Computer Fundamentals and PC Software

SEMESTER-I

MASTER OF COMPUTER APPLICATION /

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

BLOCK-1

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COURSE INTRODUCTION

The course on ***Computer Fundamentals and PC Software*** is designed with an aim to acquaint the learners with the basics of computer, operating systems, computer security, hardware and software and also how to use basic application programs for managing data in a computer system.

The course consists of fifteen units. The course introduces the learner to computer system, its basic components and the number system used in computers. Different crimes commilted using computers and the various security mechanisms are also discussed in this course. It includes the fundamental concept of different hardware configurations and operating system. Different operating systems like MS DOS, MS Windows and LINUX operating systems are introduced in this course. The course also deals with Microsoft Office which is an application software consists of different applications that helps us to perform different activities. It covers MS-Word, MS-Excel and MS-PowerPoint. MS-Word is the word processing program that allows us to create documents and reports. MS-Excel helps us to develop spreadsheets that display data in various tabular and visual formats. MS-PowerPoint creates multimedia presentations to display information in a graphical format.

The course is divided into two blocks :

Block 1 deals with the fundamentals of computer systems and its components and number systems. Different aspects of computer security along with cyber crimes are also introduced in this block. An introduction to MS DOS along with an overview on different types of operating system is also included in this block.

Block 2 concentrates on Windows and LINUX opearting system. Different application softwares in windows like Microsoft Word, Microsoft Excel and Microsoft Power Point are also introduced in this block.

Each unit of this course includes some along-side boxes to help you know some of the difficult, unfamiliar terms. Some “EXERCISES” have been included to help you apply your mind to some of the points in the units. You may find some boxes marked with: “LET US KNOW”. These boxes will provide you with some additional interesting and relevant information. Again, you will get “CHECK YOUR PROGRESS” questions. These have been designed to enable you to self-check your progress of study. It will be helpful for you if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with “ANSWERS TO CHECK YOUR PROGRESS” given at the end of each unit.

MASTER OF COMPUTER APPLICATION /

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Computer Fundamentals and PC Software

DETAILED SYLLABUS

Page No.

UNIT 1 : Introduction to Computer [5 Marks] — 7-20

Block Diagram of Computer, Evolution, Generations, Classification and application of computers

UNIT 2 : Number System [8 Marks] — 21-52

Binary, Decimal Hexadecimal, Octal Number Systems 1's complement and 2's complement representation.

UNIT 3 : Basic Components of Computer [8 Marks] — 53-81

Concept of Bit and Byte; Block Diagram of Computer, CPU, ALU, CU; Computer Memory: Primary and Secondary; Input/Output Devices; Buses : Address, Data, Control.

UNIT 4 : Computer Security [5 Marks] — 82-94

Computer Security Computer Virus, Worm, SpyWare, Malware, Trojan Horse, Antivirus Software.

UNIT 5 : Cyber Crimes [5 Marks] — 95-112

Cyber Crimes, Hacking , Digital Forgery, Cyber Stalking, Identity Theft & Fraud, Cyber terrorism, Cyber Defamation, Software Piracy, Different offences under IT Act 2000

UNIT 6 : Hardware Configuration [5 Marks] — 113-129

Different hardware configuration(Laptop/desktop), Typical RAM/ Harddisk size, Mother board series, different OEM(original equipment manufacturer), Processor series, FCC & UL for quality measure.

UNIT 7 : Introduction to Operating System [5 Marks] — 130-144

Definition and functions of an Operating System, Types of OS (Single User, Multiuser, Single tasking, Multitasking, Real time, Network OS, Distributed OS)

UNIT 8 : MS DOS Operating System [6 Marks] — 145-175

Introduction to DOS, System files of DOS, concept of Booting, Files and Directory Structure, Concept of Paths, Internal and External commands, Batch File.

BLOCK INTRODUCTION

This is the *First Block* of the course '***Computer Fundamentals and PC Software*'.** After completing this block, which consists of eight units, you will get a detailed overview of the computer system, the number system, security aspects in computer, hardware aspects and overview of operating systems.

This block comprises the following eight units :

Unit - 1 introduces you to the evolution of computers. The different generations and applications of computer system are also discussed in this unit.

Unit - 2 introduces you to the different number system. Decimal, Binary, Octal and Hexadecimal number systems are discussed in this unit. It also concentrates on the concept of binary arithmetic like addition, subtraction and multiplication. 1's and 2's complement is also discussed in this unit.

Unit - 3 deals with the concepts of basic components of computer - CPU, ALU and Control Unit. The concept of buses are also covered.

Unit - 4 concentrates on computer security aspects. Different types of virus, worms, malware along with different counter measures are discussed in this unit.

Unit - 5 introduces concepts on cyber crimes. Different types of cyber crimes and the IT Act are discussed in detail in this unit.

Unit - 6 includes the basic concepts of hardware configuration. Different motherboard and processor components are discussed in detail in this unit.

Unit - 7 introduces concepts on operating system. Different types of OS are discussed in this unit.

Unit - 8 includes the basic concepts of MS DOS operating system.

The structure of Block 1 is as follows :

UNIT 1 : Introduction to Computer

UNIT 2 : Number Systems

UNIT 3 : Basic Components of Computer

UNIT 4 : Computer Security

UNIT 5 : Cyber Crimes

UNIT 6 : Hardware Configuration

UNIT 7 : Introduction to OperatingSystem

UNIT 8 : MS DOS Operating System

UNIT 1 : INTRODUCTION TO COMPUTER

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Computer Evolution and Generation

1.4 Classification of Computer

1.5 Applications of Computer

1.6 Let Us Sum Up

1.7 Further Reading

1.8 Answers to Check Your Progress

1.9 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- describe the evolution of computer
- classify the different types of computer
- describe applications of computer.

1.2 INTRODUCTION

Computer is one of the most powerful tools man has ever created. Computers have made a great impact on our everyday life.Today, computer technology has permeated every sphere of existence of modern man. With the growing information needs in the modern world, the computer has become one of the vital components for the survival of the business houses. The presence of computers is felt in almost every working place from the bus, air and railway ticket counters to satellite launching, from retail stores to medical diagnosis and from home use to research organizations. Everywhere, we witness the elegance, sophistication and efficiency made possible only with the help of computers. Computer has become a part and parcel of our daily life.

In this unit, we will introduce you to the computer fundamentals including its various components and functionality. Besides discussing the characteristics of computers including its evolution and generations, this unit also throws light on the categories of computers along with its application in the various fields of the modern world.

1.3 COMPUTER EVOLUTION AND GENERATION

The term ***computer*** is derived from the word ***compute***, which means ***to calculate.*** It can be defined as an ***electronic machine*** capable of performing calculations and other manipulations of various types of data, under the control of a stored set of instructions. In the simplest form, a computer can be defined as a ***programmable machine***. A computer accepts data from an input device and processes it into useful information which it displays on its output devices. A general purpose computer generally has an *input unit*, an *output unit*, a *central processing unit* and a *memory unit*.

Most of today's computer designs are based on the concepts developed by **John Von Neumann** refered to as the "**Von Neumann architecture**". According to this architecture, a computer must have *two* units - a *processing unit* and a single *separate storage unit*. The term "*stored program computer*" is generally used to represent a computer of this design. The processing unit is termed as **central processing unit (CPU)** which mainly comprises of two units, namely Arithmetic and Logic Unit (**ALU**) and Control Unit (**CU**). The ALU performs the arithmetic operations on data such as addition, subtraction, multiplication and division, and the logical operations such as, >, <, >=, <= etc. The control unit directs the ALU to perform specific arithmetic and logical functions on the data. The storage unit is used to store instructions and data temporarily. This component is referred to as memory. The memory unit stores all the information in a group of memory cells, also called memory locations. Each memory location has a unique address and can be addressed independently.

The following figure shows the basic structure of a conventional Von Neumann machine :

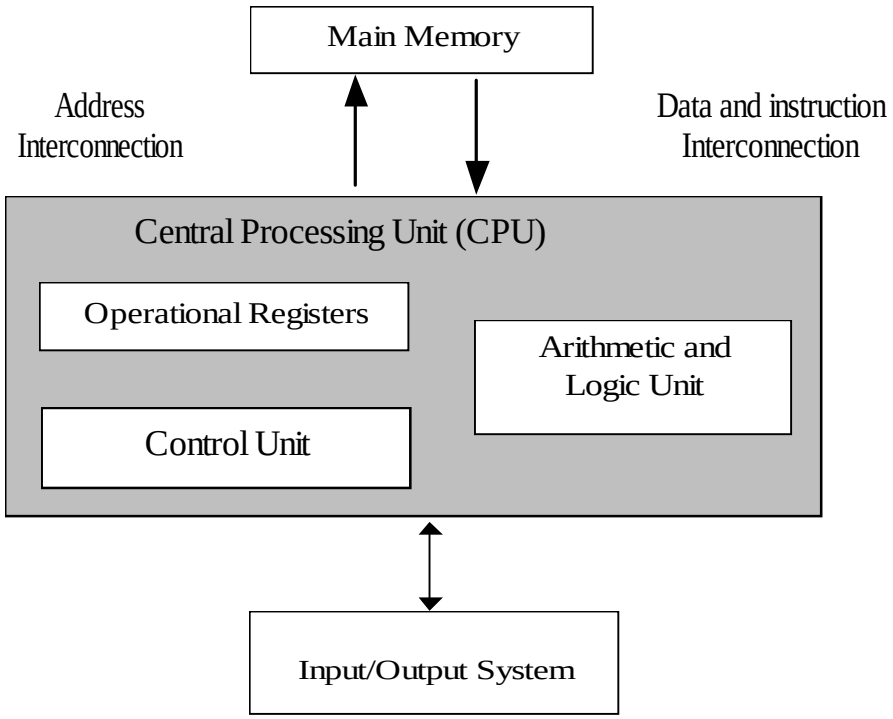


Figure 1.1 : Von Neumann Architecture

Depending on the major technological development, the whole evolution process of the computer can be categorised into five generations, where each generation has some special characteristics.

The *five* generations of computers are described as follows :

First Generation (1945 – 55) : The computers of this generation used vacuum tubes and consumed more power. Assembly languages were used for preparing programs. Mercury delay line memories and electrostatic memories were used for storing programs. Punched cards and paper tape were invented to feed programs and data to get results. The cost of the first generation computers was very high and they were mainly used for scientific computations.

Examples of computers of this generation are :

ENIAC – Electronic Numerical Integrator And Calculator

EDSAC – Electronic Delay Storage Automatic Calculator

EDVAC – Electronic Discrete Variable Automatic Computer

UNIVAC – Universal Automatic Computer IBM 701



NOTE :

All the arithmetic and logical operations are performed in the CPU in special storage areas called registers. The size of the register is one of the important consider-ations in determining the processing capabilities of the CPU. Register size refers to the amount of information that can be held in a register at a time for processing. The larger the register size, the faster may be the speed of processing CPU. Processing power is measured in Million Instruction Per Second (MIPS).

Second Generation (1955 – 65) : The second generation computers used transistors. They consumed less power and were smaller in size. Magnetic ferrite core memories were used as main memory and magnetic tapes and magnetic disks were used as secondary memory. High level languages such as FORTRAN, COBOL etc were used.

Examples of computers of this generation are– IBM 7030, Digital Data Corporation's PDP 1/5/8 Honeywell 400.

Third Generation (1965 – 75) : The third generation computers used IC(Integrated Circuits). Small Scale Integration and Medium Scale Integration technology were implemented during this generation. Semiconductor memories were introduced in this generation. The computers have became smaller in size with fast processors and the cost of the computers is less compared to second generation.

Examples of computers of this generation are - 360 Mainframe from IBM, PDP-8 Mini Computer from Digital Equipment corporation.

Fourth Generation (1975 – 89) : Microprocessors were introduced as CPU. Very large Scale Integration (VLSI) techniques were used during this generation. Semiconductor memory chips were used as main memory. Hard disks, floppy disks, magnetic tapes were used as secondary memory. Lots of techniques like parallelism, pipelining, cache memory, virtual memory and networking techniques were applied during this generation.

Examples of computers of this generation are - Intel's 8088, 80286, 80386, 80486 .., Motorola's 68000, 68030, 68040, Apple II, CRAY I/2/X/MP etc.

Fifth Generation (1989 to present) : Computers based on artificial intelligence belong to the fifth generation. ULSI (Ultra Large Scale Integration) technology used in fifth generation computer. For example, Intel's Pentium 4 microprocessor contains 55 million transistors, millions of components on a single IC chip. Superscalar processors, Vector processors, SIMD processors, 32 bit micro controllers and embedded processors, Digital Signal Processors (DSP) etc have been developed in fifth generation. Recent development of grid technology and nanotechnology in this generation will radically change the phase of computers.

Examples of computers of this generation are– IBM notebooks, Pantium PCs-Pentium 1/2/3/4/Dual core/Quad core.. SUN work stations, Origin 2000, PARAM 10000, IBM SP/2).

1.4 CLASSIFICATION OF COMPUTER

Computers can be classified according to their size and power as follows :

- Micro computer
- Mini computer
- Mainframe
- Supercomputer

(I) Micro Computers

- A microcomputer uses a microprocessor as its central processing unit. Microcomputers are tiny computers that can vary in size from a single chip to the size of a desktop model.
- They are designed to be used by only one person at a time.
- Small to medium data storage capacities 500MB – 2GB or more

The common examples of microcomputers are chips used in washing machines, TVs, cars, note book and personal computers.

Eg. : IBM PC, PS/2 and Apple Macintosh

Applications : Used in the field of desktop publishing, accounting, statistical analysis, graphic designing, investment analysis, project management, teaching, entertainment etc. The different models of microcomputers are given below :

- **Personal computers :** The name PC was given by the IBM for its microcomputers. PCs are used for word processing, spreadsheet calculations, database management etc.
- **Note book or Laptop :** It is small in terms of size and can be folded and carried around. Its monitor is made up of LCD and the keyboard and system units are contained in a single box. It has all the facilities of a personal computer (HDD, CDD, Sound card, N/W card, Modem etc) and a special connection to connect

to the desktop PC which can be used to transfer data.

- **Palm Top :** Smaller model of the microcomputer. Its size is similar to that of a pocket size calculator. It has a processor, memory and a special connection to connect to the desktop PC which can be used to transfer data.
- **Personal Digital Assistance :** A personal digital assistant is a small palm-sized hand-held computer which has a small colour touch screen with audio and video features. They are used as smart phones, web-enabled plamtop computers, portable media players or gaming devices. Most PDAs today have a touch screen for data entry, a memory card, bluetooth, Wi-Fi or an infra red connectivity and can be used to access the Internet and other networks.



a) Personal computer



b) Notebook computer



d) Palmtop computer



e) PDA (personal digital assistant)

Figure. 1.2 : Micro Computer

(II) Mini Computers

- Perform better than micros
- Large in size and costlier than micros
- Designed to support more than one user at a time

- Possess large storage capacities and operate at higher speed
- Support faster peripheral devices like high speed printers
- Can also communicate with main frames

Applications :

- These computers are used when the volume of processing is large. For example, data processing for a medium sized organization
- Used to control and monitor production processes
- Used to analyze results of experiments in laboratories
- Used as servers in LANs (Local Area Networks)

Examples of mini computers are - Digital Equipments PDP 11/45 and VAX 11 etc. The figure 1.3. shows a mini computer.

(III) Mainframe Computers :

- Are able to process large amount of data at a very high speed
- Support multi-user facility
- Number of processors varies from one to six.
- Cost: 3500 to many million dollars
- Are to be kept in air conditioned room to keep them cool
- Support many I/O and auxiliary storage devices
- Support network of terminals



Figure. 1.3 : Mini computer



Figure. 1.4 : Mainframe computer

Applications :

- Mainframe computers are used to process large amount of data at a very high speed such as in the case of banks insurance companies hospitals railways which need online processing of large number of transactions and requires massive data storage and processing capabilities
- Used as controlling nodes in WANs (Wide Area Networks)
- Used to mange large centralized databases

Examples of main frame computers are– IBM 370, IBM 3081, IBM 3000 series, Univac 1180, DEC IBM 3000 series, CDC Cyber - 2000V etc.

(IV) Super Computer

Supercomputer is a broad term for one of the fastest computers currently available. The main characteristics of a super computer are :

- Most powerful Computer system -it needs a large room
- Minimum world length is 64 bits
- CPU speed: 100 MIPS (Million instruction per second)
- Equivalent to 4000 computers
- High cost: 4 – 5 millions
- Able to handle large amount of data
- High power consumption
- High precision



Figure. 1.5 : PARAM 1000 Series Super Computer

Applications :

- In petroleum industry - to analyze volumes of seismic data which are gathered during oil seeking explorations to identify areas where there is possibility of getting petroleum products inside the earth.
- In Aerospace industry - to simulate airflow around an aircraft at different speeds and altitude. This helps in producing an effective aerodynamic design for superior performance.
- In Automobile industry – to do crash simulation of the design of an automobile before it is released for manufacturing – for better automobile design.

- In structural mechanics – to solve complex structural engineering problems to ensure safety, reliability and cost effectiveness. For example the designer of a large bridge has to ensure that the bridge must be proper in various atmospheric conditions and pressures from wind, velocity etc and under load conditions.
- Meteorological centers use super computers for weather forecasting.
- In Biomedical research – atomic nuclear and plasma analysis – to study the structure of viruses.
- For weapons research and development, sending rockets to space etc.

Examples of supercomputers are : Cray-1(1976), Cray-2(1985), Cray T3D(1993), NEC's SX-S/44(1991), Fujitsu VP 2600/10(1991), Hitachi 820/80(1987), C-DAC's PARAM Series of supercomputers etc. A PARAM 10000 series super computer of IIT Guwahati is shown in figure 1.5.

1.5 APPLICATIONS OF COMPUTER

Now a days, computers are used almost in every aspect of life. Every company, small or large, government offices, educational institutions are now directly or indirectly dependent on computers mainly for information processing. Computer based railway and airway reservation are common examples of computer applications. Computer system are helping in the efficient management of the banking sector, hospital records, payroll records and so on. Some of the areas where computers are being used mostly can be listed as below:

Science : Scientists are using computers to carry out their research works based on complex computations because of computer's fast speed and the accuracy.

Education : In schools and colleges, to make education much more interesting, computers are used now a days. Computer Aided Education (CAE) and Computer Based Training (CBT) packages are making learning much more interactive.

Health and Medicine : Starting from diagnosing the illness to monitoring a patient's status during a surgery, in pathological analysis ,in CAT scans or MRI scans etc. Some special purpose computers are available which can even be operated within the human body.

Engineering : Engineers and architects are using computers in designing machineries, drawing design layouts. Architects use computers to view objects that can be viewed from all the three dimensions by using techniques like virtual reality. In manufacturing industries, using computerized robotic arms hazardous jobs can be performed. The packages like Computer Aided Designing (CAD), Computer Aided Manufacturing (CAM) and so on are used in designing the product, ordering the parts and planning production.

Entertainment : With the use of multimedia facilities, computers are now greatly used in entertainment industry. Computers are used to control and bring special effects on image and sound.

Communication : Computer network and finally the Internet has brought a drastic change in communication system. Through E-mail or Electronic mail, it is possible to send messages and reports very fast from one person to another or a group of persons with the aid of computers and telephone lines.

Business and Banking : In order to deposit or withdraw cash from bank, people can use ATM (Automated Teller Machine) services 24 hours of the day. Through the computer networks among different branches of a bank, inter branch transactions can be carried out without delay.

Apart from the above mentioned applications, there are many other applications of computers that can be seen in our day to day activities.



CHECK YOUR PROGRESS

1. State True or False:
   i) PARAM is a super computer.
   ii) A laptop is a portable computer.
   iii) Vacuum tubes were part of the second generation computers.
   iv) Micro computers are more powerful than mini computers.
   v) EDSAC is an example of a second generation computer.
2. Fill in the blanks :
   i) Physical components of a computer are called _____.
   ii) The basic components of first generation computers was _____.
   iii) PDA stands for _____.
   iv) _____ is a very small computer that can be held in the palm of the hand.
   v) Analytical Engine was developed by _____.
3. What is a PDA?

   .....
4. Name some storage device used in computer.

   .....



ACTIVITY

- Create a table on various generations of computers with hardware and software details.
- Prepare a list of areas where computers are used. Mention the specific software for each application and its significance.



1.6 LET US SUM UP

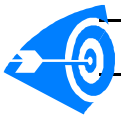
- Computer is an electronic device that is used to perform diverse operations with the help of instructions to process the data in order to produce desired results.
- Computer development is divided into five generations.
- The first generation of computers used **vacuum tubes** for circuitry and **magnetic drums** for memory, and were often enormous, taking up entire rooms.
- In the second generation of computers, **transistors** replaced vacuum tubes.
- The **integrated circuits** were used in the third generation of computers.
- The fourth generation of computers are based on **microprocessors.**
- Fifth generation computers are based on ***artificial intelligence.***
- Micro computer is a small, low cost digital computer and includes desktop, laptop, PDA.
- A mini computer is a small digital computer which is more powerful than a micro computer.
- A mainframe computer consists of several processors that carry out most of the computations and have direct control over all the other computers in a network.
- Supercomputers are the most powerful computers used for processing complex scientific applications that involve task with highly complex calculations and solving problems with mechanical physics, such as weather forcasting and climate research systems, nuclear weapon simulation and simulation of automated aircrafts.



1.7 FURTHER READING

- Sinha, P. K., & Sinha, P. (2010). Computer fundamentals (Vol. 4). BPB publications.

- Ram, B. (2000). Computer fundamentals: architecture and organization. New Age International.



1.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : i) True, ii) True, iii) False, iv) False, v) False

Ans. to Q. No. 2 : i) Hardware, ii) Vacuum tubes, iii) Personal Digital Assistant, iv) Palmtop, v) Charles Babbage.

Ans. to Q. No. 3 : A personal digital assistant is a small palm-sized hand-held computer which has a small colour touch screen with audio and video features.

Ans. to Q. No. 4 : Hard Disk, CD-ROM, DVD-ROM, Pen Drive etc.



1.9 MODEL QUESTIONS

Q1. Who invented the concept of stored program ? Why is this concept so important ?

Q2. List the key hardware technologies used in building computer of each of the five generations.

Q3. What are the advantages of transistors over vacuum tubes?

Q4. What is an IC ? How does it help in reducing the size of computers

Q5. Discuss the important features of various generations of computers. Give some examples of the computers of each generation.

Q6. What is computer? What are the characteristics of a Computer? Do you think computers are superior to human being?

Q7. Describe the evolution of computers.

Q8. How are computers categorized into different categories?

****

UNIT 2: INTRODUCTION TO NUMBER SYSTEMS

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Number System

2.4 Categories of Number System

- 2.4.1 Decimal Number System
- 2.4.2 Binary Number System
- 2.4.3 Octal Number System
- 2.4.4 Hexadecimal Number System

2.5 Number System Conversion

- 2.5.1 Binary to Decimal Conversion
- 2.5.2 Decimal to Binary Conversion
- 2.5.3 Octal to Decimal Conversion
- 2.5.4 Decimal to Octal Conversion
- 2.5.5 Octal to Binary Conversion
- 2.5.6 Binary to Octal Conversion
- 2.5.7 Hexadecimal to Decimal Conversion
- 2.5.8 Decimal to Hexadecimal Conversion
- 2.5.9 Hexadecimal to Binary Conversion
- 2.5.10 Binary to Hexadecimal Conversion

2.6 Sign Number Representation

2.7 Sign Magnitude

2.8 Complement of Numbers

- 2.8.1 (r-1)'s Complement
- 2.8.2 r's Complement
- 2.8.3 1's Complement
- 2.8.4 2's Complement

2.9 Binary Arithmetic

- 2.9.1 Addition
- 2.9.2 Subtraction

2.9.3 Multiplication
2.9.4 Division
2.10 Let Us Sum Up
2.11 Further Reading
2.12 Answers to Check Your Progress
2.13 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- define and describe the number system used in computers
- identify different types of number system from their bases
- describe how data is represented in computers
- define the converting procedure from one number system to another
- define the sign magnitude of binary numbers and their representation.
- find out the complement form of a given number

2.2 INTRODUCTION

Computer system uses different number systems to represent data. In this unit, you will be able to understand how data are represented in computer and how they are used. We will also come across the conversion procedure between numbers from one system to other systems.

In this unit, we will discuss the sign magnitude of a number and the representation of negative numbers in system. We will also discuss how to find out the complements of a number which is used basically in their arithmetic operations. In addition, this unit covers the arithmetic operations like addition, subtraction, multiplication and division.

2.3 NUMBER SYSTEM

A number system is a system for expressing numbers, or a mathematical notation for representing numbers of a given set. It uses digits or other symbols. In short, we can say, a number system will:

- Represent a useful definite set of numbers
- Give every number represented a unique representation
- Reflect the algebraic and arithmetic structure of the numbers

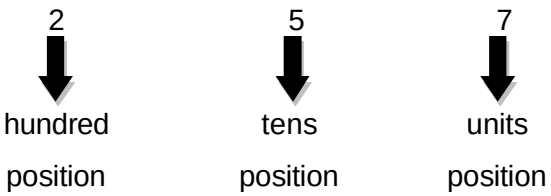
There are different ways of representing numbers in computer. In our day-to-day life we use decimal number system which is represented with the combination of ten separate digits from 0 to 9. The base of this number system is 10. But digital computers can store, understand and manipulate information composed of only zeros and ones (0 and 1). So, computers use basically binary number system for which the base is 2. On the other hand, a programmer or a user who works on a computer is allowed to use all digits (0 - 9), letters (in upper and lower case), special symbols present in the key board. So, each decimal digit, letters, symbols etc. written by the user are converted to binary codes in the form of 0's and 1's within the computer as per the convenience. Coding systems such as ASCII, EBCDIC etc. are universally accepted for representing the numbers as well as the other symbols. On the other hand, we need numbers for calculation or performing different operations in computers. There are different number systems used in computer systems, which are explained in the following section.

2.4 CATEGORIES OF NUMBER SYSTEM

The categories are according to the base (or radix) of the system. If a number system has base r, then the system has r distinct symbols for r digits. The knowledge of the number system is essential to understand the operation of a computer. In computer, we have four different categories to represent our number system. They are Decimal, Binary, Octal and Hexadecimal number systems.

2.4.1 Decimal Number System

- Decimal number system has ten unique or distinct digits represented by 0,1,2,3,4,5,6,7,8 and 9. So, the base or radix of such system is 10.
- In this system the successive position to the left of the decimal point represent units, tens, hundreds, thousands etc. For example, if we consider a decimal number 257, then the digit representations are:



The weight of each digit of a number depends on its relative position within the number.

Example 2.1

The weight of each digit of the decimal no. 6472 is:

$6472=6000+400+70+2=6X10^3+4X10^2+7X10^1+2X10^0$

The weight of digits from right hand side are-

Weight of 1st digit = $2 X 10^0$

Weight of 2nd digit = $7 X 10^1$

Weight of 3rd digit = $4 X 10^2$

Weight of 4th digit = $6 X 10^3$

The above expressions can be written in general forms as the weight of nth digit of the number from the right hand side

= n^{th} digit $X 10^{n-1}$

= n^{th} digit X $(base)^{n-1}$

The number system in which the weight of each digit depends on its relative position within the number is called positional number system. The above form of general expression is true only for positional number system.

