



# Lectures in Computer Science and Information Technology

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# Contents

# Chapter 1

# Computer Basics

This chapter lays a foundation for one of the most influential forces available in modern times, the computer. A computer is an electronic device, operating under the control of instructions, which tells the machine what to do. It is capable of accepting data (input), processing data arithmetically and logically, producing output from the processing, and storing the results for future use. The chapter begins with the characteristics, evolution, and various generations of computers. The discussion also explores the classification of computers and their features. The chapter concludes with an overview on basic computer units and computer applications.

## 1.1 Introduction

In the beginning of the civilization, people used fingers and pebbles for computing purposes. In fact, the word digits in Latin actually means finger and calculus means pebble. This gives a clue into the origin of early computing concepts. With the development of civilization, the computing needs also grew. The need for a mechanism to perform lengthy calculations led to the invention of, first, calculator and then computers.

The term computer is derived from the word compute, which means to calculate. A computer is an electronic machine devised for performing calculations and controlling operations that can be expressed either in logical or in numerical terms. In simple words, a computer is an electronic device that performs diverse operations with the help of instructions to process the data in order to achieve desired results. Although the application domain of a computer depends totally on human creativity and imagination, it covers a huge area of applications including education, industries, government, medicine, scientific research, law, and even music and arts.

Computers are one of the most influential forces available in modern times. Harnessing the power of computers enables relatively limited and fallible human capacities for memory, logical decision making, reaction and perfection to be extended to almost infinite levels. Millions of complex calculations can be done in a mere fraction of time; difficult decisions can be made with unerring accuracy for comparatively little cost. Computers are widely seen as instruments for fu- ture progress and as tools to achieve sustainability by way of improved access to information with the help of video-conferencing and e-mail. Indeed, computers have left such an impression on modern civilization that we call this era as the "information age".

### 1.1.1 Characteristics of Computers

The human race developed computers so that it could perform intricate operations, such as calculation and data processing, or simply for entertainment. Today, much of the world's infrastructure runs on computers and it has profoundly changed our lives, mostly for the better. Let us discuss some of the characteristics of computers, which make them an essential part of every emerging technology and such a desirable tool in human development.

- **Speed:** The computers process data at an extremely fast rate, at millions or billions of instructions per second. A computer can perform a huge task in a few seconds that otherwise a normal human being may take days or even years to complete. The speed of a computer is calculated in MHz (mega-hertz), that is, one million instructions per second. At present, a powerful computer can perform billions of operations in just one second.

- **Accuracy:** Besides the efficiency, the computers are also very accurate. The level of accuracy depends on the instructions and the type of machines being used. Since the computer is capable of doing only what it is instructed to do, faulty instructions for data processing may lead to faulty results. This is known as Garbage In Garbage Out (GIGO).

- **Diligence:** Computer, being a machine, does not suffer from the human traits of tiredness and lack of concentration. If four million calculations have to be performed, then the computer will perform the last four-millionth calculation with the same accuracy and speed as the first calculation.

- **Reliability:** Generally, reliability is the measurement of the performance of a computer, which is measured against some predetermined standard for operation without any failure. The major reason behind the reliability of the computers is that, at hardware level, it does not require any human intervention between its processing operations. Moreover, computers have built-in diagnostic capabilities, which help in the continuous monitoring of the system.

- **Storage Capability:** Computers can store large amounts of data and can recall the required information almost instantaneously. The main memory of the computer is relatively small and it can hold only a certain amount of data; therefore, the data are stored on secondary storage devices such as magnetic tape or disks. Small sections of data can be accessed very quickly from these

storage devices and brought into the main memory, as and when required, for processing.

- **Versatility:** Computers are quite versatile in nature. It can perform multiple tasks simultaneously with equal ease. For example, at one moment it can be used to draft a letter, another moment it can be used to play music andin between, one can print a document as well. All this work is possible by changing the program (computer instructions).

- **Resource Sharing:** In the initial stages of development, computers used to be isolated machines. With the tremendous growth in computer technologies, computers today have the capability to connect with each other. This has made the sharing of costly resources like printers possible. Apart from device sharing, data and information can also be shared among groups of computers, thus creating a large information and knowledge base.

Although processing has become less tedious with the development of computers, it is still a time-consuming and expensive job. Sometimes, a program works properly for some period and then suddenly produces an error. This happens because of a rare combination of events or due to an error in the instruction provided by theuser. Therefore, computer parts require regular checking and maintenance in orderto give correct results. Furthermore, computers need to be installed in a dust-free place. Generally, some parts of computers get heated up due to heavy processing.Therefore, the ambient temperature of the computer system should be maintained.

## 1.2 Generations of Computers

The history of computer development is often discussed with reference to the different generations of computing devices. In computer terminology, the word generation is described as a stage of technological development or innovation. A

major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful, and more efficient and reliable devices, characterizes each generation of computers. According to the type of "processor" installed in a machine, there are five generations of computers.

### 1.2.1 First Generation (1940 to 1956): Vacuum Tubes

First-generation computers were vacuum tubes/thermionic valve-based machines. These computers used vacuum tubes for circuitry and magnetic drums for memory. A magnetic drum is a metal cylinder coated with magnetic iron oxide material on which data and programs can be stored. The input was based on punched cards and paper tape, and the output was in the form of printouts (see Figure 1.1)


**Figure 1.1:** Vacuum tube

First-generation computers relied on binary-coded language also called machine language (language of 0s and 1s) to perform operations and were able to solve only one problem at a time. Each machine was fed with different binary codes and hence, were difficult to program. This resulted in lack of versatility and speed. In addition, to run on different types of computers, instructions must be rewritten or recompiled.

**Examples:** ENIAC, EDVAC and UNIVAC.

**Characteristics of First-generation Computers:**

- These computers were based on vacuum tube technology.

- These were the fastest computing devices of their times (computation time was in milliseconds).
- These computers were very large and required a lot of space for installation.
- Since thousands of vacuum tubes were used, they generated a large amount of heat. Therefore, air conditioning was essential.
- These were non-portable and very slow equipments.
- They lacked in versatility and speed.
- They were very expensive to operate and used a large amount of electricity.
- These machines were unreliable and prone to frequent hardware failures. Hence, constant maintenance was required.
- Since machine language was used, these computers were difficult to program and use.
- Each individual component had to be assembled manually. Hence, commercial appeal of these computers was poor.

### 1.2.2 Second Generation (1956 to 1963): Transistors

Second-generation computers used transistors, which were superior to vacuum tubes. A transistor is made up of semiconductor material like germanium and silicon. It usually has three leads (see Figure 1.2) and performs electrical functions such as voltage, current or power amplification with low power requirements. Since a transistor is a small device, the physical size of computers was greatly reduced. Computers became smaller, faster, cheaper, energy efficient and more reliable than their predecessors. In second-generation computers, magnetic cores were used as the primary memory and magnetic disks as the secondary storage devices. However, they still relied on punched cards for the input and printouts for the output.

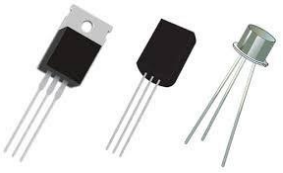

**Figure 1.2:** Transistor

One of the major developments of this generation includes the progress from machine language to assembly language. Assembly language uses mnemonics (abbreviations) for instructions rather than numbers, for example, ADD for additionand MULT for multiplication. As a result, programming became less cumber- some. Early high-level programming languages such as COBOL and FORTRANalso came into existence in this period.

**Examples:** PDP-8, IBM 1401 and IBM 7090.

**Characteristics of Second-generation Computers**

- These machines were based on transistor technology.
- These were smaller as compared to the first-generation computers.
- The computational time of these computers was reduced to microseconds from milliseconds.
- These were more reliable and less prone to hardware failure. Hence, they required less frequent maintenance.
- These were more portable and generated less amount of heat.
- Assembly language was used to program computers. Hence, programming became more time-efficient and less cumbersome.
- Second-generation computers still required air conditioning.

- Manual assembly of individual components into a functioning unit was still required.

### 1.2.3 Third Generation (1964 to Early 1970s): Integrated Circuits

The development of the integrated circuit, also called an IC, was the trait of the third-generation computers. An IC consists of a single chip (usually silicon) with many components such as transistors and resistors fabricated on it. ICs replaced several individually wired transistors. This development made computers smaller in size, reliable and efficient (see Figure 1.3).

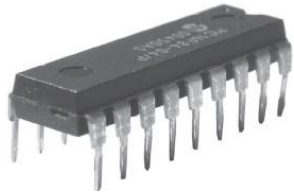

**Figure 1.3:** Integrated Circuit (IC)

Instead of punched cards and printouts, users interacted with third-generation computers through keyboards and monitors, and interfaced with the operating system. This allowed the device to run many different applications simultaneously with a central program that monitored the memory. For the first time, computers became accessible to mass audience because they were smaller and cheaper than their predecessors.

**Examples:** NCR 395 and B6500.

**Characteristics of Third-generation Computers**

- These computers were based on IC technology.
- These were able to reduce the computational time from microseconds to nanoseconds.

- These were easily portable and more reliable than the second-generation computers.
- These devices consumed less power and generated less heat. In some cases, air conditioning was still required.
- The size of these computers was smaller as compared to previous-generation computers.
- Since hardware rarely failed, the maintenance cost was quite low.
- Extensive use of high-level languages became possible.
- Manual assembling of individual components was not required, so it reduced the large requirement of labour and cost. However, highly sophisticated technologies were required for the manufacturing of IC chips.
- Commercial production became easier and cheaper.

### 1.2.4 Fourth Generation (Early 1970s to Till Date): Microprocessors

The fourth generation is an extension of third generation technology. Although, the technology of this generation is still based on the IC, these have been made readily available to us because of the development of the microprocessor (circuits containing millions of transistors). The Intel 4004 chip, which was developed in 1971, took the IC one step further by locating all the components of a computer (CPU, memory and I/O controls) on a minuscule chip. A microprocessor is built on to a single piece of silicon, known as chip. It is about 0.5 cm along one side and no more than 0.05 cm thick.

The fourth-generation computers led to an era of Large Scale Integration (LSI) and VLSI technology. LSI technology allowed thousands of transistors to be constructed on one small slice of silicon material, whereas VLSI squeezed hundreds of

thousands of components on to a single chip. Ultra Large Scale Integration (ULSI) increased that number to the millions. This way computers became smaller and cheaper than ever before (see Figure 1.4).

