.

Combinations of multiple logic gates of different types are often used to build electronic circuits in computers.

Out of many types of logic gates available, we shall study here only some of the most important ones. These are sufficient to introduce the concept of electronic logic circuit with the use of logic gates.

5.4.1 AND Gate

An AND gate is the physical realization of logical multiplication (AND) operation. It is an electronic circuit that generates an output signal of 1, only if all input signals are also 1.

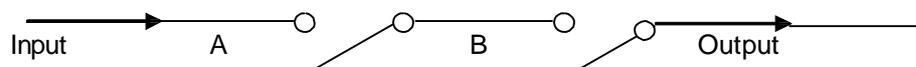


Fig 5.1 Two or more switches connected in series behave as an AND gate

Behavior of a logic gate (the state of its output signal, depending on various

combinations of input signals) is represented conveniently by means of a truth table. Below Figure shows the truth table and block diagram symbol for an AND gate for two input signals. Since there are only two inputs (A and B), only four (2^2) combinations of inputs are possible. Notice that the output is 1 only when both inputs are in 1 state, otherwise it is 0.

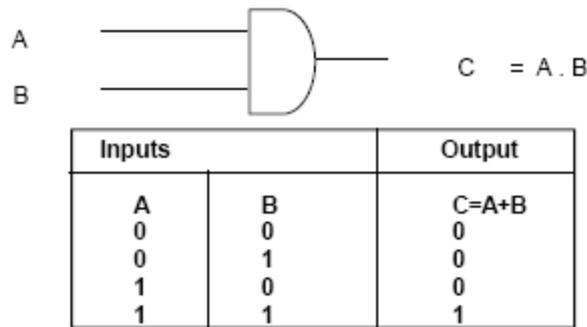


Fig. 5.2 Block diagram symbol and truth table 5.4 for an AND gate.

5.4.2 OR Gate

An OR gate is the physical realization of logical addition (OR) operation. It is an electronic circuit that generates an output signal of 1, if any of the input signals is also 1.

Two or more switches connected in parallel behave as an OR gate. Observe from the below Figure that the input current will reach the output point when any one of the two switches (A or B) are in ON (1) state. There will be no output only when both the switches are in OFF (0) state.

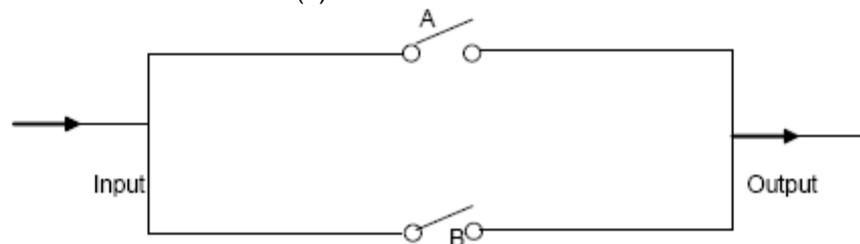
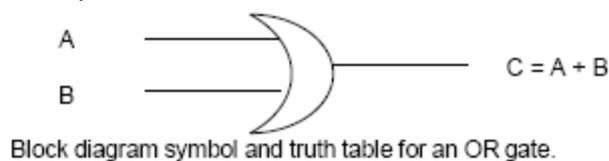


Fig. 5.3 that demonstrates Two or more switches connected in parallel behave as an OR gate

Below fig 5.4 shows the truth table and block diagram symbol for an OR gate for two input signals. Notice that the output is 1, when any of the input signals is n 1. It is 0 only when both inputs are 0.



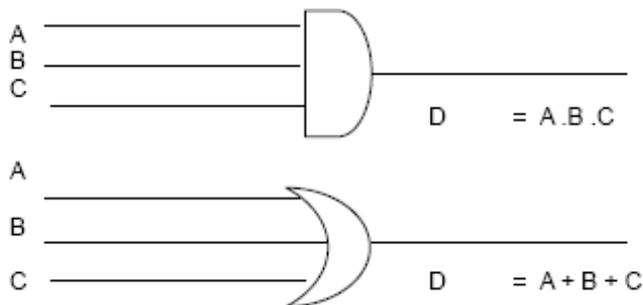
Inputs		Output
A	B	C = A + B
0	0	0
0	1	1
1	0	1
1	1	1

Fig.5.4 Block Diagram and Truth Table for an OR Gate

Just as + and . Operations could be extended to several variables by using associative law, AND gates and OR gates can also have more than two inputs. Above shows three-input AND and OR gates and the table of all input combinations for each. Notice that the output of the AND gate with inputs A,B and C is 1 only if all three inputs

are 1, so that we write the output as $A \cdot B \cdot C$. Similarly, the OR gate with inputs, A,B, and C has a 1 output if any one of the inputs is 1, so that we write the output as $A + B + C$.

The above argument can be extended. A four-input AND gate has a 1 output only when all four inputs are 1 and a four-input OR gate has a 1 output when any of its inputs is a 1.



Inputs			Output
A	B	C	$D = A \cdot B \cdot C$
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(a) Three- input AND gate

Inputs			Output
A	B	C	$D = A + B + C$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(b) Three-input OR gate.

Fig. 5. 5 Block diagram symbol and truth and truth table for (a) Three-input AND gate and b) Three- input OR gate.

5.4.3 NOT Gate

A NOT gate is the physical realization of complementation operation. It is an electronic circuit that generates the reverse of the input signal as output signal as output signal. It is also known as an inverter because it inverts the input.

Below Figure 5.6 shows the truth table and block diagram symbol for a NOT gate.

Recall that Complementation operation is unary operation defined on a single variable. Hence, a NOT Gate always has a single input. Below figure also shows that two NOT gates connected in Series given an output equal to the input. This is the gating counterpart of the law of the Double complementation. $A = \overline{\overline{A}}$.

Input	Output
A	\overline{A}
0	1
1	0

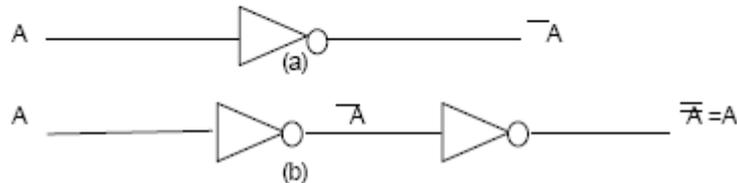


Fig 5.6 (a) Block diagram symbol and truth table for NOT gate. (b) Two NOT gates in series

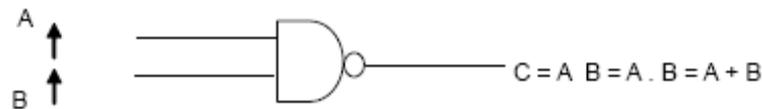
5.4.5 NAND Gate

A NAND gate is a complemented AND gate. That is the output of NAND gate will be 1 if any one the input is 0, and it will be 0 only when all inputs are 1.

Below Figure 5.7 shows the truth table and block diagram symbol for a NAND gate. The symbol ' ' is usually used to represent a NAND operation in Boolean expressions.

Hence

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$



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

Fig. 5.7 Block diagram symbol and truth table for a NAND gate.

An AND gate followed by a NOT gate operates as a NAND gate (see Figure above) . In the figure, the output of the AND gate will be $A \cdot B$ that is turn is fed as input to the NOT gate. Hence, the final output will be complement of $A \cdot B$, which is equal to $\overline{A \cdot B}$ or $A + \overline{B}$ or $\overline{A} \cdot \overline{B}$. In fact, the small circle on the output of NAND gate (see Figure 6.24) represents complementation.



Figure 5.8 Demonstrating NAND gate realization with AND gate and a NOT gate

Multiple-input NAND gates can be analyzed similarly. A three-input NAND gate with inputs, A,B, and C will have output equal to $A \cdot B \cdot C$ or $A + B + C$ meaning that the output will be 1 if any of the inputs is a 0, and it will be 0 only when all three inputs are 1.

5.4.6 NOR Gate

A NOR gate is complemented OR gate. That is, the output of a NOR gate will be 1 only when all input are 0, and it will be 0 if any input is a 1.

Below figure 5.9 shows the truth table and block diagram symbol for a NOR gate. The symbol ‘ \downarrow ’ is usually used to represent a NOR operation in Boolean expressions.

Hence $A \downarrow B = A + B = A \cdot B$.

Inputs		Output
A	B	$C = A \downarrow B$
0	0	1
0	1	0
1	0	0
1	1	1

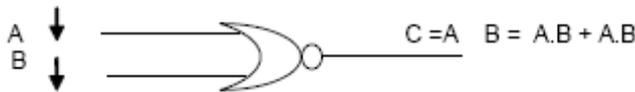


Fig 5.9 Block diagram symbol and truth table for a NOR gate

An OR gate followed by a NOT gate operates as a NOR gate (see the below figure). In the

Figure the output of the OR gate will be $A + B$ that in turn is fed as input to the NOT gate. Hence, the final output will be complement of $A + B$, which is equal to $(A + B)$ or $A \cdot B$ or $A \cdot B$. In fact, the small circle on the output of NOR gate (see Figure 5.10) represents Complementation.

Multiple-input NOR gates can be analyzed similarly. A three-input NOR gate with inputs A,B, and C will have an output equal to $A + B + C$ or $A \cdot B \cdot C$ meaning that the output will be

1 only when all three inputs are 0, and it will be 0 if any of the three inputs is a 1

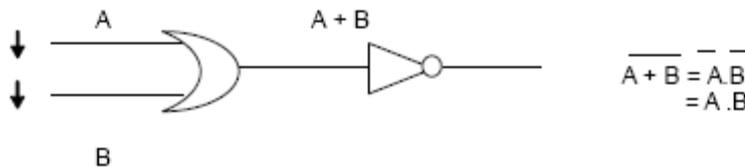


Fig.5.10 NOR gate realization with an OR gate and a NOT gate

Check Your Progress - 5.2 & 5.4

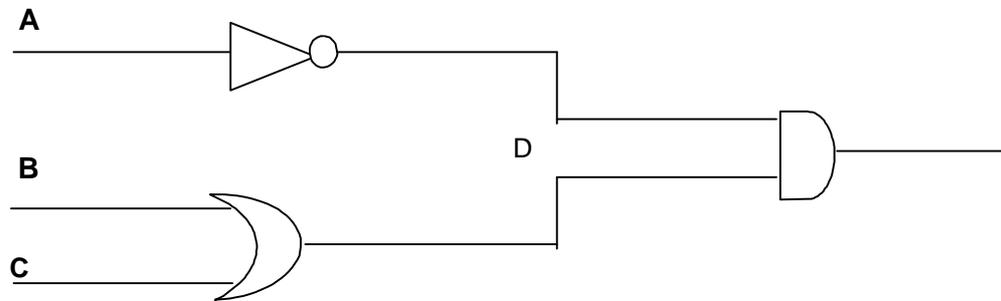
State whether the following statements are true or false

1. Boolean algebra provides an economical and straightforward approach to the design of relay and other types of switching circuits.
2. AND gates and OR gates cannot have more than two inputs.
3. All operations within a computer are carried out by means of combinations of signals passing through standard blocks of built-in circuits known as logic gates.
4. Zero NOR Zero produces Zero.
5. An OR gate followed by a NOT gate operates as a NOR gate.

5.5 LOGIC CIRCUITS

Logic gates described in the previous section are seldom used alone but are used in combinations. They are interconnected to form gating/logic networks known as combinational logic circuits. Boolean algebra expression for a given logic circuit can be derived by systematically progressing input to output on its gates. Few examples are given below. Example

Find the Boolean expression for the output of the logic circuit given below



Solution

Input A is fed to the NOT gate, whose output will be \bar{A} .
 Inputs B and C are fed to the OR gate, whose output will be $B + C$.
 These two outputs (\bar{A} and $B + C$) are in turn fed as input to the AND gate, whose output will be $\bar{A} \cdot (B + C)$.
 Hence, $D = \bar{A} \cdot (B + C)$ is the Boolean expression for the output of the given logic circuit.

Find the logic expression for the output produced by the logic circuit given below.

Solution

The output of the OR gate is

$A + B$

(a) The output of the first AND gate is

$A \cdot B$

(b) Expression (a) is fed as input to the NOT gate, whose output will be

$\bar{A \cdot B}$

(c)

Now, expressions (a) and (c) are fed as input to the second AND gate, whose output will be

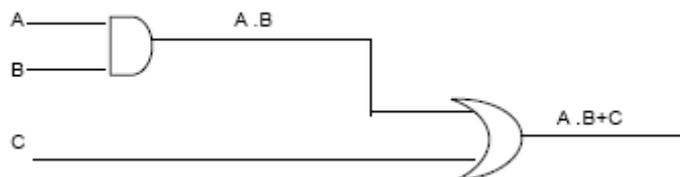
$(A + B) \cdot (\bar{A \cdot B})$

Hence, $C = (A + B) \cdot (\bar{A \cdot B})$ is the logic expression for the output produced by the given logic circuit.