2.4.2 Binary Number System

Only two digits 0 and 1 are used to represent in a binary number system. So the base or radix of binary system is two (2). The digits 0 and 1 are called bits (Binary Digits). In this number system the value of the digit will be two times greater than its predecessor. Thus, the value of the places are-

<-- 64 <-- 32 <-- 16 <--8 <--4 <--2 <--1

The weight of each binary bit depends on its relative position within the number. It is explained by the following example--

Example 2.2

The weight of bits of the binary number 10110 is-

$= 1X2^4+0X2^3+1X2^2+1X2^1+0X2^0$

= 16+0+4+2+0 = 22(decimal number)

The weight of each bit of a binary no. depends on its relative position within the no. and explained from right hand side.

Weight of 1st bit = 1st bit X 2^0

Weight of 2nd bit = 2nd bit X 2^1

.....

.....

and so on.

The weight of the nth bit of the number from right hand side

$=$nth bit X 2^{n-1}

$=$nth bit X $(Base)^{n-1}$

It is seen that this rule for a binary number is same as that for a decimal number system. The above rule holds good for any other positioned number system. The weight of a digit in any positioned number system depends on its relative position within the number and the base of the number system.

Table 2.1 shows the binary equivalent numbers for decimal digits.

Table 2.1 Binary equivalent of decimal numbers

Decimal Number	Equivalent Binary Number
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

2.4.3 Octal Number System

Another commonly used positional number system is the Octal Number System. This system has eight (8) digit representations. They are 0,1,2,3,4,5,6 and 7. The base or radix of this system is 8. The values increase from right to left as 1, 8, 64, 512, 4096 etc as

8^3 8^2 8^1 8^0 = 512 64 8 1 respectively. The decimal value 8 is represented in octal as 10, 9 as 11, 10 as 12 and so on. As $8=2^3$, an octal number is represented by a group of three binary bits. For example, 3 is represented as 011, 4 as 100 etc.

Table 2.2 Octal number system and their binary representations.

Decimal Number	Octal Number	Binary Coded Octal No.
0	0	000
1	1	001
2	2	010
3	3	011
4	4	100
5	5	101
6	6	110
7	7	111
8	10	001 000
9	11	001 001
10	12	001 010

2.4.4 Hexadecimal Number System

The hexadecimal number system is now extensively used in computer

industry. Its base (or radix) is 16, and the numbers are represented as 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. The hexadecimal numbers are used to represent binary numbers because of ease of conversion and compactness.

As 16 = 2^4, hexadecimal number is represented by a group of four binary bits. For example, 5 is represented by 0101. Table 2.3 shows the binary equivalent of a decimal number and its hexadecimal representation.

Table 2.3 Hexadecimal number system and their Binary representation

Decimal No.	Hexadecimal No.	Binary coded Hex. No
0	0	0000
1	1	0001
2	2	0010
:	:	:
:	:	:
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111



CHECK YOUR PROGRESS

1. Fill in the blanks:

a) Number system is used for expressing numbers as well as _____ of a given set.

b) In binary number system, ____ represents on and _____ represent off.

c) Octal number system uses total ____ numbers.

d) The radix of hexadecimal number system is ____.

e) Hexadecimal number is represented by a group of ___ binary bits.

2.5 NUMBER SYSTEM CONVERSION

There are different ways of representing numbers in computer. We know that digital computer uses information composed of only 0 and 1. On the other hand, a programmer or a user who works on a computer is allowed to use all digits (0 - 9), letters (in upper and lower case), special symbols present in the key board. So, each decimal digit, letter, symbol etc. written by the programmer is converted to binary codes in the form of 0's and 1's within the computer as per convenience. Accordingly, the number system is divided into some categories.

As the computer uses different number systems, there is a provision for converting any number system to others. Following are the processes of converting generally used decimal number systems to other number systems and vice-versa.

2.5.1 Binary to Decimal Conversion

To convert a binary number to its decimal equivalent we use the following expression. The weight of the nth bit of the number from right hand side

$= n^{th}$ bit $X\ 2^{n-1}$

First, we mark the bit position and then we give the weight of each bit of the number depending on its position. The sum of the weight of all bits (with 1) gives the equivalent number.

Example 2.3 Convert binary $(110100)_2$ to its decimal equivalent

Solution:

$(110100)_2 = 1X2^5+1X2^4+0X2^3+1X2^2+0X2^1+0X2^0$

$= 1X2^5+1X2^4+1X2^2$

$= 32+16+4$

$= (52)_{10}$

Therefore, $(110100)_2 = (52)_{10}$

Example 2.4 Convert binary fraction $(111011.101)_2$ to its equivalent decimal fraction.

Solution:

$(111011.101)_2=(1X2^5+1X2^4+1X2^3+0X2^2+1X2^1+1X2^0)+(1X2^{-1}+0X2^{-2}+1X2^{-3})$

$= (32+16+8+0+2+1) + (0.5+0+0.125)$

$= (59.625)_{10}$

Therefore, $(111011.101)_2= (59.625)_{10}$

2.5.2 Decimal to Binary Conversion

There are different methods used to convert decimal number to binary number. The most common method is the repeated-division method. In this method, the number is successively divided by 2 and its remainders whether 0's or 1's are recorded. The final binary result is obtained by assembling the remainders in reverse order to obtain the binary equivalent of the decimal number. In this case, the last remainder will be the most significant bit (MSB).

Example 2.5 Convert $(75)_{10}$ to its binary equivalent

	Remainder	
2 |75		
2|37	1	á
2|18	1	
2|9	0	Read in this
2|4	1	order
2|2	0	
2|1	0	
0	1	

So, $(75)_{10}= (1001011)_2$

The method to convert the fraction part of a decimal number to its binary equivalent is that, it should repeatedly multiply the fraction part by 2 to give an integer part and a fraction part. The new fraction part again is to be multiplied by 2 to give a new integer and fraction part. This process is to be repeated until the fraction part becomes zero or we obtain required number of digits. Integers, so obtained are to be placed next to the binary point in the order in which they are produced i.e. the first integer appears first and so on.

Example 2.6 Convert decimal fraction $(12.75)_{10}$ to its equivalent binary fraction.

Solution:

	Remainder	MSB	.75	
2|12				
2|6	0		X 2	
2|3	0		1.50	Read
2|1	1		X 2	the MSB
0	1		1.00	bits.

So, $(12)_{10} = (1100)_2$ and $(.75)_{10} = (.11)_2$

Now, by combining both we will get $(12.75)_{10} = (1100.11)_2$

2.5.3 Octal to Decimal Conversion

The method of converting octal numbers to decimal numbers is simple. The decimal equivalent of an octal number is the sum of the numbers multiplied by their corresponding weights.

Example 2.7 Find decimal equivalent of octal number $(153)_8$

Solution: $1X8^2 + 5X8^1 + 3X8^0 = 64 + 40 + 3 = 107$

So, $(153)_8 = (107)_{10}$

Example 2.8 Find decimal equivalent of octal number $(123.21)_8$

Solution: $(1X8^2 + 2X8^1 + 3X8^0) + (2X8^{-1} + 1X8^{-2})$

$= (64 + 16 + 3) + (0.25 + 0.0156) = 83.2656$

So, $(123.21)_8 = (83.2656)_{10}$

2.5.4 Decimal to Octal Conversion

The procedure for conversion of decimal numbers to octal numbers is exactly similar to the conversion of decimal number to binary numbers except replacing 2 by 8.

Example 2.9 Find the octal equivalent of decimal $(3229)_{10}$

Solution: Remainders

8 | 3229

8 | 403	5	read in
8 | 50	3	reverse
8 | 6	2	order
0	6	

So, $(3229)_{10} = (6235)_8$

Example 2.10 Find the octal equivalent of $(.123)_{10}$

Solution: Octal equivalent of fractional part of a decimal number as follows:

8 X 0.123 = 0.984	0
8 X 0.984 = 7.872	7 read in
8 X 0.872 = 6.976	6 forward order
8 X 0.976 = 7.808	7

Read the integer to the left of the decimal point

The calculation can be terminated after a few steps if the fractional part does not become zero.

The octal equivalent of $(0.123)_{10} = (0.0767)_8$

2.5.5 Octal to Binary conversion

To convert an octal number to its binary equivalent, we just have to replace each bit separately by its 3-bit binary equivalent. For example, process to convert octal number 15 to its binary equivalent is to replace binary equivalent of octal 1 and 5 separately. 3-bit binary equivalent of 1 and 5 are 001 and 101 respectively. Therefore, the binary equivalent of octal 15 is 001101.

Example 2.11 Find the Binary equivalent of $(124.73)_8$

Solution: Given octal number is 1 2 4 . 7 3

Converting each to binary is 001 010 100 . 111 011

Therefore, the result is $(001010100.111011)_2$

2.5.6 Binary to Octal conversion

To convert a binary number to its equivalent octal, make a group of 3 bits each starting from right to the last for the numbers before decimal point and left to right for the numbers after the decimal point. Then replace each group by its equivalent octal number.

Example 2.12 Find the Octal equivalent of $(1110011.1111)_2$

Solution: Given binary number after making group of 3 is

1 110 011.111 1

The equivalent octal number is: 1 6 3 . 7 1

Therefore, the result is $(163.71)_8$

2.5.7 Hexadecimal to Decimal Conversion

The method of converting hexadecimal numbers to decimal number is simple. The decimal equivalent of a hexadecimal number is the sum of the numbers multiplied by their corresponding weights.

Example 2.13 Find the decimal equivalent of $(4A83)_{16}$

Solution: $(4A83)16= (4 \times 16^3) + (10 \times 16^2) + (8 \times 16^1) + (3 \times 16^0)$

$= 16384+2560+128+3$

$= (19075)_{10}$

$(4A83)_{16}= (19075)_{10}$

Example 2.14 Find the decimal equivalent of $(53A.0B4)_{16}$

Solution:

$(53A.0B4)_{16} = (5 \times 16^2) + (3 \times 16^1) + (10 \times 16^0) + (0 \times 16^{-1}) + (11 \times 16^{-2}) + (4 \times 16^{-3})$

$=1280+48+10+0+0.04927+0.0009765$

$= (1338.0439)_{10}$

$(53A.0B4)_{16} = (1338.0439)_{10}$

2.5.8 Decimal to Hexadecimal Conversion

To convert a decimal integer number to hexadecimal, successively divide the given decimal number by 16 till the quotient is zero. The last remainder is the MSB (Most Significant Bit). The remainders read from bottom to top give the equivalent hexadecimal integer.

To convert a decimal fraction to hexadecimal, successively multiply the given decimal fraction by 16, till the product is zero or till the required accuracy is obtained, and collect all the integers to the left of decimal point. The first integer is the MSB and the integers read from top to bottom give the hexadecimal fraction.

Example 2.15 Convert decimal $(1234.675)_{10}$ to hexadecimal.

Solution: Let us first consider $(1234)_{10}$

	Remainder	
	Decimal	Hexadecimal
16|1234	2	2
16|77	13	D
16|4	4	4

$(1234)_{10} = (4D2)_{16}$

Now considering the decimal part $(0.675)_{10}$

Hexadecimal conversion of fractional part of a decimal number is as follows:

Decimal	Hexadecimal
0.675 X 16 = 10.8 10	A
0.800 X 16 = 12.8 12	C
0.800 X 16 = 12.8 12	C
0.800 X 16 = 12.8 12	C

$(0.675)_{10} = (0.ACCC)_{16}$

Hence, $(1234.675)_{10} = (4D2.ACCC)_{16}$

If the decimal number is very large, it is tedious to convert the number to binary directly. So it is always advisable to convert the number into hexadecimal first, and then convert the hexadecimal to binary.

2.5.9 Hexadecimal to Binary Conversion

To convert a hexadecimal number to its binary equivalent, we just have to replace each bit separately by its 4-bit binary equivalent. For example, process to convert hexadecimal number B5 to its binary equivalent is to replace binary equivalent of hexadecimal B and 5 separately. 4-bit Binary equivalent of B and 5 are 1011 and 0101 respectively. Therefore, the binary equivalent of hexadecimal B5 is 10110101.

Example 2.16 Find the binary equivalent of $(12A.D3)_{16}$

Solution:

Given hexadecimal number is 1 2 A . D 3

Converting each to binary is 0001 0010 1010 . 1101 0011

Therefore, the result is $(000100101010.11010011)_2$

2.5.10 Binary to Hexadecimal Conversion

To convert a binary number to its equivalent hexadecimal, make a group of 4 bits each starting from right to the last for the numbers before decimal point and from left to the last for the numbers after decimal point and replace each group by its equivalent hexadecimal number.

Example 2.17 Find the hexadecimal equivalent of $(11100111.1111)_2$

Solution: Given binary number after making group of 4 is

1110 0111.1111

The equivalent hexadecimal number is: E 7. F

Therefore, the result is $(E7.F)_8$



CHECK YOUR PROGRESS

2. Convert the following:

   a) $(65)_{10}$ to its equivalent binary number.

   b) $(256)_8$ to decimal equivalent.

   c) $(13B)_{16}$ to decimal equivalent.

   d) $(1010.110)_2$ to decimal equivalent.

2.6 SIGN NUMBER REPRESENTATION

In computing, representation of negative number is also important because digital system is not able to understand our "-" sign which we use as prefix to represent negative sign. Therefore, signed number representations are required to encode negative numbers in binary number systems.

The best methods to represent sign bit in binary number system are sign magnitude method and complements of a number. There is no definitive criterion by which one can say which one of the representations is universally superior. Though, there were lots of argument, the representation used in most current computing devices is two's complement. PDP-11, VAX, MIPS, SPARC, ARM, Itanium, PA-RISC, DEC Alpha processors are all uses two's complement. But CDC 3000 and 6000 series, and the Unisys ClearPath Dorado series mainframes, use ones' complement.

2.7 SIGN MAGNITUDE

This is also called signed magnitude representation. In this approach, the most significant bit i.e. the left most bit is allocated for the sign bit separately. For the negative sign, the value of this bit is 1, and for positive number it is 0. The remaining bits in the number indicate the magnitude or absolute value. Hence, in a byte, only 7 bits, ranging from 0000000 (0) to 1111111 (127), are used to represent the number. Thus numbers ranging from -127_{10} to $+127_{10}$ can be represented once the sign bit (the 8th bit) is added.

This approach has natural relation with common usage. It is directly comparable to the common way of showing a sign (placing a "+" or "-" before the number's magnitude). Some early binary computers (e.g., IBM 7090) use this representation. Signed magnitude is the most common way of representing floating point values.

2.8 COMPLEMENT OF NUMBERS

Complements are used in digital computers for simplifying the subtraction operation and for logical manipulation. After finding out the complement of the number to be subtracted (subtrahend), it is added with the other number (minuend) to obtain the result of subtraction operation. The complement of a binary number is obtained by inverting all the bits.

For example, the complement of 10011 is 01100 and 00101 is 11010 etc. The complement again depends on the base of the number.

There are two types of complements for a number of base r. These are,-

- r's complement and
- (r-1)'s complement,

For example, for decimal numbers the base is 10. Therefore, complements will be 10's complement and (10-1) = 9's complement. For binary numbers, the complements are 2's complement and 1's complement since base is 2.

2.8.1 (r-1)'s Complement

Given a number N with base r having n digits, the (r-1)'s complement of N is defined as $(r^{n-1}) - N$.

9's Complement: For decimal numbers r=10 and r-1=9, so the 9's complement of N is $(10^n-1) - N$.

For example, with n=4 we have $10^4=10000$ and $10^4-1=9999$. It follows that the 9's complement of a decimal number is obtained by subtracting each digit from 9.

For example, 9's complement of 37 is (99-37) = 62

9's complement of 127 is (999-127) = 872

2.8.2 r's Complement

The r's complement of an n-digit number N in base r (r>1) is defined as r^n - N for N not = 0. Comparing with the (r-1)'s complement, we got that the r's complement is obtained by adding 1 to the (r-1)'s complement.

10's Complement:

The 10's complement of a decimal number is equal to the 9's complement of the number plus 1

i.e. 10's complement of decimal number = Its 9's complement +1

So, 10's complement of 37 is (99-37) + 1 = 62+1 = 63

10's complement of 127 is (999-127) + 1 = 872+1 = 873

Or, without help of 9's complement also we can directly find out 10's complement with the formula r^n-N

For example, for the same value, 10's complement of 37 is:

$N = (37)_{10}$

here r = 10

n = 2

Hence, we can write the 10's complement of this number as

10^2 - 37 = 63.

Hence, we can say that 10's comp of 37 is 63.

2.8.3 1's Complement

For binary numbers, r=2 and (r-1)=1, so the 1's complement of N is (2^n-1)-N. Again, 2^n is represented by a binary number that consists of a 1 followed by n 0's. 2^n-1 is a binary number represented by n 1's.

For example, with n=4, we have $2^4 = (10000)_2$ and 2_4-1=$(1111)_2$. Thus the 1's complement of a binary number is obtained by subtracting each digit from 1.

However, the subtraction of a binary digit from 1 causes the bit to change from 0 to 1 or from 1 to 0. Therefore, the 1's complement of a binary number is formed by changing 1's into 0 and 0's into 1's. For example, 1's complement of 101010 is 010101.

2.8.4 2's Complement

It is obtained by adding 1 to the 1's complement form of the binary numbers.

i.e. 2's complement of binary number =

1's complement of that number + 1

For example, 2's complement of 10101 is 01010 + 1 = 01011



CHECK YOUR PROGRESS

3. Find 9's complement and 10's complement of decimal numbers 54 and 172.

4. Find 1's complement and 2's complement of binary numbers 101100 and 0000

2.9 BINARY ARITHMETIC

We have mainly 4 arithmetic operations in binary arithmetic. They are explained in the next few sections.

2.9.1 Addition

In the binary number system,

1+0=1

and 0+1=1.

When 1 is added to 1, the sum is 0 with a carry 1. If the sum is written in 2 bits it is equal to 10 (2 decimal). The table is shown below-

BIT 1	BIT 2	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

The complexity may arise when adding combination of positive and negative binary number. In this case the arithmetic addition is dependent on the representation of any one of the following:

a) Signed magnitude

b) Signed 1's complement

c) Signed 2's complement

Let discuss this with the help of following example:-

Example 2.18: Add 25 and -30 in binary using 7 bit register in:

Signed magnitude representation

Signed 1's complement representation

Signed 2's complement representation

Solution:

In Signed magnitude representation: To do the arithmetic addition with one negative number in signed magnitude representation we have to follow the rules of ordinary arithmetic. First, we have to check the magnitude of the numbers. The number having smaller magnitude is then subtracted from the bigger number and the sign of bigger number is selected.

For example, (+25) + (-30)

= - (30 -25)

= -5

This process requires the comparison of the sign and the magnitude of the number and then taking decision whether to perform addition or subtraction operation. For this reason, it would not be appropriate to discuss at this point.

In signed 2's complement representation

We get that +30 is 0 011110

-30 is 1 011110

Now, 2's complement of -30 (not including sign bit) 1 100010

+25 is 0 011001

Now, addition of these two is,

+25	0	011	001
-30	1	100	010
-05	1	111	011 (Just add the numbers)

Result shows sign bit 1. It means the value is negative value which is true in general subtraction also.

The result for negative number is stored in signed 2's complement form and hence the above result is in signed 2's complement format. We have to take again 2's complement of the above result to interpret the result. Therefore, 2's complement of 111011 is,

1 000 100 + 1 = 1 000 101 which is -05 in decimal system

â

Sign bit

From the above example, it is noticed that, signed 2's complement representation is simpler than signed magnitude representation. This procedure requires only one central decision and only one circuit for adding the two numbers. But it puts additional condition that the negative numbers should be stored in signed 2's complement form in the register.

This can be achieved by complementing the positive number bit by bit then incrementing the resultant by 1 to get signed 2's complement.

In signed 1's complement representation

This method is also simple, but it has a rule. Add the two numbers including the sign bit. If there is a carry of the most significant bit or sign bit, then add it to the sum to obtain the result. In case of negative results, they will be in 1's complement representation. We have to take 1's complement again for interpreting the result.

+25	=	0 011 001
-30	=	1 100 001 (1's complement of -30)
-5	=	1 111 010

Note:- CARRY: When we add two binary numbers of n bits each and the result shows that a "1" occupies the (n+1)th position of the result then we say that a carry occurs or there is a carry.

The result will store in 1's complement format so 1111 010 in 1's complement format including the sign bit is 1 000 101 which is the required result.

Let us consider another example -25 + 30

-25	1	100	110	(1's complement of 25)
+30	0	011	110	
+5	1 0	000	100	

CARRY

In the above result, there is a carry, so add it to the resultant sum.

This sum is now = 0 000 101 which is +5

Now, for example -25 -30

-25	1	100	110	(1's complement of 25)
-30	1	100	001	(1's complement of 30)
-55	1 1	000	111	

There is a carry in the above result. So we add it to sum to obtain the result.

So, sum = 1 001 000 which is in 1's complement form. Now taking 1's complement of this is

1 110111 which is -55 in decimal form

â

Sign bit

The interesting feature about this representation is the representation of 0 in signed magnitude and 1's complement. There are two representations for zero are,--

Signed magnitude	+0		-0	
	0	000000	1	000000
Signed 1's complement	0	000000	1	111111

But in signed 2's complement there is just one zero and there are no positive or negative zero.

+0 000000

-0 in 2's complement is +0 = 1 111111

1

1 0 000000

Now, discarding the carry, it is 0 000 000.

Thus, both +0 and -0 are same in 2's complement notation. This is an added advantage in favor of 2's complement notation. The maximum

number which can be accommodated in registers also depends on the type of representation. In general, in a 8 bit register 1 bit is used as sign, therefore, the rest of 7 bit are used for representing the value. The value of maximum and minimum number which can be represented are:

For signed magnitude representation 2^7 -1 to -(2^7-1)

=128-1 to - (128-1)

= 127 to -127

For signed 1's complement representation is from +127 to -127, but for signed 2's complement represents +127 to -128. The -128 is represented is signed 2's complement notation as 10000000.

2.9.2 Subtraction

Though there is another method of performing subtraction, we will consider the method of subtraction known as complementary subtraction where, subtraction operation has been realized in terms of addition operation. This is a more efficient method of subtraction while using electronic circuits. Following are the ways of subtracting binary numbers in complementary method.

1's complement method:

Steps:

1. Find the 1's complement of the number to be subtracted (subtrahend).
2. Add the other number (minuend) with the complement value obtained from the previous step (step 1)
3. If there is a carry of 1 after addition, add the carry with the result obtained.

   Else, we again take complement of the result and attach a negative sign with the result.

Example 2.19 Subtract 3 -5 by 1's complement method .

Solution: 3 011

5 101

Step 1: 1's complement of 5 is 010

Step 2: Adding 010 with 011 give result

010

011

101

(No carry)

Step 3: As there is no carry in the result, we take complement of the result again and the result is now 010. After attaching the negative sign with the result, the obtained result is now -10 (in binary) which is -2 in decimal form.

2's complement method:

It is almost same as 1's complement method. Steps 1 & 2 are same as 1's complement method; instead we have to take 2's complement here. Step 3 is different from 1's complement. Following are the steps,-

1. Find the 2's complement of the number (subtrahend) which is subtracting.
2. Add the other number (minuend) with the complement value obtained from step 1.
4. If there is a carry, in the result obtained from step 2, ignore it.

   Else, take again 2's complement of the result and attach a negative sign with the result.

Example 2.20: Subtract 3 -5 by 2's complement method

Solution: Binary form of 3 is : 011

Binary form of 5 is : 101

Step 1: The 2's complement of 5 is 011 (1's complement 010+1)

Step 2: Adding 011 with 011 will give result

011

011

110

(No carry)

Step 3: As there is no carry with the result, again we have to take 2's complement of 110 which is 001 + 1 = 010 and attaching a negative sign the required result is -10 (in binary) which is -2 in decimal form.

Overflow:

An overflow occurrs when the sum of two n digits number occupies n+i digits. This definition is valid for both binary as well as decimal digits. But what is the significance of overflow for binary numbers since it is not a problem for the cases when we add two numbers. Well, the answer lies in the limits or representation of numbers. Every computer employs a limit for representation number. For example, in our examples we are using 8 bit registers of calculating the sum. But what will happen if the sum of the two numbers can be a combination of 9 bits? Where will we store the 9th bit? The problem will be made clear with the following example.

Example 2.21: Add the numbers 65 and 75 in 8 bit register

Solution:

Number	sign bit	binary form
65	0	1000001
75	0	1001011
140	1	0001100

The result indicates a negative number as the sign bit of the result is 1 and is equal to -116 which is a wrong result. This has occurred because of the overflow.

Now again the question is how does the computer know that overflow has occurred? If the carry into the sign bit is equal to the carry bit out of the sign bit then overflow must have occurred. For example

-65		1	0111111	-65		1	0111111
-15		1	1110001	-75		1	0110101
-80	1	1	0110000	-140	1	0	1110100
	Carry into sign bit = 1			Carry into sign bit = 0			
	Carry out of sign bit = 1			Carry out of sign bit = 1			
	Over flow			No over flow			

Thus, overflow has occurred, i.e. the arithmetic results so far calculated have exceeded the capacity of the representation. This overflow also implies that the calculated results might be erroneous.

2.9.3 Multiplication

Multiplication in binary follows the same operations that are followed in the decimal system. Instead here we use only two digits 0 and 1. The rules to be remembered are:

0 X 0 = 0

0 X 1 = 0

1 X 0 = 0

1 X 1 = 1

For example let us multiply 10101 with 11001.

```
    10101
  X 11001
  -------
    10101
   00000
  00000
 10101
 10101
 ---------
1000001101
```

In this example, the multiplication answer is 1000001101.

2.9.4 Division

The complete table for binary division is:

0/1 = 0

1/1 = 1

The steps for binary division are:

1. Start from the left of the divided.
2. Perform subtraction in which the divisor is subtracted from the dividend.

a) If subtraction is possible put a 1 in the quotient and subtract the divisor from the corresponding digits of the dividend put a 0 in the quotient

b) Bring down the next digit to the right of the remainder.

3. Execute step 2 till there are no more digits left to bring down from the dividend.

For example,let us divide 100001/110. Then,

```
                101      (Quotient)
(Divisor) 110 | 100001   (Dividend)
                110        --Step 1
                1001       --Step 2b
                 110       --Step 2a
                  11       (Remainder)
```

In this example, the quotient is 101 and the remainder is 11.



CHECK YOUR PROGRESS

Q5. Add 35 and -30 in binary using 7 bit register in 2' complement representation.

Q6. Subtract $(1010101)_2$ - $(1001100)_2$ by 2's complement method.

Q7. Multiply $(1100)_2$ by $(1001)_2$.

Q8. Divide $(101101)_2$ by $(10)_2$.



2.10 LET US SUM UP

- We are familiar with decimal number system, but computer cannot understand our language. Computers understand only their language which uses three different number systems. These are binary, octal and hexadecimal number system.
- As computer uses three other number systems, our decimal number system that entered from the key board or from any other input devices should convert to system understandable form. Again, system wise use of number systems may vary. Therefore, conversion from one number system to another is very important to do any work in computer.

These conversions from one to the other are also discussed elaborately in this unit with various examples.