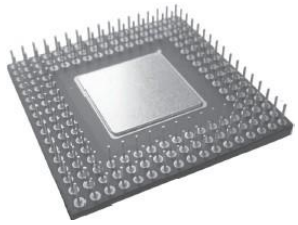

**Figure 1.4:** Microprocessor

The fourth-generation computers became more powerful, compact, reliable and affordable. As a result, it gave rise to the PC revolution. During this period, magnetic core memories were substituted by semiconductor memories, which resulted in faster random access main memories. Moreover, secondary memories such as hard disks became economical, smaller and bigger in capacity. The other significant development of this era was that these computers could be linked together to form networks, which eventually led to the development of the Internet. This generation also saw the development of the Graphical User Interfaces (GUIs), mouse and handheld devices. Despite many advantages, this generation required complex and sophisticated technology for the manufacturing of the CPU and the other components.

**Examples:** Apple II, Altair 8800 and CRAY-1.

**Characteristics of Fourth-generation Computers**

- These computers are microprocessor-based systems.
- These are very small in size.
- These are the cheapest among all the other generation computers.
- These are portable and quite reliable.

- These machines generate negligible amount of heat, hence do not require air conditioning.
- Hardware failure is negligible so minimum maintenance is required.
- The production cost is very low.
- The GUI and pointing devices enabled users to learn to use the computer quickly.
- Interconnection of computers led to better communication and resource sharing.

### 1.2.5 Fifth Generation (Present and Beyond): Artificial Intelligence

The dream of creating a human-like computer that would be capable of reasoning and reaching at a decision through a series of what-if-then analyses has existedsince the beginning of computer technology. Such a computer would learn from its mistakes and possess the skill of experts. These are the objectives for creating the fifth generation of computers. The starting point for the fifth generation of computers had been set in the early 1990s. The process of developing fifth-generation computers is still in the development stage. However, the expert system concept is already in use. The expert system is defined as a computer system that attempts to mimic the thought process and reasoning of experts in specific areas. Three characteristics can be identified with the fifth-generation computers. These are:

- **Mega Chips:** Fifth-generation computers will use Super Large Scale Integrated (SLSI) chips, which will result in the production of microprocessors having millions of electronic components on a single chip. In order to store instructions and information, fifth-generation computers require a great amount of storage capacity. Mega chips may enable the computer to approximate the memory capacity of the human mind.

- **Parallel Processing:** Computers with one processor access and execute only one instruction at a time. This is called serial processing. However, fifth-generation computers will use multiple processors and perform parallel processing, thereby accessing several instructions at once and working on them at the same time.
- **Artificial Intelligence (AI):** It refers to a series of related technologies that try to simulate and reproduce human behavior, including thinking, speaking and reasoning. AI comprises a group of related technologies: expert systems (ES), natural language processing (NLP), speech recognition, vision recognition and robotics.

## 1.3 Classification of Computers

These days, computers are available in many sizes and types. Some computers can fit in the palm of the hand, while some can occupy the entire room. Computers also differ based on their data-processing abilities. Based on the physical size, performance and application areas, we can generally divide computers into four major categories: micro, mini, mainframe and supercomputers (see Figure 1.5).

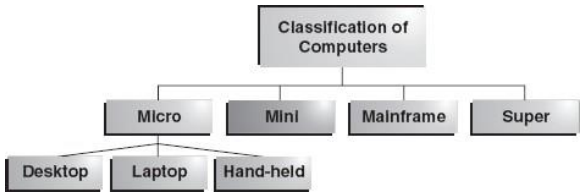


**Figure 1.5:** Classification of Computers

### 1.3.1 Microcomputers

A microcomputer is a small, low-cost digital computer, which usually consists of a microprocessor, a storage unit, an input channel and an output channel, all of

which may be on one chip inserted into one or several PC boards. The addition of power supply and connecting cables, appropriate peripherals (keyboard, monitor, printer, disk drives and others), an operating system and other software programs can provide a complete microcomputer system. The micro-computer is generally the smallest of the computer family. Originally, these were designed for individual users only, but nowadays they have become powerful tools for many businesses that, when networked together, can serve more than one user. IBM-PC Pentium 100, IBM-PC Pentium 200 and Apple Macintosh are some of the examples of microcomputers. Microcomputers include desktop, laptop and hand-held models such as Personal Digital Assistants (PDAs).

**Desktop Computer:** The desktop computer, also known as the PC, is principally intended for stand-alone use by an individual. These are the most-common type of microcomputers. These microcomputers typically consist of a system unit, a display monitor, a keyboard, an internal hard disk storage and other peripheral devices. The main reason behind the importance of the PCs is that they are not very expensive for the individuals or the small businesses. Some of the major PC manufacturers are APPLE, IBM, Dell and Hewlett-Packard (see Figure 1.6).

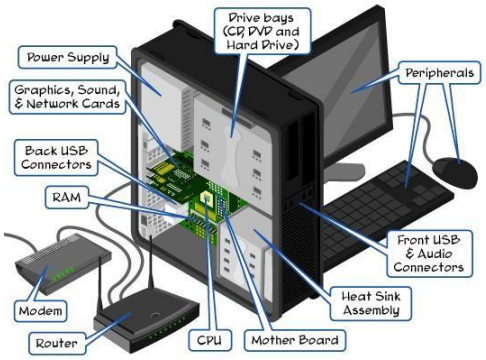


**Figure 1.6:** Desktop Computer

**Laptop:** A laptop is a portable computer that a user can carry around. Since the laptop resembles a notebook, it is also known as the notebook computer. Laptops

are small computers enclosing all the basic features of a normal desktop computer. The biggest advantage of laptops is that they are lightweight and one can use them anywhere and at anytime, especially when one is travelling. Moreover, they do not need any external power supply as a rechargeable battery is completely self-contained in them. However, they are expensive as compared to desktop computers (see Figure 1.7).

**Figure 1.7:** Laptop

### 1.3.2 Minicomputers

In the early 1960s, Digital Equipment Corporation (DEC) started shipping its PDP series computer, which the press described and referred to as *minicomputers*. A minicomputer is a small digital computer, which normally is able to process and store less data than a mainframe but more than a microcomputer, while doing so less rapidly than a mainframe but more rapidly than a microcomputer. It is about the size of a two-drawer filing cabinet. Generally, these computers are used as desktop devices that are often connected to a mainframe in order to perform the auxiliary operations (see Figure 1.8).

**Figure 1.8:** Minicomputer

A minicomputer (sometimes called a mid-range computer) is designed to meet the computing needs of several people simultaneously in a small- to medium-sized business environment. It is capable of supporting from four to about 200 simultaneous users. It serves as a centralized storehouse for a cluster of workstations or as a network server. Minicomputers are usually multi-user systems so these are used in interactive applications in industries, research organizations, colleges and universities. They are also used for real-time controls and engineering design work. Some of the widely used minicomputers are PDP 11, IBM (8000 series) and VAX 7500.

### 1.3.3 Mainframes

A *mainframe* is an ultra-high performance computer made for high-volume, processor-intensive computing. It consists of a high-end computer processor, with related peripheral devices, capable of supporting large volumes of data processing, high-performance online transaction processing, and extensive data storage and retrieval. Normally, it is able to process and store more data than a minicomputer and far more than a microcomputer. Moreover, it is designed to perform at a faster rate than a minicomputer and at even more faster rate than a microcomputer. Mainframes are the second largest (in capability and size) of the computer family, the

largest being the supercomputers. However, mainframes can usually execute many programs simultaneously at a high speed, whereas supercomputers are designed for a single process (see Figure 1.9).

**Figure 1.9:** Mainframe

The mainframe allows its users to maintain a large amount of data storage at a centralized location and to access and process these data from different computers located at different locations. It is typically used by large businesses and for scientific purposes. Some examples of the mainframe are IBM's ES000, VAX 8000 and CDC 6600.

### 1.3.4 Supercomputers

*Supercomputers* are the special-purpose machines, which are especially designed to maximize the numbers of floating point operations per second (FLOPS). Any computer below one gigaflop per second is not considered a supercomputer. A supercomputer has the highest processing speed at a given time for solving scientific and engineering problems. Essentially, it contains a number of CPUs that operate in parallel to make it faster. Its processing speed lies in the range 40010,000 MFLOPS (millions of floating point operations per second). Due to this fea- ture, supercomputers help in many applications including information retrieval and computer-aided designing (see Figure 1.10).

**Figure 1.10:** Supercomputer

A supercomputer can process a great deal of data and make extensive calculations very quickly. It can resolve complex mathematical equations in a few hours, which would have taken many years when performed using a paper and pencil or using a hand calculator. It is the fastest, costliest and most powerful computer available today. Typically, supercomputers are used to solve multivariant mathematical problems of existent physical processes, such as aerodynamics, metrology and plasma physics. They are also required by the military strategists to simulate defence scenarios. Cinematic specialists use them to produce sophisticated movie animations. Scientists build complex models and simulate them in a supercomputer. However, a supercomputer has limited broad-spectrum use because of its price and limited market. The largest commercial uses of supercomputers are in the entertainment/advertising industry. CRAY-3, Cyber 205 and PARAM are some well-known supercomputers.

## 1.4 The Computer System

A computer can be viewed as a system, which consists of a number of interrelated components that work together with the aim of converting data into information. In a computer system, processing is carried out electronically, usually with little or no intervention from the user.

The general perception of people regarding the computer is that it is an “intelli-

gent thinking machine". However, this is not true. Every computer needs to be instructed exactly what to do and how to do. The instructions given to computers are called programs. Without programs, computers would be useless. The physical parts that make up a computer (the CPU, input, output and storage unit) are known as hardware. Any hardware device connected to the computer or any part of the computer outside the CPU and working memory is known as a peripheral. Some examples of peripherals are keyboards, mouse and monitors.

### 1.4.1 Components of a Computer System

There are several computer systems in the market with a wide variety of makes, models and peripherals. In general, a computer system comprises the following components:

- **CPU:** This unit performs processing of instructions and data inside the computer.
- **Input Unit:** This unit accepts instructions and data.
- **Output Unit:** This unit communicates the results to the user.
- **Storage Unit:** This unit stores temporary and final results (see Figure 1.11).