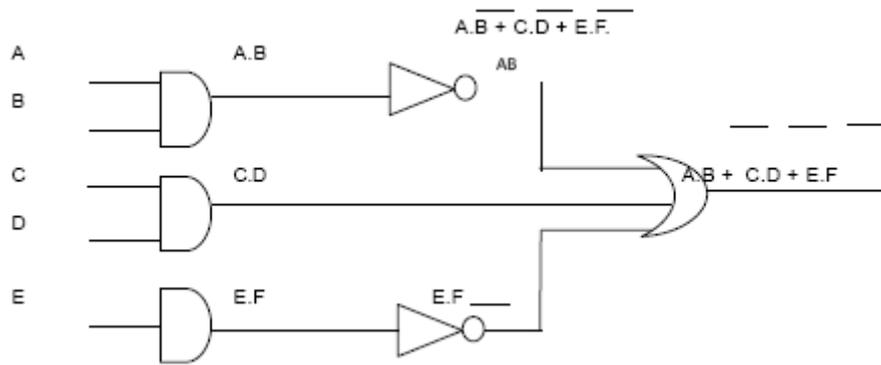
• **Converting Expressions to logic circuits**

The method for constructing logic circuits for Boolean expressions by using these three gates only is illustrated below with some example. Construct a logic circuit for the Boolean expression $A \cdot B + C$

Solution: method of constructing logic circuits for Boolean expressions by using



The desired logic circuit is shown above and it self-explanatory. Construct a logic circuit for the Boolean expression



5.6 DESIGN OF COMBINATIONAL CIRCUIT

Design of a combinational circuit starts from the outline of the problem and ends in a logic circuit diagram.

1. State the given problems completely and exactly.
2. Interpret the problem to determine available input and required output variables.
3. Assign a letter symbol to each input variable and each output variable.
4. Design a truth table that defines the required relations between inputs and outputs.
5. Obtain the simplified Boolean expression for each output
6. Draw a logic circuit diagram to implement the Boolean expression.

The design procedure is illustrated below with the design of adder circuits because addition is the most basic arithmetic operation for any computer system.

The following four rules summarize addition in binary number system.

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 10$$

The first three operations produce a single-digit sum, but when both augends and addend bits are equal to 1, the sum consists of two digits. The higher significant bit of this result is called a carry. When both augends and addend numbers contain more than one digit, the carry obtained from addition of two

bits at any stage is added to the next pair of significant bits. A combinational circuit that performs the addition of two bits is called a half-adder. One that performs the addition of three bits (two significant bits and previous carry) is called a full-adder. The name of the former comes from that fact that two half-adders can be employed to implement of a full-adder.

5.6.1 Design of Half-Adder

From the definition given above, a half-adder needs two binary inputs and two binary outputs.

The input variables designate the augends and addend bits whereas the output variables produce the sum and carry bits. Let A and B be the two inputs and S (for sum) and C (for carry) be the two outputs. The truth table of the Figure defines the function of a half-adder.

Inputs		Output	
A	B	C	D
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

$$S = A.B + A.B$$

Figure 5.11 showing Truth table for a half –adder.

The Boolean expressions for the two outputs, obtained from the truth table, are:

$$S = A.B + A.B$$

$$C = A.B$$

The logic circuit diagram to implement these expressions is shown in the below Figure 5.12

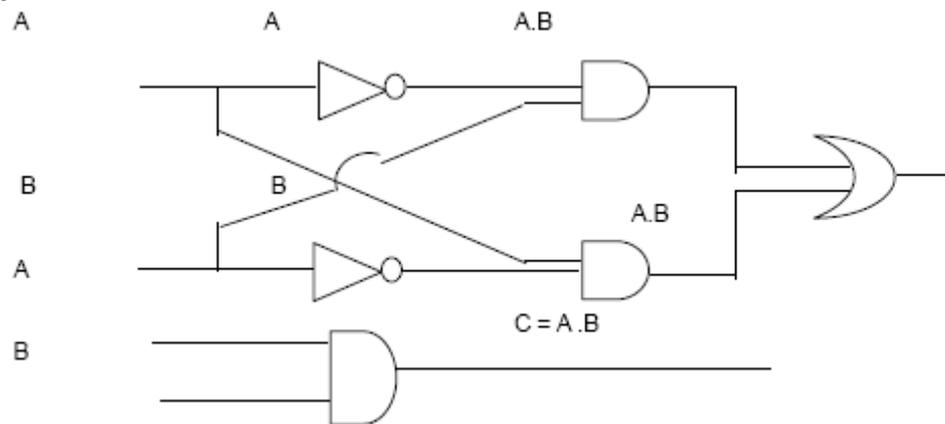


Figure 5.12 showing the logic circuit diagram for a half-adder

A half-adder is limited in the sense that it can add only two single bits. Although, it generates a carry for the next higher pair of significant bits it cannot accept a carry generated from the previous pair of lower significant bits. A full-adder solves this problem.

5.6.2 Design of Full-Adder

A full-adder forms the arithmetic sum of three input bits. Hence, it consists of three inputs and two outputs. Two of the input variables (A and B) represent the augends and addend bit and the third input variable (D) represents the carry from the previous lower significant position. Two outputs are necessary because the sum of three binary digits ranges from 0 to 3 and binary 2 and 3 need two digits. These two outputs are designated by the symbols S (for sum) and C (for carry). The truth table of the below Figure defines the function of a full-adder.

The 1s and 0s for the output variables are determined from the arithmetic sum of the three input variables. When all input variables are 0, the output is 0 for both C and S. The S output is equal to 1 when only one input is equal to 1, or when all three inputs are equal to 1. The C output is 1 if two or three inputs are equal to 1.

Inputs			Outputs	
A	B	D	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Figure 5.13 showing Truth table for a full-adder.

The sum-of-products expressions for the two outputs can be obtained directly from the truth table and are given below.

$$S = A.B.D + A.B.D + A.B.D + A.B.D$$

$$C = A.B.D + A.B.D + A.B.D + A.B.D$$

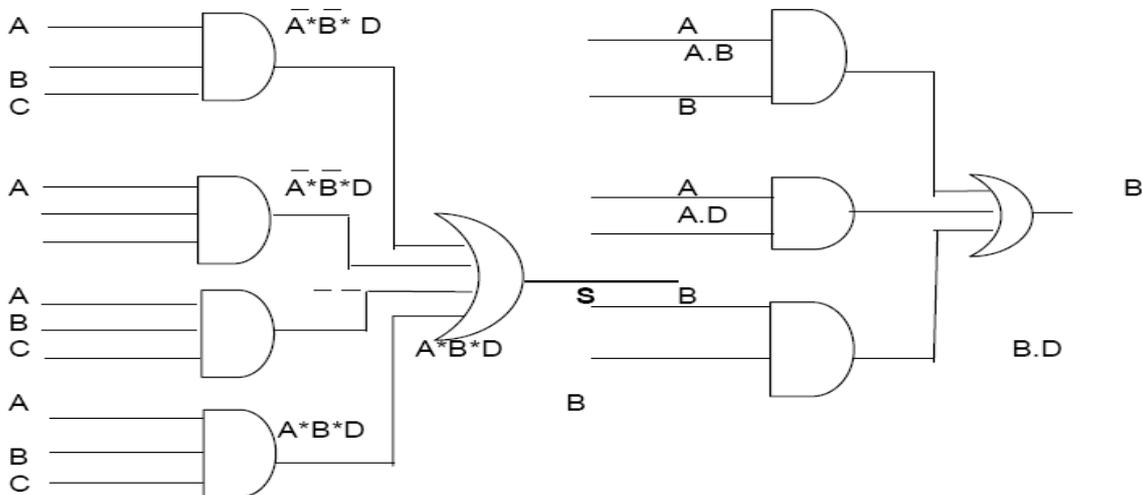
Although, the expression for S cannot be simplified, it is possible to simplify the expression for C as follows.

$$\begin{aligned}
 C &= A.B.D + A.B.D + A.B.D + A.B.D \\
 &= A.B.D + A.B.D + A.B.D + A.B.D + A.B.D + A.B.D \\
 &\text{(since } x + x = x \text{)} \\
 &= (A.B.D + A.B.D) + (A.B.D + A.B.D) + (A.B.D + A.B.D) \\
 &= (A+A) .B.D + (B+B).A.D + (D+ D) .A.B \\
 &= B.D + A.D + B.D \text{ (since } x + x = x \text{)} \\
 &= A.B + A.D + B.D
 \end{aligned}$$

Hence, we obtain the following expressions for the two outputs:

$$S = A.B.D + A.B.D + A.B.D + A.B.D$$

$$C = A.B + A.D + B.D$$



- a) Logic circuit diagram for sum
- (b) Logic circuit diagram for carry

Figure showing the logic circuit diagrams to implement these expressions.

The S output from the second half-adder is the exclusive-OR of D and the output of the first half-adder giving.

$$\begin{aligned}
 S &= (A.B. + A.B.).D + (A.B. + A.B.).D \\
 &= (A.B. + A.B.).D + A.B.D + A.B.D \\
 &= (A.B.).(A.B.).D + A.B.D + A.B.D \\
 &= (A.A + A.B + A.B + B.B).D + A.B.D + A.B.D \\
 &= (A.B. + A.B.).D + A.B.D + A.B.D \\
 &= A.B.D + A.B.D + A.B.D + A.B.D \\
 &= A.B.D + A.B.D + A.B.D + A.B.D
 \end{aligned}$$

The carry output is:

$$\begin{aligned}
 C &= (A.B. + A.B.).D + A.B \\
 &= A.B.D + A.B.D + A.B.(D + D) \\
 &= A.B.D + A.B.D + A.B.D + A.B.D
 \end{aligned}$$

This can be simplified, as before, to

$$C = A.B + A.D + B.D$$

Check Your Progress - 5.5 & 5.6

Fill in the blanks

1. Aneeds two binary inputs and two binary outputs.
2. A half-adder is limited in the sense that it can add only
3. Aforms the arithmetic sum of three input bits.

5.7 SUMMARY

- 1) Boolean algebra deals with binary number system. That is, the variables used in Boolean equations may have only two possible values (0 and 1).
- 2) In Boolean algebra the 'OR' operator used for logical addition is represented by the symbol '+'; the 'AND' operator used for logical multiplication is represented by the symbol '.', and the 'NOT' operator used for complementation is represented by the symbol '-'.
- 3) As regards precedence of Boolean operators, 'NOT' operator takes precedence over 'AND' and 'OR' operators, and 'AND' operator takes precedence over 'OR' operator.
- 4) In Boolean algebra, there is a precise duality between the operators. (AND and + (OR) and the digits 0 and 1. This property is known as the principle of duality.
- 5) A Boolean function is an expression formed with binary variables, the two binary operators OR and AND, the unary operator NOT, parentheses, and equal to sign.

- 6) Complement of a Boolean function F is \bar{F} is obtained by interchanging 0s and 1s and 1s for 0s in the truth table defining the function.
- 7) A sum-of-products expression is a single product term (midterm), or several product terms (midterms) logically added (OR) together. For example, expression $x.y$ and $x.y + z$ is a sum-of-products expression.
- 8) A logic gate is electronic circuit that operators on one more input signals to produce standard output signals. These logic gates are the building blocks of all electronic circuits in a computer.
- 9) The logic gates are interconnected to form gating or logic networks known as combinational logic circuits.

5.8 CHECK YOUR PROGRESS-ANSWERS

5.2 & 5.4

1. True 2. False 3. True 4. False 5. True

5.5 & 5.6

1. A Half Adder 2. Two Single Bits 3. Full adder.

5.9 QUESTIONS FOR SELF - STUDY

- 1) Explain the principle of duality in Boolean algebra. How it is useful?
- 2) Write the dual of following Boolean expressions:

a) $A+B$	b) $A + B + C$	c) $A. B + A.B$
d) $A+B$	e) $A. (A + B)$	f) $A + A.B$
- 3) Write the dual of the rule $A + A.B = A + B$
- 4) State and prove the two basic De Morgan's theorems.
- 5) Prove following rules by perfect induction method:

a) $A.B + A .B = A$	b) $A + A .B = A + B$
c) $A. (A + C) = A$	d) $(A + B). (A .B) = A .B + B.A$
e) $(A + B). (A .B) = A .B + B.A$	
- 6) Explain gates with example for OR, NOR, AND, NAND.
- 7) Write a Note on Half adder of circuit
- 8) Write Short notes on :

Logical Circuit, Additional Circuit, Full order Circuit.