- In short,
  - Ø radix or base of decimal number system is 10, since it consists of 10 (ten) distinct/unique symbols or digits viz., 0 to 9.
  - Ø radix or base of binary number system is 2, since it consists of only 2 distinct/unique digits viz., 0 and 1.
  - Ø radix or base of octal number system is 8, with only 8 distinct unique digits, viz. 0 to 7.
  - Ø radix or base of hexadecimal number system is 16, where number of distinct/unique symbols is 16 and they are 0 to 9,A,B,C,D,E and F.
- The best methods to represent sign bit in binary number system are sign magnitude method and 2's complements of a number.
- In signed magnitude representation the most significant bit is allocated for the sign bit separately.
- The complement of a binary number is obtained by inverting its all the bits.
- Given a number N with base r having n digits, the (r-1)'s complement of N is defined as (rn-1) - N.
- The r's complement of an n-digit number N in base r (r>1) is defined as r^n - N for N not = 0.



2.11 FURTHER READING

- Ram, B. (2000). Computer Fundamentals: Architecture and Organization. New Age International.
- ITL Education Solutions Limited, & Sargunar, J. (2011). Introduction to Computer Science. Pearson Education India.
- Morris, M. M. (1987). Digital Logic and Computer Design.
- Sinha, P. K., & Sinha, P. (2010). Computer Fundamentals (Vol. 4). BPB publications.

2.12 ANSWERS TO CHECK YOUR PROGRESS

Answer to 1: a) mathematical notation

b) 1, 0

c) 8

d) 6

e) 4

Answer to 2: a) $(1000001)_2$

b) $(174)_{10}$

c) $(316)_{10}$

d) $(10.75)_{10}$

Answer to 3: 9's complement of 54 is 45 and 172 is 827

10's complement of 54 is 46 and 172 is 828

Answer to 4: 1's complement of 101100 is 010011 and 0000 is 1111

2's complement of 101100 is 010100 and 0000 is 10000

Answer to 5: $(000110)_2$

Answer to 6: $(0001001)_2$

Answer to 7: $(1101100)_2$

Answer to 8: $(10110)_2$

2.13 MODEL QUESTIONS

Q1. Define number system? What are the different number systems used in computer? Explain.

Q2. What is 'Base' or 'radix' of a number system? Write radix of binary, decimal, octal and hexadecimal number system.

Q3. How to convert one octal number to its binary equivalent?

Q4. What is overflow?

Q5. Define sign magnitude representation.

Q6. Subtract 65 from 70 by 1's complement and 2's complement method.

Q7. Perform the addition of the following using 7 bit register in sign 2's complement method.

a) +25 and +30

b) +25 and -30

c) -25 and -30

d) -25 and +30

Q8. Perform the operations in 1's complement method.

Q9. Divide $(11001.101)_2$ by $(101)_2$

Q10. Convert the following:

a) $(156.4)_8$ to its binary equivalent

b) $(A5F.B7)_{16}$ to its binary equivalent

c) $(269.25)_{10}$ to its binary equivalent

d) $(1010110.001)_2$ to its decimal equivalent

e) $(110011.110)_2$ to its octal equivalent

f) $(111001100.1010)_2$ to its hexadecimal equivalent

****

UNIT 3 : BASIC COMPONENTS OF COMPUTER

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Concepts of Bits and Bytes

3.4 Block Diagram of a Computer

3.5 Computer Memory

- 3.5.1 Primary Memory
- 3.5.2 Secondary Memory

3.6 Input Devices

- 3.6.1 Keyboard
- 3.6.2 Mouse
- 3.6.3 Hand-held Devices
- 3.6.4 Optical Input Devices

3.7 Output Devices

- 3.7.1 Display Devices
- 3.7.2 Printers

3.8 Computer Bus

3.9 Let Us Sum Up

3.10 Further Reading

3.11 Answers to Check Your Progress

3.12 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- describe the concept of bits and bytes
- understand the block diagram of a computer
- discuss the primary and secondary memory in computer
- analyse the different types of input and output devices
- describe the different types of buses

3.2 INTRODUCTION

A computer system is composed of various components which perform many functions. In this unit, we will introduce you to the basic components of a computer system where, you will first learn how the data is represented in the form of bits and bytes. Through this unit you will be acquinted with the types of computer memory. Various types of input and output devices and the basic functioning of a bus are also included as a part of discussion in this unit.

3.3 CONCEPTS OF BITS AND BYTES

You may be surprised to know that the computer is made up of millions of tiny electric circuits that are not visible to us. The memory elements are also built with these tiny circuits which are used for storing data. For every circuit in a computer chip, there are two possibilities:

- an electric current flows through the circuit, or
- an electric current does not flow through the circuit.

When an electric current flows through a circuit, the circuit is on. When no electricity flows, the circuit is off. An "on" circuit is represented by the number one (1) and an off circuit is represented by the number zero (0). The number 1 or 0 is called ***bit***. A number system that uses only two digits, 0 and 1, is called the ***binary number system***. The binary number system is also called the base two system. The two symbols 0 and 1 are known as binary digits. The word **bit** comes from "**bi**nary digi**t**".

Always remember that each time a computer reads an instruction, it translates that instruction into a series of bits, 1's and 0's. On most computers

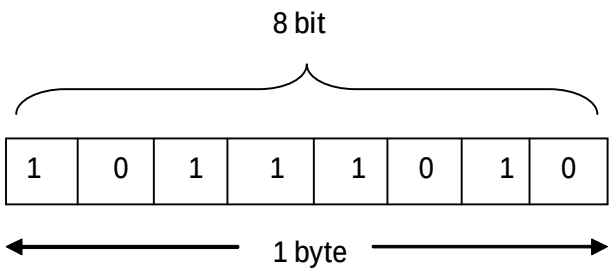


Figure 3.1 Byte representation

every character from the keyboard is translated into eight bits, a combination of eight 1's and 0's. Each group of 8 bits is called 1 byte as shown in figure 3.1. Each group of four bits is called a nibble.

Thus, 8 bits = 1 byte and 4 bits = 1 nibble

and 1024 byte = 1 kilo byte

We know that, all the quantities, physical or abstract, can be measured in some units. For example, time is measured in seconds; length is measured in metres, and mass in grams. Similarly, the computer memory can be measured in terms of bits, bytes, kilobytes, megabytes, gigabytes etc.

The followings are the measuring units given in terms of bytes :

1 kilobyte (KB) = 1,024 byte

1 megabyte (MB) = 1,048,576 bytes

1 gigabyte (GB) = 1,073,741,824 bytes

1 terabyte (TB) = 1,099,511,627,776 bytes

3.4 BLOCK DIAGRAM OF A COMPUTER

All general-purpose computers require the following hardware components:

Input Unit : This is the unit through which data and instructions are entered into a computer. Usually a keyboard and mouse are the common input devices.

Output Unit : This unit communicates the results to the user. A display screen and a printer are the common devices that let you see the results in the computer.

Central Processing Unit (CPU) : Execution of programs is the main function of the computer. The program is a set of instructions that is stored in the computer's memory. A task becomes completed when the instructions of the program are executed by the central processing unit. All the major calculations and comparisions are carried out inside the CPU. The CPU is responsible for activating and controlling the operations of various units (input & output) of the computer system.

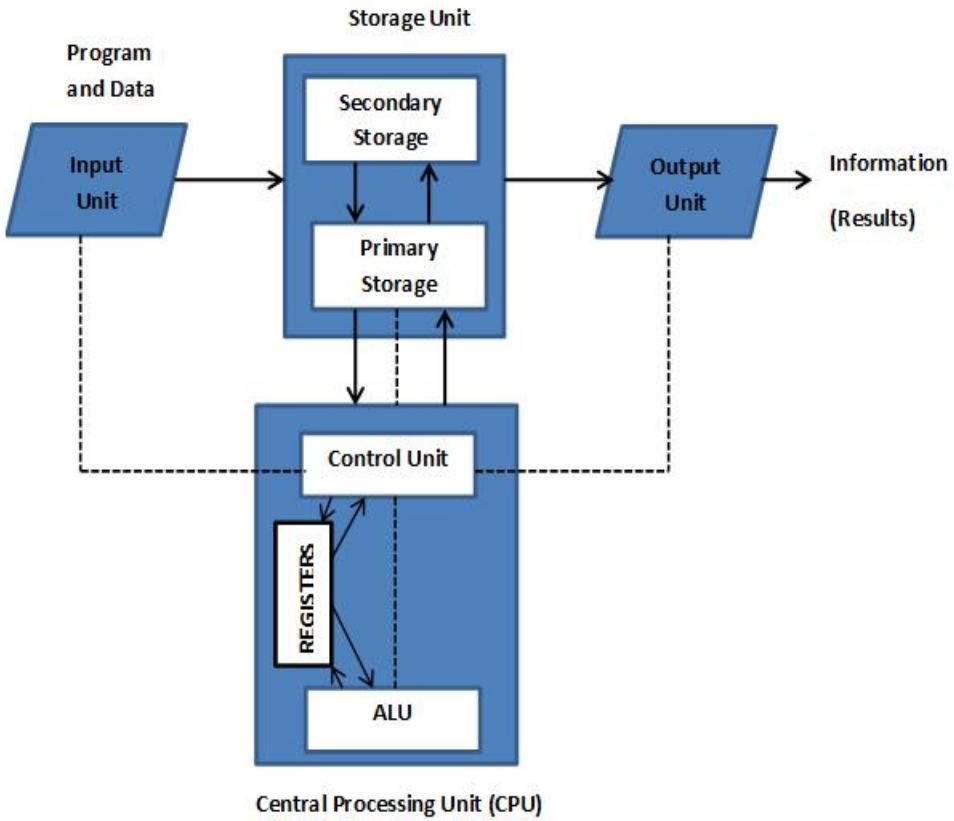


Figure 3.2: Central Processing Unit

The CPU is made up of three major components : the **registers,** the a**rithmetic and logic unit (ALU)** and the **control unit**. The registers are responsible for storing the intermediate data during the execution of program. The control unit supervises the transfer of information between the registers and instructs the ALU to perform the required operation.

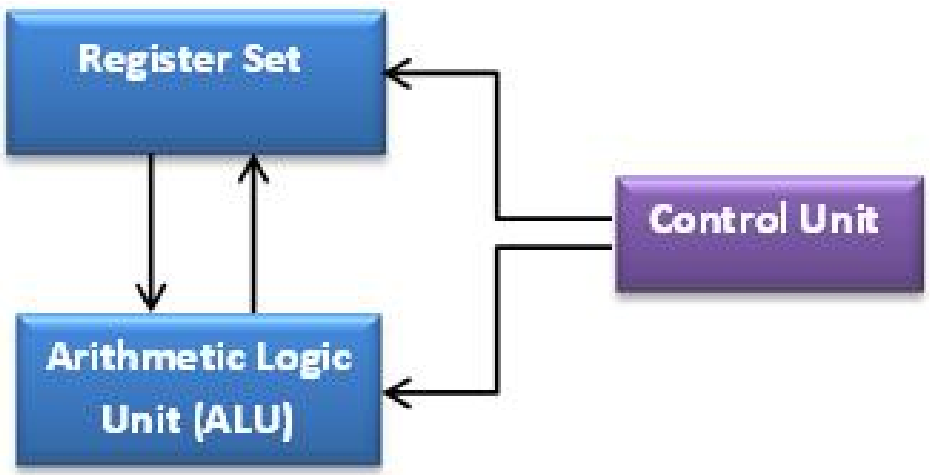


Figure 3.3 : Components of CPU

Control Unit (CU) : The control unit controls and guides the interpretation, flow and manipulation of all the data and information. It does not perform the actual processing of data, but manages and coordinates the entire computer system, including the input and output (I/O) devices. Control unit retrieves and interprets the instructions from the main memory and send signals to the other units to execute them one after the other. Some special purpose registers found inside the CPU like *instruction register, program counter* etc. help the CU to perform its function smoothly.

Arithmetic Logic Unit (ALU) : The ALU performs all the arithmetical functions +, -, *, / and some logical functions like <, >, =, <=, >=, <> etc. When two numbers are required to be added, these numbers are sent from memory to ALU where addition takes place and the result is sent back to memory. ALU has special circuits to carry out the logical operations.

Storage Unit : The storage unit allows a computer to permanently store large amount of data. The storage unit can be categorised into two types namely *primary storage* and *secondary storage,* which we will discuss in the next section. Common mass storage devices include disk drives and tape drives etc.

3.5 COMPUTER MEMORY

The term ***memory*** usually refers to a form of semiconductor storage and sometimes other forms of fast but temporary storage. In a computer, the data and instructions are stored and subsequently retrieved from the memory. We know that the CPU has some storage elements known as registers for storing data and instructions during the program execution. Every computer requires storage space for storing programs and data temporarily during the time of program execution or storing the data permanently for future use. Generally, a computer has three set of memories:

a) **Primary storage or main memory :** Primary memory, also known as *memory*, is the only one *directly accessible to the CPU*. The CPU continuously reads instructions stored there and executes them. Any data actively operated on is also stored there in uniform manner. It is a form of semiconductor storage known

as random access memory (**RAM**) and sometimes other forms of fast but temporary storage. It is small-sized, light, but quite expensive. This type of memory is divided into the following two types : *RAM (Random Accress Memory) & ROM (Read Only Memory).*

b) **Secondary storage or auxiliary memory :** Secondary memory or *storage* provides the facility of storing information and programs permanently. It differs from primary storage in that it is *not directly accessible by the CPU*. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down; it is non-volatile. It is less expensive than primary storage.

c) **Internal processor memory :** It consists of a small set of high-speed registers that are used as temoprary locations inside the processors during the execution of instructions.

Another type of memory, is the *cache memory*. Its logical position is between the main memory and the internal memory(registers). Its primary function is to store and cache part of the main memory's contents that the processor is currently using.

The computer system has a memory hierarchy consisting of the storage devices in it. A typical memory hierarchy is illustrated in the figure 3.4.

There are three key characteristics of the memory. They are cost, capacity and access time. On moving down the memory hierarchy, it is found that the cost of the storage devices decreases but their storage capacity as well as the memory access time increases. In other words, the smaller memories are more expensive and much faster. These are supplemented by the larger, cheaper and slower storage devices.

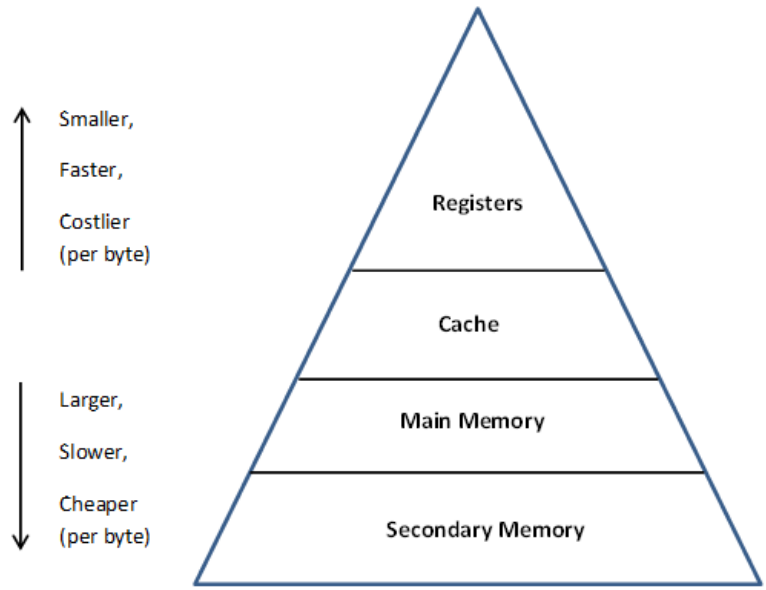


Figure 3.4 : Memory hierarchy

Thus, from the above figure it can be seen that the registers are at the top of the hierarchy and so provides the fastest, the smallest and the most expensive type of memory device for the CPU to access data.

Memory Capacity : Capacity in a computer system is defined in terms of the number of bytes that it can store in its main memory. This is usually stated in terms of kilobytes (KB) which is 1024 bytes or megabyte which is 1,048,576 bytes. The rapidly changing memory capacity of computer system has resulted in defining the capacity in terms of gigabytes (GB) which is 1,073,741,824 bytes. Thus, a computer system having a memory of 1GB is capable of storing (1024 X 1024 X 1024) bytes.

3.5.1 Primary Memory

Primary memory can be categorised into two types - RAM and ROM. We will now briefly describe RAM and ROM.

Random Access Memory (RAM) : A computer's **main memory** is often referred to as RAM - an area in the computer system unit that temporarily holds user data, operating system instructions and program instructions. Every time we turn on our computer, a set of operating system instructions is copied from hard disk into RAM.

These instructions, which help control basic computer functions, remain in RAM until we turn the computer off.

RAM features :

a) RAM is the place which holds the data that has to be processed by the computer's processor. Moreover, it holds the operating system and other application programs also.

b) RAM is made up of different ICs (Integreted Circuits). They are also called *semiconductor memory*.

c) Each element of RAM is a memory location in which data can be stored. Each location has a **unique address**. Using this address, data can be directly retrieved or stored.

d) Since RAM must hold both the data to be processed and the instructions for processing, its size or capacity is one of the measures of power of the computer.

e) RAM is a volatile memory. It loses its data when the computer is turned off.

There are generally two broad categories of random access memory :

i) **DRAM** memories (*Dynamic Random Access Memory*)

ii) **SRAM** memories (*Static Random Access Memory*)

DRAM : Dynamic RAM is a type of RAM in which data is stored in a storage cell, consisting of transistors and capacitors. A common property of a capacitor is its tendency to get discharge, it means the current goes down in the circuit and data cannot hold for long time. To overcome this effect, the DRAM needs to be continuously refreshed with power supply and thus it has one *refreshing circuit* which rewrites the data in certain time intervals. This circuit refreshes or rewrites the data several hundred times in a second.

SRAM : Static RAM is a type of RAM that holds its data as long as power is supplied to the circuit. The SRAM does not need any refreshing circuit. SRAMs are used for specific applications within the PC. The SRAM has the following advantages:

- **Simplicity :** SRAMs don't require external refresh circuits to keep their data intact.
- **Speed :** SRAM is faster than DRAM.

In contrast, SRAMs have the following weaknesses, compared to DRAMs:

- **Cost :** SRAM is more expensive than DRAM.
- **Size :** SRAMs take up much more space than DRAMs

Read Only Memory (ROM) : One major type of memory that is used in PCs is called *read-only memory*, (*ROM*). ROM is the memory that stores the data permanently i.e. the instructions in ROM are permanent whether the power is on or off. We have no way to change them, unless we remove the ROM chips from the main board and replace them with another set.

Read-only memory is most commonly used to store system-level programs that we want to be made available to the PC at all times. For example, the ROM-BIOS (ROM basic input and output services) programs are stored in ROM chips which are used to boot up (start up) the computer.

The following are the different types of ROMs:

Programmable ROM (PROM) : This is a type of ROM that can be programmed using special equipment; it can be written to, but only once.

Erasable Programmable ROM (EPROM) : *EPROM* is a ROM that can be erased and reprogrammed. Ultraviolet light of a specific frequency is used for erasing the EPROM and for allowing it to be reprogrammed again.

Electrically Erasable Programmable ROM (EEPROM) : The next level of erasability is the *EEPROM*, which can be erased under software control. This is the most flexible type of ROM, and is now commonly used for holding BIOS programs.

3.5.2 Secondary Memory

Secondary memory or *storage* provides the facility of storing information and programs permanently. It differs from primary storage in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down; it is non-volatile. It is also typically less expensive than primary storage. Consequently, modern computer systems typically have an order of magnitude more secondary storage than primary storage and the data is kept for a longer time there. The figure 3.5 shows the commonly used secondary storage devices and their classification.

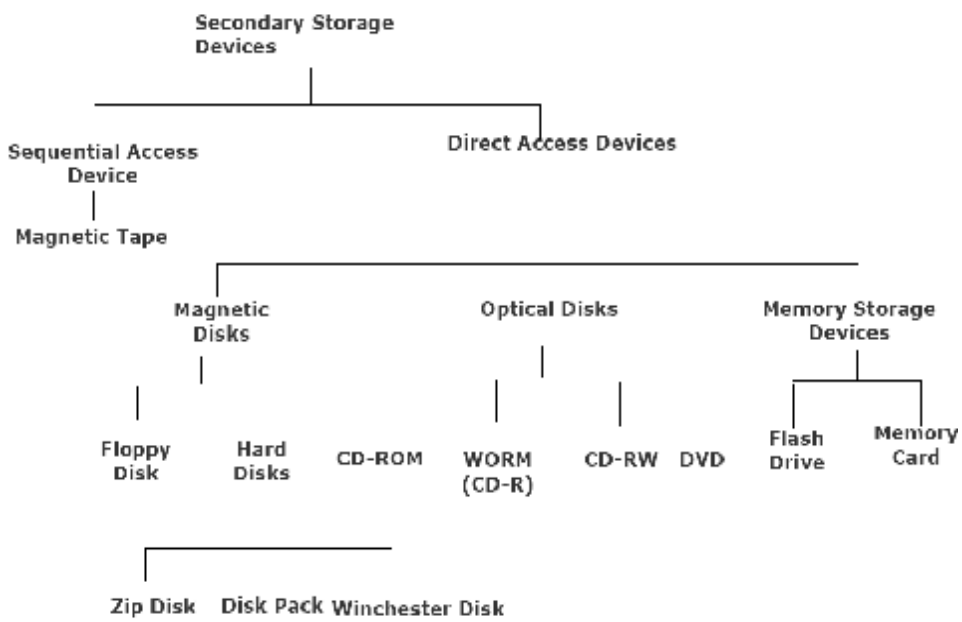
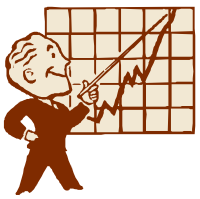


Figure 3.5 : Secondary storage devices and their classification

In modern computers, hard disks are usually used as secondary storage. The time taken to access a given byte of information stored on a hard disk is typically a few thousandths of a second, or milliseconds. By contrast, the time taken to access a given byte of information stored in random access memory is measured in

thousand-millionths of a second, or nanoseconds. Some other examples of secondary storage technologies are: Flash Memory (e.g. USB sticks or keys), Floppy Disks, Magnetic tape, Paper tape, Punch Cards, standalone RAM disks, and Zip drives.



CHECK YOUR PRPOGRESS

1. State True or False:
   i) The secondary memory is slower than the main memory but has a large capacity.
   ii) In random access memory any memory location can be accessed independently.
   iii) Cache memory increases load on main memory.
   iv) Flash memory is one kind of ROM.
   v) High speed memories are needed to bridge the gap of speed between I/O device and memory.
   vi) Registers are the fastest memory element in computer system.
   vii) Main memory of a computer system cannot store very large data.
2. Which memory is known as the main memory of the computer system ?

   .....

   .....
3. What are the differences in :
   a) Volatile versus Non-volatile memory

      .....

      .....

      .....
   b) Static RAM versus dynamic RAM

      .....

.....

.....

.....

4. What is the similarity between ROM and PROM?

.....

.....

3.6 INPUT DEVICES

The main function of the input unit of a computer system is to provide information for execution. Programs and data must be entered into the computer memory for processing through the input devices, and the results obtained from the execution by the CPU must be displayed or recorded for the user's. The most commonly used input devices can be classified into the following categories :

- **Keyboard devices**
- **Point and draw devices** (mouse, track ball, joystick, light pen, touch screen)
- **Scanning devices** (optical mark recognition, magnetic ink ch aracter recognition, optical bar code reader, digitizer, electronic card reader)
- **Voice recognition devices**
- **Vision-input devices** (Webcam, video camera etc)

3.6.1 Keyboard

It is the main input device used in most of the computer systems. It has letter and number (alphanumeric) keys, function keys, computer specific task keys, that allow the user to use an English-like language to issue instructions to an electronic environment. It uses a cursor to keep your place on the screen and to let you know where to begin typing. You are able to input commands, type data into documents, compose documents, draw pictures with use of certain keys, pull down menus, and respond to prompts issued by

the computer. The keyboard contains s*pecial function keys* labelled F1, F2, ..., F12 to manipulate the user interface. When a key is touched, an electrical impulse is sent through the device which is picked up by the operating system software, and sent through the computer to be processed.

The keyboard operates as a typical typewriter and uses a standard “QWERTY” keyboard. QWERTY is the way the keyboard is set up for typing. If you look at the keyboard under the top number row, you will see that the alphabet top row begins with QWERTY.

Some special purpose keyboards are also found which are used for specific applications. An example of such kind of keyboards can be seen at the Automatic Teller Machines or the ATMs where the keyboard is required for limited functionality by the customers.

3.6.2 Mouse

The mouse is a hand held pointing device that lets you to point and select items on your screen. In any mouse there are mostly 2-3 buttons and on a Mac there is one. A ball under the mouse senses movement. The mouse is included in almost every computer that is sold today. Besides becoming an important input tool, it has provided access to the computer for many individuals with disabilities that might not otherwise have the opportunity to use the computer.

Variants of a Mouse :

Touchpad : A touchpad is a touch sensitive input device which takes user input to control the onscreen pointer and perform other functions similar to that of a mouse. Instead of having an external peripheral device such as a mouse, the touchpad enables the user to interact with the device through the use of one or multiple fingers being dragged across the relative positions on a sensitive pad. These touch pads are mostly found in Notebook and Laptops.Touchpads are pressure and touch sensitive.



Figure 3.6 : Touchpad of a Laptop

3.6.3 Hand-held Devices

Trackball : The trackball is an upside-down mouse. It uses the same principle as the mouse except that the rollers are reversed and the ball is on top. This ball does not need as much attention as the normal mouse because the only thing that touches it is your hand as the normal mouse touches a surface.

Joystick : The joystick is a vertical stick that moves the graphic cursor in the direction the stick is moved. It consists of a spherical ball, which moves within a socket, and has a stick mounted on it.The user can move the ball with the help of the stick in any direction. Video games, training simulators and control panel of robots are some common uses of a joystick.



Figure 3.7 : Trackball



Figure 3.8 : Joystick

Light pen : The light pen is a pen shaped tool that allows the user to touch the computer screen with a lighted pen to activate commands and make selections. Light pens are typically used in CAD (Computer Aided Design) applications to directly draw on

screen.

Touch Screen : A touch screen is probably one of the simplest and most intuitive of all input devices. It uses optical sensors in, or near, the computer screen that can detect the touch of a finger on the screen.

3.6.4 Optical Input Devices

Scanner : Scanning devices are input devices used for direct data entry from the source document into the computer system. Scanners capture and store information in a graphical format, and then display it on the graphical screen. A scanner consists of two parts, one that illuminates the page for capturing the optical image, and the other that converts and stores the graphical image in a digital format. Once this is done, the computer can then see and directly process this scanned graphical image. A scanner's sophistication is the ability to translate an unlimited number of analog voltage levels to digital values. The scanner takes the information it sees on a page and converts into code that the computer can use. A picture once scanned can be edited, printed, or used in an application. Capturing information by using scanners reduces the possibility of human error typically seen during large data entry.

Optical Mark Recognizer (OMR) : Optical mark recognization devices sense the marks on computer readable paper. They are usually used by academic institutions for grading aptitude tests where the correct option is marked from multiple options given on special kinds of answer sheets. The OMR device directly reads this paper, and the computer can then use it for further processing.



Figure 3.9: Magnetic Ink Character Recognizer

Magnetic Ink Character Recognition (MICR) : MICR is similar to optical mark recognition and is used exclusively by the banking industry. The banking industry makes use of MICR devices for directly reading the account numbers written on cheques and for processing them further as required. MICR characters are printed in special typefaces with a magnetic ink or toner, usually containing iron oxide.