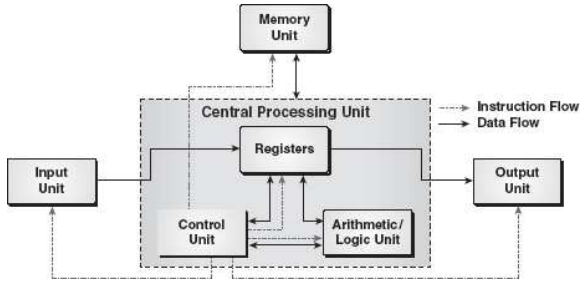


**Figure 1.11:** Components of a Computer System

**Central Processing Unit:** The CPU, also known as a processor, is the brain of

the computer system that processes data (input) and converts it into meaningful information (output). It is referred to as the administrative section of the computer system that interprets the data and instructions, coordinates the operations, and supervises the instructions. The CPU works with data in discrete form, that is, either 1 or 0. It counts, lists, compares and rearranges the binary digits of data in accordance with the detailed program instructions stored within the memory. Eventually, the results of these operations are translated into characters, numbers and symbols that can be understood by the user. The CPU itself has three parts:

- **Arithmetic Logic Unit (ALU):** This unit performs the arithmetic (add, subtract) and logical operations (and, or) on the data made available to it. Whenever an arithmetic or logical operation is to be performed, the required data are transferred from the memory unit to the ALU, the operation is performed and the result is returned to the memory unit. Before the completion of the processing, data may need to be transferred back and forth several times between these two sections.

- **Control Unit:** This unit checks the correctness of the sequence of operations. It fetches the program instructions from the memory unit, interprets them and ensures correct execution of the program. It also controls the I/O devices and directs the overall functioning of the other units of the computer.

- **Registers:** These are the special-purpose, high-speed temporary memory units that can hold varied information such as data, instructions, addresses and intermediate results of calculations. Essentially, they hold the information that the CPU is currently working on. The registers can be considered as the CPU's working memory, an additional storage location that provides the advantage of speed.

**Note:** The circuits necessary to create a CPU for a PC are fabricated on a microprocessor.

**Input, Output and Storage Unit:** The user must enter instructions and data into the computer system before any operation can be performed on the given data. Similarly, after processing the data, the information must go out from the computer system to the user. For this, every computer system incorporates the I/O unit that serves as a communication medium between the computer system and the user.

An input unit accepts instructions and data from the user with the help of input devices such as keyboard, mouse, light pen, etc. Since the data and instructions entered through different input devices will be in different form, the input unit converts them into the form that the computer can understand. After this, the input unit supplies the converted instructions and data to the computer for further processing.

The output unit performs just opposite to that of input unit. It accepts the output (which is in machine-coded form) produced by the computer, converts them into the user-understandable form and supplies the converted results to the user with the help of an output device such as printer, monitor and plotter.

Besides, a computer system incorporates a storage unit to store the input entered through the input unit before processing starts and to store the results produced by the computer before supplying them to the output unit. The storage unit of a computer comprises two types of memory/storage: primary and secondary. The primary memory, also called the main memory, is the part of a computer that holds the instructions and data currently being processed by the CPU, the intermediate results produced during the course of calculations and the recently processed data. While the instructions and data remain in the main memory, the CPU can access them directly and quickly. However, the primary memory is quite expensive and has a limited storage capacity.

Due to the limited size of the primary memory, a computer employs the secondary memory, which is extensively used for storing data and instructions. It supplies

the stored information to the other units of the computer as and when required. It is less expensive and has higher storage capacity than the primary memory. Some commonly used secondary storage devices are floppy disks, hard disks and tape drives (see Figure 1.12).


**Figure 1.12:** Typical Hardware and Peripherals in a Computer System

### 1.4.2 How Does a Computer Work?

A computer performs three basic steps to complete any task: input, processing and output. A task is assigned to a computer in a set of step-by-step instructions, which is known as a program. These instructions tell the computer what to do with the input in order to produce the required output. A computer functions in thefollowing manner:

- **Step 1:** The computer accepts the input. The computer input is whatever entered or fed into a computer system. The input can be supplied by the user (such as by using a keyboard) or by another computer or device (such as a diskette or CD-ROM). Some examples of input include the words and symbols in a document, numbers for a calculation, instructions for completing a process, and so on.
- **Step 2:** The computer processes the data. During this stage, the computer follows the instructions using the data that have been input. Examples of processing include calculations, sorting lists of words or numbers and modifying documents according to user instructions.

- **Step 3:** The computer produces output. Computer output is the information that has been produced by a computer. Some examples of computer output include reports, documents and graphs. Output can be in several formats, such as printouts, or displayed on the screen (see Figure 1.13).

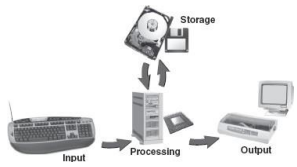


**Figure 1.13:** Basic Computer Operations

## 1.5 Applications of Computers

In the last few decades, computer technology has revolutionized the businesses and other aspects of human life all over the world. Practically, every company, large or small, is now directly or indirectly dependent on computers for data processing. Computer systems also help in the efficient operation of railway and airway reservation, hospital records, accounts, electronic banking and so on. Computers not only save time, but also save paper work. Some of the areas where computers are being used are listed below.

- **Science:** Scientists have been using computers to develop theories, to analyse and to test the data. The fast speed and the accuracy of the computer allow different scientific analyses to be carried out. They can be used to generate detailed studies of how earthquakes affect buildings or pollution affects weather pattern. Satellite-based applications would not have been possible without the use of computers. It would also not be possible to get the information of our solar system and the cosmos without computers.
- **Education:** Computers have also revolutionized the whole process of education. Currently, the classrooms, libraries and museums are utilizing computers

to make the education much more interesting. Unlike recorded television shows, computer-aided education (CAE) and computer-based training (CBT) packages are making learning much more interactive.

- **Medicine and Healthcare:** There has been an increasing use of computers in the field of medicine. Now, doctors are using computers right from diagnosing the illness to monitoring a patient's status during complex surgery. By using automated imaging techniques, doctors are able to look inside a person's body and can study each organ in detail (such as CAT scans or MRI scans), which was not possible few years ago. There are several examples of special-purpose computers that can operate within the human body such as a cochlear implant, a special kind of hearing aid that makes it possible for deaf people to hear.
- **Engineering/Architecture/Manufacturing:** The architects and engineers are extensively using computers in designing and drawings. Computers can create objects that can be viewed from all the three dimensions. By using techniques like virtual reality, architects can explore houses that have been designed but not built. The manufacturing factories are using computerized robotic arms in order to perform hazardous jobs. Besides, computer-aided manufacturing (CAM) can be used in designing the product, ordering the parts and planning production. Thus, computers help in coordinating the entire manufacturing process.
- **Entertainment:** Computers are finding greater use in the entertainment industry. They are used to control the images and sounds. The special effects, which mesmerize the audience, would not have been possible without the computers. In addition, computerized animation and colourful graphics have modernized the film industry.
- **Communication:** E-mail or electronic mail is one of the communication media in which computers are used. Through an e-mail, messages and reports

are passed from one person to one or more persons with the aid of computers and telephone lines. The advantage of this service is that while transferring the messages it saves time, avoids wastage of paper, and so on. Moreover, the person who is receiving the messages can read the messages whenever he is free and can save it, reply it, forward it or delete it from the computer.

- **Business Application:** This is one of the important uses of the computer. Initially, computers were used for batch processing jobs, where one does not require the immediate response from the computer. Currently, comput- ers are mainly used for real-time applications (like at the sales counter) that require immediate response from the computer. There are various concerns for which computers are used such as in business forecasting, to prepare pay bills and personal records, in banking operations and data storage, in various types of life insurance business, and as an aid to management. Businesses are also using the networking of computers, where a number of computers are connected together to share the data and the information. Use of an e-mail and the Internet has changed the ways of doing business.
- **Publishing:** Computers have created a field known as Desktop Publishing (DTP). In DTP, with the help of a computer and a laser printer one can perform the publishing job all by oneself. Many of the tasks requiring long manual hours, such as making a table of contents and an index, can be automatically performed using the computers and DTP software.
- **Banking:** In the field of banking and finance, computers are extensively used. People can use the Automated Teller Machine (ATM) services 24 hours a day in order to deposit and withdraw cash. When the different branches of the bank are connected through the computer networks, the inter-branch transactions, such as drawing cheques and making drafts, can be performed by the computers without any delay

# Let Us Summarize

1. Computer is an electronic device that performs diverse operations with the help of instructions to process the data in order to achieve desired results. Speed, accuracy, reliability, versatility, diligence, storage capability and resource sharing characterize the computers.

2. Many devices, which humans developed for their computing requirements, preceded computers. Some of those devices were Sand Tables, Abacus, Napier Bones, Slide Rule, Pascaline, Stepped Reckoner, Difference Engine, Analytical Engine and Hollerith's Tabulator.

3. Computer development is divided into five main generations. With every generation, computer technology has fundamentally changed, resulting in an increasingly smaller, cheaper, more powerful, more efficient and reliable devices.

4. First-generation computers were vacuum tube based machines. These computers were very large, required a lot of space for installation, generated a large amount of heat were non-portable and have very slow equipments. In addition, these machines were unreliable and prone to frequent hardware failures.

5. Second-generation computers used transistors in place of vacuum tubes. Since a transistor is a small device, the physical size of computers was greatly reduced. Computers became smaller, faster, cheaper, energy-efficient and more reliable than their predecessors.

6. Third-generation computers were IC-based machines. The IC replaced several individually wired transistors, making computers smaller in size, reliable and efficient.

7. Fourth-generation computers use microprocessors (circuits containing millions of transistors) as their basic processing device. These computers are the most powerful, compact, reliable and affordable as compared to their predecessors.

8. Fifth-generation computers are still in the development stage. These comput- ers will use megachips, which will result in the production of microproces-sors having millions of electronic components on a single chip. They will use intelligent programming (AI) and knowledge-based problem-solving techniques.

9. A microcomputer is a small, low-cost digital computer, which usually consists of a microprocessor, a storage unit, and an input and output channel, all of which may be on one chip inserted into one or several PC boards. Microcomputers include desktop, laptop and hand-held models, such as PDAs.

10. A minicomputer is a small digital computer, which normally is able to process and store less data than a mainframe but more than a microcomputer, while doing so less rapidly than a mainframe but more rapidly than a microcomputer.

11. A mainframe is an ultrahigh performance computer made for high-volume, processor-intensive computing. It is capable of supporting large volumes of data processing, high-performance online transaction processing, and extensive data storage and retrieval.

12. Supercomputers are the special-purpose machines, which are specifically designed to maximize the number of FLOPS. Any computer below one gigaflop per second is not considered as a supercomputer.

13. A computer can be viewed as a system that comprises several units (CPU, input unit, output unit and storage unit). These individual units work together

to convert data into information.