5.10 Suggested Reading's

- **Computer Fundamentals**
Concepts, Systems & Applications – P.K Sinha

References

- <http://www.tutorialspoint.com/>



Chapter 6

Computer Software, Programming Languages and Program Development

6.0	Objectives
6.1	Introduction
6.2	Classification of Software
6.3	Programming Languages
6.4	Program Development Process
6.5	Summary
6.6	Check your Progress - <i>Answers</i>
6.7	Questions for Self – Study
6.8	Suggested Reading's

6.0 OBJECTIVES

Friends after studying this lesson, you will be able to :

- State the definition of software, the classification of software viz Application Software, System Software, Utility Software and Firmware.
- Discuss various programming languages and their evolution from Machine Language to Fourth Generation languages, through assembly and high level languages.
- Describe translators and their types
- Discuss program development process and the various stages in the development of a computer program.

6.1 INTRODUCTION

As is already seen, a computer cannot do anything on its own. It has to be provided a detailed set of instructions to perform a specific task to achieve a desired goal, this set of instructions, which are written in the form which is understood by the computer, is known as a computer program. The program controls the processing of the computer.

6.2 CLASSIFICATION OF SOFTWARES

Software means a set of programs, procedures and other associated documentation which describes what the program does and how it is to be used. Hardware and software both have to work together. A number of software's can be run on the same hardware to perform different types of jobs. The software acts as an interface between the user and the computer.

Software is mainly classified into:

- Application Software
- System Software

6.2.1 Application Software:

Application software is a program or a set of programs which are written to carry out a specific application.eg. Payroll, financial accounting etc. Nowadays special application software or packages for specialized areas like drawing, engineering, manufacturing, banking, and publishing are available. The set of programs which together make an application package are called application programs.

6.2.2 System Software :

The systems software controls the working of the computer system. It helps the user to use the computer by allowing him to communicate with the system. System software controls the working of other software's, hardware, hardware devices like printers, memory, CPU etc. Thus, they make the operation of the computer more efficient. The programs included in system software are systems programs. Without the systems programs, it would not be possible for the application programs to work on the computer. The systems software is generally provided by the manufacturer of the computer hardware. Without the systems software the hardware would not work.

6.2.3 Utility Software:

These are a set of programs or tools which are used in program development or for performing limited tasks, eg. scandisk.

6.2.4 Firmware:

With the advances in technology it is now possible to make the software available on ROM (Read Only Memory) chips. These chips, which form a part of the software, have the programs in them. Thus programs available on hardware are called Firmware. Today not only systems software, but even some dedicated application programs are being made available on firmware.

Check your Progress - 6.2

1. Match the following.

A

1. Application Software
2. Firmware
3. Systems Software
4. Utility Software

B

- a. Program to control system working of computer
- b. Scandisk
- c. payroll
- d. Software available on Rom chips

2. Answer in 1-2 sentences.

What is software?

.....
.....

6.3 PROGRAMMING LANGUAGES

A programming language is a means of communication for the user to communicate with the computer system. The programming language is a set of instructions which tells the computer what to do. This is a language which is understood by both man and machine. There are a number of programming languages. However all these languages are designed to perform at least certain basic instructions and operations; These instructions and operations are :

- Input/output operations,
- Arithmetic operations - mathematical operations like addition, subtraction,
- Logical operations - Comparison for equality, inequality etc.
- Movement of instructions and data to and from the CPU.

To use the programming language, the programmer has to strictly follow the rules of

the language including all commas, punctuation marks etc. otherwise the program will not be understood by the computer. Thus, although the programming languages are much smaller and simpler than the natural languages, they have to be used with the greatest accuracy.

6.3.1 Types of programming languages

- a) Machine Language
- b) Assembly Language
- c) High Level Language

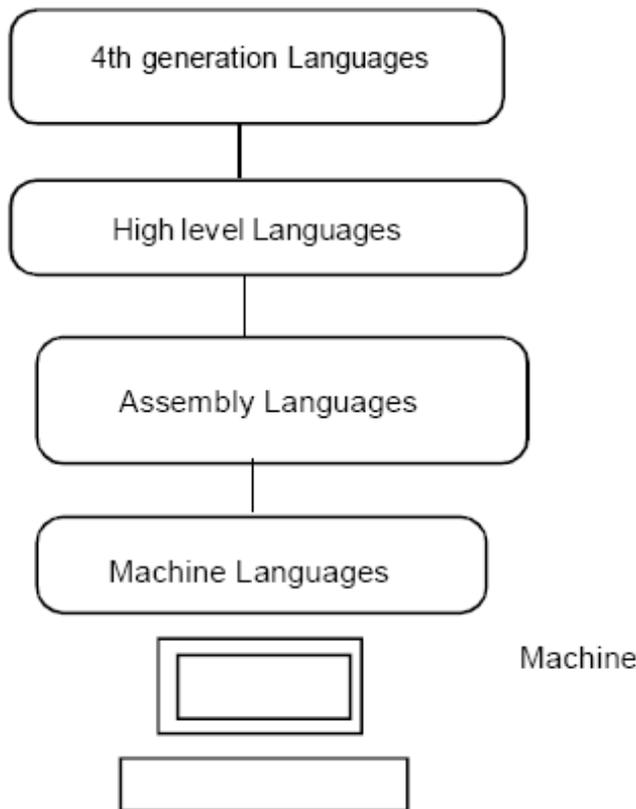


Fig 6.1

a) Machine Language:

This is the only language which is understood by the computer. This is the language nearest to the machine. In this language the programs are written in binary code i.e. the instructions are made only by a combination of binary digits 0 and 1. Machine language may vary from machine to machine depending upon the computer architecture. Machine languages execute the fastest since they are immediately understood by the computer. No translation of the programs is required. Also they make efficient use of primary memory. But it is very difficult to program in this binary or machine language. It is also very tedious and time consuming, since all the instructions have to represent as a series of 0s and 1s. Therefore there is always a possibility of errors.

b) Assembly Language:

The 0s and 1s of the machine language were substituted by letters and symbols in assembly languages. The assembly languages use mnemonics (memory aid) in place of operation codes. The language uses symbols instead of numbers to write programs. A program written using such symbols in the assembly language is called the source program. The program written in assembly language has to be converted into machine language for use by the computer. This is achieved with the help of the **assembler**. The assembler is a system program which is supplied by the manufacturer. It converts the assembly program into a machine readable program and the resulting program is called the **object program**. Thus the input to the assembler is the source program and the output of the assembler is the object program. The assembler translates each assembly language instruction into a corresponding machine code.

It is relatively easy to write programs in assembly language as compared to machine

language. They can be also modified relatively easily. However, like the machine language, assembly languages are also hardware dependant. When the machine changes, the program has to be changed.

Since the machine language and assembly language both are dependent on the hardware, they are referred to as **low level** programming languages. Both these languages require a deep understanding of the internal structure of the computer.

1. High Level Languages :

Higher level languages make use of English like words and statements and mathematical symbols for instructions. Higher level languages make programming easier, since they are relatively easy to learn. Less time is required to write programs in high level languages. The programmer is not required to know the detailed working of the computer system in order to program in a high level language. They are machine independent. Higher level languages are also known as problem oriented languages. However a high level language is not directly understood by the computer. It is required to be translated into machine language. Therefore they generally execute more slowly and require more memory than the same program written in assembly language.

The programs which are used to translate programs written in high level language into machine language are known as translators.

The types of translators are:

- I) Compiler
- II) Interpreter

I) Compiler:

The compiler translates the entire source program into machine language program at once. The source code remains intact. Once a program is compiled it can be run as many times as required, without being required to be recompiled. A compiler can translate only those programs which have been written in the language for which it is designed. Also each machine has to have its own compiler.

A compiler is a program which normally resides on the secondary storage device. It gets loaded into the CPU when the source program is to be translated. A compiler checks for errors like illegal symbols, statements etc. during compilation and gives out a list of error messages at the end of execution. This is a very valuable aid to the programmer to correct the programs. However, the compiler is incapable of detecting any logical errors in the program.

II) Interpreter:

The interpreter is the program which translates a high level language program into machine language as follows :

- it takes one statement from the high level language program
 - translates it into a machine instruction and the instruction is immediately executed.
- Since the program is translated statement by statement, the machine level program of the source program is not stored anywhere in memory.

Therefore, the program has to be interpreted every time when it has to be run. Thus no object code is generated. The interpreted programs are generally slower than compiled programs. However, if any changes are made in the source program it can interpret only those statements and it is not required to compile the entire program again. Interpreters are relatively easy to write and smaller in size as compared to compilers.

Thus assemblers, compilers and interpreters are systems software which translate the source program into object program i.e. program which can be understood by the computer. These translators are also known as language processors.

c) Fourth Generation Languages (4 GL) :

Programming languages are sometimes classified with generations - from the lowest to the highest.

- The First Generation - Machine Language
- The Second Generation - Assembly Language
- The Third Generation - High Level Language

Unlike procedural languages which require that a programmer writes all the steps to complete the program and generate output, which are related to a more structural approach towards programming. It is the first standardized language.

- BASIC:**
 BASIC stands for **B**eginners **A**ll **P**urpose **S**ymbolic **I**nstruction **C**ode. The language was developed by Prof. John Kemeny and Thomas Kurtz in USA. It is relatively easy to learn. Programs written in BASIC language are interpreted. It resembles FORTRAN in many ways, but can also be effectively used in business applications. Thus it can be used for both business and scientific applications. BASIC is one of the most popular languages for use in microcomputer systems.
- COBOL:**
Common **B**usiness **O**riented **L**anguage was designed especially for business applications. A COBOL program is constructed from sentences, paragraphs, sections and divisions. A COBOL program must have four divisions: the identification division, the environment division, data division, and the procedure division. Thus COBOL is a self documenting language. It is one of the most widely used commercial languages.
- RPG:**
 Report Generator is a general purpose, business oriented language designed to generate output reports. The language was developed by IBM and was launched for use on the IBM 1401 computer. It is best suited for applications where large data files have to be read and extensive reports are to be output. It has limited mathematical capability and is not suited for scientific applications.
- PASCAL:**
 PASCAL has been named after the French mathematician Blaise Pascal; It allows the programmer to structure the programming language. The features of PASCAL allow it to be used for both scientific and business applications. It is a very powerful language. It is implemented on several computers including microcomputers and minicomputers and is also widely used to teach programming to students and beginners.
- C:**
 C was designed and developed at Bell Laboratories USA. It is a block structured language which allows the use of various concepts of structured programming. C also has the advantage of being able to manipulate internal processor registers of the computer. Thus it has some powers of the assembly language. C is also very portable. C is the most popular language used for systems programming like designing compilers and operating systems.
- LISP:**
 LISP stands for **l**ist **p**rocessing. This language is mostly used in non numeric applications which require logical rather than numerical operations. Therefore it is widely used in games, pattern recognition and artificial intelligence.

Check Your Progress - 6.3

1. Match the following.

- | A | B |
|----------------------------------|---|
| (i) COBOL | a. Formula Translation |
| (ii) BASIC | b. |
| Non numeric applications (iii) C | c. |
| Structured Programming | d. |
| (iv) FORTRAN | e. widely used language for systems programming |
| needs an interpreter | f. Self documenting language |
| (v) LISP | |
| (vi) PASCAL | |

6.4 PROGRAM DEVELOPMENT PROCESS

While writing a computer program, it is absolutely necessary to write each and every instruction in the correct sequence. The logical control of element within the computer program is the most important aspect of programming.

The various stages in the development of a computer program are :

- Problem Definition
- Program Design
- Coding
- Debugging
- Testing
- Documentation
- Maintenance

6.4.1 Problem Definition:

The first step in the process of program development is the thorough understanding and identification of the problem for which the program or software is to be developed. In this step the problem has to be defined formally. All the factors like Input/output, processing requirement, memory requirements, error handling, interfacing with other programs have to be taken into consideration in this stage.

6.4.2 Program Design:

The next stage is the program design. The software developer makes use of tools like algorithms and flowcharts to develop the design of the program.

- **Algorithm:**

An algorithm represents the logic of the processing to be performed. It is a sequence of instructions which are designed in such a way that if they are executed in the specified sequence, the desired goal is achieved. It is imperative that the result be obtained after execution of a finite number of steps.

In an algorithm,

- Each and every instruction has to be precise and clear.
- The instruction has to be executed in a finite time.
- When the algorithm terminates the desired result should be achieved.