Optical Barcode Reader (OBR) : Data coded in the form of small vertical lines forms the basis of barcoding. Alphanumeric data is represented using adjacent vertical lines called barcodes. These are of varying width and the spacing between them is used to uniquely identify books, merchandise in stores, postal packages etc. A barcode reader uses laser beam technology. The laser beam is moved across the patterns of bars in a barcode. These bars reflect the beams in different ways. The reflected beam is then sensed by a light-sensitive detector, which then converts the light patterns into electrical pulses, thereby transmitting them to logic circuits for further conversion to alphanumeric value.



Figure 3.10: Optical Bar Code

Digitizer : The digitizer is another kind of input device used for converting (digitizing) picture,maps and drawings into digital form for storage in computers. These devices are commonly used in the

area of Computer Aided Design (CAD) by architects and engineers to design car, buildings, medical devices, robots and mechanical devices.

Electronic Card Reader : Card readers are devices that allow direct data input into computer system. The electronic-card reader is connected to a computer system and reads the data encoded on an electronic card and transfers it to the computer system for further processing. Typical example of electronic cards are the plastic coated cards provided by the banks to its customers for use in Automatic Teller Machines or ATMs.

3.7 OUTPUT DEVICES

The outputs produced by a computer system can be in two forms : *hard copy and soft copy*.

Hard copy : The output produced in a physical form is called hard copy output. This type of output is permanent and a relatively stable form of output. Paper is one of the most commonly used hard copy output media. The most widely used hard copy output device is the printer.

Soft copy : The output that remains in electronic form, stored in computer memory or on disk are called soft copy outputs. This kind output is not permanent and is usually displayed on monitor or screen. It includes both audio and visual forms of output.

A wide range of output devices are available today which are :

- Display device (monitors, multimedia projectors, terminals)
- Plotters (flatbed, drum)
- Voice response system (voice response system, speech synthesizer)
- Printers

3.7.1 Display Devices

The display device shows the processed output from a computer system. The increasing demand for displaying the graphics and

pictures for presenting information in a visual form has led to the popularity of graphics display device. Display screen technology may belong to one of the following categories :

a) **Cathod Ray Tube(CRT) :** The CRT is a vacuum tube containing an electron gun (a source of electrons) and a fluorescent screen, with internal or external means to accelerate and deflect the electron beam. It is used for creating images in the form of light emitted from the fluorescent screen. A CRT display can be either of the following two types : *Raster scan display and Vector display*.

b) **Liquid Crystal Display(LCD) :** The LCD technology is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have replaced cathode ray tube (CRT) displays in most applications. They are usually more compact, less energy consuming, lightweight, portable, less expensive, more reliable, and easier on the eyes.

Monitor : The monitor is one of the most commonly by used output devices. It can be thought of as a high resolution TV set. The monitor displays text and images (pictures) converted to output from the video adapter. The video adapter is an expansion card that plugs into the motherboard. The adapter changes the instructions from the central processing unit (CPU) into a way that the monitor can understand it.

Most computer monitors are based on Cathode Ray Tube (CRT) technology. The basic operation of these tubes is similar to that in television sets. With the widespread use of smaller computers like PDAs and laptops now-a-days, a new type of display screen Liquid Crystal Display (LCD) has been used.

3.7.2 Printers

It is a widely used output device. A printer prints information and data from the computer onto a paper. Some printers can produce only textual information but some others can produce graphics also.

Printers can be classified into categories based on : *printing technology, printing speed, printing quality.*

Printing technology : Printers can be divided into two types - *(i)impact printers* and *(ii)non impact printers*.

(I) Impact printers : The printers that work by physically striking a head or needle against an ink ribbon to make mark. Impact printers are divided into *Dot matrix printers , Daisy-Wheel printers* and *Drum printers.*

Dot Matrix Printer : This printer is the cheapest but loudest of all the printers. This printer prints one character at a time. The printer uses a fine stripe of carbon and depending on what pin it is, will determine the quality of the printing. The pin sizes range from 9-24. The print head hits the ink ribbon with one of its many pins causing it to form a letter number or character.



Figure 3.11 : A Dot-Matrix Printer

With the pins hitting the ribbon this printer becomes quite loud. The ppm (page per minute) ranges from 1 to 3. But with new changes in the technology it is being more and more used in offices today and it can also print 3 - 6 ppm. The drawback in most dot matrix printers is the on-roll paper which has a track which feeds it through

the printer. Also, in most new dot matrix printers there is a paper feed which allows most forms of paper.

Daisy Wheel Printer : Daisy-wheel printers operate in much the same fashion as a typewriter. A hammer strikes a wheel with petals (the daisy wheel), each petal containing a letter form at its tip. The letter form strikes a ribbon of ink, depositing the ink on the page and thus printing a character. By rotating the daisy wheel, different characters are selected for printing.You can change the daisy wheel to print different fonts. This printer is also called the letter quality printer.

Drum printer : Drum printer is one of the most commonly used line printers.

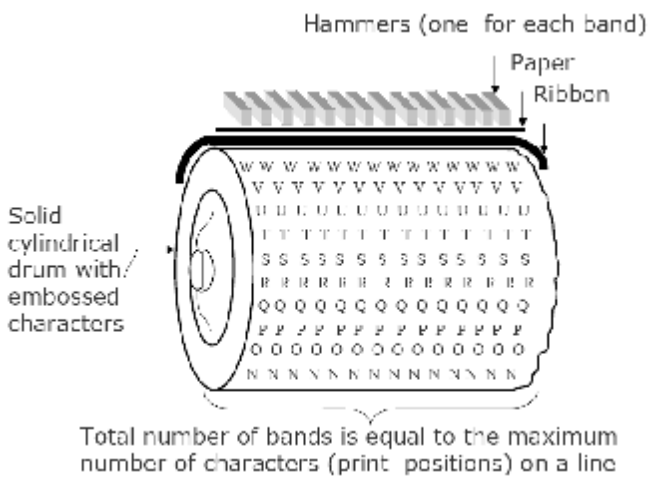


Figure 3.12 : Printing Mechanism of a Drum Printer

In a typical drum printer design, a fixed font character set is engraved onto the periphery of a number of print wheels, the number matching the number of columns (letters in a line) the printer could print. The wheels, joined to form a large drum (cylinder), spin at high speed and the paper and an inked ribbon are stepped (moved) past the print position. As the desired character for each column passes the print position, a hammer strikes the paper from the rear and presses the paper against the ribbon and the drum, causing the desired character to be recorded on the continuous paper. Because the drum

carrying the letterforms (characters) remains in constant motion, the strike-and-retreat action of the hammers has to be very fast. Typically, they are driven by voice coils mounted on the moving part of the hammer.

(II) Non impact printers : These printers work by not physically striking a head or needle against an ink ribbon to make a mark. Inkjet, Laser and thermal printers fall under this category of printers.

The ***non impact printers*** commonly used are :

Inkjet Printer : This printer is generally used in homes. It is a non impact printer and it does not touch the paper while printing. Instead, the print head sprays ink onto paper forming an image or text.

For business letters, a injet printer is the most common as it is used for its high quality printing. The common speed on an ink jet printer is about 3 ppm and 300 dpi (dots per inch).

Laser Printer : Among the different types of printers, laser printers remain the fastest, and the most efficient way to reproduce text and images, offering high resolution and quick speeds at a relatively low cost. A laser printer uses an electrostatic process similar to a photocopier. The laser charges the areas of a photosensitive image drum. Toner particles are then attracted to these areas of the drum. By rolling this drum against a piece of paper, the printer creates an image on a page.In the final stage, heat is used to fuse the toner to the paper.



Figure 3.13 : Inkjet printer and Laser Printer

Plotter : A plotter is a hard copy output device which is used to

draw high-resolution charts, graphs, maps, and other line based diagrams. It is a pen based output device, attached to a computer for making vector graphics, that is, images created by a series of many straight lines. A plotter is a very slow and expensive output device. It is mainly used for Computer Aided Design(CAD) and Computer Aided Manufacturing applications. Plotters are classified as Drum plotters and Flatbed plotters.



Figure 3.14 : Plotter

Audio Output : Voice response systems enable the computer to talk to its users. It consists of an audio-response device that produces the audio output. Voice response systems are of *two* types : *voice reproduction system* and *speech synthesiser.*

Voice reproduction system produce an audio output by selecting the appropriate response from a predefined set of responses. These responses may be in the form of speech (words or phrases spoken by human beings), musical sounds, alarms, or other sounds. Text is converted into spoken words by speech access systems.



CHECK YOUR PROGRESS

5. State true or false
   a) One of the most common input device is keyboard.
   b) Plotters are devices used for outputting pictures, drawings.
   c) Digitizers are used as output devices.
   d) In case where graphical user interfaces are common mouse should not be used.
   e) Speech recognition devices are input devices.
6. Answer the followings :
   a) What are electronic card readers?
   b) Compare and contrast the Laser and Dot Matrix Printers.
   c) What is an OMR device?
   d) On what basis are the printers classified?

3.8 COMPUTER BUS

Bus is an electrical pathway through which the processor communicates with the internal and external devices that are assembled with the computer. Buses resposible to carry memory address as well as data to the control location in memory. Computer system contains a number of different buses that provide pathways between components at various levels of the computer system hierarchy. The name of the bus is determined by the type of the signals it carries and the operations it performs. A bus that connects major computer components (CPU, memory, I/O) is called a *system bus*.

The interaction between the CPU and memory and CPU and I/O takes place very frequently. To enable this interaction, some type of connectivity is needed between the units of a computer system. This connectivity channel is known as *bus*. A key characteristic of a bus is that it

is a shared transmission medium. Physically, a bus is set of wires, which carries a group of bits in parallel and has an associated control scheme. The bus width is defined as the number of parallel lines in the bus. Every computer has three types of buses for interconnecting the CPU and memory and CPU and I/O. The functions performed by bus are as follows :

- Bus transfers data between the computer subsystem. It sends instructions and commands to and from the processors.
- It connects all internal computer components to the main memory and the CPU.
- It logically connects various peripheral devices which can easily communicate with the CPU.
- It has clock speed which is measured in MHz.

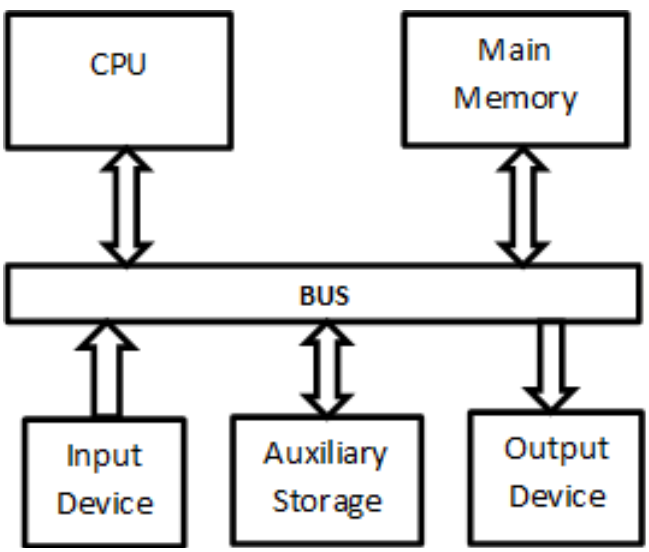


Figure 3.15: Computer Bus

Data Bus : The data bus is used to transfer data between the CPU and memory and CPU and I/O. The one that you hear most about is the data bus. The bus width of the data bus is an important parameter that affects the overall speed of a computer system. This is because each wire of a bus can transfer one bit at a time. Hence, a 8-bit bus can move 8 bits data time, a 16 bit bus can transfer two bytes, and 32 bit bus can transfer four bytes at a time. This is similar to a multi-lane highway. The wider the highway, the more traffic can flow simultaneously. Similarly the wider the bus enables more bits of data to travel, simultaneously resulting in faster

exchange of data. The data bus is also referred to as a *memory bus* which is often called *system bus.*

Address Bus : Every location in the memory has a unique address. The address of a location does not change, but the data stored in it can change. In order to retrieve some data from memory, it is necessary to specify the address of the location where the data is stored. The address bus is used to carry the address of a memory location whenever data is to be transferred to or from memory.

Again, a computer system normally has multiple I/O devices like disk, tape, network etc simultaneously connected to it. Each I/O device has a unique identifier associated to it. The address bus is used to carry the address of the I/O device to be accessed by the CPU.

Control Bus : In addition to sending address and exchanging data with the memory, the CPU also needs to send control signals to the memory to specify whether the data is to be read from or written to the specified address location. The control bus carries such signals, which are in the form of READ/WRITE commands. A typical bus structue is shown in the figure 3.16.

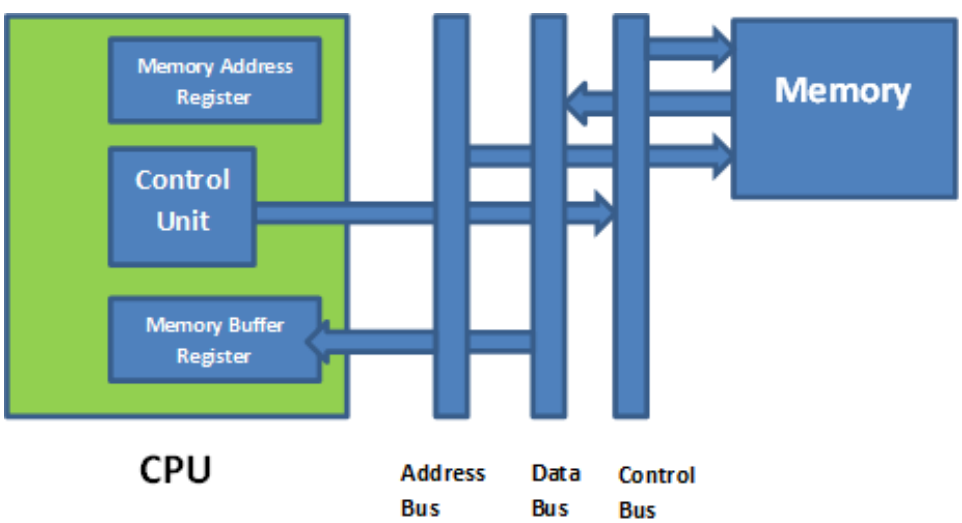


Figure 3.16: Different types of Bus



ACTIVITY

- Find out the capacity and structure of the memory types used in a computer system.
- Prepare a list of all old and new input and output devices with illustrations.



3.9 LET US SUM UP

- Data inside a computer is stored in the form of 0s and 1s. These 0 and 1s are called bit. 4 bit constitute a nibble and 8 bit constitute a byte.
- The ***memory*** usually refers to a form of semiconductor storage i.e. primary memory and ***storage*** refers to mass storag i.e. secondary memory.
- Random access memories are the semiconductor memory. They are volatile in nature. RAMs are of two types - dynamic RAM and static RAM.
- ROMs are also the semiconductor memory. The instructions in ROMs are permanent whether the power is on or off. PROM, EPROM, EEPROM are the types of ROMs.
- Cache memory is a special type of RAM which is the faster memory used in a computer system in between the CPU and main memory.
- Secondary memory also called secondary storage stores information and programs permanently. In personal computer, secondary memory typically consists of hard disk or any removable media, if present, such as a CD or DVD etc.
- Magnetic tapes are the magnetic-coated plastic tapes, which are used for storing data and audio or video files.
- Input device is an electromechanical device that accepts data or information from the user in user readable form, and translates them into computer readable form.

- An output device is an electromechanical device, which produces the output of processing by the computer to the user. Computer produces the output in a machine readable form, and the output device converts it to a human readable form.
- Bus is an electrical pathway through which the processor communicates with the internal and external devices that are assembled with the computer. Basically ,the buses are of three types : data bus, address bus and control bus.



3.10 FURTHER READING

- Ram, B. (2000). *Computer Fundamentals: Architecture and Organization*. New Age International.
- ITL Education Solutions Limited, & Sargunar, J. (2011). *Introduction to Computer Science*. Pearson Education India.
- Morris, M. M. (1987). Digital Logic and Computer Design.
- Sinha, P. K., & Sinha, P. (2010). *Computer Fundamentals* (Vol. 4). BPB publications.



3.11 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : i) True, ii) True, iii) False, iv) True, v)True, vi)True, vii) True

Ans. to Q. No. 2 : Random Access Memory is known as the main memory of the computer system.

Ans. to Q. No. 3 :

a)	**Volatile Memory**		**Non-volatile memory**
i)	Power is required all the time	i)	Power is not required once data is stored
ii)	Temporary storage	ii)	Permanent storage
iii)	Normally faster than non-volatile types	iii)	Slower than volatile memories.

b)	**Static memory**	**Dynamic memory**
i)	Loses its signal	i) Doesnot lose signal strength
ii)	Periodic refreshing of memory is needed	ii) No refreshing
iii)	Expensive	iii) Cheap
iv)	Used as Cache	iv) Used as main memory

Ans. to Q. No. 4 : The similarity in ROM and PROM is that both write operations which can be performed only once and whatever has been written cannot be changed.

Ans. to Q. No. 5 : a) True, b) True, c) False, d) False, e) True

Ans. to Q. No. 6 : a) Card readers are devices that allow direct data input into a computer system. The electronic-card reader is connected to a computer system and reads the data encoded on an electronic card and transfers it to the computer system for further processing.

b)	**Laser Printer**	**Dot Matrix Printer**
i)	High cost	i) Low cost
ii)	Forms character using laser beam	ii) Use Dot Matrix to print character
iii)	Non-impact printer	iii) Impact printer
iiv)	High quality output	iv) Output is of low quality
v)	Noiseless operation	v) Noisy
vi)	Cannot produce multiple copies of a single print	vi) Can produce multiple copies in a single print with the help of carbon paper.

c) An input device (a scanner) is capable of recognizing a pre-specified type of mark made by pencil or pen. Any input data that is of a choice or selection nature can be recorded for OMR input.

d) Printers can be classified into categories based on : printing technology, printing speed, printing quality. Printing technology : Printers can be divided into two types - *impact printers* and *non impact printers*.



3.12 MODEL QUESTIONS

Q1. Differentiate between a bit and a byte.

Q2. What is computer memory? List the two different categories of memory.

Q3. What is a RAM? What are its two types? Differentiate between them.

Q4. What is a ROM? Why is it called so? List the differenet types of ROMs and their key features.

Q5. What is a cache memory? How is it different from a primary memory?

Q6. Differentiate between

a) PROM and EPROM.

b) Static RAM and Dynamic RAM

Q7. Why are input and output devices necessary for a computer system?

Q8. What are pointing devices? Discuss some of the commonly used pointing devices.

Q9. Explain the different types of printers. Make a clear difference among them in terms of speed, cost, and method of operation.

Q10. What is a bus? List out the main functions performed by buses in a computer system.

Q11. Write short note :

a) RAM b) Light pen

c) MICR d) Scanner

e) Computer Bus

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UNIT 4: COMPUTER SECURITY

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Computer Security

4.4 Malware

4.5 Computer Viruses

4.6 Worms

4.7 Other Threats

- 4.7.1 Trojan Horses
- 4.7.2 Spyware
- 4.7.3 Adware
- 4.7.4 Scareware

4.8 Counter Measures

- 4.8.1 Antivirus
- 4.8.2 Deception Techniques
- 4.8.3 Working of Antivirus

4.9 Let Us Sum Up

4.10 Further Reading

4.11 Answers to Check Your Progress

4.12 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- learn about computer security and its goals
- describe different threats related to computer security
- describe the classification of the threats
- describe measures of threats

4.2 INTRODUCTION

The advancement of computer networking and information technology has been explosive in recent times. This technology has been propagated around the world rapidly and has affected every aspect of day-to-day life. Most computer facilities continue to protect their physical machine better than their data, but in reality the value of the data is greater than the value of the hardware. Throughout this chapter, the discussion of computer security emphasizes the problem of protecting information from unauthorized disclosure.

4.3 COMPUTER SECURITY

The state of being free from danger or threat is called security. So computer security means protection of the computer systems from theft or damage to its hardware or to its software or to the information it stores, as well as from disruption or misdirection of the services it provides. More precisely we can explain with the CIA triad of information security, which maintains these three security goals:

- **Confidentiality:** It means protecting the information from disclosure to unauthorized parties.
- **Integrity:** It means keeping the data pure and trustworthy by protecting system data from intentional or accidental changes
- **Availability:** It refers to ensuring that authorized parties are able to access the information when needed.

Let us describe a day-to-day example to understand this CIA triad. Suppose I own a bank account and I am not willing to share my ATM card number, PIN and bank statements. So, me and my bank is protecting the information, this is confidentiality. Suppose, one day I make a online transaction to a 3rd party for rupees 1000.00, but in the meantime somehow, someone tampered the information and changed the amount to 10000.00. I don't want to have such tampering with my confidential data. That is integrity. I want my bank account to be accessed and manipulated only by me not by others, my bank should protect my account from unauthorized attempt of access. This is an example of availability.

4.4 MALWARE

If we can ensure these goals for our system then we can say our system is protected and any threat to these goals is a threat to computer security. The threats to computer security can be in the form of unauthorized access or deception or disruption to the services or data. Generally these violations to security are caused by some malicious software. A software is potentially malicious if it can be used to harm either the computer on which it is hosted or another computer. Software may also be considered malicious if it is designed to install itself on a computer without the permission of the owner of that computer, particularly if it does so in a way that may compromise the security of the computer. Malicious may be loosely interpreted. A piece of software may be considered malicious even though it may have been launched with the intention of providing an arguable benefit. These types of software are referred as malware (= malicious + software) in general.

Malware can be classified as

- **Transient -** They need a host to exist (Viruses, Trapdoors)
- **Resident -** They can exist on their own (Worms)

Most malicious software takes advantage of the vulnerability-exploit cycle in software development if it is not managed properly. Vulnerability is a system susceptibility or flaw, and vulnerability-exploit cycle is the continuous process of identifying, classifying, remediating, and mitigating vulnerabilities as they are discovered.

4.5 COMPUTER VIRUSES

A computer virus is an executable program that replicates itself or attached to a file where it infects the computer when the file is executed. Sometimes it may also replace an existing program. There are many techniques used by virus to spread or replicate or attach to a file, but the self replicating nature is the main criterion that distinguish a virus from other software. And not all viruses show harmful activities on system.

But why is such malicious software is termed with the biological term "Virus"? This is so because most computer viruses are parasitic like biological virus i.e.: they work by attaching themselves to a carrier object (e.g.: a file). And when this carrier object is transmitted to other systems the virus is also transmitted and it is activated when the host program is executed. After activation the computer virus like its biological one search for another host and gets attached to it.

Working of a Computer Virus

A virus does not appear as an object in itself. A virus always resides hidden in some useful object and it may perform the main parts of a virus code which are the replication routine and the payload routine. A virus is not a virus without the replication routine, but the pay load routine for a virus is optional.

- **Virus replication:**

The replication routine contains a code that locates suitable objects to attach the virus to and to copy the virus to these elements. There are different techniques for this purpose.

Virus code can be executed when the object is executed. Viruses that infect program files may attach the virus code at the start or at the beginning of the program and patch the entry point so that when the program is run the virus code is executed first. The virus usually transfers control to the original program when it has finished its tasks. This ensures that the original program works properly and the virus avoids detection.

- **Payload Execution:**

Payload routine of a virus is optional, some of the viruses may not have the payload routine which give them the efficiency to replicate more quickly. Payload part of the virus code generally contains the malicious activity such as slowing down the PC, deleting system files, making short cuts of every folder, swiping out the memory etc. The payload routine usually contains some activation criteria that must be met before the payload activates. This gives the virus some time to spread without

detection. The activation criteria may be any data that can be found in computer like a particular date after infection or a lapse of time period or execution of certain application etc.

From the above discussion one thing is clear: a virus always need a host to spread and it cannot spread on its own. It needs some activation criterion to be fulfilled. Then only it can be executed or it can take over the computer resources. But there are some other types of malicious software commonly mistaken as virus but unlike the viruses. They can survive without a host. These malware are called worms.

4.6 WORMS

A worm is more independent than a virus. A pure worm works by itself as an independent object. The main feature that separates worms from viruses is that worms are self replicating. A worm can initiate network communication by itself and send copies to other computers. So there is no need for activation criteria or host process. As worms can spread rapidly across a network infecting every PC so they are the most notorious of malwares. There are some malicious software that resemble both viruses and worms.

One common example of this kind is mass mailing worms. They are attached to documents or other object like a virus, but uses email clients to mass mail themselves in a worm like way. This type of worm needs some kind of activation as for example, in mass mail worms can only activated when a receiver opens an attachment. It makes the worm slow but as it initiate the network by its own they are much faster transmitted than viruses. Worms and viruses are the most common wide-spread malicious software. There are some other programs also which work may not be so vicious like the virus or worm, but still they are malicious.



CHECK YOUR PROGRESS

1. What are the three security goals?
2. What is computer virus?
3. Differentiate between worm and virus.

4.7 OTHER THREATS

In this section we will briefly introduce malicious software other than virus and worm which may not exploit or damage the system like virus or worms do, but may be a potential threat in point of view of security.

4.7.1 Trojan Horses

The term trojan horse comes from the tale of the Trojan horse from the Trojan war described in Greek mythological epic. In the Trojan War, the Greeks were unable to enter the city of Troy despite 10 years long siege and finally they constructed a large wooden horse and hid some soldiers in it. The citizens of Troy thought it was just a mere wooden horse and they let it in their city and in the night the soldiers inside the horse opened the city gates, which eventually became the downfall of their city. The wooden horse is coined as Trojan horse in the epic. The Trojan horses in computer security also serve the same purpose.

Trojan horses are applications which appear to be useful, legitimate applications, but run malicious, hidden code. The application may appear to perform tasks, such as scanning for spyware, but actually steal personal data from your system. Executing Trojans may result in changing desktop wallpaper, creating popups, or even deleting files. One of their most popular uses is creating backdoors to allow malicious users to gain access to files and information. Unlike viruses or worms, Trojans cannot infect other systems.

4.7.2 Spyware

Spyware are the software that collects user sensitive information like browsing and searching habit, password, social interactions without your knowledge and uses such information to gain profit. Information collection by spyware is done using technique like key logging, browser activity monitoring. Spyware is meant to make money by using personal information so it does not exploit the PC like other malware do. In fact, many spyware may be running in our PC without our knowledge.

4.7.3 Adware

Adware are the software that supports advertising. In general it is the entire program that downloads or displays unwanted banner advertisements in the software being used. Adware can be also used to collect user personal data and based on these data the adware shows up with classified advertisement. This type of software doesn't harm the system but collecting information and running advertisement without user knowledge is a threat.

4.7.4 Scareware

Scareware is a new type of attack, where a user is tricked into downloading a software that appears to be a useful one. After installing, it shows that the machine is infected and it can clean all the infection if you purchase the full license version of the software. These scareware applications are malware that hold the PC hostage until people don't pay the ransom. In most of cases, these scareware can't be uninstalled also.

4.8 COUNTER MEASURES

"Prevention is better than cure". To detect and eliminate security threat is always tougher than to prevent it. We can say a standalone system

is more secure than any other. But it is not ideal scenario that a PC will never expose to security threats. A threat to computer security may be in many forms and hence we have to deploy different technique also to encounter them. But in this unit we will mainly focus on counter techniques for malware.