14. The CPU interprets, coordinates the operations and supervises the instructions. It has three parts: ALU, CU and registers. The ALU performs arithmetic (add, subtract) and logical operations (and, or) on the stored numbers. The CU checks the correctness of the sequence of operations, controls the I/O devices and directs the overall functioning of the other units of the computer. The registers are special-purpose, high-speed temporary memory units that can hold varied information such as data, instructions, addresses and intermediate results of calculations.

15. The input unit involves the receipt of data or instructions from the user, in a computer acceptable form. The computer takes in the data through input devices like keyboard, mouse, light pen, etc.

16. The output unit supplies the resulting data obtained from the data processing to the user. Monitors, printers and plotters are some of the examples of output devices.

17. During processing, the intermediate and the results of processing are held by the storage unit until the manipulation of the data is completed. When the data to be processed or the results produced by the processing are in large volumes, they are stored on various storage media like floppies, hard disks and tapes.

18. A computer performs three basic steps to complete any task: input, processing and output. A computer receives data as input, processes it, stores it and then produces output.

19. Computers have entered in every sphere of human life and found applications in various fields, such as medicine and healthcare, business, education, science, technology, government, entertainment, engineering and architecture.

# Exercises

## Fill in the Blanks

1. The basic component of first-generation computers was .....
2. The speed of a computer is calculated in .....
3. Third-generation computers were..... based machines.
4. Keyboard is an..... device.
5. Laptops are also known as .....
6. Computers can be classified as ....., .....,..... and ..... computers.
7. A computer performs three basic steps to complete any task, which are..... , ..... and .....
8. PDA stands for .....
9. The CPU consists of ....., ..... and .....
10. Physical components on which the data are stored permanently are called .....

## Multiple-choice Questions

1. The development of computers can be divided..... into generations.

   (a) 3

   (b) 4

   (c) 5

   (d) 6

2. Choose the odd one out.

   (a) Microcomputer

   (b) Minicomputer

   (c) Supercomputer

   (d) Digital computer

3.is a very small computer that can be held in the palm of the hand.

   (a) PDA

   (b) PC

   (c) Laptop

   (d) Minicomputer computer

4. Analytical engine was developed by .....

   (a) Gottfried Wilhem Von Leibriz

   (b) Charles Babbage

   (c) Charles Babbage

   (d) Joseph-Marie Jacquard

5. The main distinguishing feature of fifth-generation computers will be .....

   (a) Liberal use of microprocessors

   (b) Artificial Intelligence

   (c) Extremely low cost

   (d) Versatility

6. The computer that is not considered as a portable computer is .....

   (a) Laptop

   (b) PDA

(c) Minicomputer

(d) None of these

7. The CPU stands for .....

(a) Central protection unit

(b) Central processing unit

(c) Central power unit

(d) Central prerogative unit

8. UNIVAC is an example of .....

(a) First-generation computer

(b) Second-generation computer

(c) Third-generation computer

(d) Fourth-generation computer

9. The unit that performs the arithmetic and logical operations on the stored numbers is known as .....

(a) Arithmetic logic unit

(b) Control unit

(c) Memory unit

(d) Both (a) and (b)

10. The..... is the administrative section of the computer system.

(a) Input unit

(b) Output unit

(c) Memory unit

(d) Central processing unit

## State True or False

1. The ALU is responsible for performing the arithmetic and logical operations.
2. Microcomputers are more powerful than minicomputers.
3. Laptop is also known as a notebook.
4. Vacuum tubes were a part of third-generation computers.
5. EDVAC was a second-generation computer.
6. LSI and VLSI technology are part of fifth-generation computers.
7. A laptop is a portable computer.
8. Primary memory and main memory are synonyms.
9. Computer development is divided into four main generations.
10. PARAM is an example of a portable computer.

## Descriptive Questions

1. Discuss the characteristics of computers.
2. What are the advantages of transistors over vacuum tubes?
3. Discuss various types of computers in detail.
4. List out various applications of computers.
5. Discuss various computer generations along with the key characteristics of the computers of each generation.
6. Discuss the basic organization of a computer system and explain the functions of various units of a computer system.

# Chapter 2

# Input Output Media

This chapter deals with two basic computer unitsinput and output devices. Input devices are used to enter the data and instructions into the computer system before any processing can be performed. Output devices are used for the conversion of machine-readable information into human-readable form. The chapter discusses some commonly used input devices including keyboard, mouse, joystick, scanner, and optical scanners. The functions of all these input devices along with the hard copy and soft copy output devices under which, various types of printers and plotters have been explored. Next display devices such as CRT monitors, LCD monitors and speech synthesisers are explained. The chapter concludes by giving an overview of computer terminals.

## 2.1 Introduction

Previously, we discussed that a computer accepts input and processes it to get a desired output according to the sequence of instructions. Essentially, a computer system consists of four components: input devices, CPU, output devices and memory. Input devices are used to provide data to the CPU for processing. After

processing, the input data is converted into meaningful information and this output is presented to the user with the help of output devices. In computer terminology, a device can be referred to as a unit of hardware, which is capable of providing input to the computer or receiving output, or both.

An input device is an electromechanical device that allows the user to feed information into the computer for analysis, storage and to give commands to the computer. Data and instructions are entered into the computer's memory through an input device. It captures information and translates it into a form that can be processed and used by the other parts of the computer. After processing the in- put data, the computer provides the results with the help of output devices. An output device converts machine-readable information into human-readable form. The basic functioning of the output device is just the opposite of the input device,that is, the data is "fed into" the computer system through the input device while the output is "taken out" from the computer through the output device. However,the output, which comes out from the CPU, is in the form of digital signals (see Figure 2.1). The output devices display the processed information by converting them into graphical, alphanumeric, or audio-visual form.

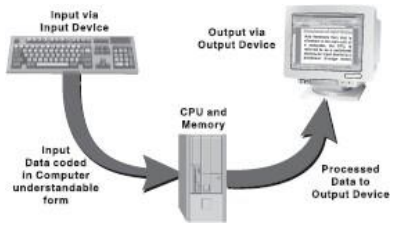


**Figure 2.1:** Data Processing

### 2.1.1 Importance of Input/Output Devices

As we know, the processing of the data by the computer system can be viewed as a three-step process:

- **Step 1:** Data input via an input device.

- **Step 2:** Processing of data.
- **Step 3:** Data output via an output device.

Input devices play a major role in the processing of any data via the computer system because the output of the computer is always based on the given input. Generally, data that is given to the input devices is raw. Therefore, it is the function of the input devices to manipulate the raw data and then send them for further processing. The preparation of the computerized input is the initial step in the creation of useful output. This output must be supplied to the outside world, which is done through output devices.

## 2.2 Types of Input Devices

Computer accepts input in two ways, either manually or directly. In case of manual data entry, the user enters the data into computer by hand, for example, by using keyboard and mouse. A user can also enter data directly by transferring information automatically from a source document (like from a cheque using MICR) into the computer. The user does not need to enter information manually. Direct data entry is accomplished by using special direct data entry devices like a barcode reader. Some of the commonly used input devices are keyboard, pointing devices like mouse and joystick, speech recognition, digital camera and scanners.

### 2.2.1 Keyboard

A keyboard is the most common data entry device. Using a keyboard, the user can type text and commands. The keyboard is designed to resemble a regular typewriter with a few additional keys (see Figure 2.2). Data is entered into the computer by simply pressing keys. The layout of the keyboard has changed very little since it was introduced. In fact, the most common change in its technology

has simply been the natural evolution of adding more keys that provide additional functionality. The number of keys on a typical keyboard varies from 84 to 104.

***Qwerty Query***

The layout of a keyboard comes in various styles, such as QWERTY, AZERTY and DVORAK. QWERTY is the most common layout in English language computer keyboards. It takes its name from the first six letters shown on the keyboard's top row of letters. Similarly, French language keyboards use A and Z in place of Q and W and are known as AZERTY keyboards.

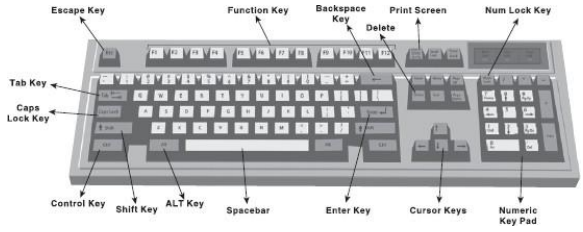


**Figure 2.2:** Keyboard

Portable computers such as laptops quite often have custom keyboards that have slightly different key arrangements than a standard keyboard. In addition, many system manufacturers add special buttons to the standard layout. A keyboard is the easiest input device, as it does not require any special skill. Usually, it is supplied with a computer so no additional cost is incurred. The maintenance and operational cost of a keyboard is also less. However, using a keyboard for data entry may be a slow process because the user has to manually type all the text. In addition, it can be difficult for people suffering from muscular disorders.

### 2.2.2 Pointing Devices

Most computers come with an alphanumeric keyboard but in some applications, the keyboard is not convenient. For example, if the user wants to select an item

from a list, the user can identify that item's position by selecting it through the keyboard. However, this action could be performed quickly by pointing at the correct position. A pointing device is used to communicate with the computer by pointing to locations on the monitor screen. Such devices do not require keying of characters; instead the user can move a cursor on the screen and perform move, click, or drag operations. Some of the commonly used pointing devices are mouse, trackball, joystick, light pen, touch screen and trackpad.

**Mouse:** A Mouse is a small handheld pointing device with a rubber ball embedded at its lower side and buttons on the top. Usually, a mouse contains two or three buttons, which can be used to input commands or information (see Figure 2.3). It may be classified as a mechanical mouse or an optical mouse, based on the technology it uses. A mechanical mouse uses a rubber ball at the bottom surface, which rotates as the mouse is moved along a flat surface, to move the cursor. It is the most common and least expensive pointing device. An optical mouse uses a light beam instead of a rotating ball to detect movement across a specially patterned mouse pad. As the user rolls the mouse on a flat surface, the cursor on the screen also moves in the direction of the mouse's movement. It is pricier than their mechanical counterparts but are accurate and often do not need a mouse pad.

**Figure 2.3:** Mouse

A mouse allows us to create graphic elements on the screen such as lines, curves and freehand shapes. Since it is an intuitive device, it is easier and convenient to work as compared to the keyboard. Like a keyboard, it is also supplied with a computer; therefore, no additional cost is incurred. However, it needs a flat space close to the computer. The mouse cannot easily be used with laptop (notebook) or

palmtop computers. These types of computers need a trackball or a touch sensitive pad called a touchpad.