- **Flowchart :**

A flowchart is a pictorial representation of the algorithm. It represents the steps involved in the procedure and shows the logical sequence of processing using boxes of different shapes. The instruction to be executed is mentioned in the boxes. These boxes are connected together by solid lines with arrows, which indicate the flow of operation.

The first step in the design of a program is the algorithm. The algorithm is then represented in the form of a flowchart and the flowchart is then expressed in the computer language to actually prepare the computer program.

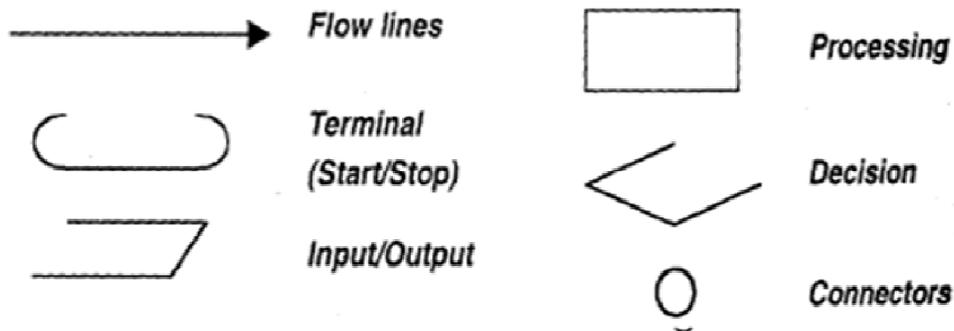


Fig. 6.2 Symbols used in a flowchart.

The symbols used in the flowchart are:

Terminal (Start/Stop):

The symbol denotes the beginning, ending and halt operation in the program logic. Thus it is the first and the last Symbols! in any nov-chart to indicate the start and stop of the process.

Input/output:

Indicates when an input or output operation is to performed in the process.

Processing:

This represents the arithmetic operations like addition, subtraction etc, and the movement of data in the process

Decision:

The decision symbol is used to represent a point where one or more alternatives is possible. The criteria for decision making are written in the decision box. On each path the condition for which the particular path is to be followed has to be written. During the execution the appropriate path will be followed depending upon the result of the decision.

Flow lines:

These indicate the flow of operation ie. The sequence of instruction execution. Flow lines are normally drawn with arrowhead indicating the direction of flow of the program.

Connectors:

A connector is used to indicate the logic flow from one page to another when the flowchart becomes very long. Connectors do not represent any operation. They are mainly used in the flowchart for clarity and convenience.

Types of logic used in the flowchart:

Sequential Execution: In this logic the instructions are executed one after the other sequentially.

Transfer of control: This is a logic which is used when the option to be chosen depends upon the result of the decision. The control is transferred to a particular path if the result of the decision branches to that path.

Looping: In looping or repetitive logic, an instruction or a number of instructions are executed more than once. The instructions are executed till the decision criteria is true. The decision criteria can be placed before the loop or after the loop depending upon the statements which are to be executed in the loop.

Let us see some examples of writing algorithms and flowcharts.

(1) Write an algorithm and develop a flowchart to convert the temperature input in Celsius scale to Fahrenheit scale.

Solution :

First write a detailed stepwise algorithm to do the conversion

Step 1: Start.

Step 2: Input temperature in Celsius (C).

Step 3: Convert to Fahrenheit (F) using the formula $F = 9/5 * C + 32$.

Step 4: Print the temperature in Fahrenheit (F).

Step 5: Stop.

Next on the basis of this step wise algorithm develop the flowchart using the appropriate flowchart symbols as follows:

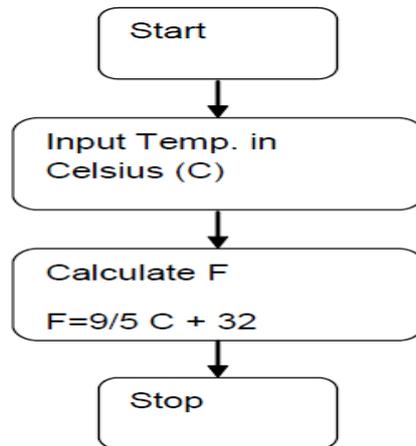


Fig 6.3

(2) Write an algorithm and flowchart to read two numbers A and B and compare them. If

A is greater than B print, A is greater than B else print B is greater than A. **Algorithm :**

Step 1: Start.

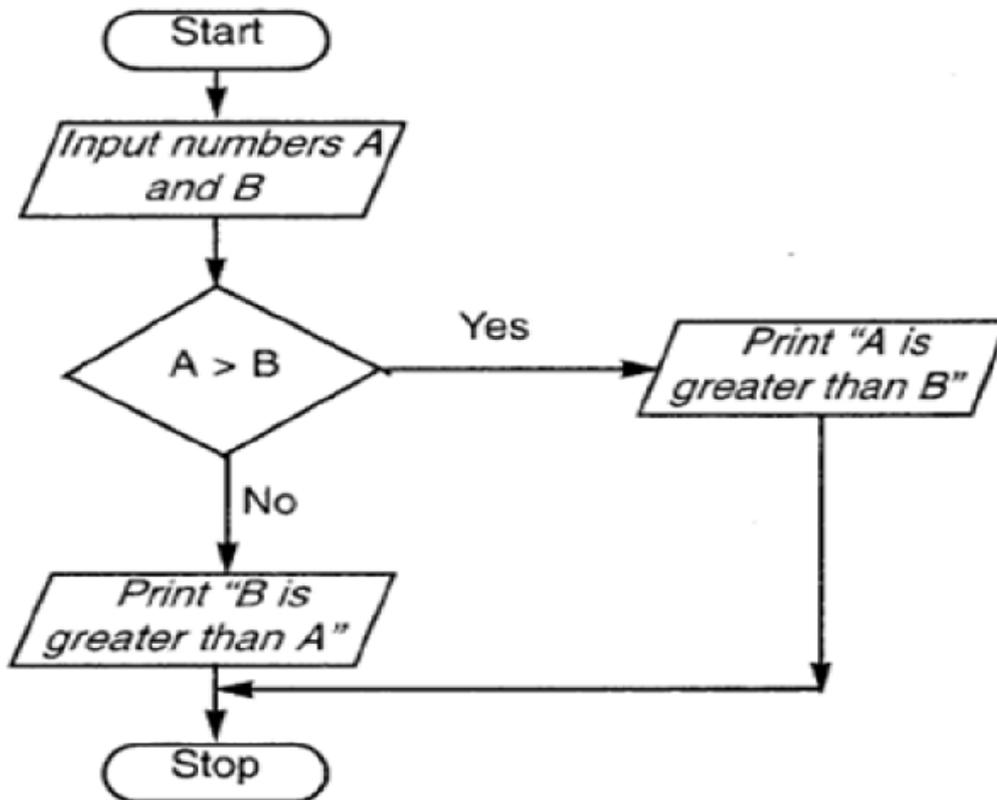
Step 2: Input values of A and B.

Step 3: Compare values of A and B (Is $A > B$?).

Step 4: If yes then print "A is greater than B".

Step 5: If no, the print "B is greater than A".

Now draw the flowchart for the above.



Other techniques which can be useful in designing of the program are:

Modular Programming:

Using this method the entire program is divided into smaller manageable modules so that the smaller modules can be designed, coded and debugged separately.

Top-Down Design:

Here the overall problem is first defined in terms of general subtask. These subtasks are divided into further sub tasks.

6.4.3 Coding:

Once the design process is complete, the actual computer program is written, i.e. the instructions are written in a computer language. Coding is generally a very small part of the entire program development process and also a less time consuming activity in reality. In this process all the syntax errors i.e. errors related to spelling, missing commas, undefined labels etc. are eliminated. For effective coding some of the guidelines which are applied are

- Use of meaningful names and labels of variables,
- Simple and clear expressions,
- Modularity with emphasis on making modules generalized,
- Making use of comments and indenting the code properly,
- Avoiding jumps in the program to transfer control.

6.4.4 Debugging:

At this stage the errors in the programs are detected and corrected. This stage of program development is an important process. Debugging is also known as program validation.

Some common errors which might occur in the programs include:

- Un initialization of variables,
- Reversing of order of operands,

- Confusion of numbers and characters,
- Inverting of conditions eg jumping on zero instead of on not zero.

The tools or methods which can be used to debug the programs include:

- **Simulator** -This is a computer program which simulates the execution of the program on another computer.
- **Logic Analyzers:** This test instrument detects the states of digital signals during each clock cycle and stores them in memory. It then displays this data on the monitor.
- **Breakpoints:** This is introduced in the program to halt the execution at some intermediate point. At this point, the values of the various inputs, outputs, variables etc. can be checked.
- **Software interrupts:** This is an instruction which saves the current value of the program counter and then branches to a specific memory location. At this location there is the debugging program which displays the status information.
- **Memory dump:** This gives a listing of the current contents of a section of the memory. Memory dumps are common in most simulator programs, and microcomputer systems.
- **Trace routine:** This program prints the current status of the processor at specified intervals.

6.4.5 Testing (Validation):

The program is tested on a number of suitable test cases. A test plan of the program has to be done at the stage of the program design itself. This ensures a thorough understanding of the specifications. The most trivial and the most special cases should be identified and tested. It is always useful to include the maximum and minimum values of all variables as test data.

6.4.6 Documentation:

Documentation is a very essential step in the program development. Documentation help\$ the users and the people who maintain the software. This ensures that future modification if required can be done easily. Also it is required during redesigning and maintenance.

6.4.7 Maintenance:

Updating and correction of the program for changed conditions and field experience is accounted for in maintenance.

Maintenance becomes essential in following situations:

- Change in specification,
- Change in equipment,
- Errors which are found during the actual execution of the program. Modularity, structured programming, thorough testing and debugging and proper documentation greatly reduce the time and cost of maintenance of the software.

Check your Progress - 6.4

1. Answer in 1-2 words.

a. Name any two stages in the development of a computer program.

.....
.....

b. Name any two tools used to develop the program design,

.....
.....

c. Name and draw any two symbols used in flowchart,

.....
.....

d. List any two methods used for debugging the program.

.....
.....

e. List any two situations where the maintenance stage of program development becomes essential.

.....
.....

2. Write algorithms and draw flowcharts for the following:

a) Input the marks of five subjects of a student.

Calculate the percentage and print the grades as follows:

Grade A for 90% and above, grade B for percentage greater than or equal to 75 and less than 90 and grade C for percentage less than 75.

b) Find the area and perimeter of a rectangle given the sides s_1 and s_2 .

6.5 SUMMARY

A set of programs, procedures and associated documentation together constitute the computer software. The computer software is classified as :

Application Software : These carry out specific applications like payroll, financial accounting etc.

Systems Software : This set of programs controls the execution of the computer system. It controls the functions of the other software's, and hardware.

Utility software : These are program tools used in program development or to perform limited tasks.

Firmware : These are programs available on hardware i.e. ROM chips.

Programming languages : A language is a set of instructions which tells the computer what to do. All languages perform the basic operations of input/output, arithmetic and logic operations and data movement from and to the CPU.

The broad categories of programming languages are:

Machine Language : The only language understood by the computer, it is a language of 0s and 1s. It is machine dependant and difficult for the user to learn.

Assembly Language : Assembly language uses mnemonics to write the program code. This is then converted into machine language by the assembler.

High Level Languages : They make use of English like words and statements and are easy to learn. They are translated into machine language with the use of compilers and interpreters. Some of the commonly used high level languages are FORTRAN, BASIC, COBOL, RPG, PASCAL, C, LISP etc.

Fourth Generation Languages : These are non procedural languages. They are normally used in conjunction of a data base and its data dictionary.

The various stages in the development of a computer program are:

Problem Definition : Thorough understanding and identification of the problem for which a program is to be written.

Program Design : Tools like algorithms and flowcharts are used to design the program. The techniques employed in design are modular-programming, top-down design.

Coding : At this stage, the actual program is written using a computer language.

Debugging : Here the errors in the program are detected and corrected.

Testing : A test plan for the program which has been done at the design stage is applied here to test the program on a number of suitable test cases.

Documentation : This stage ensures that further modifications, redesign and maintenance can be made easy to the user who maintains the software.

Maintenance : Updating and correction of programs is covered in maintenance.

Thus a computer program is not just writing code in a computer language, but a detailed procedure of going through the various stages of definition, design, coding, debugging, testing, documentation and maintenance.

6.6 CHECK YOUR PROGRESS-ANSWERS

6.2

1. 1 -c 2-d 3-a 4- b

2. Software means a set of programs, procedures and other associated documentation which describes what the program does and how it is to be used.