4.8.1 Antivirus

Malware uses different strategies for deception and replication. Hence, for detection and elimination of different malware involved, different techniques and tools are used which is impossible to be done manually. A special kind of software is developed for this purpose commonly known as antivirus. So, antivirus software is a program or set of programs designed for searching, preventing, detecting and eliminating malware. The detection techniques of antiviruses are generally based on malware deception strategies. So let's go through a brief overview of different deceptions strategies used by the malware.

4.8.2 Deception Techniques

Different malicious software uses different strategies to spread or replicate them and exploit the system. Deception helps malware to stay in the system and replicate for a longer time by disguising as a part of the host program. Malware employ different kinds of deception to hide them such as–

- **Overwriting:** In this technique, the virus overwrites files with their own copy. It's a primitive technique but it is simple and easy to implement. This type of viruses can be disinfected from system simply by deleting the infected files.

- **Companion Infection:** In this approach the virus disguises itself as a companion of .exe file by naming it with same base name as the targeted program, but use a .COM extension instead of .EXE, because Windows gives priority to a file with the .COM extension over a file with the .EXE extension.

- **Appending:** In this method, a jump (JMP) or goto instruction is encoded at the start of the of the host program that will point at the end of the original host. And the starting of virus code is laid there.
- **Pre-appending:** In this strategy the virus code has been inserted at the front of host programs. This is a simple efficient method.
- **Cavity filling:** Here the virus tries to install itself in the empty space of the host while not damaging the actual program itself. An advantage of this technique is that the virus does not increase the length of the program but it also minimizes a number of possible hosts. Cavity viruses are rare.
- **Compressing:** Generally after infection, size of the affected files increase, but by using compression techniques in this method size of the affected files has reduced so that change in file become negligible.
- **Encryption:** In this scenario the virus consists of a constant decryptor or set of decryptor, followed by the encrypted virus code, after decryption of the encrypted code with different decryptor yield different virus. This type of malware is called oligomorphic virus.
- **Boot Sector Execution:** Due to the executable nature of master boot record (MBR) and partition boot sector (PBS), if any executable code is present in these sections, it will execute when the machine is booted and hence bypass all the security measures.
- **Macros:** Macros are generally targeted for Microsoft word or similar products and damage only such documents. They are embedded in such application and while activation triggered some other application or insert unreadable character in the documents.
- **Malicious mobile code (MMC):** Mobile codes are lightweight programs that are downloaded from a server and executed with minimal or no user intervention on your local machine. JavaScript scripts, VB Script, and ActiveX controls are some of examples of mobile code that we

encounter while browsing. These code are used to monitor browsing activities, getting unauthorized access to local file system, showing pop ups, adding unwanted browser add-ons etc. Spyware, adware, Trojan are such malware that uses MMC.

4.7.3 Working of Antivirus

Antivirus software scans all the file system and search for virus definition in there and tries to disinfect it by removing the malware code or deleting the infected file. Virus definition of a malware is signature by which the malware can be identified. The signature is determined based on the strategy adopt by the malware to replicate themselves. These definitions are provided by the antivirus company. Antivirus program try to match the files with these definition. The basic searching methods used by the antivirus can be broadly classified into five categories. These are:

1. **Signature based detection:** Once a virus is detected, it is analyzed precisely and a unique sequence of bytes extracted from the virus code. This string is the signature of that virus. The antivirus engine scans the binary code of files to find these strings. If it encounters with a known pattern, it alerts detection of the matching virus. Some of commonly known signature based techniques are:

- **String Scanning method:** Searches for sequence of bytes (strings) that are unique to a specific virus but can't be found in other programs. In this process, a known virus is analyzed precisely and a unique sequence of bytes extracted from the virus code. For example a virus Die.448 has a unique bit string like B440 B9E8 0133 D2CD 2172 1126 8955 15B4 40B9 0500 BA5A 01CD in its code by which we can detect it.

- **Wildcards method:** Including a wild card character like ? or * allows skipping bytes or byte ranges of code in the signature code and try to match next which will enable the antivirus engine to detect slightly modified virus. For example: presence of a wildcard character * in the malware code means that scanner will try to match the next byte in the file.

- **Mismatches method:** This method allows a negligible number of bytes in a signature string to be of random values, regardless of their position. For example, virus X has signature string of 2A 80 4D 01 F6 and following strings contains the same signature values in different places and also mismatched by 2.

  11 2A 32 01 17 80 4D 24

  0A D9 1E 17 80 F6 24 AA

  But using mismatched method we can still say that these two strings contains the virus X.

- **Generic Detection method:** This technique uses one common generic string as a signature string to detect several or all known variants of a family of viruses. When a virus has lots of its variant then the variants are analyzed to extract a common string that can identify the whole genre. This type of technique often uses the wildcard and mismatched technique to determine a common unique string.

- **Bookmarks method:** Bookmark method can ensure more reliable detection of viruses while it is used along with string scanning by negating the false positive. The byte distance between the start of the virus code and start the signature string vary in different viruses. So it can be used to bookmark particular viruses when string based scanning is used.

- **Smart Scanning:** Smart scanning optimizes the signature based detection. Some new variants of viruses try to hide their signature by inserting junk code or instruction in their code which have no effect in execution. Smart scanning skip junk instructions, such as NOPs (No Operation) in the host file to obtain the actual virus body.

- **Skeleton Detection:** The scanner parses the statements of a file line by line and drops all nonessential statements like statements which are not part of the virus or any blank gaps before actual procedure start and try to find essential virus code for execution of the virus which is called

skeleton of the virus. An antivirus named Kaspersky uses this particular method very efficiently to detect macro viruses.

2. **Heuristic Based Detection:** This type of detection helps in detecting new unknown or altered version of malware, but it produces false positive often. So is used with along with signature based scanner. As the name suggest this detection mainly focus on heuristics (experimental trial and error methods) like analysis of file structure and the code organization of the virus or CPU emulation of virus code. Some common heuristic based detection methods are:

- **Heuristics Analysis:** It is an expert based analysis that determines the susceptibility of a malware code by running it on virtual runtime environment and analyzing system towards particular risk using various decision rules or weighing methods. Multi Criteria Analysis (MCA) is one of the means of weighing.

- **Virus specific detection:** There are cases when the standard algorithm of the virus scanner cannot detect a particular malware. In such cases, a new detection code must be introduced to implement a virus specific detection algorithm to detect only specific malware. This method includes-

Ø **Filtering:** A virus only effects a particular type of known objects. So viruses can be classified according to its infection type. For example, executable viruses infect only programs such as .EXE and .COM, macro viruses only attack to files or that can perform macro statements. So whenever a particular set of files are scanned we have to check only the specific virus signature that is relevant to those files. Such filtering minimizes the searching time.

Ø **Static Decryptor Detection:** Some viruses encrypt their body to bypass string matching so they have a decryptor in the virus code. Detection of this decryptor code also result in efferent detection but it also produces false negative and false positive if not used with specific

types of viruses which used that particular decryption. So this method is used after filtering of encrypted virus like oligomorphic virus.

- **XRay scanning:** This method tries to find the weakness in encryption algorithm of viruses. It is also virus specific and can be only used with encrypted viruses and give more suitable result than static decryptor detection as its tries to find the encryption strategy.

3. **Behavioral Based Detection:** When a malware attach to its host or execute its code some particular behavioral pattern or dynamic signature they exhibit is not common to other programs and therefore by observing such signature we may detect them. But as these signatures are dynamic we need a continuous process for monitoring such abnormal behavior. A malware may produce dynamic signature like

- Opening an executable file, with both read and write permission.
- Reading the portion of the file header containing the executable's start address
- Writing the same portion of the file header.
- Seeking to the end of the file.
- Appending to the file.

This detection method monitors a running program's behavior in real time, watching for suspicious activity like the dynamic signature mentioned above. If any such activities are detected, it report to the antivirus engine that as a response prevents such operations from being executed or terminate the program. This detection method can only work when malware perform some malicious activity during runtime.

4. **Sandbox Detection or Emulation Detection:** This type of detection is also based on behavioral traits of the malware. Here the malware code under analysis is executed in an emulated environment or sandbox and the antivirus try to detect it during runtime based on behavioral traits.

But unlike the Behavioral Based detection malware code, it is run in a virtual environment and not in real system and hence, minimizes the risk of being affected.

5. **Data mining techniques:** It is the recent technology used for detecting malware which uses data mining techniques like analyzing very huge sets of infected data and try to find out particular behavioral pattern or try to find out a common signature strings from a large number of different variants of malware and using this signature try to detect a known malware or to classify a code for malware.

After detection, antivirus program try to remove the malware code from host program. If it is not possible to remove the viral code and the host program is not so significant than, the antivirus delete the infected file itself. On the other hand, if the infected file is important from system point of view then it pushes it to quarantine.



CHECK YOUR PROGRESS

4. What are Trojan horses?
5. Differentiate between spyware and adware.
6. Define antivirus.



4.9 LET US SUM UP

- The basic goal of computer security is Confidentiality, Availability and Integrity.
- Violation of these goals leads to a security treats.
- Malware is a term for all malicious programs, such as viruses, worms, Trojan horses, spyware, adware and scareware which are designed to infect and perform malicious activity on computers.

- Antivirus software is designed to protect system against malware. It is available as a standalone product and is also included in most security software packages.
- They use different static and dynamic method to identify malware and neutralize them.



4.10 FURTHER READING

- Stallings, W. (2006). Cryptography and network security: principles and practices. Pearson Education India.
- Canavan, J. E. (2001). Fundamentals of network security. Artech House.



4.11 ANSWERS TO CHECK YOUR PROGRESS

Answer 1: The three security goals are

- **Confidentiality:** It means protecting the information from disclosure to unauthorized parties.
- **Integrity:** It means keeping the data pure and trustworthy by protecting system data from intentional or accidental changes
- **Availability:** It refers to ensuring that authorized parties are able to access the information when needed.

Answer 2: A computer virus is an executable program that **replicates itself** or attached to a file where it infects the computer when the file is executed.

Answer 3: A worm is more independent than a virus. A pure worm works by itself as an independent object. The main feature that separates worms from viruses is that worms are self replicating. A worm can initiate network communication by itself and send copies to other computers. So there is no need for activation criteria or host process. As worms can spread rapidly across a network infecting every PC so they are the

most notorious of malwares.

Answer 4: Trojan horses are applications which appear to be useful, legitimate applications, but run malicious, hidden code. The application may appear to perform tasks, such as scanning for spyware, but actually steal personal data from your system. Executing Trojans may result in changing desktop wallpaper, creating popups, or even deleting files.

Answer 5: Spyware are the software that collects user sensitive information like browsing and searching habit, password, social interactions without your knowledge and uses such information to gain profit. Adware are the software that supports advertising. In general it is the entire program that downloads or displays unwanted banner advertisements in the software being used.

Answer 6: Antivirus software is a program or set of programs designed for searching, preventing, detecting and eliminating malware.



4.12 MODEL QUESTIONS

Q1. Define computer security?

Q2. What are the goals of computer security?

Q3. Give an example of computer virus. Explain its working principle.

Q4. What is the difference between computer virus and worms?

Q5. Why is scareware considered as malware?

Q6. Name any antivirus and explain how it works.

Q7. Briefly describe different detection mechanism used by antivirus software.

Q8. Why deception is needed for malware? Explain various deception strategy used by malwares.

Q9. Is deception strategy of malware and detection method of antivirus related to each other? Explain.

Q10. List out some of the common malware we encounter and list out whether they are viruses, worms, Trojan or any other malicious software.

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UNIT 5: CYBER CRIMES

UNIT STRUCTURE

5.1 Learning Objectives
5.2 Introduction
5.3 Cyber Crime
5.4 Hacking
5.5 Digital Forgery
5.6 Identity Theft
5. 7 Cyber Stalking
5.8 Cyber Terrorism
5.9 Cyber Defamation
5.10 Software Piracy
5.11 Information Technology Act, 2000
5.12 Let Us Sum Up
5.13 Further Reading
5.14 Answers to Check Your Progress
5.15 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- learn what constitutes cyber crime
- describe hacking, digital forgery, cyber stalking
- define identity theft, cyber terrorism and defamation
- learn about different types of software piracy
- describe different offences under IT Act 2000

5.2 INTRODUCTION

In the previous unit you have been introduced to the concept of computer security. We have learned about different types of computer virus and worms. Different threats like malware, spyware, adware and Trojan

horse were explored. Counter measures to deal with these threats like antivirus software were also explored.

In the present unit you will be introduced to the concepts of cyber crime and how cyber crimes are committed against individuals, institutions and state. Cyber crimes like hacking, digital forgery, cyber stalking, and cyber terrorism are some of the cyber crimes introduced in this unit. The IT Act 2000 which criminalizes cyber crime is also discussed in this unit.

You will be made familiar with the different cyber crimes and laws against cyber crime in this unit, and then in the next unit you will be made familiar with the basics of computer hardware configuration. Different hardware configuration of computers, motherboards and processors will be covered in the next unit.

5.3 CYBER CRIME

Computers have become an essential part of our life. And along with the widespread growth of computers, internet use is also expanding. Although the use of internet and technology has made the life of people easier, it has also given rise to a new type of crime - cyber crime. The term cyberspace is used to represent the electronic medium of computer networks, in which online communication takes place. This term not only represents the internet but also includes computers, computer networks, the internet, data, software etc. Cyber crime can be defined as any crime that is performed using a computer and network either as a tool or as a target. Cyber crimes are often referred to as computer crimes.

According to a definition in the book ‘‘Cyber Crime and the Victimization of women, Laws, Rights and Regulations’’ Cyber crime can also be defined as "Offences that are committed against individuals or groups of individuals with a criminal motive to intentionally harm the reputation of the victim or cause physical or mental harm, or loss, to the victim directly or indirectly, using modern telecommunication networks such as Internet (Chat rooms, emails, notice boards and groups) and mobile phones (SMS/MMS)".

Some of the common cyber crimes are mentioned below :

- computer hacking
- digital forgery
- cyber stalking
- identity theft
- identity fraud
- cyber terrorism
- cyber defamation
- software piracy
- cyber pornography
- cyber bullying
- unwarranted cyber surveillance
- cyber warfare

We will look at some of these cyber crimes in detail in the next few sections.

Cyber crimes are generally divided into two categories depending on the use or activity of the computer. In the first category, the computer is the target of the cyber crime. Some examples of this category of cyber crime include hacking, virus attacks and denial of service attacks. In the second category, the computer is the tool used to perform the cyber crime. Some examples of this category include cyber frauds, cyber stalking and cyber terrorism.

Cyber crimes can also be divided into different categories depending on the target of the crime. The cyber crime performed can be committed against an individual, an institution or against a state. An example of cyber crime committed against an individual can be cyber stalking. Similarly, an example of cyber crime committed against an institution can be hacking their websites. An example of cyber crime committed against a state is cyber terrorism or cyber warfare.

5.4 HACKING

Hacking is one of the most common cyber crimes. It can be defined as an illegal intrusion into a computer system or network. This is a type of

crime where an individual or institution's computer is broken into so that personal or sensitive information can be accessed. The act that is committed towards breaking into a computer system or network is known as hacking.

The person who performs the act of hacking is known as a hacker. The hacker tries to find the vulnerabilities in a person's or in the institutions computer system or passwords to exploit the weakness and gain access into the system. The hackers are usually highly skilled computer professionals. Depending on the intent of the hackers, the hackers are classified into different groups.

The first category of hackers are ethical hackers. Ethical hackers are persons who hack into the computer system with an aim to identify the weaknesses present in the system and not for any personal gain. Because of this they are also called white hat hackers. Mostly, ethical hackers hack into computer systems on a request from the organization itself to test vulnerabilities present in the system.

The second category of hackers are crackers. Crackers are persons who hack into the computer system with an aim to gain unauthorized access to the system or network for personal gain. They aim to steal sensitive and important personal data, or corporate data or bank information. Both types of hackers use a variety of software to enter a person's computer. Most of the victims are sometimes not even aware that they had been hacked.

5.5 DIGITAL FORGERY

Digital forgery is the digitization of the process of forgery. Forgery in traditional systems is the crime of falsely and fraudulently making or altering a document and even possessing such a forged document. Digital forgery is the crime of falsely and fraudulently making or altering a documents and pictures in the digital domain. Examples of digital forgery include counterfeit currency notes, forgery of postage and revenue stamps, forgery of mark

sheets etc. All of these acts of forgery are done by using computers and high quality scanners and printers.

There are different types of digital forgery. The most common types of digital forgery are mentioned below :

- **Document Forgery:** This type of forgery occurs when a legal document is forged or replicated by another person using digital means. This also includes forgery of mark sheets and revenue stamps.
- **Counterfeit Money Forgery:** This type of forgery occurs when the legal currency of a nation is forged or replicated by using digital means.
- **Digital Signature Forgery:** This type of forgery occurs when the signature of an individual is forged or replicated by another person using digital means.
- **Art Forgery:** This type of forgery occurs when a piece of art is replicated and sold as the original art piece. Sometimes the whole painting is forged and sometimes only the signature of a famous painter is forged into the painting with an intention to get more money.

5.6 IDENTITY THEFT

Identity theft is one of the oldest crimes in human history. Identity theft can be defined as stealing personal information of a person and impersonating as that person. The terms identity theft and identity fraud are often used interchangeably. But they refer to different crimes. In identity theft, a criminal impersonates another person who actually exists. In identity fraud, a criminal creates a fictional person and assumes this fictional person's identity. The criminal in identity fraud creates a whole new person, with both personal and financial details.

Identity theft is a much more common crime than identity fraud. Most of the information stolen is in identity theft is financial in nature regarding bank account or credit card details. But according to the victim's need different personal or financial information may be stolen. For example information like name, address, passport number, PAN number, bank account details, bank passwords, and debit or credit card details.

While most of the identity thefts are done for financial gain, there are many identity thefts done with other intentions too. According to a non-profit Identity Theft Resource Center, identity theft can be categorized into five types depending on the intent. These categories are mentioned below:

- **Criminal Identity Theft:** In this type of identity theft, the criminal impersonates as another person as he/she is held accountable for a crime. The criminal identifies himself as another person to the state authority by using simple documents such as fake identity cards. This is usually done to get the police or court authorities off their back. The victim's of this identity theft may never come to know of these crimes done using their false impersonations.

- **Financial Identity Theft:** This is the most common type of identity theft. In this type of identity theft the criminal uses another person's identity to obtain money, loans or any other financial services using the victim's identity. These types of crimes are usually found out only when the debts mount or when it is time to pay off the loan installments.

- **Identity Cloning:** In this type of identity theft, the criminal impersonates another person to conceal their own identity. The criminals are mostly persons hiding from debt collectors or who want to became someone else for personal reasons.

- **Medical Identity Theft:** This is a new type of identity theft where the criminals steal the identity of the victim's for medical benefits. The criminals pose as another person to get medical care like medical insurances and high cost drugs.

- **Child Identity Theft:** This is another type of identity theft where the criminals target minor children for their personal gain. The criminals steal the social security numbers of children and use is information for their own benefit.



CHECK YOUR PROGRESS

1. Define cyber crime?
2. Differentiate between identity fraud and identity theft.
3. Who are the crackers?

5.7 CYBER STALKING

Stalking can be defined as an act of harassment targeting the victim. Stalking includes various acts such as following the victim, making harassing phone calls, vandalizing victim's property, leaving written messages or objects etc. Cyber stalking can be defined as the act of stalking done by using the means of computer systems or internet. The terms cyber stalking and cyber bullying are often used interchangeably. But there is a difference between these two terms, even though in essence both are crimes. The term cyber bullying is generally used when the parties involved are not adults and includes teenagers or children.

In most of the cases of cyber stalking, the victim is harassed by the criminal by sending repeated storm of online messages and emails. The criminals often harass the victims by posting messages on websites or discussion groups. The criminals often try to track every moment of the victim's daily activity using the help of social media. Cyber stalkers use social media sites like Facebook, Twitter, MySpace to keep track of the victim's activities and location. In most of the cyber stalking cases, the stalkers are known to the victims and they use internet to stalk the victims. Also, in many cases, if the criminals find that online stalking does not have their desired effect, they then resort to both online and offline stalking. This crime is punishable by law in India and in the first conviction for cyber stalking the person was sent to jail for three months.

5.8 CYBER TERRORISM

Cyber terrorism can be defined as an act of terrorism that is committed using computer systems and networks. Spreading terrorism through the means of internet has become an attractive option for modern terrorists. This is due to the fact that the terrorists prefer using the internet and other advanced technology in comparison to traditional methods because these machines can be accessed remotely. Another term that frequency comes when we speak of cyber terrorism is cyber warfare. Cyber warfare can be defined as the action by a nation or a state to penetrate another nation's computers or networks for the purpose of causing damage.

In cyber terrorism, the terrorists use the internet to conduct violent acts that may cause loss of life or bodily harm. The terrorists not only target human property and life but also try to cause deliberate failure of functioning of government services by targeting communication networks. Government services like electric and solar power plants, air and rail traffic systems, telecommunication systems, medical services, police and military services are targeted mostly to paralyze the victim country. Large scale disruptions of these services are caused by using tools like computer viruses, worms and other malicious software. Most of the government websites are brought down by performing denial-of-service (DOS) attacks. In 1998, cyber terrorism attack was done by ethnic Tamil guerrillas by disrupting the Sri Lankan embassies using DOS attacks. The Sri Lankan embassies were attacked by sending around 800 e-mails a day for over a two week period.

5.9 CYBER DEFAMATION

Cyber defamation can be defined as defamation done using digital media usually through the internet. When a person publishes defamatory matter about someone on a website or sends e-mails containing defamatory information to all of that person's friends, it is termed as cyber defamation. The defamation can be done using words spoken orally or in written form or by signs or similar visible representations.

In most cases of cyber defamation when it is done with no serious grudge, it can be stopped by a cease and desist letter and by removing the messages from the digital media. But, if it is done with serious intent then the law can be used to punish the criminal. Cyber defamation not only harms the individual victim but also his family, the individual's organization and sometimes even the state or country of the victim. This depends on who the victim is and on what position the individual is currently working on. In such cases, the target for cyber defamation is often chosen not for personal grudge but for damaging the image of the organization or the country of the individual. The harm that is caused in defamation by using digital media is widespread and often irreparable as the information is already out over the whole internet. Some of the digital media that is used to perform cyber defamation are mentioned below :

- world wide web
- social networking sites
- email and messaging
- discussion groups
- bulletin boards

In India, there are two types of liability for defamation. The first category involves cases in which the liability is of the primary publishers of the defamatory content material. This category includes persons who has written the defamatory content material and then published this material in the cyber space. The second category involves cases in which the liability is of the internet service providers or bulletin board operators. This category includes persons who had authorized publication of the defamatory materials.

5.10 SOFTWARE PIRACY

Software piracy can be defined as the unauthorized copying or illegal distribution of copyrighted materials. Software piracy causes loss of

revenue for the makers which in turn lads to the increased prices of software for the licensed consumers. Most of the software has an end user license agreement with the consumers. Violation of this agreement leads to software piracy.

Software piracy has been categorized into six categories. Let us look at each of these six software piracies.

- **Softlifting:** Softlifting or softloading is one of the most common types of software piracy. Softlifting is defined as sharing a program or software with someone who is not authorized to use that software in accordance with the licensing agreement. Most often a single licensed copy of the software is brought and but then it is loaded into multiple computer systems. Softloading is quite common in college campuses and businesses.
- **Internet piracy:** With the increasing number of internet users every year the number of persons committing internet piracy has grown tremendously. Internet piracy occurs when software is downloaded from the internet. There are a lot of websites where software is available for free unlimited download without following any licensing agreements.
- **Software Counterfeiting:** Software counterfeiting is the illegal duplication, distribution and sale of copyrighted software material. In software counterfeiting it is common to make duplicate copies of the programs, the documentation and also the licensed agreements. Microsoft products are one of the most common products to be counterfeited.
- **Hard Disk Loading:** Hark disk loading software piracy occurs when new computers are sold with unauthorized software. This is done by hardware dealers to make their products more attractive to the buyers.
- **Renting:** Renting involves the process of renting software to another person temporarily who does not have the authorized permission or license to use the software.
- **Original Equipment Manufacturer (OEM) Unbundling:** In this type of software piracy, sellers sell standalone software which are originally meant to be included with some other licensed product.

5.11 INFORMATION TECHNOLOGY ACT, 2000

The Information Technology (IT) Act, 2000 is an Act of the Indian Parliament enacted with the prime objective to create an enabling environment for commercial use of information technology. The IT Act specifies the acts which have been made punishable by law regarding cyber crime and electronic commerce in India. The IT Act has amended various sections of the Indian Penal Code (IPC) of 1860, the Indian Evidence Act of 1872, the Bankers Book of Evidence Act of 1891 and the Reverse Bank of India Act of 1934 to include cyber crimes done using new technologies. A major amendment of the IT Act was made in the year 2008 to include penalties for offensive messages, child pornography, cyber terrorism and voyeurism. In 2013, another amendment was made to include the offence of cyber stalking. Let us look at the various offenses that have been made punishable under the IT Act.

Some of the cyber crimes under the IT Act are mentioned below :

- Tampering with Computer source documents - Sec.65
- Hacking with Computer systems, Data alteration - Sec.66
- Sending any message that is offensive - Sec 66 A
- Publishing obscene information in electronic form - Sec.67
- Un-authorised access to protected system Sec.70
- Breach of Confidentiality and Privacy - Sec.72
- Publishing false digital signature certificates - Sec.73

Some of the cyber crimes under IPC are mentioned below :

- Cyber stalking - Sec 354D IPC
- Web-Hijacking - Sec. 383 IPC
- Bogus websites, cyber frauds - Sec 420 IPC
- Email spoofing - Sec 463 IPC
- Forgery - Sec 463 IPC
- Cyber defamation - Sec 499 IPC
- E-Mail Abuse - Sec.500 IPC

- Sending threatening messages by email - Sec 503 IPC



CHECK YOUR PROGRESS

4. What are the different types of software piracy?
5. Define cyber stalking.
6. What are the different types of medium used for cyber defamation?
7. What is the IT Act, 2000?



5.12 LET US SUM UP

- Cyber crime can be defined as any crime that is performed using a computer and network either as a tool or as a target.
- Hacking can be defined as an illegal intrusion into a computer system or network. This is a type of crime where an individual or institution's computer is broken into so that personal or sensitive information can be accessed. The person who performs the act of hacking is known as a hacker.
- Ethical hackers are persons who hack into the computer system with an aim to identify the weaknesses present in the system and not for any personal gain. Crackers are persons who hack into the computer system with an aim to gain unauthorized access to the system or network for personal gain.
- Digital forgery is the digitization of the process of forgery. Forgery in traditional systems is the crime of falsely and fraudulently making or altering a document and even possessing such a forged document. Digital forgery is the crime of falsely and fraudulently making or altering a documents and pictures in the digital domain.