**Trackball:** A Trackball is another pointing device that resembles a ball nestled in a square cradle and serves as an alternative to a mouse. In general, a trackball is as if a mouse is turned upside down (see Figure 2.4). It has a ball, which can be rotated by fingers in any direction, the cursor moves accordingly. The size of the ball in the trackball varies from as large as a cue ball, to as small as a marble.Since it is a static device, instead of rolling the mouse on the top of the table the ball on the top is moved by using fingers, thumbs and palms. This pointing devicecomes in various shapes and forms but with the same functions. The three shapes,which are commonly used are a ball, button and square.

**Figure 2.4:** Trackball

**Joystick:** A joystick is a device that moves in all directions and controls the movement of the cursor. The basic design of a joystick consists of a stick that is attached to a plastic base with a flexible rubber sheath. This plastic base houses a circuit board that sits beneath the stick. The electronic circuitry measures the movement of the stick from its central position and sends the information for processing. A joystick also consists of buttons which can be programmed to indicate certain actions once a position on the screen has been selected using stick (see Figure 2.5). It offers three Joystick types of control: digital, glide and direct. Digital control allows movement in a limited number of directions such as up, down, left and right. Glide and direct control allow movements in all directions (360). Direct control joysticks have the added ability to respond to the distance and speed with which

the user moves the stick.

**Figure 2.5:** Joystick

**Light Pen:** A light pen (sometimes called mouse pen) is a hand-held electro-optical pointing device which a when touched to or aimed closely at a connected computer monitor, will allow the computer to determine where on that screen the pen is aimed. It facilitates drawing images and selects objects on the display screen by directly pointing to the objects. It is a pen-like device, which is connected to the machine by a cable (see Figure 4.10). Although named light pen, it actually does not emit light but its light-sensitive diode would sense the light coming fromthe screen. The light coming from the screen causes the photocell Figure 2.6 LightPen to respond by generating a pulse. This electric response is transmitted to the processor that identifies the position to which the light pen is pointing. With the movement of light pen over the screen, the lines or images are drawn.

**Figure 2.6:** Light Pen

Light pens give the user the full range of mouse capabilities without the use of a pad or any horizontal surface. Using light pens, users can interact more easily with

applications, in such modes as drag and drop, or highlighting. It is used directly on the monitor screen and it does not require any special hand-eye coordinating skills. Pushing the light pen tip against the screen activates a switch, which allows the user to make menu selections, draw and perform other input functions. Light pens are perfect for applications where desk space is limited, in harsh workplace environments, and any situation where fast accurate input is desired. It is very useful to identify a specific location on the screen. However, it does not provide any information when held over a blank part of the screen. A light pen is economically priced and requires little or no maintenance.

**Touch Screen:** A touch screen is a special kind of input device that allows the direct selection of a menu item or the desired icon with the touch of finger (see Figure 2.7). Essentially, it registers the input when a finger or other object is touched to the screen. It is normally used when information has to be accessed with minimum effort. However, it is not suitable for input of large amounts of data. Typically, it is used in information-providing systems like hospitals, airlines and railway reservation counters, amusement parks, and so on.


**Figure 2.7:** Touch Screen

The controller connects the touch sensor and the computer. It takes information from the touch sensor and translates it into information that a computer can understand. The driver is a software update for the computer system that allows the touch screen and computer to work together. It tells the operating system how to

interpret the touch event information that is sent from the controller.

**Trackpad:** Trackpad (also referred to as touchpad) is a stationary pointing device that works by sensing the movement of fingers across a small sensitive surface (1.5 or 2 inches) and translating them into the pointer movement on the screen (see Figure 2.8). It is generally used in laptops but can also be connected to a PC through a cord. It is also equipped in personal digital assistants (PDAs) and media players such as the iPod. Typically, a trackpad also consists of two or three buttons which work as mouse buttons. Many trackpads are also strike sensitive, that is, the user can tap on the trackpad to perform operations like selecting an object, maximizing/ minimizing the window, etc.

**Figure 2.8:** Trackpad

**Note:** The device manufactured by Apple is referred to as Trackpad while the device manufactured by others is known as Touchpad.

### 2.2.3 Speech Recognition

Speech recognition is one of the most interactive systems to communicate with the computer. The user can simply instruct the computer, with the help of a micro-phone (along with a speech recognition software), to perform a task (see Figure 2.9). It is the technology by which sounds, words or phrases spoken by humans are converted into digital signals, and these signals are transformed into computer-

generated text or commands. Most speech recognition systems are speaker-dependent so they must be separately trained for each individual user. The speech recognition system "learns" the voice of the user, who speaks isolated words repeatedly. Then, these voiced words are recognizable in the future.

**Figure 2.9:** Trackpad

Speech recognition is gaining popularity in the corporate world among non-typists, people with disabilities, and business travellers who record information for later transcription. The computer-based speech-recognition systems can be used to create text documents such as letters or e-mails, to browse the Internet, and to navigate among applications by voice commands. They have relatively high accuracy rates. They allow the user to communicate with the computer directly without using a keyboard or a mouse. However, as compared to other input devices, the reliability of the speech recognizer is lesser. Sometimes, it is unable to differentiate between two similar sounding words such as see and sea. It is also not suitable for noisy places.

### 2.2.4 Digital Camera

A Digital camera, as shown in Figure 2.10, stores images digitally rather than recording them on a film. Once a picture has been taken, it can be transferred to a computer system and then manipulated with an image editing software, and printed. The big advantage of digital cameras is that making photos is both inexpensive and fast because there is no film processing.

**Figure 2.10:** Digital Camera

### 2.2.5 Webcam

A webcam (short form of web camera) is a portable video camera, which captures live video or images that may be viewed in real time over a network or the Internet. It is just a small digital camera that is either built in your computer (in most laptops) or can be connected through a USB port (see Figure 2.11). It is normally placed on top of the PC monitor or laptop to capture images of the user while he/she is working on the computer.

**Figure 2.11:** Webcam

Nowadays, a wide variety of webcams are available, and according to their varied capabilities and features, they are classified into two categories, namely, streaming and snapshot. A streaming webcam captures moving images (about 30 images per second), thus creating a streaming videoa web video that plays on the computer immediately as its data arrive via network; the recipient need not download the video. However, a high-speed Internet connection is needed to transfer the video smoothly, and the image quality is also comparatively poor. On the other hand, a snapshot webcam captures only still images (usually, once every 30 seconds) and refreshes it continuously. It produces better quality images and is easier to configure than streaming videos.

The popularity of webcams is increasing everyday due to their unlimited uses. The most popular use of webcams is in videoconferencing to provide real-time communication where groups of people can see and interact with each other. It can be used with various messenger programs like Yahoo and Windows Live Messenger where you can share your videos while instant messaging with somebody. It is also being used in educational institutions to conduct distance-learning activities; one can attend the classes sitting at home only.

Webcams are cheap, compact and are easy to install and use. They are affordable because of their low manufacturing cost. However, a major drawback of using webcams is that they produce only real-time images and cannot be used unless attached with the PC. Some webcams also comprise advanced features such as automatic lightning controls, automatic face tracking and autofocus, which increase their cost.

### 2.2.6 Scanners

There are a number of situations when some information (picture or text) is available on paper and is needed on the computer for further manipulation. A scanner is an input device that converts a document into an electronic format that can be stored on the disk. The electronic image can be edited, manipulated, combined and printed by using the image editing software. Scanners are also called optical scanners as they use a light beam to scan the input data.

Note that most scanners come with a utility program that allow them to communicate with the computer and save the scanned images as a graphic files on the computer. Moreover, they can store images in both greyscale and colour mode. The two most common types of scanners are hand-held scanners and flatbed scanners.

**Hand-held Scanner:** A hand-held scanner consists of LEDs, which are placed

over the document to be scanned (see Figure 2.12). This scanner performs the scanning of the document very slowly from the top to the bottom with its light on. In this process, all the documents are converted and then stored as images. While working, the scanner is dragged very steadily and carefully over the document at a constant speed without stopping or jerking in order to obtain best results. Hand-held scanners are widely used where high accuracy is not of much importance. The size of the hand-held scanners is small. They come in various resolutions, up to about 800 dpi (dots per inch) and are available in either greyscale or colour. Furthermore, they are used when the volume of the documents to be scanned is low. These devices read the data on price tags, shipping labels, inventory part numbers, book ISBNs and so on.

**Figure 2.12:** Hand-held Scanner

**Flatbed Scanner:** A flatbed scanner looks similar to a photocopier machine. It consists of a box containing a glass plate on its top and a lid that covers the glass plate (see Figure 2.13). This glass plate is used for placing the document to be scanned. The light beam is placed below the glass plate and when it is activated, it moves horizontally from left to right. After scanning one line, the light beam moves in order to scan the next line and the procedure is repeated until all the lines are scanned. Scanning an A4 size document takes about 20 seconds. These scanners can scan black and white as well as colour images. Flatbed scanners are larger in size and more expensive than hand-held scanners. However, they usually produce better quality images because they employ better scanning technology.

**Figure 2.13:** Flatbed Scanner

Some scanners use a three-pass scanning method. Each pass uses a Working of a Flatbed Scanner different colour filter (red, green or blue) between the lens and CCD array. After the three passes are completed, the scanner software assembles the three filtered images into a single full-colour image. Nowadays, most scanners use the single-pass method. The lens splits the image into three smaller versions of the original image. Each smaller version passes through a colour filter (either red, green or blue) onto a discrete section of the CCD array. The scanner combines the data from the three parts of the CCD array into a single full-colour image, which is then sent to the computer.

### 2.2.7 Optical Character Recognition

As stated earlier, a scanner converts an input document into an electronic format that can be stored on the disk. If the document to be scanned contains an image, it can be manipulated using image editing software. However, if the document to be scanned contains text, you need an optical character recognition (OCR) software. This is because when the scanner scans a document, the scanned document is stored as a bitmap in the computer's memory. The OCR software translates the bitmap image of text to the ASCII codes that the computer can interpret as letters, numbers and special characters.

Because of OCR, data entry becomes easier, error-free and less time consuming.

However, it is very expensive and if the document is not typed properly, it will become difficult for the OCR to recognize the characters. Furthermore, except for tab stops and paragraph marks, most document formatting is lost during text scanning. The output from a finished text scan will be a single column editable text file. This text file will always require spell checking and proof reading as well as re-formatting to get the desired final layout.