1 a. Machine Language, Assembly Language, High Level language, Fourth Generation

Languages.

b. The programs which translate the source programs into object programs i.e machine programs are called translators, eg. compiler.

c. The aims of 4 GL are : to develop programs faster, write programs which can be easily modified and make them easy to learn.

6.3 (i) -f (ii) -d (iii) -e (iv) -a (v) -b (vi) -c

6.4

1. a) Problem definition, program design b) Algorithm, Flow chart
c) Connectors, Flow lines d) Break points, simulators e) Change in specification, change in equipment.

2 a) Algorithm :

Step 1 : Start,

Step 2 : Input marks of five subjects (m1,m2,m3,m4,m5).

Step 3 : Calculate percentage ($p = (m1 + m2 + m3 + m4 + m5)/5$).

Step 4 : Check if percentage (p) ≥ 90 .

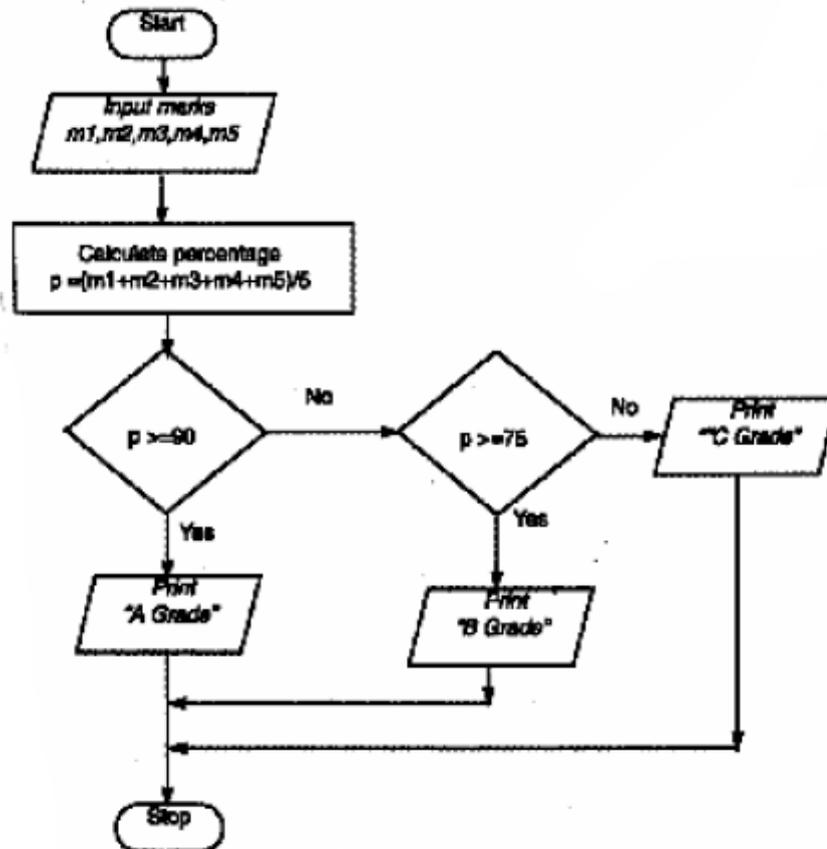
Step 5 : If yes, print "A grade".

Step 6 : If no, check if percentage (p) ≥ 75 .

Step 7 : If yes, print "B grade".

Step 8 : If no, print "C grade". Step 9: Stop.

Stop



b) Algorithm :

Step 1 : Start.

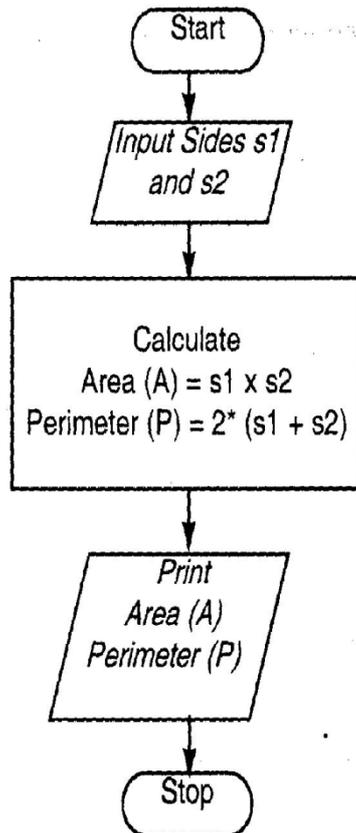
Step 2 : Enter the sides of the rectangle s1 and s2.

Step 3 : Calculate area (A) = s1 x s2.

Step 4 : Calculate perimeter (P) = 2 * (s1 + s2).

Step 5 : Output area (A) and perimeter (P).

Step 6 : Stop.



6.7 QUESTIONS FOR SELF - STUDY

1. Describe the kinds of software.
2. What is a programming language? What are the types of programming languages? Describe each in brief.
3. What are translators? Describe the types of translators.
4. Describe in brief any two commonly used high level languages.
5. What are the steps in the program development? Describe any two.
6. Write short note on Algorithms and flowcharts.
7. Describe in brief the tools used for debugging computer programs.
8. Explain what is maintenance of a computer program and when it becomes necessary.

6.8 SUGGESTED READING'S

- **Computer Fundamentals**
Concepts, Systems & Applications – P.K Sinha

REFERENCES

- <http://www.tutorialspoint.com/>

Chapter 7

Introduction to Operating Systems

7.0	Objectives
7.1	Introduction
7.2	Definition
7.3	Computer Processing Techniques,
7.4	Summary
7.5	Check your Progress - Answers
7.6	Questions for Self – Study
7.7	Suggested Reading's

7.0 OBJECTIVES

Friends, after studying the chapter “Operating Systems” You will be able to:

- Define an operating system and understand the functions of the system
- Discuss terms like resident and transient programs, throughput, response time etc.
- Explain the different processing techniques

7.1 INTRODUCTION

The operating system acts as an interface between the humans and the computer. the operating system ensures smooth and efficient operation of a computer.

7.2 DEFINITION

An **Operating system** is defined as an integrated set of programs which manage the various resources and operations of a computer system. The operating system acts as an interface between the humans and the computer. The operating system ensures smooth and efficient operation of a computer.

- **Memory management:** Allocation of main memory and other storage to the system programs and the user data and programs.
- **Input/output management:** Management of the input/output devices and their assignment to the various programs that are being executed
- **File management:** The files have to be stored in various storage devices. They have to be transferred from one storage device to another. This is taken care of by the Operating System.
- **Data security and integrity:** The data and programs have to be handled in such a way that they do not interfere with each other.
- **Assigning priority to jobs:** The operating system is the one which has to decide and allot priority to the jobs which are to be executed.
- **Interpret commands and detect errors:** Each of these functions are performed by a program or a set of programs and all the programs together make the operating system. Normally, there is one control program of the operating system that resides in the main memory of the computer. This program is known as the resident program. The other programs known as transient programs or service programs reside on the disk and are accessed as and when required. The total amount of work performed by the operating system over a period of time is known as throughput.
- The response time is the time interval between the time the user submits request and the -time he receives the response. Response time is also known as

turnaround time the efficiency of a computer system depends upon the throughput and the response time.

- **Functions of the Operating Systems** : The operating systems are designed to perform the following functions :
- **Processor management**: A process is a program in execution. The processor is a hardware device which processes a sequence of instructions. Assigning of processors to the different tasks being executed by the computer is processor management.

Check your Progress - 7.2

1. Fill in the blanks.

- A.....is a program in execution.
- The control program of the operating system which resides in the main memory of the
Computer is known as the.....
- The total amount of work performed by the operating system over a period of time is the.....
- Response time is also known as.....

2. Answer in 1-2 Sentences

- List any two functions of an operating system.

.....
.....

- On what factors does the efficiency of the operating system depend?

.....

7.3 COMPUTER PROCESSING TECHNIQUES

7.3.1 Batch Processing:

In **batch processing**, a numbers of jobs are collected by the operator offline and when a batch of jobs gets collected they are input to the computer for processing. The jobs are then processed without user intervention.

Typical applications of batch processing include applications like payroll, preparation of bills etc. where the information is not to be updated freq 5.2.2

Spooling: Spooling is used to improve the processing speed of batch processing. Spooling means Simultaneous Peripheral Output on Line. The process of storing input data and output results on secondary storage is known as spooling. The input data is stored on magnetic disks and is fed to the CPU when it is not too busy. The processor then processes the data and the resulting output is again stored on secondary storage device. Thus in spooling, the magnetic storage media acts as a buffer between the memory and the input/ output devices.

In many computers special purpose input/output processors which can function independent of the CPU are provided, thus leaving the main processor free once the program execution is over. The I/O processors then print the spooled data from the tape or disk on the printer. Thus spooling improves the efficiency of use of memory and CPU.

7.3.3 Multiprogramming:

In **multiprogramming** the CPU is capable of running more than one program concurrently. More than one programs can reside in the main memory at any given time, however the processor is able to execute only one instruction at a time. The, operating speed of the CPU is much faster than that of the I/O devices. Therefore when one program is busy with I/O operations, the CPU is able to allocate time to other programs instead of remaining idle. Thus a number of users can share CPU time.

A number of programs can reside in the main memory of the computer system. The place in memory where a program resides is known as partition. Depending upon the operating system, the actual number of partitions in the memory and the number of programs that can reside simultaneously is decided. Thus in multiprogramming it is possible to run a number of programs in much less time than would be required to execute them one after the other.

Multiprogramming increases both the throughput and response time of the computer system. However operating systems which can support multiprogramming are required to have high memory capacity and at the same time effective mechanism of protecting the memory.

7.3.4 Multiprocessing:

In multiprocessing systems, two or more CPUs are connected together. Therefore it is possible to execute instructions from different programs at the same time. Thus more than one instruction can be executed simultaneously. The idle time of the computer reduces, since there is not user intervention in between jobs.

The disadvantages of batch processing are:

- The data has to be first accumulated and then processed. Therefore there is a possibility of delay in execution of jobs,
- It is not possible to change priority of jobs. If both jobs have the same priority, one of them has to wait in the batch till the complete execution of the other.

Execute different instructions of the same program. Different multiprocessing systems use different types of memory configurations. Some systems have a Common main memory for all the CPUs, in some systems each system has its own main memory while in still others each CPU can have its own memory as well as share a common memory with other processors.

Multiprocessing systems require a very complex and sophisticated operating system to coordinate all the activities of the multiple CPUs and other devices. Multiprocessing systems are also very expensive.

7.3.5 Time Sharing:

In time sharing, it is possible for multiple users to run more than one application at the same time on the computer. This is accomplished by providing a=separate terminal to each user. All these terminals are connected to the main computer. The GPU time is divided among all the users on a scheduled basis. The time that each user gets is called a time slice. The CPU switches from one user to the another, and e|^cutes a part of the process in the time slice. This process continues till the job is executed. In time sharing, like in multiprogramming only one program is in control of the CPU at any given time.

In time sharing environment, it is not always possible that all the programs of all the users reside in the main memory. Only the control program and some programs reside in the main memory. The remaining programs are loaded from the secondary memory as and when they are to be executed.

7.3.6 On line Processing:

In on line processing the transaction data is directly sent to secondary on-line storage devices by the CPU without sorting, from the point where data is generated. The accessing and retrieval of data is very fast. In these systems-devices are directly connected to the

CPU for input or inquiry.

7.3.7 Real Time Processing:

Real time processing is an on line processing system where the records are updated and data is processed as soon as the transaction takes place-Real time systems allow the users to communicate with the computer during the processing itself. Typical examples of real time systems are the air line reservation market systems etc. In real time systems a number of terminals may be linked to a single CPU. A number of remote stations are connected to the computer with communication lines and several stations operate simultaneously. The transactions update records. In off line processing, the data processing is not directly controlled by the CPU. In minicomputers a number of terminals are used to enter the data onto a secondary storage like a tape or disk. The data is validated, and then entered into the main CPU in batch mode for processing.

Check your Progress - 7.3

Match the following.

A	B
(i) Batch Processing	a. Multiple user, multiple applications at same time
(ii) Spooling	b. Multiple CPUs connected together
(iii) Multiprogramming	c. off line data collection
(iv) Multiprocessing	d. Simultaneous Peripheral Output Online
(v) Time Sharing	e. multiple program execution at same time

7.4 SUMMARY

An Operating System is defined as an integrated set of programs which manage the various resources and operations of a computer system. It is the interface between the user and the computer. The functions of the operating system are

Processor Management: It assigns the processor to the various tasks which are being executed by the computer.

Memory Management : Allocation of main memory and other storage to all the programs and data.

Input/output Management: Management of I/O devices and their assignment to various programs.