- Identity theft can be defined as stealing personal information of a person and impersonating as that person. In identity theft, a criminal impersonates another person who actually exists. In identity fraud, a criminal creates a fictional person and assumes this fictional person's identity.
- Cyber stalking can be defined as the act of stalking done by using the means of computer systems or internet. The term cyber bullying is generally used when the parties involved are not adults and includes teenagers or children.
- Cyber terrorism can be defined as an act of terrorism that is committed using computer systems and networks. Cyber warfare can be defined as the action by a nation or a state to penetrate another nation's computers or networks for the purpose of causing damage.
- Cyber defamation can be defined as defamation done using digital media usually through the internet. When a person publishes defamatory matter about someone on a website or sends e-mails containing defamatory information to all of that person's friends, it is termed as cyber defamation.
- Software piracy can be defined as the unauthorized copying or illegal distribution of copyrighted materials.
- The Information Technology (IT) Act, 2000 is an Act of the Indian Parliament enacted with the prime objective to create an enabling environment for commercial use of information technology. The IT Act specifies the acts which have been made punishable by law regarding cyber crime and electronic commerce in India.
- A major amendment of the IT Act was made in the year 2008 to include penalties for offensive messages, child pornography, cyber terrorism and voyeurism.



5.13 FURTHER READING

- Chander, H. (2012). Cyber laws and IT protection. PHI Learning Pvt. Ltd..
- Singh, K. K. (2011). Information security and cyber law. kk singh.
- Godbole, N., & Belapure, S. (2011). Cyber Security: Understanding Cyber Crimes, Computer Forensic and Legal Perspective.



5.14 ANSWERS TO CHECK YOUR PROGRESS

Answer to 1: Cyber crime can be defined as any crime that is performed using a computer and network either as a tool or as a target.

Answer to 2: In identity theft, a criminal impersonates another person who actually exists. In identity fraud, a criminal creates a fictional person and assumes this fictional person's identity. The criminal in identity fraud creates a whole new person, with both personal and financial details whereas in identity theft, the criminal impersonates an already existing person.

Answer to 3: Crackers are persons who hack into the computer system with an aim to gain unauthorized access to the system or network for personal gain.

Answer to 4: There are six types of software piracy. They are - softloading, internet piracy, renting, software counterfeiting, hard disk loading and OEM unbundling.

Answer to 5: Cyber stalking can be defined as the act of stalking done by using the means of computer systems or internet. In most of the cases of cyber stalking, the victim is harassed by the criminal by sending repeated storm of online messages and emails. The criminals often harass the victims by posting messages on websites or discussion groups.

Answer to 6: The different types of media used for cyber defamation are world wide web, social networking sites, discussion groups, bulletin boards and using emails and messages.

Answer to 7: The Information Technology (IT) Act, 2000 was enacted with the prime objective to create an enabling environment for commercial use of information technology. The IT Act specifies the acts which have been made punishable by law regarding cyber crime in India.



5.15 MODEL QUESTIONS

Q1. What are the different types of cyber crime?

Q2. Define digital forgery. What are the different types of digital forgery?

Q3. Differentiate between cyber trolling and cyber bullying.

Q4. What is cyber warfare? Give an example.

Q5. Differentiate between identity fraud and identity theft?

Q6. Describe the different types of identity theft?

Q7. Describe the different categories of cyber defamation.

Q8. Define hacking. How are the ethical hackers different from crackers?

Q9. Define cyber stalking. How is the crime of cyber stalking performed? Whch section of IT Act deals with cyber stalking?

Q10. Describe the laws related to cyber crime in India?

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UNIT 6: HARDWARE CONFIGURATION

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Different Hardware Configuration (Laptop/Desktop)

6.4 Typical RAM/ Hard Disk Size

6.4.1 Random Access Memory (RAM)

6.4.2 Hard Disk

6.5 Motherboard

6.6 Original Equipment Manufacturer (OEM)

6.7 Processor Series

6.8 FCC and UL for Quality Measure

6.9 Let Us Sum Up

6.10 Further Reading

6.11 Answers To Check Your Progress

6.12 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- define hardware configuration of a system
- describe various hardware configuration for laptop and desktop
- classify various types of RAM/HARD DISK
- describe various components of Motherboard
- define the concept of original equipment manufacturer
- classify various processor
- define the role of federal communications commission
- define the role of Underwriters Laboratories Inc.

6.2 INTRODUCTION

Hardware configuration of a computer system defines the details and system resource settings allotted for a system. In other words it can be defined as mutually supportable size and capacity of different components of the system to achieve the overall best performance. A computer system consists of many components like CPU, RAM, and Graphics Card etc. The configuration of a computer is supposed to be designed in such a way that all the resources are utilized properly. For example, a high end processor with a small size main memory (RAM) may be unutilized most of the time. Similarly an old series of processor with a large size of main memory, most of the memory will be remain unutilized. Many computer specialists improve hardware performance by adjusting configurations, which may also include settings for the motherboard and the BIOS, as well as the bus speeds. With newer technology, most computers have plug-and-play (PnP) allowing the OS to detect and configure external and internal peripherals, as well as most adaptors. PnP has the ability to locate and configure hardware components without needing to reset jumpers and dual in-line package (DIP) switches.

6.3 DIFFERENT HARDWARE CONFIGURATION (LAPTOP/DESKTOP)

A computer system comprise of various core components and subordinate component. Basic functionality of the system is provided by the core component whereas the subordinate part enhance the basic functionality to support different applications like graphics imaging, multimedia applications etc. PCs are a package of matched components. In order to improve the performance various components are matched. There is no point of having a super fast Central Processing Unit (CPU) with slow Random Access Memory (RAM). Such type of combination always produces a slow system. The PC core components ranked from fastest to slowest are:

- CPU chip-fastest
- RAM
- Display adapter
- Read-Only Memory (ROM)
- Fixed disk drive
- Universal Serial Bus (USB)
- Network adapter
- CD-ROM drive
- CD Rewriteable (CD-RW) drive
- Digital Versatile Disk (DVD) drive
- Floppy disk drive
- Parallel port
- Serial port
- Mouse
- Keyboard

Core and subordinate hardware components are physically installed in the PC or connected to it. PC hardware core components include the CPU chip, the ROM, the RAM, chip sets and buses, the power supply, serial and parallel Input/Output (I/O) ports, the floppy disk controller and drive, the fixed disk controller and drive, the CD-ROM drive, the DVD-ROM drive, the display adapter and monitor, the keyboard, and the mouse. Subordinate components are sound cards, LAN adapters, video cameras, and so forth. Some of the recommended configurations for desktop computers are mentioned below:

Processor (CPU):	Intel Core i5-6xxx or equivalent
Operating System:	Microsoft **Windows 10 Professional** x64 SP1 (free via **Imagine**. Restrictions may apply.)
Memory:	8 GB RAM
Storage:	512 GB internal Solid State Drive (SSD) or 1 TB internal HDD
Sustainability	EPEAT Silver rating (preferably EPEAT Gold)
Monitor/Display:	24" " LCD monitor
Network Adaptor:	802.11ac 2.4/5 GHz wireless adaptor
Other:	Webcam, lock, external drive for backups

Following are recommended minimum computer configurations:

Processor (CPU):	Intel Core i3-3xxx
Operating System:	Microsoft **Windows 7 Professional** x64 SP1. UMass Amherst IT recommends Windows 10 Professional. (Both can be obtained for free via **Imagine**. Restrictions may apply.)
Memory:	4 GB RAM
Storage:	500 GB internal hard drive
Monitor/Display:	15" LCD monitor
Other:	Dual-band WiFi-certified 802.11 a/g - compliant adapter

Some of the recommended configurations for Laptops and Computers are mentioned below:

Processor (CPU):	Intel Core i5-6xxx or equivalent
Operating System:	Microsoft **Windows 10 Professional** x64
Memory:	8 GB RAM
Storage:	500 GB internal hard drive
Monitor/Display:	14" LCD monitor, resolution of 1600 x 900 or better.
Network Adapter:	802.11ac 2.4/5 GHz wireless adaptor
Other:	Internal or external Webcam, lock, carrying case, external hard drive for backups

Following are recommended minimum Laptop computer configurations:

Processor (CPU):	Intel Core i3-3xxx or equivalent
Operating System:	Microsoft **Windows 7 Professional** x64 SP1. UMass Amherst IT recommends Windows 10 Professional. (Both operating systems can be obtained via **Imagine**. Restrictions may apply)
Memory:	4 GB RAM
Storage:	500 GB internal hard drive
CD-ROM:	DVD/CD-RW (optional)
Monitor/Display:	13" LCD monitor
Network Adapter:	Dual-band 802.11a/g - compliant adapter
Other:	Lock, carrying case

6.4 TYPICAL RAM/ HARDDISK SIZE

6.4.1 Random Access Memory (RAM)

RAM is the working area of the PC. While processing, RAM temporarily holds all the data. It holds both programs and data. While executing a program on certain data, the program along with the data usually resides in RAM. In a Windows environment, RAM is virtualized. The operating system (OS) has the capability of holding components and applications in their virtual memory which may have size of many gigabytes. The OS translates the virtual address into a combination of disk accesses and memory paging and allocation. Most of the activity of PC requires swapping data between RAM and the CPU. Because of the volatile nature of RAM, the data resides on the RAM are transferred to the disk as soon as the PCs are powered down. RAM is classified and rated by access time. The slowest RAM chips were 250 nanoseconds (ns), and the fastest is around 10 ns. Typically RAM chip speeds are about 50 to 70 ns. Most PC RAM is comprised of DRAM chips that must be continually refreshed. SRAM is very fast and more expensive than DRAM. SRAM is used for external CPU cache.

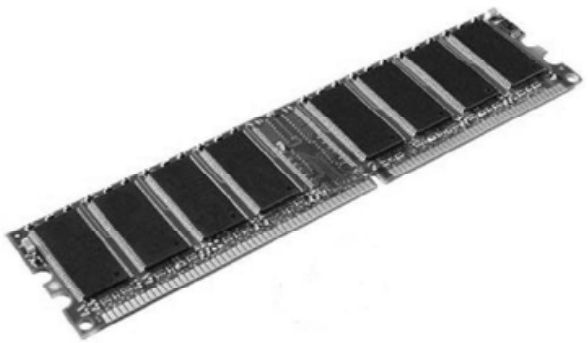


Figure 6.1: Random Access Memory

Basically, there are two types of RAM, namely Static RAM (SRAM) and Dynamic RAM (DRAM). Some other types of RAM include EDO (Extended Data Output) RAM, SDRAM (Synchronous DRAM) and DDR (Double Data Rate) SDRAM. Now-a-days different versions of DDR SDRAM is available. DDR3 is the latest in DDR memory technology, with newer desktop computer PCs, laptops, and servers requiring high-speed. DDR3 has improved

memory speed when compared to DDR2 over 100% and when compared to DDR over 300%.

6.4.2 Hard Disk

Hard Disk or hard disk drives (HDD) are data storage device which uses magnetic storage. It is non volatile storage of data that retains data even after the power is off. It was first introduced by IBM in 1956. HDDs became the dominant secondary storage device for general-purpose computers by the early 1960s. The following diagram below shows the moving disk head mechanism applied to a disk drive. As shown in the figure 6.2 disk platter is of circular shape. The information is recorded on both of the surfaces which are covered with magnetic material. The disk surface is subdivided into tracks which are further subdivided into sector. Sector is the smallest unit where data can be read or write. When the disk is in use a drive motor rotate it at a constant speed.

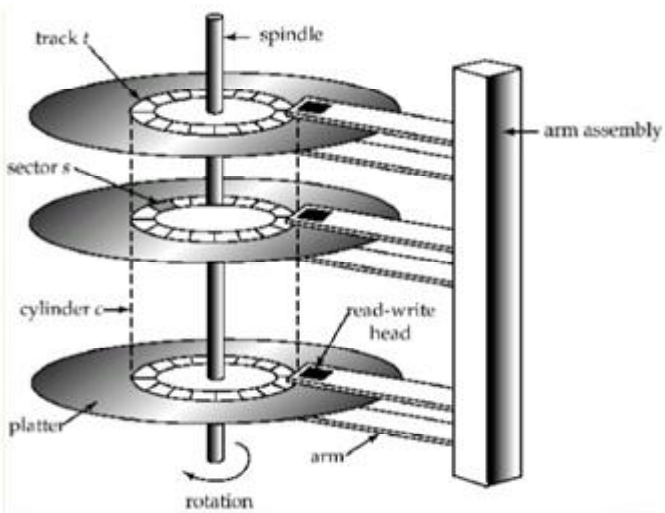


Figure 6.2: Moving Disk Head Mechanism

The read-write head moves to a particular sector to read or write the data. It stores information magnetically on a sector.



Figure 6.3: Typical Hard Disk

Hard Disk was historically produced by more than 200 companies. But after extensive industry consolidation, most current units are manufactured by Seagate, Toshiba, and Western Digital. The size of a hard disk is expressed in gigabyte and terabyte. Hard disk of size 320 GB to around 8TB are available in the market.



CHECK YOUR PROGRESS

1. Define Hardware configuration of a system.
2. What are the types of a RAM?
3. Write a few names of company that produces Hard Disk.

6.5 MOTHERBOARD

Motherboard is one of the most essential parts of a computer system. It is the main printed circuit board found in general purpose computer and other expandable systems. It provides a platform for other crucial component to interact with each other. The motherboard typically contains the system bus, processor and coprocessor sockets, memory sockets, serial and parallel ports, expansion slots, and peripheral controllers. Sometimes it is also referred to as System Board or Main Board. The figure 6.4 shows the components of a motherboard. Various parts are numbered and referred by the accompanying legend.

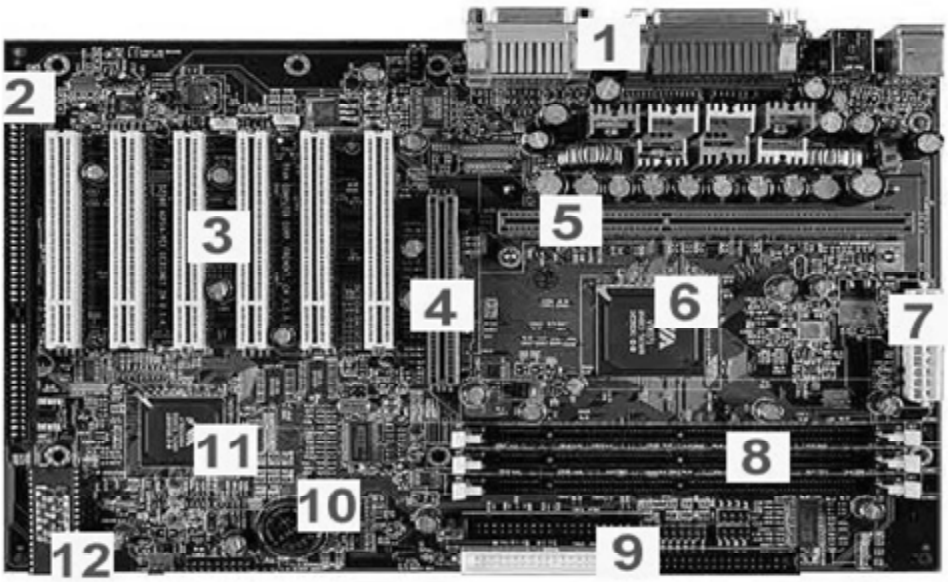


Figure 6.4: Mother Board

1. Ports
2. ISA Slot
3. PCI Slots
4. AGP Slot
5. CPU Slot
6. Chipset (Northbridge)
7. Power connector
8. Memory sockets
9. I/O connectors
10. Battery
11. Chipset (Southbridge)
12. BIOS chip

Motherboard Series: A number of companies around the globe manufacture motherboard. The most popular among them are Intel, Asus, Acer, MSI, AOpen, ABIT, Biostar, Gigabyte etc.

During 1980s the most popular computer of like Apple II and IBM PC had published schematic diagram of Motherboard. The Apple II was an 8-bit home computer which was one of the first highly successful mass-produced

micro computer products. The IBM Personnel Computer, popularly known as IBM PC was introduced in on August 12, 1981. Both of these computers actually provided a way for third party replacement of motherboard. Prior to that a digital computer contains a number of printed circuit boards in within a card cage where components are connected by a backplane. During the late 1980s and early 1990s, it became economical to move an increasing number of peripheral functions onto the motherboard. In the late 1980s motherboard started including facilities for connecting low speed peripherals like keyboard, mouse etc. along with parallel ports. By the late 1990s, many personal computer motherboards included consumer grade embedded audio, video, storage, and networking functions without the need for any expansion cards at all. Higher-end systems for 3D gaming and computer graphics typically retained only the graphics card as a separate component. Following are some of the motherboard manufactured by Intel:

Table 6.1: Some of the Motherboard manufactured by Intel

Chipset	**Release Date**	**Processor Brands**
860	May 2001	Xeon
845	January 2002	Celeron, Pentium 4
850	November 2000	Pentium 4
850E	May 2002	Pentium 4
845E	May 2002	Celeron, Celeron D, Pentium 4
845G	May 2002	
845GV	October 2002	
845GL	May 2002	Celeron, Pentium 4
845GE	October 2002	
845PE		
848P	August 2003	Pentium 4, Pentium 4 EE, Pentium D, Celeron, Celeron D

865P	May 2003	Pentium 4, Celeron D
865PE		Pentium 4, Pentium 4 EE, Pentium D, Pentium Extreme Edition, Celeron, Celeron D, Core 2, Pentium Dual Core
865G		
865GV	September 2003	
875P	April 2003	Pentium 4, Pentium 4 EE, Pentium D, Pentium Extreme Edition, Celeron, Celeron D, Xeon
E7205	November 2002	Pentium 4
E7500	February 2002	Xeon
E7501	December 2002	Xeon, Pentium M
E7505	November 2002	Xeon

Based on the requirement of the processing power various types of motherboard can be used in computer. Nowadays various computers use specially designed motherboard for playing computationally intensive video games. Some of them along with the supported processor are listed below:

Table 6.2: Some supported processor

Name of the Mother Board	**Description**
Z370 AORUS Gaming 7	Supports 8th Gen Intel® Core™ Processors
GIGABYTE AORUS GA-Z270X-Gaming 9	Supports 7th/6th Generation Intel Core Processors
MSI Pro Series Intel Z270	Supports 7th/6th Gen Intel Core/Pentium/Celeron processors
ASUS ROG Maximus IX Hero Z270	supports 7th/6th Generation Intel Core i7/ Core i5/ Core i3/ Pentium/ Celeron Processors

6.6 ORIGINAL EQUIPMENT MANUFACTURER (OEM)

Original Equipment Manufacturer or OEM is a company which produces different parts of a product to be used by other company. The company that buys the part of a product uses it to produce the final usable product. Since this company incorporates features or services to the original item, it is sometimes referred to as Value Added Reseller (VAR). OEM often customizes designs based on the requirement of VAR. For example, Microsoft is company that issues Windows Operating system for PCs manufactured by different company like HP, Dell, Acer etc. These companies incorporate windows operating system into its PCs and then sell a complete system directly to the public. So Microsoft is an OEM whereas other companies can be called as VAR. Seagate, Western Digital Technologies Inc and Toshiba are also OEM which manufacture hard disk used by most of the PC manufacturers.

6.7 PROCESSOR SERIES

Processor is the heart of a computer system. The processor executes instructions, performs calculations, and coordinates input/output operations. It is also sometimes called Central Processing Unit.



Figure 6.5: An Intel 80486DX2 CPU (as seen from above)

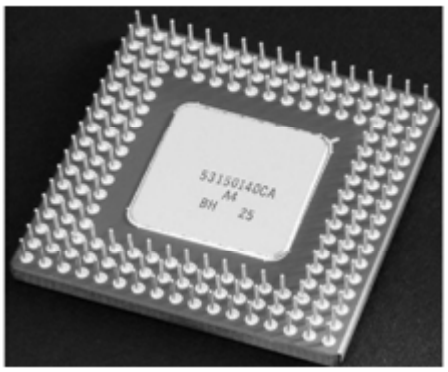


Figure 6.6: Bottom side of an Intel 80486DX2, showing its pins

During the course of their history the form, design and implementation have changed retaining its fundamental operations. The form, design, and implementation of CPUs have changed over the course of their history, but their fundamental operation remains almost unchanged. The CPU comprises of the Arithmetic and Logic Unit (ALU) along with some registers. The ALU performs arithmetic and logic operations on the operand that supplies to it from the registers. The control unit coordinates the fetching and execution of instruction. Intel is the pioneer in manufacturing processor. In 1971 it designed a four bit processor Intel 4004. From 1971 onwards Intel designed a number of series of processor which includes Celeron, Pentium series, Dual Core, Core 2 Duo and now core i3 to core i9. Latest 64 bit core i9 processor consists of ten cores having base frequency 3.30 GHz. Intel. Apart some other companies such AMD, Qualcomm, NVIDIA, IBM, Samsung, Motorola also manufacture their own processor.

6.8 FCC AND UL FOR QUALITY MEASURE

FCC which stands for Federal Communications Commission enacted electromagnetic-interference (EMI) regulations for various products such as transmitters, receivers, information technology, and similar microprocessor-based equipment. It rates personnel computer and other equipment between two classes namely class A and class B. This ratings or certification is issued on the basis of the emitted radiation by a computer. Class A requirements are satisfied by almost all personnel computer which means they are suitable for office use. Class B machines, which are suitable

for anywhere, including the home, must pass more stringent tests. The radio frequency emissions of such machines are so low that they do not interfere with other devices such as radios and TV. The FCC is supposed to rate computer component and systems before they are released for sale. UL (Underwriters Laboratories Inc.) has been regarded as one of the most trusted resources for product safety testing, certification and information for more than a century. UL is an American safety consulting and certification company headquartered in Northbrook, Illinois. It maintains offices in 46 countries. It was established in 1894 by William Henry Merrill, in the name of Underwriters' Electrical Bureau. Later it was known as Underwriters Laboratories. It participated in the safety analysis of many of that century's new technologies, most notably the public adoption of electricity and the drafting of safety standards for electrical devices and components. It published its first standard in 1903. The next year it made its debut with the labeling of a fire extinguisher. In 1905, UL established a Label Service for certain product categories that require more frequent inspections. Underwriters Laboratories transformed from a non-profit organization to a for-profit company in the U.S.A on January 1, 2012 with a new introduction UL LLC, a limited liability corporation, took over Underwriters Laboratories' product testing and certification business.



CHECK YOUR PROGRESS

4. Write the names of various parts of a Motherboard
5. Write a few names of a Motherboard Manufacturer
6. Define Original Equipment Manufacturer.
7. State the role of FCC and UL.



6.9 LET US SUM UP

- Hardware configuration of a computer system defines the details and system resource settings allotted for a system. In other words it can be defined as mutually supportable size and capacity of different components of the system to achieve the overall best performance.
- A computer system comprise of various core components and subordinate component. Basic functionality of the system is provided by the core component whereas the subordinate part enhance the basic functionality to support different applications like graphics imaging, multimedia applications etc. PCs are a package of matched components.
- RAM is the working area of the PC. While processing, RAM temporarily holds all the data. It holds both programs and data. While executing a program on certain data, the program along with the data usually resides in RAM.
- Hard Disk is a data storage device which uses magnetic storage. It is non volatile storage of data that retains data even after the power is off. It was first introduced by IBM in 1956.
- Mother board is one of the most essential parts of a computer system. It is the main printed circuit board found in general purpose computer and other expandable systems. It provides a platform for other crucial component to interact with each other.
- OEM or Original Equipment Manufacturer is a company which produces different parts of a product to be used by other company. The company that buys the part of a product uses it to produce the final usable product.
- Processor is the heart of a computer system. The processor executes instructions, performs calculations, and coordinates input/output operations. It is also sometimes called Central Processing Unit.
- FCC which stands for Federal Communications Commission enacted electromagnetic-interference (EMI) regulations for various products such as transmitters, receivers, information technology, and similar

microprocessor-based equipment.

- UL (Underwriters Laboratories Inc.) has been regarded as one of the most trusted resources for product safety testing, certification and information for more than a century. It is a an UL is an American safety consulting and certification company headquartered in Northbrook, Illinois.



6.10 FURTHER READING

- Websites University of Massachusetts, Amherst. https://www.umass.edu/it/support/hardware/recommended-minimum-computer-configurations-windows
- Juniper Networks Inc (2008). Hardware, Installation, and Software Configuration Guide



6.11 ANSWERS TO CHECK YOUR PROGRESS

Answer to 1: Hardware configuration of a computer system defines the details and system resource settings allotted for a system. In other words it can be defined as mutually supportable size and capacity of different components of the system to achieve the overall best performance.

Answer to 2: Basically there are two types of RAM, namely Static RAM (SRAM) and Dynamic RAM (DRAM). Some other types of RAM include EDO (Extended Data Output) RAM, SDRAM (Synchronous DRAM) and DDR (Double Data Rate) SDRAM.

Answer to 3: Current Hard Disks are manufactured mostly by Seagate, Toshiba, and Western Digital.

Answer to 4: The names of a few parts of a motherboard are respectively Ports, ISA Slot,PCI Slots, AGP Slot, CPU Slot, Chipset (Northbridge), Power connector, Memory sockets, I/O connectors, Chipset (Southbridge), BIOS chip.

Answer to 5: The most popular Moother Board manufacturers are Intel, Asus, Acer, MSI, AOpen, ABIT, Biostar, Gigabyte etc.

Answer to 6: OEM or Original Equipment Manufacturer is a company which produces different parts of a product to be used by other company. The company that buys the part of a product uses it to produce the final usable product.

Answer to 7: FCC which stands for Federal Communications Commission enacted electromagnetic-interference (EMI) regulations for various products such as transmitters, receivers, information technology, and similar microprocessor-based equipment. It rates personnel computer and other equipment between two classes namely class A and class B. UL (Underwriters Laboratories Inc.) has been regarded as one of the most trusted resources for product safety testing, certification and information for more than a century.



6.12 MODEL QUESTIONS

Q1. Define core and subordinate component of a computer system.

Q2. Give one configuration for each laptop and desktop computer.

Q3. Define platter, track and sector of a Hard Disk.

Q4. Write short note on FCC and UL.

Q.5. Define OEM. How is OEM related to VAR?

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UNIT 7 : INTRODUCTION TO OPERATING SYSTEM

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Definition of Operating System

7.4 Functions of Operating System

7.5 Types of Operating System

- 7.5.1 Single User Operating System
- 7.5.2 Multi User Operating System
- 7.5.3 Single Tasking Operating System
- 7.5.4 Multi Tasking Operating System
- 7.5.5 Multiprogramming Operating System
- 7.5.6 Real Time Operating System
- 7.5.7 Network Operating System
- 7.5.8 Distributed Operating System

7.6 Let Us Sum Up

7.7 Further Reading

7.8 Answers to Check Your Progress

7.9 Model Questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- learn about the basic definition of operating systems
- describe the different functions of operating systems
- distinguish between the various types of operating systems
- distinguish between network operating system and distributed operating systems.

7.2 INTRODUCTION

Operating systems have evolved through a number of phases during the last half of a century or earlier. The earliest electronic computer developed

in the mid-1940s had no operating system at all. At that time, the machines were equiped with a console consisting of toggle switches and display lights. There were no programming languages or translators for developing high-level language programs and converting them to machine understandable instruction. The scene was improved from 1960 onwards. A lot of new techniques and technology were developed and finally the concept of operating system came. Operating System is an important component of a computer. The primary objective of an operating system is to make computer system convenient to use and utilise computer hardware and various resources in an efficient manner. An operating system is a large set of software which is also an interface between users and computer systems. It is a system software. Operating system also manages resources of the computer system, such as memory, processor, file system and input/output devices.

The introductory concepts and principles of operating system will be the main issues for our discussion in this unit. Moreover, various types of operating system will also be covered in this unit.