### 2.2.8 Optical Mark Recognition

Optical mark recognition (OMR) is the process of detecting the presence of intended marked responses. A mark registers significantly less light than the surrounding paper. Optical mark reading is done by a special device known as optical mark reader. In order to be detected by the OMR reader, a mark has to be positioned correctly on the paper and should be significantly darker than the surrounding paper. The OMR technology enables a high-speed reading of large quantities of data and transferring this data to a computer without using a keyboard. Generally, this technology is used to read answer sheets (objective type tests). In this method, special printed forms/documents are printed with boxes, which can be marked with a dark pencil or ink (see Figure 2.14). These forms are then passed under a light source and the presence of dark ink is transformed into electric pulses, which are transmitted to the computer.

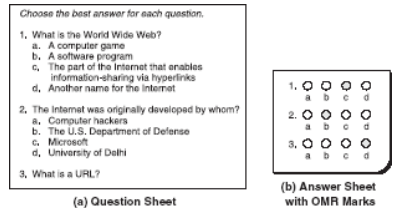


**Figure 2.14:** Questionnaire Using OMR Marks

OMR has a better recognition rate than OCR because fewer mistakes are made by machines to read marks than in reading handwritten characters. Large volumes of

data can be collected quickly and easily without the need for specially trained staff. Usually, an OMR reader can maintain a throughput of 1500 to 10,000 forms per hour. However, the designing of documents for optical mark recognition is complicated and the OMR reader needs to be reprogrammed for each new document design. OMR readers are relatively slow because the person putting marks on the documents must follow the instructions precisely. Any folding or dirt on a form may prevent the form from being read correctly. In addition, it requires accurate alignment of printing on forms and needs a paper of good quality.

### 2.2.9 Magnetic-ink Character Recognition

You must have seen special magnetic encoding using characters printed on the bottom of a cheque (see Figure 2.15). The characters are printed using special ink, which contains iron particles that can be magnetized. To recognize these magnetic ink characters, a Magnetic ink character reader (MICR) is used. It reads the characters by examining their shapes in a matrix form and the information is then passed on to the computer.

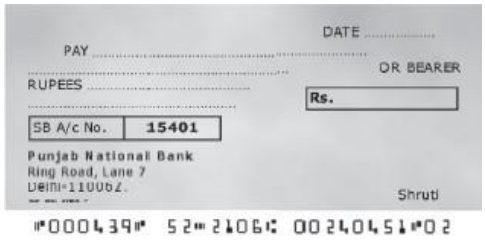


**Figure 2.15:** Cheque Number Written in MICR Font

The banking industry prefers MICR to OCR as MICR gives extra security against forgeries such as colour copies of payroll cheques or hand-altered characters on a cheque. If a document has been forged, say a counterfeit check produced usinga colour photocopying machine, the magnetic-ink line will either not respond to magnetic fields, or will produce an incorrect code when scanned using a device

designed to recover the information in the magnetic characters. The reading speed of the MICR is also higher. This method is very efficient and time saving for data processing.

### 2.2.10 Bar Code Reader

Bar code is a machine-readable code in the form of a pattern of parallel vertical lines of varying widths. It is commonly used for labelling goods that are available in super markets and numbering books in libraries. This code is sensed and read by a bar code reader using reflective light (see Figure 2.16). The information recorded in the bar code reader is then fed into the computer, which recognizes the information from the thickness and spacing of bars. Bar code readers are either hand-held or fixed-mount. Hand-held scanners are used to read bar codes on stationary items. With fixed-mount scanners, items having a bar code are passed by the scanner by hand, as in retail scanning applications or by conveyor belts in many industrial applications.

**Figure 2.16:** Bar Code Reader

Bar code data correction systems provide enormous benefits for just about every business with a bar code data-collection solution; capturing data is faster and more accurate. A bar code scanner can record data five to seven times faster than a skilled typist. A bar code data entry has an error rate of about 1 in 3 million. Bar coding also reduces cost in terms of labour and revenue losses resulting from data collection errors. Bar code readers are widely used in supermarkets, department stores, libraries and other places. You must have seen bar code on the back cover of certain books and greeting cards. Retail and grocery stores use a bar code reader

to determine the item being sold and to retrieve the item price from a computer system.

Bar code scanners are electro-optical systems that include a means of illuminating the symbol and measuring reflected light. The light waveform data are converted from analog to digital, in order to be processed by a decoder, and then transmitted to the computer software. The process begins when a device directs a light beam over a bar code. The device contains a small sensory reading element, called sensor, which detects the light being reflected back from the bar code, and converts light energy into electrical energy. The result is an electrical signal that can be converted into alphanumeric data. The pen in the bar code unit reads the information stored in the bar code and converts it into a series of ASCII characters by which the operating system gets the information stored in the bar code.

## 2.3 Types of Output Devices

Output is data that have been processed into useful information. It can be displayed or viewed on a monitor, printed on a printer, or listened through speakers or a headset. Generally, there are two basic categories of output: the output which can be readily understood and used by humans, and which is stored on secondary storage devices so that the data can be used as input for further processing. The output which can be easily understood and used by human beings are of the following two forms:

- **Hard Copy:** The physical form of output is known as hard copy. In general, it refers to the recorded information copied from a computer onto paper or some other durable surface such as microfilm. Hard copy output is permanent and a relatively stable form of output. This type of output is also highly portable. Paper is one of the most widely used hard copy output media. The principal examples are printouts, whether text or graphics from printers.

- **Soft Copy:** The electronic version of an output, which usually resides in computer memory and/or on disk, is known as soft copy. Unlike hard copy, soft copy is not a permanent form of output. It is transient and is usually displayed on the screen. This kind of output is not tangible, that is, it cannot be touched. Soft copy output includes audio and visual form of output, which is generated using a computer. In addition, textual or graphical information displayed on a computer monitor is also a soft copy form of output.

Based on the hard copy and soft copy outputs, the output devices are classified into hard copy and soft copy output devices. Printers, plotters and microfilms are the most commonly used hard copy output devices while monitors, voice response systems, projectors, electronic whiteboards, and headphones and headsets are some commonly used soft copy output devices.

### 2.3.1 Printers

Ever since the dawn of computer age, producing printed output on paper has been one of the computer's principal functions. A printer prints information and data from the computer onto paper. Generally, the printer prints 80 or l32 columns of characters in each line, and prints either on single sheets or on a continuous roll of paper, depending upon the printer itself. The quality of a printer is determined by the clarity of a print it can produce, that is, its resolution. Resolution is used to describe the sharpness and clarity of an image. The higher the resolution, the better the image. For printers, the resolution is measured in dpi (dots per inch). The more the dpi, the better will be the quality of image. The dots are so small and close together that they project the image as a solid one. If a printer has a resolution of 600 dpi, it means that the printer is capable of printing 360,000 dotsper square inch.

Printers are divided into two basic categories: impact printers and non-impact

printers. As their names specify, impact printers work by physically striking a head or needle against an ink ribbon to make a mark on the paper. This includes dot matrix printers, daisy wheel printers and drum printers. In contrast, ink-jet and laser printers are non-impact printers. They use techniques other than physically striking the page to transfer ink onto the page.

**Dot Matrix Printer:** *Dot matrix printer* (also known as the wire matrix printer) uses the oldest printing technology and it prints one character at a time (see Figure 2.17). It prints characters and images as pattern of dots. The speed of dot matrix printers is measured in characters per second (cps). Most dot matrix printers offer different speeds depending on the quality of print desired. The speed can vary from about 200 to over 500 cps. The print quality is determined by the number of pins (the mechanisms that print the dots), which can vary from 9 to 24. The more pins per inch, the Figure 2.17 Dot Matrix higher the print resolution. The best dot matrix printers Printer (24 pins) can produce near letter-quality-type image. Most dot matrix printers have a resolution ranging from 72 to 360 dpi.

**Figure 2.17:** Dot Matirx Printer

Dot matrix printers are inexpensive and have low operating costs. These printers are able to use different types of fonts, different line densities and different types of paper. Many dot matrix printers are bi-directional, that is, they can print the characters from either direction– left or right. The major limitation of the dot matrix printer is that it prints only in black and white. In addition, as compared to printers like laser printers, they produce low to medium quality printing. The image printing ability is also very limited. These printers may not be able to print graphic objects adequately but can handle applications such as accounting, per-

sonnel and payroll very well. Dot matrix printers are commonly used in low-cost, low-quality applications like cash registers. These printers are limited to situations where carbon copies are needed and the quality is not too important.

**Daisy Wheel Printer:** The major drawback of the dot matrix printer is that the pattern of dots that make up each character is visible on the print produced by it, making it look unprofessional. If you need a printer that can produce professional letter quality documents, you need a daisy wheel printer. The daisy wheel printer is named so because the print head of this printer resembles a daisy flower, with printing arms that appear like the petals of the flower (see Figure 2.18). These printers are commonly referred to as letter quality printers as the print quality is as good as that of a high-quality typewriter.

**Figure 2.18:** Daisy Wheel Printer

Daisy wheel printers produce high-resolution output and are more reliable than dot matrix printers. They can have speeds up to 90 cps. These printers are also called smart printers because of their bi-directional printing and built-in micro-processor control features. However, daisy wheel printers give only alphanumeric output. They cannot print graphics and cannot change fonts unless the print wheel is physically replaced. These printers are usually very slow because of the time required to rotate the print wheel for each character desired. Daisy wheel printers are slower and more expensive than dot matrix printers. However, if the appearance of the correspondence is important and you do not need graphics, a daisy wheel printer is a better choice.

**Drum Printer:** The dot matrix and daisy wheel printers are character or serial printers, that is, they print one character at a time. However, a drum printer (shown

in Figure 2.19) is a line printer, that is, it can print a line in a single operation. Generally, a line printer is used because of its speed as it uses special tractor-fed paper with pre-punched holes along each side. This arrangement allows a continuous high-speed printing. Its printing speed varies from 300 lines to 2000 lines per minute with 96160 characters on a 15-inch line. Although such printers are much faster than character printers, they tend to be quite loud, have limited multi-font capability and often produce lower print quality than most recent printing technologies. Line printers are designed for heavy printing applications. For example, in businesses where enormous amounts of materials are printed, the low-speed character printers are very slow; therefore, the users need high-speed line printers. Although, drum printers have high speed of printing, they are very expensive and their character fonts cannot be changed. Moreover, the strike of the hammer should be precise. A single mistimed strike of the hammer may lead to wavy and slightly blurred printing.