File Management: Managing the storage and transfer of files from various storage devices.

Data Security and Integrity: Ensure that data and programs do not interfere with one another.

Assign Priorities to various jobs which are to be executed and interpret the various commands and detect and report errors.

A resident program is the control program of the operating system which resides in the main memory of the computer system. Transient programs reside on secondary storage devices and are accessed as and when required. The total amount of work performed by the operating system over a period of time is known as throughput. The time Interval between the time the user submits a request and receives the response is known as response time or turnaround time. Throughput and response time determine the efficiency of the operating system.

Computer Processing Techniques:

Batch Processing : A number of jobs are collected offline and the input to the computer when a batch is complete. The jobs are then processed without user intervention. In batch processing it is not possible to change the priority of jobs which are once batched. **Spooling :** Spooling means Simultaneous Peripheral output on line. The process of storing input data and output results on secondary storage devices is spooling. The secondary storage media acts as a buffer between the memory and input/output devices.

Multiprogramming: In this mode of processing, the CPU is capable of running more than one program concurrently. Since a number of programs can reside in main memory at any given time a number of users can share the CPU. Multiprogramming increases both the throughput and efficiency of the computer system.

Multiprocessing : In a multiprocessing system two or more CPUs are connected together. Thus more than one instruction can be executed simultaneously. It is also possible to execute instructions from different programs at the same time.

Time Sharing : In time sharing, a separate terminal is provided for each user. All such terminals are connected to the main computer. The CPU time is divided among all the users.

On line Processing : In this processing, transaction data is directly sent to on-line storage devices. Thus access and retrieval of data is very fast.

Off line Processing: In offline data processing, the data processing is not directly controlled by the CPU. The data is first entered onto secondary storage devices like a tape or disk. It is later validated and then entered into main CPU in a batch mode for processing.

7.5 CHECK YOUR PROGRESS ANSWERS

- 7.2 1. a) Process
b) resident program
c) throughput
d) turnaround time
2. a) Memory Management, File Management
b) Throughput and Response time
- 7.3 (i) - c (ii) - d (iii) - e (iv) - b (v) - a

7.6 QUESTIONS FOR SELF - STUDY

1. What is an operating system?
2. Discuss the functions of the operating system.
3. Define the terms response time and throughput.
4. What are resident programs and transient programs?
5. Write short notes on Batch processing and Spooling.
6. What is multiprogramming?
7. Discuss multiprogramming
8. Differentiate between on line processing and off line processing.

7.7 Suggested Reading's

- **Computer Fundamentals**

Concepts, Systems & Applications – P.K Sinha

Popular Operating System

8.0	Objectives
8.1	Introduction
8.2	Operating System
8.3	Unix Operating System
8.4	MS-DOS-Disk Operating System
8.5	Windows XP
8.6	Windows Vista
8.7	Windows 8
8.8	Linux
8.9	Summary
8.10	Check your Progress –Answers
8.11	Questions for Self –Study
8.12	Suggested Reading's

8.0 OBJECTIVES

Friends, this chapter gives a brief introduction of some popular operating systems. After learning this chapter you will be able to discuss the following operating systems

- UNIX
- MS-DOS
- Windows XP
- Windows Vista
- Windows 9
- Linux

8.1 INTRODUCTION

An operating system, which is a kind of system software and the programs of it provides interaction between user and computer components. There are various Operating systems available.

8.2 OPERATING SYSTEM

An operating system is a software component of a computer system that is responsible for the management of various activities of the computer and the sharing of computer resources. It hosts the several applications that run on a computer and handles the operations of computer hardware. Users and application programs access the services offered by the operating systems, by means of system calls and application programming interfaces. Users interact with operating systems through Command Line Interfaces (CLIs) or Graphical User Interfaces known as GUIs. In short, operating system enables user interaction with computer systems by acting as an interface between users or application programs and the computer hardware. Here is an overview of the different types of operating systems.

Types of Operating System.

Real-time Operating System:

It is a multitasking operating system that aims at executing real-time applications. Real-time operating systems often use specialized scheduling algorithms so that they can achieve a deterministic nature of behavior. The main object of real-time operating systems is their quick and predictable response to events. They either have an event-driven or a time-sharing design. An event-driven system switches between tasks based of their priorities while time-sharing operating systems switch tasks based on clock interrupts.

Multi-user and Single-user Operating Systems:

The operating systems of this type allow a multiple users to access a computer system concurrently. Time-sharing system can be classified as multi-user systems as they enable a multiple user access to a computer through the sharing of time. Single-user operating systems, as opposed to a multi-user operating system, are usable by a single user at a time. Being able to have multiple accounts on a Windows operating system does not make it a multi-user system. Rather, only the network administrator is the real user. But for a Unix-like operating system, it is possible for two users to login at a time and this capability of the OS makes it a multi-user operating system

Multi-tasking and Single-tasking Operating Systems:

When a single program is allowed to run at a time, the system is grouped under a single-tasking system, while in case the operating system allows the execution of multiple tasks at one time, it is classified as a multi-tasking operating system. Multi-tasking can be of two types namely, pre-emptive or co-operative. In pre-emptive multitasking, the operating system slices the CPU time and dedicates one slot to each of the programs. Unix-like operating systems such as Solaris and Linux support pre-emptive multitasking.

Distributed Operating System:

An operating system that manages a group of independent computers and makes them appear to be a single computer is known as a distributed operating system. The development of networked computers that could be linked and communicate with each other, gave rise to distributed computing. Distributed computations are carried out on more than one machine. When computers in a group work in cooperation, they make a distributed system.

Embedded System:

The operating systems designed for being used in embedded computer systems are known as embedded operating systems. They are designed to operate on small machines like PDAs with less autonomy. They are able to operate with a limited number of resources. They are very compact and extremely efficient by design. Windows CE, FreeBSD and Minix 3 are some examples of embedded operating systems.

The operating systems thus contribute to the simplification of the human interaction with the computer hardware. They are responsible for linking application programs with the hardware, thus achieving an easy user access to the computers.

8.3 UNIX OPERATING SYSTEM

Unix (officially trademarked as **UNIX**, sometimes also written as **UNIX** with small caps) is a computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs, including Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, and Joe Ossanna. Today's Unix systems are split into various branches, developed over time by AT&T as well as various commercial vendors and non-profit organizations.

UNIX operating systems are widely used in both servers and workstations. The UNIX environment and the client-server program model were essential elements in the development of the Internet and the reshaping of computing as centered in networks rather than in individual computers. Both Unix and the C programming language were developed by AT&T and distributed to government and academic institutions, which led to both being ported to a wider variety of machine families than any other operating system. As a result, UNIX became synonymous with "open systems".

UNIX was designed to be portable, multi-tasking and multi-user in a time-sharing configuration. Unix systems are characterized by various concepts: the use of plain text for storing data; a hierarchical file system; treating devices and certain types of inter-process communication (IPC) as files; and the use of a large number of software tools, small programs that can be strung together through a command line interpreter

using pipes, as opposed to using a single monolithic program that includes all of the same functionality. These concepts are known as the Unix philosophy.

Under Unix, the “operating system” consists of many of these utilities along with the master control program, the kernel. The kernel provides services to start and stop programs, handles the file system and other common “low level” tasks that most programs share, and, perhaps most importantly, schedules access to hardware to avoid conflicts if two programs try to access the same resource or device simultaneously. To mediate such access, the kernel was given special rights on the system, leading to the division between *user-space* and *kernel-space*.

8.3.1 Components

List of Unix programs

The Unix system is composed of several components that are normally packaged together. By including — in addition to the kernel of an operating system — the development environment, libraries, documents, and the portable, modifiable source-code for all of these components, Unix was a self-contained software system. This was one of the key reasons it emerged as an important teaching and learning tool and has had such a broad influence. The inclusion of these components did not make the system large — the original V7 UNIX distribution, consisting of copies of all of the compiled binaries plus all of the source code and documentation occupied less than 10MB, and arrived on a single 9-track magnetic tape.

The names and file system locations of the Unix components have changed substantially across the history of the system. Nonetheless, the V7 implementation is considered by many to have the canonical early structure:

- Kernel — source code in /user/sys, composed of several sub-components:
- conf — configuration and machine-dependent parts, including boot code
- dev — device drivers for control of hardware (and some pseudo-hardware)
- Sys — operating system “kernel”, handling memory management, process scheduling, system calls, etc.
- h — header files, defining key structures within the system and important system-specific invariables

Development Environment — Early versions of Unix contained a development environment sufficient to recreate the entire system from source code:

- cc — C language compiler (first appeared in V3 Unix)
- as — machine-language assembler for the machine
- ld — linker, for combining object files
- lib — object-code libraries (installed in /lib or /usr/lib) libc, the system library with C run-time support, was the primary library, but there have always been additional libraries for such things as mathematical functions (libm) or database access. V7 Unix introduced the first version of the modern “Standard I/O” library stdio as part of the system library. Later implementations increased the number of libraries significantly.
- make — build manager (introduced in PWB/UNIX), for effectively automating the build process
- include — header files for software development, defining standard interfaces and system invariants
- Other languages — V7 Unix contained a Fortran-77 compiler, a programmable arbitrary-precision calculator (bc, dc), and the awk “scripting” language, and later versions and implementations contain many other language compilers and toolsets. Early BSD releases included Pascal tools, and many modern Unix systems also include the GNU Compiler Collection as well as or instead of a proprietary compiler system.
- **Commands** — Unix makes little distinction between commands (user-level programs) for system operation and maintenance (e.g. cron), commands of general utility (e.g. grep), and more general-purpose applications such as the text formatting and typesetting package. Nonetheless, some major categories are:
- sh — The “shell” programmable command line interpreter, the primary user interface on Unix before window systems appeared, and even afterward (within a

- “command window”).
- Utilities — the core tool kit of the Unix command set, including cp, ls, grep, find and many others. **Subcategories include:**
 - System utilities — administrative tools such as mkfs, fsck, and many others
 - User utilities — environment management tools such as passwd, kill, and others.
 - Document formatting — Unix systems were used from the outset for document preparation and typesetting systems, and included many related programs such as nroff, troff, tbl, eqn, refer, and pic. Some modern Unix systems also include packages such as TeX and Ghostscript.
 - Graphics — The plot subsystem provided facilities for producing simple vector plots in a device-independent format, with device-specific interpreters to display such files. Modern UNIX systems also generally include X11 as a standard windowing system and GUI, and many support OpenGL.
 - Communications — Early UNIX systems contained no inter-system communication, but did include the inter-user communication programs mail and write. V7 introduced the early inter-system communication system UUCP, and systems beginning with BSD release 4.1c included TCP/IP utilities.
 - The ‘man’ command can display a manual page for any command on the system, including itself.
 - Documentation — Unix was the first operating system to include all of its documentation online in machine readable form. The documentation included:
 - man — manual pages for each command, library component, system call, header file, etc.
 - doc — longer documents detailing major subsystems, such as the C language.

8.3.2 Features of Unix Operating System

1. The Unix system had significant impact on other operating systems. It was written in high level language rather than assembly language
2. Unix had a drastically simplified file model compared to many contemporary operating systems, treating all kinds of files as simple byte arrays. The file system hierarchy contained machine services and devices (such as printers, terminals, or disk drives).
- 3 Making the command interpreter an ordinary user-level program, with additional commands provided as separate programs, was another Multics innovation popularized by Unix. The Unix shell used the same language for interactive commands as for scripting.
4. Over time, text-based applications have also proven popular in application areas, such as printing languages (PostScript, ODF), and at the application layer of the Internet protocols, e.g., Telnet, FTP, SSH, SMTP, HTTP, SOAP and SIP.
5. Unix popularized syntax for regular expressions that found widespread use. The Unix programming interface became the basis for a widely implemented operating system interface standard (POSIX, see above).
8. Unix provided the TCP/IP networking protocol on relatively inexpensive computers, which contributed to the Internet explosion of worldwide real-time connectivity, and which formed the basis for implementations on many other platforms. This also exposed numerous security holes in the networking implementations.

8.3.3 Free Unix-like operating systems

In 1983, Richard Stallman announced the GNU project, an ambitious effort to create a free software Unix-like system; “free” in that everyone who received a copy would be free to use, study, modify, and redistribute it. The GNU project’s own kernel development project, GNU Hurd, had not produced a working kernel, but in 1992 Linus Torvalds released the Linux kernel as free software under the GNU General Public License. In addition to their use in the Linux operating system, many GNU packages — such as the GNU

Compiler Collection (and the rest of the GNU toolchain), the GNU C library and the GNU core utilities — have gone on to play central roles in other free Unix systems as well.