7.3 DEFINITON OF OPERATING SYSTEM

A computer system is made up of hardware, operating system and user interface. Computer software can be divided into *system programs* which manage the operation of the computer itself and the *application programs,* which solve problems for their users. **Operating System i**s the most fundamental of all the system programs (or System Software). The operating system controls the entire computer's resources and provides the base upon which the application programs can be written.

We can define operating system in different ways. Some of the definitions are: An operating system is program that makes the computing power available to users by controlling the hardware. Another definition is that operating system is a program that controls the execution of application programs. It is a set of processes permanently or transitively resident within the computer that makes the resources of the computer system available to the user in a consistent, reliable, friendly way.

Operating system can be divided into two parts: the *Kernel* and the *shell*. The kernel is the essential centre of a computer operating system, the core that provides basic services for all other parts of the operating system. A synonym of kernel is *nucleus*. A kernel can be contrasted with a shell, the outermost part of an operating system that interacts with user commands. *Kernel* and *shell* are terms used more frequently in UNIX. Users interact with operating system through *Command Line Interfaces* (CLIs) or *Graphical User Interfaces* (GUIs). The operating system thus contributes 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.

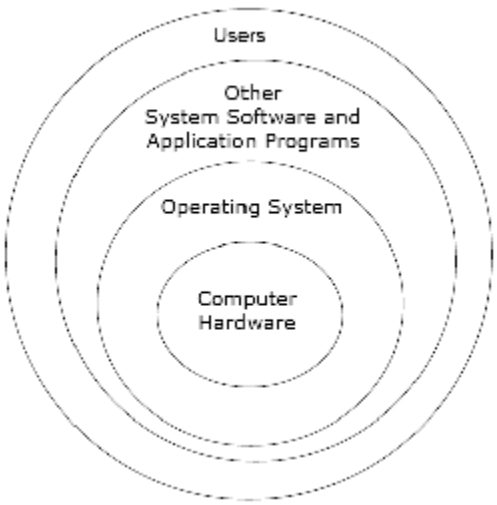


Figure 7.1: Computer System

7.4 FUNCTIONS OF OPERATING SYSTEM

There are various functions performed by an operating system. The basic functions are :

1. Input/Output management
2. Memory management
3. Process management
4. File and directory management
5. Security management
6. Command interpretation

1. Input/Output management : An operating system makes efficient usage of input and output devices and controls them properly. The input/ output management module of the operating system coordinates and assigns different input and output devices, namely terminals, printers, disk drives, tape drives ete. It controls all input and output devices, keeps track of input and output requests, issues commands to these devices and takes measures which would ensure that data is transmitted efficiently and correctly to and from input and output devices.

2. Memory or storage management : Memory is an important resource for a computer system. So memory allocation and deallocation for programs and data is an another function of an operating system. Memory management module of an operating system takes care of allocation and de-allocation of main memory to various procsses. It allocates the main memory and secondary memory to the system programs, user programs and data.

3. Process management : Process can be defined as a program in execution. It is the job which is currently being executed by the processor (CPU). During its execution, a process would require certain system resources, such as processor time, main memory, files, input and output devices etc. UNIX operating system supports multiple processes simultanously. The process management module of UNIX takes care of creation and termination of processes, assigning required resources to different processes currently running, scheduling processor's time to different processes etc.

4. Files and directory management : Files and directories are also properly managed by an operating system. Data is stored in a computer system as files. The file management module of the operating system would manage files as well as directories held on various storage devices as well as transfer of files from one storage device to another device. Thus, file management takes care of organization, storage, retrieval, naming, sharing and protection of different files. It also allows files to be read and modified by using text editors or some other file manipulation software packages.

5. Security management : It is also one of the most important function of an operating system to protect its various resources from the outer world. Security management module of the operating system which are executing concurrently in the memory, in such a way that system can ensure data security and integrity. That is, it protects data and program stored in the computer system from destruction and unauthorised access. It keeps different programs and data in such a way that they donot interfere with each other. Moreover, it protects files from being accessed or modified by unauthorised users.

Role of Operating System :

- Must communicate with the PC's hardware
- Works with the BIOS to provide access to devices such as hard drives
- Communicates with device drivers
- Provides a user interface

Let us explain these in details :

To ***communicate with the PC's hardware***, the operating system starts running immediately after the PC has finished its Power-On Self Test (POST), when it takes control of the PC. The operating system works with the BIOS to provide access to devices such as hard drives, floppy drives, keyboards, mouse, and basic video. If a user wants to access a file on a diskette in a floppy drive, the operating system passes the request to the appropriate set of BIOS instructions that tells the floppy controller to send the requested information to RAM.

If the BIOS is unable to talk with the hardware, the operating system talks to the hardware directly. For this capability, it needs some additional programming. Device drivers provide the code necessary for the operating system to communicate with specific hardware. Device drivers are written specifically for a particular operating system, usually by the hardware manufacturer.

In addition to ***communicating with hardware***, the operating system provides for some type of error handling and error notification. If a piece of hardware is not functioning properly, the operating system tries to fix the

problem or tries to communicate with the device a few more times. If it is still unable to communicate with the device, it provides an error screen notifying the user of the problem.

Providing a user interface is the second function of an operating system. Basically, the operating system organizes applications so that the users can easily access them, use them, and store application data. When an application is opened, the operating system lets the application provide the majority of the user interface. That is, the operating system disappears or moves away from the center of the screen. The operating system still has the responsibility of providing access to the hardware for whatever the application needs. If the program cannot function properly, the operating system again takes control, stops the application, and provides some sort of error message.

7.5 TYPES OF OPERATING SYSTEM

Operating systems are categorised based on the types of computers they control and the sort of applications they support. The types are:

1. Single User Operating System
2. Multi User Operating System
3. Single Tasking Operating System
4. Multi Tasking Operating System
5. Multiprogramming Operating System
6. Real Time Operating System
7. Network Operating System
8. Distributed Operating System

7.5.1 Single User Operating System

A computer system in which only one user can work at a time is called a single user operating system. The familiar Intel processor based Windows OS personal computer is an example of single user system. Such a typical system will have a single keyboard, mouse

and monitor as I/O devices for the user to interact with the system. Users apply command through the keyboard and mouse and the computer displays its responses (output) on the monitor.

7.5.2 Multi User Operating System

This type of operating system which is running on a computer will manage the work of different users, without letting them know that they all are actually working on a single computer. A multi user operating system allows a number to work together on a single computer. Each user will be provided with a terminal and all such terminals will be connected to the single computer. For example, UNIX, Linux, Windows XP etc.

A multi user operating system allows many different users to take advantage of the computer's resources simultaneously. The operating system must make sure that the requirements of the various users are balanced, and that each of the programs they are using has sufficient and separate resources so that a problem with one user does not affect the entire community of users. Unix, mainframe operating systems, such as *MVS*, are examples of multi user operating systems.

7.5.3 Single Tasking Operating System

It is a type of operating system which can execute a single job at a time and is known as Single Tasking operating system. For example, MS-DOS is a single tasking operating system because one can open and run only one application at one time in MS-DOS.

When a single program is allowed to run at a time, the system is grouped under a single-tasking system.

7.5.4 Multi Tasking Operating System

Multitasking is concerned with a single user executing more than one program simultaneously or concurrently. Now a days most of

the operating systems such as UNIX, LINUX, OS/2 etc. are multi tasking operating system.

Multi tasking can be of two types namely, pre-emptive and 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 multi tasking. Cooperative multi tasking is achieved by relying on each process to give time to the other processes in a defined manner. *MS Windows* prior to *Windows 95* used to support cooperative multitasking.

7.5.5 Multiprogramming Operating System

In multiprogramming technique of processing, the CPU runs several programs at the same time. Multiprogramming is implemented in such a way that it appears as if many programs are being executed concurrently. Multiprogramming keeps the CPU busy, switching its attention from one program to another. For example, while one program is waiting for some input or output operation, another program can use the processor because of the high speed of the processor.

Multiprogramming is the rapid switching of the CPU between multiple processes in memory. It is done only when the currently running process requests I/O, or terminates. It was commonly used to keep the CPU busy while one or more processes are doing I/O. It is now mostly superceded by multitasking, in which processes also lose the CPU when their time quantum expires.

Multiprogramming makes efficient use of the CPU by overlapping the demands for the CPU and its I/O devices from various users. It attempts to increase CPU utilization by always having something for the CPU to execute.

The prime reason for multiprogramming is to give the CPU something to do while waiting for I/O to complete. If there is no DMA,

the CPU is fully occupied doing I/O, so there is nothing to be gained (at least in terms of CPU utilization) by multiprogramming. No matter how much I/O a program does, the CPU will be 100% busy. This of course assumes that the major delay is the wait while data is copied. A CPU could do other work if the I/O were slow for other reasons (arriving on a serial line, for instance). I/O operations are exceedingly slow (compared to instruction execution). A program containing even a very small number of I/O operations, will spend most of its time waiting for them. Hence, poor CPU usage when only one program is present in memory.

7.5.6 Real Time Operating System

Real time operating systems work towards providing immediate processing and also responding to user's commands in a very short period of time. This type of operating system is more commonly used in chemical industries for process control and scientific processing like airplane control and space vehicle control operations. The success of a real time operating system does not depend only on the correctness of the result but also on the timeliness of the result. For example: HP-RT and VTWorks etc. 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 system 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 on their priorities while time-sharing operating systems switch tasks based on clock interrupts.

7.5.7 Network Operating System

Network Operating System (NOS) is an operating system specifically designed to establish network connections for

workstations, personal computers (PC) accross the world via Local Area Network and internetworking. NOS provides support for multiuser operating system as well as administrative, security and network management functions. Some examples of network operating system are Windows NT, Novell's Netware etc.

A network operating systems has to acknowledge and respond to requests from many workstations, managing network access, resource allocation and sharing, data protection as well as error control.

Features of Network OS :

All network ooperating system provide certain core functions such as connection to other computers on the network. Some of the significant features of NOS are as follows :

- It gives the features of basic (Operating System) such as protocols, processors, hardware detection and multi processing.
- It supports name and directory services.
- It provides file and print services over the network, back up and replication services, web services.
- It facilitates internetworking such as routing, switching, wireless set-up and WAN ports.
- It provides cluster and grid computing capabilities, fault tolerance and high availability systems.
- It provides user management services such as log on, logoff, remote access, auditing tools with Graphical User Interface (GUI) features and administration tools.
- It strictily provides security features such as authentication, authorization, log on restrictions for users and access controls etc.

7.5.8 Distributed Operating System

A distributed system is composed of large a number of computers connected by high-speed networks. The computers in the distributed

system are independent, but they appear to the users as a single system. A distributed operating system hides the existence of multiple computers which are interconnected by a network from the user. That is, the user remains unaware of the fact that many computers are being used to process the data. These computers may be located at many places around the globe.

Distributed Operating System provides single-system image to its users. All these computers work in close coordination with each other. Processes and systems resources are managed globally and controlled from specific locations.

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.

Advantages :

i) Data sharing : Allows data sharing access to common databases.

ii) Device sharing : Allows many users to share expensive peripherals like high resolution printers, scanners and digital cameras.

iii) Communication : Makes communication between users easier.

iv) Spreads the availability workload over independent computers of the system in cost-effective way.

Disadvantages :

i) Network communication is delayed due to saturation or other problems.

ii) Security : Needs tools and techniques for providing controlled



cess to sensitive data.

CHECK YOUR PROGRESS

Q.1. Choose the correct option :

(i) An operating system is a software that

(a) helps the operators who are maintaining a computer system.

(b) helps other programs to run.

(c) helps in resource management.

(d) all of the above.

(ii) UNIX is an example of

(a) batch processing operating system

(b) time sharing operating system.

(c) real time operating system.

(d) none of these.

(iii) The program which takes user input , interprets it and takes necessary actions is

(a) kernel (b) system calls

(c) shell (d) scheduler.

(iv) The main job of one of the following is to allocate CPU to process

(a) kernel (b) shell (c) sceduler (d) login

(v) The objective of a multiprogramming operating system is to

(a) minimize the net execution time.

(b) maximize the processor utilization.

(c) minimize the user response time.

(d) none of above.

(vi) In UNIX, a process is a

(a) program in execution.

(b) sub-program which can be called from other

programs.

(c) sequence of commands required to run a program.

(d) none of above.

(vii) MS-DOS operating system is a

(a) time sharing operating system

(b) single user operating system.

(c) distributed operating system

(d) all of the above.

(viii) The example of real time operating system is

(a) UNIX (b) MS-DOS

(c) WINDOWS 2000 (d) HP-RT

(ix) Example of embedded operating system is

(a) FreeBSD (b) Unix

(c) MS-DOS (d) Linux.



7.6 LET US SUM UP

- An operating system is an important component of a computer system. The primary objecives of an operating system is to make computer system convenient to use and utilise computer hardware and various resources in an efficient manner. An operating system is a large set of software which is also an interface between users and computer systems. It is also a system software.
- **Input and Output management :** An operating system makes efficient usage of input and output devices and controls properly.
- **Memory or storage management :** Memory is an important resource for a computer system. So memory allocation and deallocation for programs and data is an another function of an operating system.
- **Process management :** Process can be defined as a program in execution.It is the job which is currently being executed by the processor (CPU).
- **Files and directories management :** Files and directories are also properly managed by an operating system.Data is stored in a computer

system as files.

- **Scheduling :** The operating system also establishes and enforces process-priority. That is, it determines and maintains the order in which jobs are to be executed by the computer system.
- **Security management :** It is also one of the most important function of an operating system to protect its various resources from the outer world.
- **Single user Operating System** the simplest operating system which allows only one user to work.
- **Multi user operating system** which is running on a computer will manage the work of all different users.
- **Multitasking operating system** allows the user to perform more than job at the same time on a computer.
- In **multiprogramming technique of processing ,** the CPU runs several programs at the same time.
- **Real time operating system** work towards providing immediate processing and also responding to user's commands in a very short period of time.
- **Network operating System (NOS)** is an operating system specifically designed to support interconnection of several computers.
- **A distributed operating System** hides the existence of multiple computers which are interconnected by a network from the user.



7.7 FURTHER READING

- Tanenbaum, A. S., & Woodhull, A. S. (1987). Operating systems: design and implementation (Vol. 2). Englewood Cliffs, NJ: Prentice-Hall.
- Deitel, H. M., Deitel, P. J., & Choffnes, D. R. (2004). Operating systems. Pearson/Prentice Hall.



7.8 ANSWERS TO CHECK YOUR PROGRESS

Answer to 1 : (i) (d), (ii) (b), (iii) (c), (iv) (c), (v) (b), (vi) (a), (vii) (b), (viii) (d), (ix) (a)



7.9 MODEL QUESTIONS

Q.1. What is an operating system? Why is it necessary to use operating system for a computer ?

Q.2. What is process? What are the main objectives of the process-management module of the operating system?

Q.3. Differentiate between multiprogramming and multi-tasking operating system.

Q.4. Describe the role of operating system in the computer system.

Q.5. What are different functions performed by an operating system?

Q.6. Describe different types of operating systems?

Q.7. What is virtual memory? Why is it so called? How is it used?

Q.8. What is network operating system? How is it different from the distributive operating system?

****

UNIT 8 : MS DOS OPERATING SYSTEM

UNIT STRUCTURE

8.1 Learning Objectives

8.2 Introduction

8.3 DOS Operating System

8.4 System Files of DOS

8.5 Concept of Booting

8.6 Files and Directory Structure

8.7 Concept of Paths

8.8 Internal and External Commands

8.9 Batch File

8.10 Let Us Sum up

8.11 Further Reading

8.12 Answers to Check Your Progress

8.13 Model Questions

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- describe the DOS operating system
- identify the system files of DOS
- describe files and directory structure
- identify the internal and external commands
- identify the batch files.

8.2 INTRODUCTION

From the previous unit you are aware of the basic definition of an operating system including its functions and various types. In this unit, we will introduce you to the Microsoft Disk Operating System (MS DOS) which is a single user, single tasking operating system. We will also discuss about the system files of DOS, files and directory structure and internal and external commands of DOS.

8.3 DOS OPERATING SYSTEM

Microsoft Disk Operating System (MS-DOS) is the most popular single user operating system in the world. Microsoft Corporation of USA had released it in August 1981. First version of MS-DOS was a refined version of an operating system developed by Tim Peterson of Seattle Computers, which he had named as QDOS (Quick and Dirty Operating System) as he had developed it in record two months and could not introduce some good functions of process management and memory management into it. After the release of the first version of MS-DOS, every time some refinement is made, a new version of it is launched.

8.4 SYSTEM FILES OF DOS

The modern DOS operating system is distributed on 3-5 high density floppy disks. It comes with backup utilities and (depending on how the layers feel) disk compression drivers. However, all the stuff that goes into C:\DOS and its subdirectories are programs and utilities. The core DOS operating system consists of six files:

- The boot sector is a 512 byte record placed at the beginning of the C: drive when DOS was installed, or placed there subsequently using the “sys c:” command.
- Two “hidden” files are stored in the root directory of the C: drive. They do not show up in a DIR listing unless the /A switch is used. On IBM PC DOS systems, they are *IBMBIO.SYS* and *IBMDOS .SYS*. On MS DOS systems, they are called *IO.SYS* and *MSDOS.SYS*. These files form the kernel of the DOS system.
- *COMMAND.COM* is the “shell” or command interpreter. It prints out the “C:\&gt “ prompt and reads user commands. It also supports BAT files.
- The user configuration files are *CONFIG.SYS* and *AUTOEXEC. BAT*. The reader is assumed to be familiar with these files.

COMMAND.COM is initially stored in the C:\ root directory. The problem is that OS/2 and Windows NT have their own versions of COMMAND.COM. To avoid confusion, each COMMAND.COM should be stored in the subdirectory that belongs to its particular operating system. In normal use, this means that the DOS version should be in C:\DOS. To relocate it, two statements must be added to the user configuration files:

"SHELL=C:\DOS\COMMAND.COM" is added to CONFIG.SYS.

"SET COMSPEC=C:\DOS\COMMAND.COM" is added to AUTOEXEC.BAT.

The hidden files IBMBIO, IBMDOS, IO, or MSDOS have names that do not conflict with each other or with any system file belonging to any other operating system. They can stay in the C:\ root directory no matter what gets added to the system. This means that the volatile part of the DOS system consists of the boot record, C:\CONFIG.SYS, and C:\AUTOEXEC. BAT.

8.5 CONCEPT OF BOOTING

The term 'boot' is used to describe the initial loading of an operating system or of some other program into a computer. The word "boot" comes from the term "Bootstrap". The loading of DOS into main memory involves loading of three essential files of DOS i.e. IO.SYS, MSDOS.SYS and COMMAND.COM into the main memory. Loading these files into main memory is called *booting up* of the computer. The booting up process is a step by step process as described below

a) As soon as the machine is switched on, POST (Power On Self Test) is performed which checks for integrity of all the components (CPU,RAM, I/O devices etc.) of a computer system. If any component is found faulty, an error message is displayed.

b) A chip called ROM-BIOS (Read Only Memory-Basin Input-Output Services) is read and executed. Then a check is performed for DOS files presence in the following order:

   i) First in 'A drive'; if found there, DOS is loaded from the drive A.

ii) If not found in drive A, then 'C drive' scanned for the DOS files and if available there from the C drive DOS is loaded.

iii) If DOS file could not be located, an error message is displayed.

c) If DOS files are found in a drive, its very first sector (called *boot sector*) is read which stores a small program called bootstrap loader in which instructions for booting up process are stored. The bootstrap loader is then loaded into the main memory and its instructions are executed and as a result DOS system files IO.STS, MSDOS.SYS and COMMAND.COM will be loaded into the main memory one by one.

Two files IO.SYS and MSDOS.SYS make the kernel of DOS which actually interacts with the hardware and the gets the work done. The user interacts with the shell of DOS which is COMMAND.COM. The shell in turn interprets user request and interacts with the kernel for carrying out the user request. Shell is resposible for user interface.

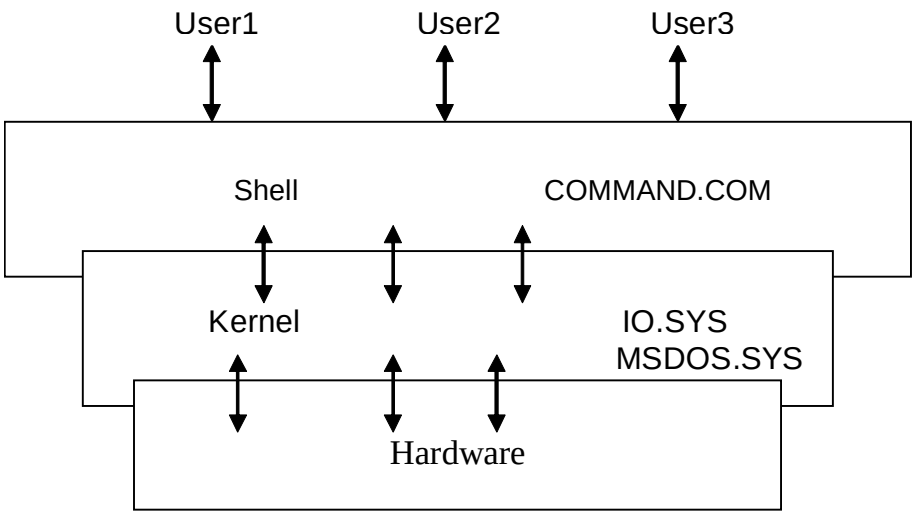


Figure 8.1 : Hierarchy of Interaction with MS-DOS

8.6 FILES AND DIRECTORY STRUCTURE

Files : Any information which is to be stored on the computer's secondary storage, would be stored as a file. A file is a logically related information, such as a file containing all details about mid-term exams, a file containing monthly sales data etc. Each file stored on the system is

given a name. The file name has two parts : *primary file name* and *secondary file name* (also called extension). A primary file name consists of one to eight (1-8) characters in length. File extension consists of a period followed by zero to three (0-3) characters. Extensions are optional, but it is better to us as they are useful for describing the contents of a file. The primary file name and file extensions can have any characters other than following :

[ ] / \ : , ; < > + " = ? |

Extension **.exe** specifies that it is an executable file, **.doc** specifies that it is a document file, **.bas** specifies it is a BASIC program file, .pas specifies that it is a PASCAL file.

Directories : In an office, the file cabinet is divided into shelves, shelves into boxes, boxes into drawers etc. and files are kept in them. Similar types of files are grouped and kept in the same drawer or box or shelf. In the same way files on the disk are stored. The disk (similar to file cabinet) is divided into sub-directories (similar to shelves); each sub-directory can further be divided into sub-directory (similar to box) and so on. DOS files with some similarity (e.g. belonging to the same project) are grouped together and a directory is formed for them under which they are kept.

So, directories let you group your files in convenient categories. These directories, in turn, may contain other directories (referred to as sub-directories). This organised file structure is referred to as multilevel or hierarchical directory system.

The first level in a multilevel directory system is root directory, which is created automatically at the time of the disk formatting. Within the root directory, additional directories and sub-directories can be created. Within each directory or sub-directory, new files or new sub-directories can be created.

Immediately after the booting, root directory is the current directory or working directory i.e. by default all operations will be performed under it unless you specify another directory or files for it. Working directories can be changed using CD or CHDIR command of DOS.

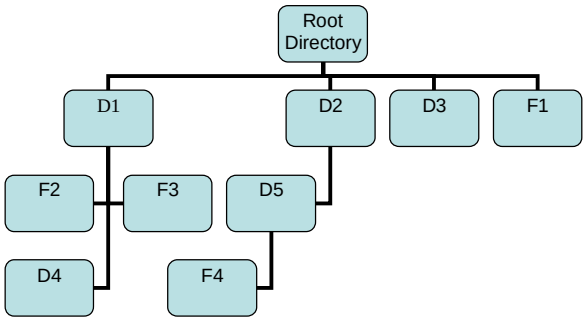


Figure 8.2: Example of Directory Structure

In the figure 8.2, D1, D2, D3 are sub-directories or child directories of root directory and root is the parent directory of D1, D2, D3. D4 is the child directory of D1 and D5 is the child directory of D2; D1 is the parent directory of D4 and D2 is the parent directory of D5. One thing, to be kept in mind is that, a directory can have many sub-directories (child), but a child directory can have only one parent directory, it cannot have more than one parent directory. Directory names follow the file naming rules.

8.7 CONCEPT OF PATHS

Full name of a file or directory consists of path ***primary name. extension***. Path is a sequence of directory names which give you the hierarchy to access a particular directory or file name. Let us consider the following directory structure :

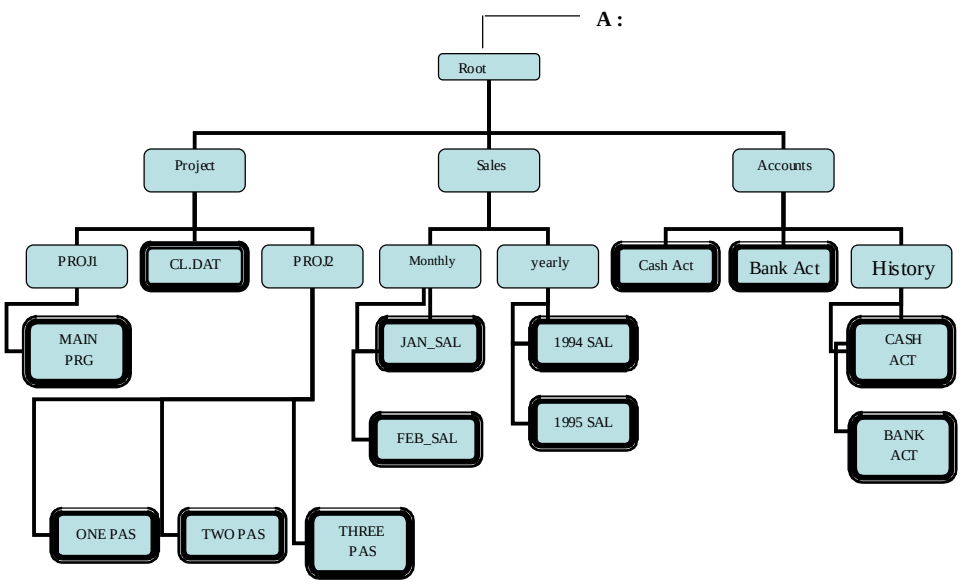


Figure 8.3 : Example of Path

Now, the full name directories PROJECT, SALES and ACCOUNTS will be

A: \PROJECT, A: \SALES and A:| ACCOUNTS respectively.

So format of path can be given as

Drive-letter: \directory[\directory.....]

Where first \ (backslash) refers to root directory and other ('\' s) separate a directory name form the previous directory name. Now the path of directory JAN SAL will be :

A: \SALES\Monthly\JAN SAL

As to reach JAN SAL the sequence one has to follow is under drive A, under root directory (first \), under SALES subdirectory of root, under Monthly subdirectories of SALES, there lies JAN SAL directory.

Similarly the full name of ONE PAS file under PROJ2 subdirectory will be :

A: \PROJECT\PROJ2\ONE PAS

Now, you can see that there are two files with the same name CASH ACT, one under the Accounts directory and the other under HISTORY directory but according to DOS rule no two files can have same names (path names). Both these files have same names but their path names differ, therefore, these can exist on system. So, the paths of the two files will be

A: \Accounts\CASH ACT

and A: \Accounts\HISTORY\CASH ACT

The above mentioned path names are *absolute path names* as they mention the paths from the top most level of the directory structure.