**Figure 2.19:** Drum Printer

**Ink-jet Printer:** The most common type of printer found in homes today is the ink-jet printer (see Figure 2.20). An ink-jet printer is a printer that places extremely small droplets of ink onto paper to create an image. Being a non-impact printer, it does not touch the paper while creating an image. Instead, it uses a series of nozzles to spray drops of ink directly onto the paper. Inkjets were origi-nally manufactured to print in monochrome (black and white) only. However, theprint head has now been expanded and the nozzles increased to accommodate cyan (C), magenta (M), yellow (Y) and black (K). This combination of colours is called

CMYK. It allows for printing images with nearly Figure 2.20 Ink-jet Printer the same quality as a photo development lab using certain types of coated paper.

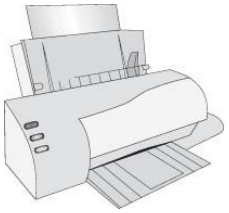

**Figure 2.20:** Ink-Jet Printer

Ink-jet printers are costlier than dot matrix printers and the quality is much better. These printers can print any shape of character, which a user can specify, as they produce printed output as patterns of tiny dots. This allows the printer to print many special characters, different sizes of prints, and enables it to print graphics such as charts and graphs. Ink-jet printers typically print with a resolution of 600 dpi or more. Due to the high resolution, these printers produce high quality graphics and text printouts. They are also affordable, which appeals to small businesses and home offices. These printers print documents at a medium pace but slow down if printing a document with multi-colours. These printers can print about six pages a minute and can be programmed to print symbols such as Japanese or Chinese characters.

Laser Printer: A laser printer provides the highest quality text and images for personal computers today (see Figure 2.21). It is a very fast printer, which operates on the same principle as that of a photocopy machine. Most laser printers can print text and graphics with a very high quality resolution. They are also known as page printers because they process and store the entire page before they actually print it. They produce sharp, crisp images of both text and graphics, providing resolutions from 300 to 2400 dpi. Today, the resolution of most printers is 600 dpi. They are quiet and fast, are able to print 4-32 text-only pages per minute for individual microcomputers and up to 200 pages per minute for mainframes.

Laser printers can print in excess of 2000 lines per minute. Furthermore, they can print in different fonts, that is, type styles and sizes. Laser printers are often faster than ink-jet printers but are more expensive to buy and maintain than the other printers. The cost of these printers depends on a combination of costs of paper, toner replacement, and drum replacement. These printers are useful for volume printing because of their speed.

**Figure 2.21:** Laser Printer

**Hydra Printer:** Hybrid document reproduction apparatus (HYDRA) printer, popularly known as all-in-one printer, is a device that consolidates the capabilities of multiple devices in one machine (see Figure 2.22). It may include some or all of the devices like printer, scanner, photocopier and fax machine. Apart from these devices, some hydra printers contain memory card slots which facilitate easier printing of photos and also have the in-built wireless capabilities that make Hydra Printer sharing of this printer with other systems easier.

**Figure 2.22:** Hydra Printer

Following are the features that must be considered to evaluate these printers:

- Print speed

- Maximum resolution
- Memory card compatibility
- Scanner resolution
- Fax speed

Hydra printers are useful for small organizations due to their small size, less space requirement and cost effectiveness. The cost of these printers depend on the technology (inkjet or laser) being used. They save power to a great extent as only one power outlet is required for performing various operations. They are easy to install and maintain and have easy-to-use GUI (graphical user interface) that help users to understand their functions easily.

### 2.3.2 Plotters

A plotter is a pen-based output device that is attached to a computer for making vector graphics, that is, images created by a series of many straight lines. It is used to draw high-resolution charts, graphs, blueprints, maps, circuit diagrams and other line-based diagrams. It is similar to a printer, but it draws lines using a pen. As a result, it can produce continuous lines, whereas a printer can only simulate lines by printing a closely spaced series of dots. Multicolour plotter uses different coloured pens to draw different colours. Colour plots can be made by using four pens (cyan, magenta, yellow and black) and need no human intervention to change them.

Being vector-based, a plotter tends to draw much crisper lines and graphics. The lines drawn by these devices are continuous and very accurate. However, the plotter is considered a very slow output device because it requires excessive mechanical movement to plot. Furthermore, it is unable to produce solid fills and shading. Plotters are relatively expensive as compared to printers but can produce more printouts than standard printers. They are mainly used for Computer Aided

Design (CAD) and Computer Aided Manufacturing (CAM) applications such as printing out plans for houses or car parts. These are also used with programs like AUTOCAD (computer assisted drafting) to give graphic outputs. As shown in Figure 2.23, there are two different types of plotters: drum plotter (where the paper moves) and flatbed plotter (where the paper is stationary).

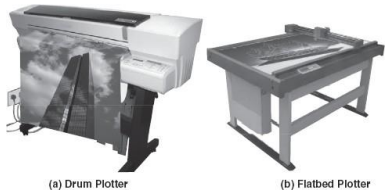


**Figure 2.23:** Plotters

- **Drum Plotter:** In drum plotters, the paper on which the design is to be printed is placed over a drum. These plotters consist of one or more pen(s) that are mounted on a carriage which is horizontally placed across the drum. The drum can rotate in either clockwise or anticlockwise direction under the control of plotting instructions sent by the computer. In case a horizontal line is to be drawn, the horizontal movement of the pen is combined with the vertical movement of the page via the drum. The curves can also be drawn by creating a sequence of very short straight lines. In these plotters, each pen can have an ink of a different colour to produce multicolour designs. Drum plotters are used to produce continuous output such as plotting earthquake activity or for long graphic output such as tall building structures.

- **Flatbed Plotter:** Flatbed plotters consist of a stationary, horizontal plotting surface on which paper is fixed. The pen is mounted on a carriage, which can move horizontally, vertically, leftwards or rightwards to draw lines. In flatbed plotters, the paper does not move, the pen-holding mechanism provides all the motion. These plotters are instructed by the computer on the movement of pens in the x - y coordinates on the page. These plotters are capable of

working on any standard, that is, from A4 size paper to some very big beds. Depending on the size of the flatbed surface, these are used in designing of ships, aircrafts, buildings and so on. The major disadvantage of this plotter is that it is a slow output device and can take hours to complete a complex drawing.

### 2.3.3 Monitor

The monitor is the most frequently used output device for producing soft-copy output. A computer monitor is a TV-like display attached to the computer on which the output can be displayed and viewed. The computer monitor can either be a monochrome display or a colour display. A monochrome screen uses only one colour (usually white, green, amber or black) to display text on contrasting background. Colour screens commonly display 256 colours at one time from a selection of over 256,000 choices. Monitors are available in various sizes like 14, 15, 17, 19 and 21 inches. The size of the display is described based on two parameters: aspect ratio and screen size (see Figure 2.24). Aspect ratio is the ratio of the width of the display screen to the height, that is, the ratio of vertical points to the horizontal points necessary to produce equal-length lines in both directions on the screen. Generally, computer displays have an aspect ratio of 4:3. Like televisions, screen sizes are normally measured diagonally (in inches), the distance from one corner to the opposite corner.

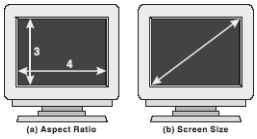


**Figure 2.24:** Aspect Ratio and Screen Size

Sometimes, while watching television, you may notice that the picture looks a bit blurred. The reason behind this is that the displayed image is not solid but is

created by the configurations of dots. These dots are known as picture elements, pels, or simply pixels. The golden rule of a sharp image is that the more the pixels, the sharper the picture. The screen clarity depends on three basic qualities:

- **Resolution:** It refers to the number of pixels in the horizontal and vertical directions on the screen. In medium-resolution graphics, pixels are large, whereas in high-resolution graphics, pixels are small. The average CRT display is currently 800 600 or 1024 768. The more dots, or pixels, available to create the image, the sharper it will be. Therefore, a resolution of 1024 768 will produce sharper images (for example, smaller icons and more information) than one of 640 480.

- **Dot Pitch:** It is the measurement of the diagonal distance between two like-coloured (red, green or blue) pixels on a display screen. It is measured in millimetres and common dot pitches are .51 mm, .31 mm, Pixel .28 mm, .27 mm, .26 mm and .25 mm. The Figure 4.44 Dot Pitch smaller the dot pitch, the sharper will be the image when displayed on the monitor. Generally, a dot pitch of less than .31 mm provides clear images. Multimedia and desktop-publishing users typically use .25 mm dot-pitch monitors (see Figure 2.25).

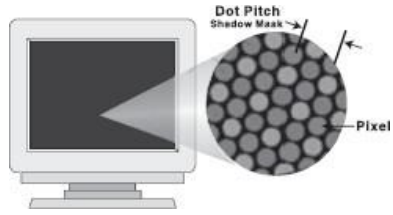


**Figure 2.25:** Dot Pitch

- **Refresh Rate:** It is the number of times per second the pixels are recharged so that their glow remains bright. Normally, screen pixels are made from phosphor. An electron beam strikes the phosphor and causes it to emit light, resulting in the display of the image. However, it needs to be Refreshed

periodically because the phosphors hold their glow for just a fraction of a second. The Refresh rate for a monitor is measured in Hertz (Hz) and varies from 60 to 75 Hz. A Refresh rate of 60 Hz means image is redrawn 60 times a second. The higher the Refresh rate, the more solid the image looks on the screen, that is, it does not flicker.

**Colour Depth:** Colour depth, also referred to as bit depth, refers to the number of bits assigned to each pixel in the image and the number of colours that can be created from those bits. In simple words, it refers to the number of colours that a monitor can display. Different colour depths depend on the amount of display memory dedicated to each pixel. One byte is used to represent 256 colours for each pixel, 16 bits (or 2 bytes) per pixel allows up to 65535 colours, and 24-bit (or 3 bytes) colour can display 16.8 million different colours per pixel. 8-bit colour is better known as pseudo colour, 16-bit mode as high colour, and 24-bit mode is called true colour. A video display unit consists of a video card or adapter that is fitted into an expansion slot and a compatible visual display, which is compatible with the video adapter. The combination of the display modes supported by the graphics adapter and the colour capability of the monitor determine how many colours can be displayed.

**Cathode Ray Tube Monitors:** Nowadays, most computer monitors are based on cathode ray ube (CRT ) technology. The basic operation of these tubes is similar to that in television sets. Figure 2.26 illustrates the basic components of a CRT.