Linux distributions, comprising Linux and large collections of compatible software have become popular both with individual users and in business. Popular distributions include Red Hat Enterprise Linux, Fedora, SUSE Linux Enterprise, openSUSE, Debian GNU/Linux, Ubuntu, Mandriva Linux, Slackware Linux and Gentoo.

8.4 DOS [DISK OPERATING SYSTEM]

In July 1980 IBM assigned Microsoft to develop a 18-bit operating system for the personal computer for the fee of 188,000 dollars. Although the company Digital Research of Gary Kildall already had with **CP/M 88** such a 18-bit version, but by circumstances no contract has been established with IBM. Microsoft did not have yet any operating system; Microsoft licensed CP/M from Digital Research in November 1977 for 50,000 dollars.

The command interpreter is integrated in the file `command.com` with the internal commands for MS-DOS. Together with the file `io.sys` for simple device routines like the access to the monitor, keyboard, fixed storage disks and interfaces as well as the booting code these form the base operating system. DOS works very hardware near.

1988 was MS-DOS established and had reached measured on the market share a monopoly in the DOS market. The number of the MS-DOS installations grew worldwide to about 80 million and surpassed all other systems with that amount. Almost every software company offered standard applications like word processing, calculation or also special solutions like measurement tools, CAD (Computer Aided Design) or image processing for MS-DOS. The PC manufacturers designed her systems compatible to MS-DOS except for few manufacturers.

8.4.1 Small reference of internal DOS commands

- del, erase** - delete files
- rd, rmdir** - delete directories
- dir** - show content of directories
- cd, chdir** - change current directory **cls** - clear the screen
- md, mkdir** - create a directory copy - copy of one or several files
- ren, rename** - rename of files or directories **type** - shows the content of text files
- set** - shows the DOS environment variables or defines a new one **ver** - shows the DOS version number
- vol** - shows the name of the storage drive

8.4.2 Small reference of external DOS commands

- attrib** - shows the attributes of files or set one of those
- fdisk** - partitioning or modify of the hard disk
- move** - move of files
- mem** - shows the occupancy of working memory tree - shows the directory structure
- format** - format of storage drives

Check Your Progress - 8.4

I. Fill in the blanks

1. Users interact with operating systems throughOr.....
2.often use specialized scheduling algorithms so that they can achieve a deterministic nature of behavior.
3. MS DOS 1.0 consists of aboutlines assembler code.
4.command shows the directory structure in DOS
5.Command shows the content of text file.

II Abbreviate the following

8. Personal Digital Assistant. :
7. International Business Machine. :
8. Business All Purpose Symbolic Instruction Code. :

8.5 WINDOWS XP

Windows XP is a line of operating systems produced by Microsoft for use on personal computers, including home and business desktops, laptops, and media centers. The name “XP” is short for “experience”. Windows XP is the successor to both Windows 2000

8.5.1 Editions of Windows XP

The two major editions are Windows XP Home Edition, designed for home users, and Windows XP Professional, designed for business and power-users. XP Professional contains advanced features that the average home user would not use. However, these features are not necessarily missing from XP Home. They are simply disabled, but are there and can become functional. These releases were made available at retail outlets that sell computer software, and were preinstalled on computers sold by major computer manufacturers.

Microsoft also released Windows XP Embedded, an edition for specific consumer electronics, set-top boxes, kiosks/ATMs, medical devices, arcade video games, point-of-sale terminals, and Voice over Internet Protocol (VoIP) components. In July 2008, Microsoft released Windows Fundamentals for Legacy PCs, a thin client version of Windows XP Embedded which targets older machines (as early as the original Pentium). It is only available to Software Assurance customers. It is intended for corporate customers who would like to upgrade to Windows XP to take advantage of its security and management capabilities, but can't afford to purchase new hardware.

Languages

Windows XP is available in many languages. In addition, MUI packs and Language Interface Packs translating the user interface are also available for certain languages.

ATMs

Automated teller machine (ATM) vendors NCR Corporation and Diebold Incorporated have both adopted Microsoft Windows XP as their migration path from OS/2. Diebold initially shipped XP Home Edition exclusively, but, following extensive pressure from customer banks to support a common operating system, switched to support XP Professional to match their primary competitor, NCR Corporation

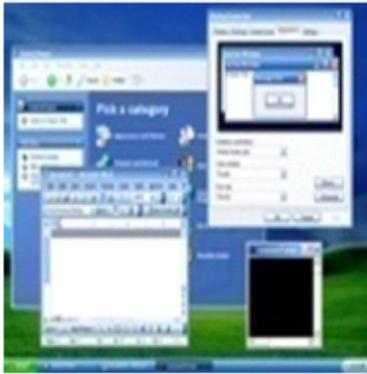
8.5.2 New and updated features Features new to Windows XP

Windows XP introduced several new features to the Windows line, including:



Default Blue (Luna)

Windows Classic



XP Media Center



The new start menu design in the "Energy blue" theme.

The "task grouping" feature introduced in Windows XP.



Fig 8.1 Windows XP themes

- Faster start-up and hibernation sequences
- The ability to discard a newer device driver in favor of the previous one (known as driver rollback), should a driver upgrade not produce desirable results
- A new, arguably more user-friendly interface, including the framework for developing themes for the desktop environment
- Fast user switching, which allows a user to save the current state and open applications of their desktop and allow another user to log on without losing that information
- The ClearType font rendering mechanism, which is designed to improve text readability on Liquid Crystal Display (LCD) and similar monitors
- Remote Desktop functionality, which allows users to connect to a computer running Windows XP Pro from across a network or the Internet and access their applications, files, printers, and devices.
- Support for most DSL modems and IEEE 802.11 connections, as well as networking over FireWire, and Bluetooth.

8.5.3 User interface

Windows XP features a new task-based graphical user interface. The Start menu and Windows indexing service were redesigned and many visual effects were added, including:

- A translucent blue selection rectangle in Explorer
- Drop shadows for icon labels on the

desktop

- Task-based sidebars in Explorer windows (“common tasks”)
- The ability to group the taskbar buttons of the windows of one application into one button
- The ability to lock the taskbar and other toolbars to prevent accidental changes
- The highlighting of recently added programs on the Start menu
- Shadows under menus (Windows 2000 had shadows under mouse pointers, but not menus)

The Windows 2000 “classic” interface can be used instead if preferred. Several third party utilities exist that provide hundreds of different visual styles. Microsoft licensed technology from Window Blinds creator Star dock to create its visual styles in XP.

8.5.4 System requirements



Fig 8.2

Designed for Windows XP computer hardware logo

System requirements for Windows XP Home and Professional editions as follows:

For many workloads that involve Web browsing, e-mail, and other activities, 84 MB of RAM will provide [the] user experience equivalent or superior to that of Windows Me running on the same hardware.”

8.5.5 Service packs

Microsoft occasionally releases service packs for its Windows operating systems to fix problems and add features. Each service pack is a superset of all previous service packs and patches so that only the latest service pack needs to be installed, and also includes new revisions. Older service packs need not be removed before application of the most recent one. The service pack details below only apply to the 32-bit editions. Windows XP Professional x84 Edition was based on Windows Server 2003 Service Pack 1 and claimed to be “SP1” in system properties from the initial release. It is updated by the same service packs and hot fixes as the x84 edition of Windows Server 2003.

Service Pack 1

Set Program Access and Defaults was added in Service Pack 1.

Service Pack 1 (SP1) for Windows XP was released on September 9, 2002. It contains post-RTM security fixes and hot-fixes, compatibility updates, optional .NET Framework support, enabling technologies for new devices such as Tablet PCs, and a new Windows Messenger 4.7 version. The most notable new features were USB 2.0 support and a Set Program Access and Defaults utility that aimed at hiding various middleware products. Users can control the default application for activities such as web browsing and instant messaging, as well as hide access to some of Microsoft’s bundled programs. This utility was first brought into the older

Windows 2000 operating system with its Service Pack 3. This Service Pack supported SATA and hard drives that were larger than 137GB (48-bit LBA support) by default.

Service Pack 2

Windows Security Center was added in Service Pack 2.

Windows XP, including a firewall, improved Wi-Fi support, such as WPA encryption compatibility, with a wizard utility, a pop-up ad blocker for Internet Explorer 8, and Bluetooth support. The new welcome screen during the kernel boot removes the subtitles “Professional”, “Home Edition” and “Embedded” since Microsoft introduced new Windows XP editions prior to the release of SP2. The green loading bar in Home Edition and the yellow one in Embedded were replaced with the blue bar, seen in Professional and other versions of Windows XP, making the boot-screen of operating systems resemble each other. Colors in other areas, such as Control Panel and the Help and Support tool, remained as before. Service Pack 2 also added new security enhancements, which included a major revision to the included firewall that was renamed to Windows Firewall and is enabled by default, additionally; security-related improvements were made to e-mail and web browsing. Windows XP Service Pack 2 includes the Windows Security Center, which provides a general overview of security on the system, including the state of antivirus software, Windows Update, and the new Windows Firewall. Third-party anti-virus and firewall applications can interface with the new Security Center.

Service Pack 3

Windows XP Service Pack 3 (SP3) was released to manufacturing on April 21, 2008 and to the public via both the Microsoft Download Center and Windows Update on May 8, 2008. It began being automatically pushed out to Automatic Update users on July 10, 2008. A feature set overview which details new features available separately as standalone updates to Windows XP, as well as back ported features from Windows Vista has been posted by Microsoft. A total of 1,174 fixes have been included in SP3. Service Pack 3 can be installed on systems with Internet Explorer versions 8 or 7.

Check Your Progress - 8.5

Fill in the blanks

1. The two major editions of Windows XP areand
2. Windows XP'sedition are used in laptops and notebooks.
3. Service Pack 1 (SP1) for Windows XP was released on
4. Service Pack 3 can be installed on systems with Internet Explorer
5.GB Hard disk or higher is required for loading Windows XP.

8.6 WINDOWS VISTA

8.6.1 New or changed features

Windows Vista revised and incorporated new features and functionalities not present in its predecessors, especially those from Windows XP.

Windows Aero:

The new hardware-based graphical user interface is named Windows Aero, which Jim Allchin stated is an acronym for Authentic, Energetic, Reflective, and Open. The new interface is intended to be cleaner and more aesthetically pleasing than those of previous Windows versions, including new transparencies, live thumbnails, live icons, and animations, thus providing a new level of eye candy.

Laptop users report, however, that battery life is shortened with the feature enabled.

- **Windows Shell:**

The new Windows shell is significantly different from Windows XP, offering a new range of organization, navigation, and search capabilities. Windows Explorer's task pane has been removed, integrating the relevant task options into the toolbar. A "Favorite links" pane has been added, enabling one-click access to common directories. The address bar has been replaced with a breadcrumb navigation system. The preview pane allows users to see thumbnails of various files and view the contents of documents. The details pane shows information such as file size and type, and allows viewing and editing of embedded tags in supported file formats. The Start menu has changed as well; it no longer uses ever-expanding boxes when navigating through Programs. The word "Start" itself has been removed in favor of a blue Windows Pearl.

- **Instant Search:**

Windows Vista features a new way of searching called Instant Search, which is significantly faster and more in-depth (content-based) than the search features found in any of the previous versions of Windows.

- **Windows Sidebar:**

A transparent panel anchored to the side of the screen where a user can place Desktop Gadgets, which are small applets designed for a specialized purpose (such as displaying the weather or sports scores). Gadgets can also be placed on other parts of the desktop.

- **Windows Internet Explorer 7:**

New user interface, tabbed browsing, RSS, a search box, improved printing, Page Zoom, Quick Tabs (thumbnails of all open tabs), Anti-Phishing filter, a number of new security protection features, Internationalized Domain Name support (IDN), and improved web standards support. IE7 in Windows Vista runs in isolation from other applications in the operating system (protected mode); exploits and malicious software are restricted from writing to any location beyond Temporary Internet Files without explicit user consent.

- **Windows Media Player 11**, a major rev amp of Microsoft's program for playing and organizing music and video. New features in this version include word wheeling (or "search as you type"), a new GUI for the media library, photo display and organization, the ability to share music libraries over a network with other Windows Vista machines, Xbox 360 integration, and support for other Media Center Extenders.

- **Backup and Restore Center:** Includes a backup and restore application that gives users the ability to schedule periodic backups of files on their computer, as well as recovery from previous backups. Backups are incremental, storing only the changes each time, minimizing disk usage. It also features Complete PC Backup (available only in Ultimate, Business, and Enterprise versions) which backs up an entire computer as an image onto a hard disk or DVD. Complete PC Backup can automatically recreate a machine setup onto new hardware or hard disk in case of any hardware failures. Complete PC Restore can be initiated from within Windows Vista or from the Windows Vista installation CD in the event the PC is so corrupt that it cannot start up normally from the hard disk.