Relative path names mention the paths relative to current working directory. Let us assume that the current working directory now is, say, PROJ2. The symbol **.** and **..** can be used now in relative paths and path names. The symbol **.** can be used in place of current working directory and **..** denotes the parent directory.

So, with PROJ2 as current working directory, path name of TWO PAS will be :

.\TWO PAS (PROJ2 being working directory)

which means under current working directory, there is file TWO PAS. Similarly, path name for file CL DAT will be :

..\CL DAT (PROJ2 being working directory)

which means under parent directory of current directory, there is a file CL DAT. Similarly, path name for MAIN PRG will be :

..\PROJ1\MAIN PRG

that is under parent directory of current directory, there lies a file MAIN PRG.

8.8 INTERNAL AND EXTERNAL COMMANDS

We have seen that, user interface is the shell's responsibility. Therefore, a user passes its request (in the form of DOS command) to the shell i.e. COMMAND.COM. Whenever a request is passed to it, the shell interprets it and then searches for its specification i.e. what is to be done and how it is to be done inside COMMAND.COM. These specification of commands can either be found inside the shell or outside it, thus giving rise to two types of DOS commands:

i) ***Internal Commands :*** DOS commands for which specifications are available within the shell (i.e. COMMAND.COM) are called Internal Commands (as they are internally available in shell).

ii) ***External Commands :*** DOS commands for which specifications are not internally available within the shell (i.e. COMMAND.COM) are called External Commands. The specification for these commands are made available to the shell through external specification files. E.g. FORMAT is an external command and its specifications are available in FORMAT.COM, for DISKCOPY external command, specification file is DISKCOPY.COM and so on. The specification files are executable files i.e. files with extensions *.EXE* or *.COM*.

A) **Internal Commands :** The Internal commands include some of the following important commands :

File Commands – File commands are those commands which operate on files. Under file commands we will discuss the following commands –

1. ***COPY :*** Allows the user to copy one or more files to an alternate location.

Syntax :

Copies one or more files to another location.

COPY [/A | /B] source [/A | /B] [+ source [/A | /B] [+ ...]] [destination] [/A | /B]] [/V] [/Y | /-Y]

source	Specifies the file or files to be copied.
/A	Indicates an ASCII text file.
/B	Indicates a binary file.
destination	Specifies the directory and/or filename for the new file(s).
/V	Verifies that new files are written correctly.
/Y	Suppresses prompting to confirm you want to overwrite an existing destination file.
/-Y	Causes prompting to confirm you want to overwrite an existing destination file.

The switch /Y may be preset in the COPYCMD environment variable. This may be overridden with /-Y on the command line.

To append files, specify a single file for destination, but multiple files for source (using wildcards or file1+file2+file3 format).

Examples :

copy *.* a:

Copy all files in the current directory to the floppy disk drive.

copy autoexec.bat c:\windows

Copy the autoexec.bat, usually found at root, and copy it into the windows directory; the autoexec.bat can be substituted for any file(s).

copy win.ini c:\windows /y

Copy the win.ini file in the current directory to the windows directory. Because this file already exists in the windows directory it normally would prompt if you wish to overwrite the file. However, with the /y

switch you will not receive any prompt.

copy myfile1.txt+myfile2.txt

Copy the contents in myfile2.txt and combines it with the contents in myfile1.txt.

copy con test.txt

A user can create a file using the copy con command as shown above, which creates the test.txt file. Once the above command has been typed in, a user could type in whatever he or she wishes. When you have completed creating the file, you can save and exit the file by pressing **CTRL+Z**, and then press enter.

2. DEL : Del is a command used to delete files from the computer.

Syntax :

Windows 2000 and Windows XP syntax

Deletes one or more files.

DEL [/P] [/F] [/S] [/Q] [/A[[:]attributes]] names

ERASE [/P] [/F] [/S] [/Q] [/A[[:]attributes]] names

names-	Specifies a list of one or more files or directories. Wildcards may be used to delete multiple files. If a directory is specified, all files within the directory will be deleted.
/P	Prompts for confirmation before deleting each file.
/F	Force deleting of read-only files.
/S	Delete specified files from all subdirectories.
/Q	Quiet mode, do not ask if ok to delete on global wildcard
/A	Selects files to delete based on attributes
attributes	R - Read-only files, S - System files, H - Hidden files, A - Files ready for archiving

Windows 2000 and Windows XP recovery console syntax

Deletes one file.

del [drive:][path]filename

delete [drive:][path]filename

[drive:][path]filenameSpecifies the file to delete.

Delete only operates within the system directories of the current Windows installation, removable media, the root directory of any hard disk partition, or the local installation sources.

Del and delete do not support replaceable parameters (wild cards).

del test.tmp = Deletes the test.tmp in the directory that you currently are in, if the file exists.

del c:\windows\test.tmp = Delete the c:\windows\test.tmp in the windows directory if it exists.

del c:\windows\temp*.* = (* is for wild character(s)) *.* indicates that you would like to delete all files in the c:\windows\ temp directory.

In the previous directory structure, to delete all the files having the .PAS extension under PROJ2, the command will be :

Del A:\PROJECT\PROJ2*.PAS/P

This command will be carried out by displaying all PAS file names for confirmation i.e.

ONE.PAS Delete (Y/N) ? Y

TWO.PAS Delete (Y/N) ? Y

THREE.PAS Delete (Y/N) ? N

3. ***REN (RENAME) :*** Used to rename files and directories from the original name to a new name.

In earlier releases of MS-DOS instead of using ren or rename you need to use the move command to rename your MS-DOS directories or files.

Syntax :

Renames a file/directory or files/directories.

RENAME *[drive:][path][directoryname1 | filename1] [directoryname2 | filename2]*

REN [drive:][path][directoryname1 | filename1] [directoryname2 | filename2]

Note that you cannot specify a new drive or path for your destination.

rename c:\chope hope

Rename the directory chope to hope.

rename *.txt *.bak

Rename all text files to files with .bak extension.

In our example to rename file CL DAT as CLASS DAT under PROJECT, the command will be -

REN A:\PROJECT\CL DAT CLASS DAT

4. TYPE : Allows the user to see the contents of a file.

To edit the files, the user would need to use either edit or copy con.

Syntax :

Displays the contents of text files.

TYPE [drive:][path]filename

Examples :

type c:\autoexec.bat

This would allow us to look at the autoexec. bat file.

In our example, to display the content of the file 1995 sal under yearly subdirectory, the command will be as follows :

TYPE A:\SALARY\YEARLY\1995 SAL

Directory Commands : In this section four internal commands of DOS will be discussed.

5. DIR : The dir command allows you to see the available files in the current and/or parent directories.

Microsoft Windows 2000 and Windows XP syntax

Displays a list of files and subdirectories in a directory.

DIR [drive:][path][filename]	[/A[[:]attributes]] [/B] [/C] [/D] [/L] [/N] [/O[[:]sortorder]] [/P] [/Q] [/S] [/T[[:]timefield]] [/W] [/X] [/4]
[drive:][path][filename] -	Specifies drive, directory, and/or files to list.
/attributes	D Directories R Read-only files H Hidden files A Files ready for archiving S System files - Prefix meaning not

/B	Uses bare format (no heading information or summary).
/C	Display the thousand separator in file sizes. This is the default. Use /-C to disable display of separator.
/D	Same as wide but files are list sorted by column.
/L	Uses lowercase.
/N	New long list format where filenames are on the far right.
/O	List by files in sorted order.
sortorder	N By name (alphabetic) S By size (smallest first) E By extension (alphabetic) D By date/time (oldest first) G Group directories first - Prefix to reverse order
/P	Pauses after each screenful of information.
/Q	Display the owner of the file.
/S	Displays files in specified directory and all subdirectories.
/T	Controls which time field displayed or used for sorting
timefield	C Creation A Last Access W Last Written
/W	Uses wide list format.
/X	This displays the short names generated for non-8dot3 file names. The format is that of /N with the short name inserted before the long name. If no short name is present, blanks are

displayed in its place.

/4 Displays four-digit years

Examples:

dir

Lists all files and directories in the directory that you are currently in.

dir /ad

List only the directories in the current directory. If you need to move into one of the directories listed use the cd command.

dir /s

Lists the files in the directory that you are in and all sub directories after that directory, if you are at root “C:\>” and type this command this will list to you every file and directory on the C: drive of the computer.

dir /p

If the directory has a lot of files and you cannot read all the files as they scroll by, you can use this command and it will display all files one page at a time.

dir /w

If you don’t need the info on the date / time and other information on the files, you can use this command to list just the files and directories going horizontally, taking as little as space needed.

dir /s /w /p

This would list all the files and directories in the current directory and the sub directories after that, in wide format and one page at a time.

dir /on

List the files in alphabetical order by the names of the files.

dir /o-n

List the files in reverse alphabetical order by the names of the files.

dir \ /s |find “i” |more

A nice command to list all directories on the hard drive, one screen page at a time, and see the number of files in each directory and the amount of space each occupies.

dir > myfile.txt

Takes the output of dir and re-routes it to the file myfile.txt instead of outputting it to the screen.

6. ***CHDIR/CD :*** CD (Change Directory) is a command used to switch directories in MS-DOS. For example, if you needed to run Windows 3.11 from DOS, you would type:

cd windows - Changing the directory to Windows;

win - To run the win.com file within the windows directory.

Syntax :

CHDIR [drive:][path]

CHDIR[..]

CD [drive:][path]

CD[..]

Examples :

cd

Goes to the highest level, the root of the drive.

cd..

Goes back one directory. For example, if you are within the C:\Windows\ COMMAND> directory, this would take you to C:\Windows>

Windows 95, 98, and later versions have a feature in the CD command that allows you to go back more than one directory when using the dots. For example, typing: **cd...** with three dots after the cd would take you back two directories.

cd windows

If present, would take you into the Windows directory. Windows can be substituted with any other name.

cd \windows

If present, would first move back to the root of the drive and then go into the Windows directory.

cd windows\system32

If present, would move into the system32 directory located in the

Windows directory. If at any time you need to see what directories are available in the directory you're currently in use the dir command.

7. ***MKDIR (MD) :*** Allows you to create your own directories in MS-DOS.

Syntax :

Creates a directory.

MKDIR [drive:]path

MD [drive:]path

Examples :

md test

The above example creates the "test" directory in the directory you are currently in.

md c:\test

Create the "test" directory in the c:\ directory.

8. ***RMDIR (RD) :*** Removes empty directories in MS-DOS. To delete directories with files or directories within them the user must use the deltree command, or if you are running Microsoft Windows 2000 or Windows XP use the /S option.

Syntax :

Removes (deletes) a directory.

RMDIR [drive:]path

RD [drive:]path

Windows 2000 and Windows XP Syntax.

RMDIR [/S] [/Q] [drive:]path

RD [/S] [/Q] [drive:]path

S Removes all directories and files in the specified directory in addition to the directory itself. Used to remove a directory tree.

/Q Quiet mode, do not ask if ok to remove a directory tree with /S.

Examples :

rmdir c:\test

Remove the test directory, if empty. If you want to delete directories that are full, use the deltree command or if you're using Windows

2000 or later use the below example.

rmdir c:\test /s

Windows 2000, Windows XP and later versions of Windows can use this option with a prompt to permanently delete the test directory and all subdirectories and files. Adding the /q switch would suppress the prompt.

Miscellaneous Commands :

In this section, we will discuss some miscellaneous commands of MSDOS.

i) Break : Break can be used to enable or disable the breaking capability of the computer. For example, if a user wanted to cancel a batch file or another MS-DOS processes, that user could simply press CTRL + C (break), which would then prompt the user if they wish to cancel the current process.

Turning break off will cancel CTRL + C; however, the user will still be able to press CTRL + PAUSE/BREAK and have the capability of getting out of a batch file current running process.

Note : Newer versions of Windows (Windows ME, Windows 2000, Windows XP, and higher) only include this command for backwards compatibility and turning the break off has no effect.

Syntax :

Sets or clears extended CTRL+C checking.

BREAK [ON | OFF]

Type BREAK without a parameter to display the current BREAK setting.

Examples :

break on

Turns on the break, which allows the Ctrl + C function.

break off

Turns off the break, not allowing Ctrl + C to cancel a process.

ii) CLS : Cls is a command that allows a user to clear the complete contents of the screen and leave only a prompt.

Syntax :

CLS

Examples :

cls

Running the cls command at the command prompt would clear your screen of all previous text and only return the prompt.

iii) DATE : Displays or sets the date.

Syntax :

DATE [date]

Type DATE without parameters to display the current date setting and a prompt for a new one. Press ENTER to keep the same date.

Examples :

date

Display the current date and prompt for a new one. If no date is entered, the current date will be kept.

iv) PATH : Path is used to specify the location where MS-DOS looks when using a command. For example, when using the command "format", if the path is not specified to where the command is you will receive bad command or file name.

Syntax :

Displays or sets a search path for executable files.

PATH [[drive:]path[;...]]

Type PATH ; to clear all search-path settings and direct Windows to search only in the current directory.

Type PATH without parameters to display the current path.

Examples :

path=c:\windows\command

This is where a lot of DOS commands are stored in Window 95; if you are not able to do a dos command, type this command in, allowing all commands you type in, such as "deltree", to be loaded from this directory. However, if you have another file in another directory such as C:\DOS it will no longer look there.

v) TIME : Allows the user to view and edit the computer's time.

Syntax :

Displays or sets the system time.

TIME [time]

Type TIME with no parameters to display the current time setting and a prompt for a new one. Press ENTER to keep the same time.

Examples :

time 12:00

Set the time to 12:00

vi) VER : Displays the version of MS-DOS or if running Windows 95 or above the version of Windows. Information about Windows versions can be found on our Windows version page.

Syntax :

Displays the MS-DOS version.

VER

Examples :

ver

Display what version of MS-DOS or Windows command prompt you're using. An example of what this may look like is:

Microsoft Windows XP [Version 5.1.2600]

vii) VOL : Displays the volume information about the designated drive.

Syntax :

Displays the disk volume label and serial number, if they exist.

VOL [drive:]

Examples :

vol c :

Display the volume of drive C: as shown in the below example.

Volume in drive C has no label.

Volume Serial Number is 1C24-AB20

B) External Commands : It has already been mentioned that external commands are those, for which specifications are not

available within COMMAND.COM. Some important external commands are discussed in this section.

1. COMP : A simple compare that compares two or more files.

Syntax :

Compares the contents of two files or sets of files.

COMP [data1] [data2] [/D] [/A] [/L] [/N=number] [/C]

data1	Specifies location and name(s) of first file(s) to compare.
data2	Specifies location and name(s) of second files to compare.
/D	Displays differences in decimal format.
/A	Displays differences in ASCII characters.
/L	Displays line numbers for differences.
/N=number	Compares only the first specified number of lines in each file.
/C	Disregards case of ASCII letters when comparing files.

To compare sets of files, use wildcards in data1 and data2 parameters.

Examples :

Note : Unless the /N option is used the comp command will only compare the size of the file.

comp file1.txt file2.txt /N=10 /A

Compares file1.txt with file2.txt. In this example we are using the /A option to display the ASCII characters that the compare has found different. If the /A option is not displayed, the comp command will display the differences in hexadecimal notation.

2. FORMAT : Format is used to erase all of the information off of a computer diskette or fixed drive.

Syntax :

Microsoft Windows 2000 and Windows XP syntax

Formats a disk for use with Windows 2000.

FORMAT volume [/FS:file-system] [/V:label] [/Q] [/A:size] [/C] [/X]

FORMAT volume [/V:label] [/Q] [/F:size]

FORMAT volume [/V:label] [/Q] [/T:tracks /N:sectors]

FORMAT volume [/V:label] [/Q] [/1] [/4]

FORMAT volume [/Q] [/1] [/4] [/8]

volume	Specifies the drive letter (followed by a colon), mount point, or volume name.
/FS:filesystem	Specifies the type of the file system (FAT, FAT32, or NTFS).
/V:label	Specifies the volume label.
/Q	Performs a quick format.
/C	Files created on the new volume will be compressed by default.
/X	Forces the volume to dismount first if necessary. All opened handles to the volume would no longer be valid.
/A:size	Overrides the default allocation unit size. Default settings are strongly recommended for general use. NTFS supports 512, 1024, 2048, 4096, 8192, 16K, 32K, 64K. FAT supports 512, 1024, 2048, 4096, 8192, 16K, 32K, 64K, (128K, 256K for sector size > 512 bytes). FAT32 supports 512, 1024, 2048, 4096, 8192, 16K, 32K, 64K, (128K, 256K for sector size > 512 bytes). Note that the FAT and FAT32 files systems impose the below restrictions on the number of clusters on a volume: FAT: Number of clusters <= 65526 FAT32: 65526 < Number of clusters < 268435446 Format will immediately stop processing if it decides that the above requirements cannot be met using the specified cluster size. NTFS compression is not supported for allocation unit sizes above 4096.

/F:size	Specifies the size of the floppy disk to format (160,180, 320, 360, 640, 720, 1.2, 1.23, 1.44, 2.88, or 20.8).
/T:tracks	Specifies the number of tracks per disk side.
/N:sectors	Specifies the number of sectors per track.
/1	Formats a single side of a floppy disk.
/4	Formats a 5.25-inch 360K floppy disk in a high-density drive.
/8	Formats eight sectors per track.

3. LABEL : Label is used to view or change the label of the computer disk drives.

Syntax :

Creates, changes, or deletes the volume label of a disk.

LABEL [drive:][label]

Examples :

label a: mydisk

This would label the disk currently in the drive to “mydisk”, but will not label if your disk is write protected.

4. MEM : Allows you to determine the available, used and free memory.

Syntax :

Displays the amount of used and free memory in your system.

MEM [/CLASSIFY | /DEBUG | /FREE | /MODULE module name] [/PAGE]

/CLASSIFY or /C	Classifies programs by memory usage. Lists the size of programs, provides a summary of memory in use, and lists largest memory block available.
/DEBUG or /D	Displays status of all modules in memory, internal drivers, and other information.
/FREE or /F	Displays information about the amount of free memory left in both conventional and upper memory.

/MODULE or /M	Displays a detailed listing of a module's memory use. This option must be followed by the name of a module, optionally separated from /M by a colon.
/PAGE or /P	Pauses after each screen full of information.

Examples :

mem

This would display information about your memory as seen in the examples below.

Windows 2000 and Windows XP example output:

655360 bytes total conventional memory
655360 bytes available to MS-DOS
633872 largest executable program size
1048576 bytes total contiguous extended memory
0 bytes available contiguous extended memory
941056 bytes available XMS memory
MS-DOS resident in High Memory Area

mem /f

Display the amount of conventional memory free.

5. PRINT : Print was first introduced in MS-DOS 2.0 as PRINT.COM and later was changed to PRINT.EXE in MS-DOS 5.0 and above. This command allowed users to print a text file to a line printer, in the background.

Syntax :

print	*/d:device /b:size /u:ticks1 /m:ticks2*
	drive:\path\ filename /c /p
/d:device	Name of printer device Printer Ports: LPT1, LPT2 orLPT3 Serial Ports:Com1, Com2, Com3 or Com4
/b:size	Sets size (in bytes) of internal buffer. Default=512 with range of 512 to 16384.

/u:ticks1	Maximum number of clock ticks PRINT is to wait for a printer to become available. Default=1 with a range of 1 to 255.
/m:ticks2	Maximum number of clock ticks PRINT can take to print a character or printer. Default=2 with a range of 1 to 255.
drive:\path\ filename	Location and filename of file to be printed.
/c	Removes files from the print queue.
/p	Adds files to the print queue.

Examples :

print c:\file.txt /c /d:lpt1

Prints the file file.txt to the parallel port lpt1.

6. TREE : Allows the user to view a listing of files and folders in an easy to read listing.

Syntax :

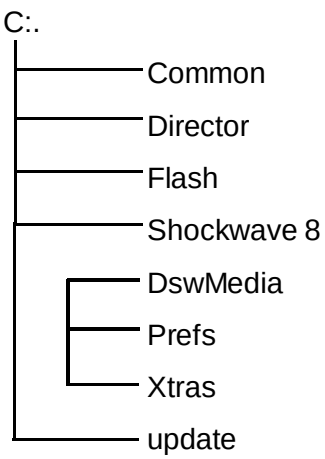
TREE Drive:\ Path /f /a

Drive:\Path	Drive and directory containing disk for display of directory structure.
/f	Displays file names in each directory. /a ext characters used for linking lines, instead of graphic characters.
/a	is used with code pages that do not support graphic characters and to send output to printers that do not properly interpret graphic characters.

Examples :

tree

List a tree listing of the current drive. A basic example of what a directory may look like is given below.



7. XCOPY : Xcopy is a powerful version of the copy command with additional features; has the capability of moving files, directories, and even whole drives from one location to another.

Syntax :

Windows 2000 and XP xcopy syntax

XCOPY source [destination] [/A | /M] [/D[:date]] [/P] [/S [/E]] [/V] [/W] [/C] [/I] [/Q] [/F] [/L] [/H] [/R] [/T] [/U] [/K] [/N] [/O] [/X] [/Y] [/-Y] [/Z] [/EXCLUDE: file1[+file2][+file3]...]

source Specifies the file(s) to copy.

destination Specifies the location and/or name of new files.

/A Copies only files with the archive attribute set, doesn't change the attribute.

/M Copies only files with the archive attribute set, turns off the archive attribute.

/D:m-d-y Copies files changed on or after the specified date. If no date is given, copies only those files whose source time is newer than the destination time.

/EXCLUDE: file1 [+file2][+file3]... Specifies a list of files containing strings. When any of the strings match any part of the absolute path of the file to be copied, that file will be excluded from being copied. For example, specifying a string like \obj\ or .obj will exclude all files underneath the directory obj or all files with the .obj extension respectively.

/P	Prompts you before creating each destination file.
/S	Copies directories and subdirectories except empty ones.
/E	Copies directories and subdirectories, including empty ones. Same as /S /E. May be used to modify /T. /V Verifies each new file.
/W	Prompts you to press a key before copying.
/C	Continues copying even if errors occur.
/I	If destination does not exist and copying more than one file, assumes that destination must be a directory.
/Q	Does not display file names while copying.
/F	Displays full source and destination file names while copying.
/L	Displays files that would be copied.
/H	Copies hidden and system files also.
/R	Overwrites read-only files.
/T	Creates directory structure, but does not copy files. Does not include empty directories or subdirectories. /T /E includes empty directories and subdirectories.
/U	Copies only files that already exist in destination.
/K	Copies attributes. Normal Xcopy will reset read-only attributes.
/N	Copies using the generated short names.
/O	Copies file ownership and ACL information.
/X	Copies file audit settings (implies /O).
/Y	Suppresses prompting to confirm you want to overwrite an existing destination file.
/-Y	Causes prompting to confirm you want to overwrite an existing destination file.
/Z	Copies networked files in restartable mode.

Examples :

xcopy c:\temp /e

The above example is the basic xcopy command to copy the files,

directories, and subdirectories to the directory you're currently in.

xcopy "c:\documents and settings\hope" /e

In the above example the xcopy command would copy all files and directories in the user "hope" directory to the directory or drive you're currently in.

xcopy h:*.* /a /e /k

The above command would copy everything located on the H drive to the drive you are currently on.

8.9 BATCH FILE

In MS-DOS, OS/2, and Windows, a **batch file** is a text file containing a series of commands intended to be executed by the command interpreter. When a batch file is run, the shell program (usually COMMAND.COM or cmd.exe) reads the file and executes its commands, normally line-by-line. A batch file is analogous to a shell script in Unix-like operating systems.

Batch files are useful for running a sequence of executables automatically. Many system administrators use them to automate tedious processes. Although batch files support elementary program flow commands such as *if* and *goto*, they are not well-suited for general-purpose programming.

DOS batch files have the filename extension .BAT. Batch files for other environments may have different extensions, e.g. .CMD in Windows NT and OS/2, or .BTM in 4DOS and related shells.

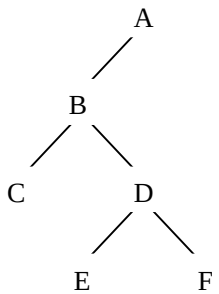
File extension : .bat .cmd .btm

Type of format : Scripting



CHECK YOUR PROGRSS

1. It is required to create six directories viz. A,B,C,D,E,F. These directories should follow the hierarchy shown in the following tree.



   The directory A should be created in the root directory of drive C. Give the sequence of MS-DOS commands which would yeild the desired results.

   .....

   .....

   .....

2. How the DOS XCOPY command differ from DOS COPY command.

   .....

   .....

   .....

3. Many times, the computer goes into hang. Which key combination is used to reboot the system?

   .....



8.10 LET US SUM UP

- MS-DOS is an acronym for Microsoft Disk Operating System, first released in August 1981.
- Loading of DOS into main memory is known as booting.

- The three system files of MS-DOS are loaded in order of IO.SYS, MSDOS.SYS and COMMAND.COM
- DOS commands are of two types : internal and external.
- Internal commands are those that are directly interpreted by the command processor, COMMAND.COM.
- External commands are those that are interpreted with the help of external files (with extension .COM or .EXE)
- Storage area on a disk are known as directories. A directory may contain files and/or subdirectories inside it.
- Path is a sequence of directory names which give you the hierarchy to access a particular directory or file name.
- The full name of a file or directory (including path) is also called path.
- Some DOS internal commands are COPY, DEL/ERASE, REN, TYPE, DIR, CHDIR/CD, MKDIR/MD, RMDIR/RD, BREAK, CLS, DATE, TIME, PATH, VER etc.
- Some external commands are DISKCOMP, DISKCOPY, FORMAT, LABEL, MEM, PRINT, TREE, XCOPY etc.
- Batches of MS-DOS commands stored under a filename with extension .BAT are known as batch files.
- The batch file with the name AUTOEXEC.BAT is automatically executed by MS-DOS at the time of booting.



8.11 FURTHER READING

- Norton, P. (1989). Peter Norton's DOS guide. Brady.
- Thomas, R. M. (1993). DOS 6.2 Instant Reference. SYBEX Inc.



8.12 ANSWERS TO CHECK YOUR PROGRESS

Answer 1 :

C>MD A ↵

C>MD C:\A\B ↵

omitting C: as it is the current i.e. dafault drive

C>MD \A\B\C ↵

C>MD \A\B\D ↵

C>MD \A\B\D\E ↵

C>MD \A\B\D\F ↵

Or alternatively

C>MD A ↵

C>CD A ↵

C>MD B ↵

C>CD B ↵

C>MD C ↵

C>MD D ↵

C>CD D ↵

C>MD E ↵

C>MD F ↵

Answer 2 : COPY can only copy the specified files from one directory only whereas XCOPY /s can copy the files from subdirectories also. COPY can not ask for confirmation before copying files whereas XCOPY /p can ask for confirmation also.

Answer 3 : Ctrl + Alt + Del



8.13 MODEL QUESTIONS

Q1. Define kernel and shell. What are their roles ?

Q2. What are internal and external commands? How are they different ?

Q3. Write the purpose of the following commands? Also state whether they are internal or external commands.

TYPE, PROMPT, DISKCOPY, MEM

Q4. Write the purpose of the following commands? Also state whether the following are internal or external commands.

RD, VER,MEM, LABEL, FORMAT

Q5. What functions do the following commands perform:

a) DISKCOPY b) DISKCOMP

Q6. How is XCOPY a better copy command then COPY?

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