- **Windows Mail:** A replacement for Outlook Express that includes a new mail store that improves stability, and features integrated Instant Search. It has the Phishing Filter like IE7 and Junk mail filtering that is enhanced through regular updates via Windows Update.

Windows Mobility Center:

- **Windows Mobility Center** is a control panel that centralizes the most relevant

information related to mobile computing (brightness, sound, battery level / power scheme selection, wireless network, screen orientation, presentation settings, etc.).

- **Windows Meeting Space** replaces NetMeeting. Users can share applications (or their entire desktop) with other users on the local network, or over the Internet using peer-to-peer technology (higher versions than Starter and Home Basic can take advantage of hosting capabilities, Starter and Home Basic editions are limited to “join” mode only)
- **Shadow Copy** automatically creates daily backup copies of files and folders. Users can also create “shadow copies” by setting a System Protection Point using the System Protection tab in the System control panel. The user can be presented multiple versions of a file throughout a limited history and be allowed to restore, delete, or copy those versions. This feature is available only in the Business, Enterprise, and Ultimate editions of Windows Vista and is inherited from Windows Server 2003.

Windows Update with Windows Ultimate Extras

- **Windows Update:** Software and security updates have been simplified, now operating solely via a control panel instead of as a web application. Windows Mail's spam filter and Windows Defender's definitions are updated automatically via Windows Update. Users who choose the recommended setting for Automatic Updates will have the latest drivers installed and available when they add a new device.
- **Parental controls:** Allows administrators to control which websites, programs and games each Limited user can use and install. This feature is not included in the Business or Enterprise editions of Vista.
- **Windows SideShow:** Enables the auxiliary displays on newer laptops or on supported Windows Mobile devices. It is meant to be used to display device gadgets while the computer is on or off.
- **Speech recognition** is integrated into Vista. It features a redesigned user interface and configurable command-and-control commands. Unlike the Office 2003 version, which works only in Office and WordPad, Speech Recognition in Windows Vista works for any accessible application. In addition, it currently supports several languages: British and American English, Spanish, French, German, Chinese (Traditional and Simplified) and Japanese.
- New fonts, including several designed for screen reading, and improved Chinese (Yahei, JhengHei), Japanese (Meiryo) and Korean (Malgun) fonts. ClearType has also been enhanced and enabled by default.
- Improved audio controls allow the system-wide volume or volume of individual audio devices and even individual applications to be controlled separately. New audio functionalities such as Room Correction, Bass Management, Speaker Fill and Headphone virtualization have also been incorporated.
- **Problem Reports and Solutions**, a control panel which allows users to view previously sent problems and any solutions or additional information that is available.
- **Windows System Assessment Tool** is a tool used to benchmark system performance. Software such as games can retrieve this rating and modify its own behavior at runtime to improve performance. The benchmark tests CPU, RAM, 2-D and 3-D graphics acceleration, graphics memory and hard disk space.
- **Windows Ultimate Extras:** The Ultimate edition of Windows Vista provides, via Windows Update, access to some additional features. These are a collection of

additional MUI language packs, Texas Hold 'Em (a Poker game) and Microsoft Tinker (a strategy game where the character is a robot), BitLocker and EFS enhancements which allow users to back up their encryption key online in a Digital Locker, and Windows Dream scene, which enables the use of videos in MPEG and W MV formats as the desktop background. On April 21, 2008, Microsoft launched two more Ultimate Extras; three new Windows sound schemes, and a content pack for Dream scene. Various Dream Scene Content Packs have been released since the final version of Dream Scene was released.

- **Reliability and Performance Monitor** includes various tools for tuning and monitoring system performance and resources activities of CPU, disks, network, memory and other resources. It shows the operations on files, the opened connections, etc.
- **Removed Features**
Some notable Windows XP features and components have been replaced or removed in Windows Vista, including Windows Messenger, NTBackup, the network Messenger Service, HyperTerminal, MSN Explorer, Active Desktop, and the replacement of NetMeeting with Windows Meeting Space. Windows Vista also does not include the Windows XP "Luna" visual theme, or most of the classic color schemes which have been part of Windows since the Windows 3.x era. The "Hardware profiles" startup feature has also been removed, along with support for older motherboard technologies like the EISA bus, APM and Game port support (though on the 32-bit version game port support can be enabled by applying an older driver). IP over FireWire (TCP/IP over IEEE 1394) has been removed as well. The IPX/ SPX Protocol has also been removed, although it can be enabled by a third-party plug-in.

Check Your Progress - 8.6

State whether the following statements true or false

1. Windows Vista includes version 3.0 of the .NET Framework,
2. Windows Vista features a new way of searching called Quick Search.
3. Parental controls allows administrators to control which websites, programs and games each Limited user can use and install.
4. Speech recognition system is not integrated into Vista.
5. Windows vista has provided, a companion program to Windows Movie Maker that provides the ability to create video DVDs based on a user's content.

8.7 WINDOWS 8

Windows 8 is a version of Microsoft Windows (an operating system developed by Microsoft) for use on personal computers, including home and business desktops, laptops, tablets, and home theater PCs. Development of Windows 8 started before the release of its predecessor, Windows 7, in 2009.

Windows Explorer, which has been renamed File Explorer, now includes a ribbon in place of the command bar. File operation dialog boxes have been updated to provide more detailed statistics, the ability to pause file transfers, and improvements in the ability to manage conflicts when copying files. A new "File History" function allows incremental revisions of files to be backed up to and restored from a secondary storage device, while Storage Spaces allows users to combine different sized hard disks into virtual drives and specify mirroring, parity, or no redundancy on a folder-by-folder basis.

Task Manager has also been redesigned, including a new processes tab with the option to display fewer or more details of running applications and background processes, a heat map using different colors indicating the level of resource usage, network and disk counters, grouping by process type (e.g. applications, background processes and Windows processes), friendly names for processes and a new option which allows users to search the web to find information about obscure processes. Additionally, the Blue Screen of Death has been updated with a simpler and modern design with less technical information displayed

Removed Features

Several notable features have been removed in Windows 8, beginning with the traditional Start menu. Support for playing DVDs has been removed from Windows Media Player due to the cost of licensing the necessary decoders (especially for devices which do not include optical disc drives at all) and the prevalence of streaming services such as Netflix. For the same reasons, Windows Media Center will no longer be included by default on Windows 8, but the software (which also includes support for DVD playback) can be purchased in the "Pro Pack" (for the base version of Windows 8, which also upgrades the system to Windows 8 Pro) or "Media Center Pack" (for Windows 8 Pro) add-ons. Windows 8 will still support third-party DVD playback software.

Backup and Restore, the former backup app of Windows, is deprecated. It still ships with Windows 8 and continues to work on preset schedules, but is pushed to the background and can only be accessed through a Control Panel applet called "Windows 7 File Recovery". Shadow, a component of Windows Explorer that once saved previous versions of changed files, no longer protects local files and folders. It can only access previous versions of shared files stored on a Windows Server computer. The subsystem, on which these components worked, however, is still available for other software to use.

8.8 LINUX OPERATING SYSTEM

Linux (commonly pronounced) is a generic term referring to Unix-like computer operating systems based on the Linux kernel. Their development is one of the most prominent examples of free and open source software collaboration; typically all the underlying source code can be used, freely modified, and redistributed by anyone under the terms of the GNU GPL and other free software licenses.

Linux is predominantly known for its use in servers, although it is installed on a wide variety of computer hardware, ranging from embedded devices and mobile phones to supercomputers. Linux distributions, installed on both desktop and laptop computers, have become increasingly commonplace in recent years, partly owing to the popular Ubuntu distribution and the emergence of net books. The name "Linux" (listen (help·info)) comes from the Linux kernel, originally written in 1991 by Linus Torvalds

8.8.1 User interface

Users can control a Linux-based system through a command line interface (or CLI), a graphical user interface (or GUI), or through controls attached to the associated hardware (this is common for embedded

systems). For desktop systems, the default mode is usually graphical user interface.

A Linux system typically provides a CLI through a shell, which is the traditional way of interacting with a Unix system. A Linux distribution specialized for servers may use the CLI as its only interface. A “headless system” run without even a monitor can be controlled by the command line via a remote-control protocol such as SSH or telnet.

Most low-level Linux components, including the GNU user land, use the CLI exclusively. The CLI is particularly suited for automation of repetitive or delayed tasks, and provides very simple inter-process communication. A graphical terminal emulator program is often used to access the CLI from a Linux desktop.

8.8.2 Servers and supercomputers



Fig 8.3

Linux distributions have mainly been used as server operating systems, and have risen to prominence in that area.

Components of IBM Roadrunner, the world’s fastest supercomputer 2008, which runs Linux. Linux distributions are the cornerstone of the LAMP server-software combination (Linux, Apache, MySQL, Perl/PHP/Python) which has achieved popularity among developers, and which is one of the more common platforms for website hosting.

Linux distributions are also commonly used as operating systems for supercomputers: as of June 2009, out of the top 500 systems, 443 (88.8%) run a Linux distribution.

8.9 SUMMARY

An operating system is a software component of a computer system that is responsible for the management of various activities of the computer and the sharing of computer resources. There are meagerly 5 types of Operating System Real-time Operating System, Multi-user and Single-user Operating Systems, Multi-tasking and Single-tasking Operating Systems Distributed Operating System, Embedded System.

1. **Unix** was designed to be portable, multi-tasking and multi-user in a time-sharing configuration. Unix systems are characterized by various concepts: the use of plain text for storing data; a hierarchical file system; treating devices and certain types of inter-process communication (IPC) as files; and the use of a large number of software tools, small programs that can be strung together through a command line interpreter using pipes, as opposed to using a single monolithic program that includes all of the same functionality.

2. **Disk Operating System** works very hardware near, The command interpreter is integrated in the file command.com with the internal commands for MS-DOS. MS- DOS established and had reached measured on the

market share a monopoly in the DOS market. The number of the MS-DOS installations grew worldwide to about 80 million and surpassed all other systems with that amount. Almost every software company offered standard applications like word processing, calculation or also special solutions like measurement tools, CAD (Computer Aided Design) or image processing for MS-DOS.

3. Windows XP is a line of operating systems produced by Microsoft for use on personal computers, including home and business desktops, laptops, and media centers. The two major editions are Windows XP Home Edition, designed for home users, and Windows XP Professional, designed for business and power-users. Microsoft occasionally releases service packs for its Windows operating systems to fix problems and add features. Each service pack is a superset of all previous service packs and patches so that only the latest service pack needs to be installed, and also includes new revisions. Older service packs need not be removed before application of the most recent one.

4. Windows Vista is a line of operating systems developed by Microsoft for use on personal computers, including home and business desktops, laptops, tablet PCs, and media center PCs. Windows XP, the longest time span between successive releases of Microsoft Windows desktop operating systems.

5. Linux (commonly pronounced) is a generic term referring to Unix-like computer operating systems based on the Linux kernel. Linux distributions, installed on both desktop and laptop computers, have become increasingly commonplace in recent years, partly owing to the popular Ubuntu distribution and the emergence of notebooks.

8.10 QUESTIONS FOR SELF - STUDY

8.3

1. True 2. False 3. False 4. True 5. True 8. True

8.4

I

1. Command Line Interfaces (CLIs) or Graphical User Interfaces
2. Real-time Operating system.
3. 1000
4. Mem
5. Type

II.

1. PDA 2. IBM 3. BASIC

8.5

1. Home Edition and Windows XP Professional.
2. Table PC Edition.
3. September 9,2002
4. Versions 8 or 7
5. 1.5 GBs

8.6

1. True
2. False
3. True
4. False
5. True

8.10 QUESTIONS FOR SELF - STUDY

I. Answer the following Questions

1. What is an operating system ? Explain types of operating systems.
2. Write a note on Unix operating system.
3. Briefly explain Windows XP operating system.
4. Explain editions of Windows XP operating System.
5. What is DOS? Explain some Dos Internal and External Commands
6. Discuss features of Windows Vista.
7. Write a note on desktop versions of Linux.
8. Explain the System Requirements for loading Windows Vista.

II. Write Short Notes on the following:

1. Service Packs
2. Embedded Device Operating System
3. Components of Unix OS
4. 2038 year problem in Linux.

8.11 SUGGESTED READING'S

- **Computer Fundamentals** Concepts, Systems & Applications – P.K Sinha

REFERENCES

- <http://en.wikipedia.org>,
- <http://learning-unix.blogspot.in>,
- <http://www.mywikibiz.com> (Links)