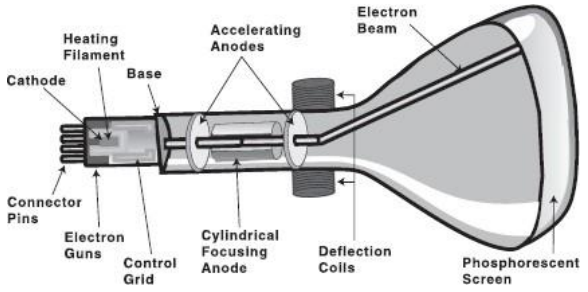


**Figure 2.26:** Cathode Ray Tube

A beam of electrons (cathode rays) emitted by an electron gun passes through focusing and deflection systems that direct the beam toward specified positions on the phosphor-coated screen. The phosphor then emits a small spot of light at each position contacted by the beam. When the electron beam strikes the phosphors, the light is emitted for a short period of time, this condition is known as persistence. Technically, persistence is defined as the time it takes for the emitted light from the screen to decay to 1/10 of its original intensity. Graphics monitors are usually constructed with persistence in the range of 10-60 microseconds. Since the light emitted by the phosphor fades very rapidly, some method is needed for maintaining the screen picture. One way to keep the phosphor glowing is to redraw the picture repeatedly by quickly directing the electron beam back over the same points. This type of display is called a Refresh CRT.

**Liquid Crystal Display Monitors:** In the previous section, we discussed the most popular CRT monitors that are used as display devices. With the widespread use of smaller computers like PDAs and laptops, a new type of display, Liquid Crystal Display (LCD), has made a big impact on the computer market. LCD screens have been used for long on notebook computers but are also becoming popular as desktop monitors.

The term liquid crystal sounds like a contradiction. We generally conceive a crystal as a solid material like quartz and a liquid as water-like fluid. However, some substances can exist in an odd state that is semi-liquid and semi-solid. When they are in this state, their molecules tend to maintain their orientation like the molecules in a solid, but also move around to different positions like the molecules in a liquid. Thus, liquid crystals are neither a solid nor a liquid. Manufacturers use this amazing ability of liquid crystals to display images.

An LCD screen is a collection of multiple layers as shown in Figure 2.27. A fluorescent light source, known as the backlight, makes up the rearmost layer. Light passes through the first of two polarizing filters. The polarized light then passes

through a layer that contains thousands of liquid crystal blobs aligned in tiny containers called cells. These cells are aligned in rows across the Figure 2.27 Coloured Liquid Crystal Screen screen; one or more cells make up one pixel. Electric leads around the edge of the LCD create an electric field that twists the crystal molecule, which lines the light up with the second polarizing filter and allows it to pass through.

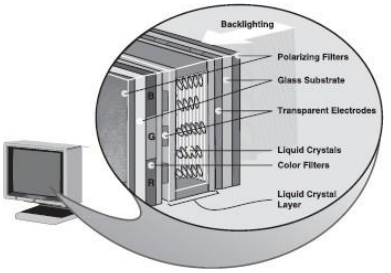


**Figure 2.27:** Coloured Liquid Crystal Screen

**Differences between LCD and CRT:** Although both the CRT and LCD monitors are the most frequently used types of displays in computers, they are worlds apart in terms of what is important when making a purchase decision. Here is a brief discussion of what is different about LCD monitors.

- **Size:** LCD is lightweight and compact, which saves desktop space as compared to a CRT.
- **Resolution:** LCD is designed to work in a single resolution while CRT is designed for many resolutions.
- **Pixel Density:** Pixel density of LCD is generally not as tight as the dot pitch in CRT but for most applications, the density is acceptable.
- **Brightness:** The illuminated phosphor of a CRT is not nearly as bright as what the LCD can produce with its florescent backlight.
- **Power Consumption:** LCD consumes significantly less power than CRT

and has a low emission risk. Typically, a LCD consumes approximately half of the power of a typical CRT.

- Flicker: With CRT monitors, the goal is to get a faster Refresh rate of at least 85 Hz,but LCD monitors are designed to run at a much slower Refresh rate (usually about 60 Hz) and flicker is never an issue.
- **Pixel Response Time:** The time taken by a pixel to change its state is called pixel response time. CRT has extremely fast pixel response time but LCD can be quite slow. As a result, the user might see ghost images when there is movement on the screen. The fastest LCD monitors today have a response time of 25 milliseconds, which is still only about half the speed of a CRT monitor.
- **Viewing Angle:** CRT can be viewed at almost any angle but LCD is best viewed head on. Even when viewing an LCD head on, narrow viewing angles can appear to have inconsistent colour and brightness.
- **Viewing Area:** The viewing area of a CRT is usually less than its advertised area. Most 19-inch CRT monitors, for example, typically have about 18 inches of viewable area. However, the LCD monitors are measured exactly, that is, if a LCD monitor is advertised as 17.4 inch, it is the same.
- **Cost:** Prices for LCD screens are quite high but they are coming down. They are still much more costlier than CRT.

### 2.3.4 Voice Response System

Previously, we discussed that voice (in speech recognition) can be taken as an input by the computer system. Similarly, the computer can also give output in the form of audio. Voice response system has an audio-response device which produces audio output. These sounds are pre-recorded in a computer system. Each sound

has a unique code. Whenever an enquiry is sought from the system, the computer responds in digital form which is sent to voice devices that unscramble the digital information and produces sound messages to the requesting computer.

There are two basic approaches to get a computer to talk to the user. The first is synthesis by analysis, in which the device analyses the input of an actual human voice speaking words, stores and processes the spoken sounds, and reproduce them as needed. The process of storing words is similar to the digitizing process we discussed while considering voice input. In essence, synthesis by analysis uses the computer as a digital tape recorder. The second approach to synthesizing speech is synthesis by rule, in which the device applies a complex set of linguistic rules to create artificial speech. Synthesis based on the human voice has the advantage of sounding more natural but is limited to the number of words stored in the computer.

The standard computer system can provide audio output with the addition of two components: a speech synthesizer that does the speaking and a screen reading software that tells the synthesizer what to say (see Figure 2.28). The synthesizer can be a computer card inserted into the computer or software that works with the computer's sound card. Screen reader is a software program that allows the user to control the synthesizer so that he can access text, which is displayed on the computer monitor, with combinations of keystrokes. Some screen review softwares use the standard computer keyboard keys, some use the numeric keypad, and some use special external keypads. A visually impaired user can use a screen reader to read anything on the screen. The screen reading software can even notify a user about various computer messages that "pop up" on the monitor from time to time.

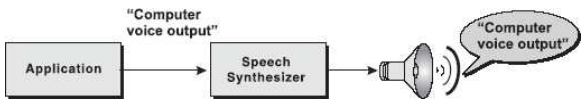


**Figure 2.28:** Audio Output

Voice output has become common in many places like airlines, bus terminals,

banks and brokerage houses. It is typically used when an inquiry is followed by a short reply (such as a bank balance or flight time). Many businesses have found other creative uses for voice output. For example, the telephone. Automatic telephone voices take surveys, inform customers that catalogue orders are ready to be picked up, and perhaps remind consumers that they have not paid their bills. Moreover, people with a total or partial speech handicap are faced with the problem of communicating their wishes and needs to others. Speech output systems are a valuable aid in this case.

### 2.3.5 Electronic Whiteboard

Electronic whiteboard is an interactive presentation device that works electronically to display digital images, drawings and text in different colours. The whiteboard is generally mounted on the wall and is connected to a computer (through USB, serial port or wireless technology like Bluetooth) and projector. The projector projects the computer's desktop on the whiteboard and user can interact with it using electromagnetic pens, fingers or other pointing devices (see Figure 2.29). The electromagnetic pens can be configured to any Figure 2.29 Electronic Whiteboard colour or width.

**Figure 2.29:** Electronic Whiteboard

A user can activate programs, applications and menus as well as enter text using either the on-screen keyboard or handwriting recognition utility. Nowadays, most whiteboards come with software that provides various tools and features to create

virtual versions of paper flipcharts with pen, highlighter, etc., enhancing the use of electronic whiteboard to a great extent. Electronic whiteboard is widely used for various purposes such as to display presentations, for teaching in classrooms, in corporate meetings, professional sports coaching and so on.

An interactive electronic whiteboard can be classified into one of the following categories:

- **Touch-based Whiteboard**
- **Pen-based Whiteboard**
- **Wii Remote, IR Pen-based Whiteboard**

**Note:** The device driver software installed on the computer enables the whiteboard to act as a *human input device* (HID), just like a mouse, to help the user with easy interaction.

### 2.3.6 Headphone and Headset

Headphone is an audio device equipped with a pair of speakers attached to a head-strap worn by the users. Headphones are used with almost all electronic devices such as portable computers, CD/DVD players, mp3 players, iPod, etc. They comprise high-quality speakers, are light in weight and very comfortable to wear. They can be easily connected to a computer via a mini stereo plug.

The headphones allow the users to listen only; however, some applications like live chats, videoconferencing and telecalling services demand the user to also speak at the same time. For such applications, a headset is used instead of a headphone. A headset is a combination of one or two speakers and a Figure 4.54 Headphone and Headset microphone with both the speaker and the microphone attached to a headstrap. The speaker(s) allows the person to hear the conversation and the

microphone allows the user to communicate with the person on the other end (see Figure 2.30).

**Figure 2.30:** Headphone and Headset

## 2.4 Computer Terminals

A computer terminal is a special unit that can perform both input and output. A terminal is an I/O device that uses a keyboard for input and a monitor for output. Due to this reason, a terminal is also known as video display terminal (VDT). Terminals can be categorized into the following types:

- **Dumb Terminal:** It refers to a terminal that has no processing or programming capabilities. It is designed to communicate exclusively with a host computer. Usually, it consists of a screen and keyboard used to access a host computer. It has electronics circuitry enough to interpret incoming instructions from the host computer, to display characters on the screen, to interpret keystrokes on the keyboard and pass them on to the host computer. Generally, dumb terminals are used for simple data entry or retrieval tasks. An example of a dumb terminal is one used by airline clerks at airport ticket and check-in counters.
- **Smart Terminal:** A smart terminal has built-in processing capability and memory but does not have its own storage capacity. In comparison to the dumb terminal, a smart terminal can communicate, retrieve data and can perform a limited processing of its own, that is, editing or verifcation of data. However, this kind of terminal cannot be used for programming. They

are often found in local area networks in offices.

- **Intelligent Terminal:** An intelligent terminal has memory and inbuilt microprocessors, thus also known as user-programmable terminal. This terminal can independently perform a certain number of jobs without even interacting with the mainframe. Although they are intelligent terminals, some workstations are designed without disk drives. Due to this, restricted data cannot be downloaded or copied.

# Let us Summarize

1. An input device is an electromechanical device that accepts data or information from the user and translates the information into a form which the computer can interpret.
2. Keyboards are the most commonly used data entry devices. By pressing down the keys of the keyboard, data are entered into the computer.
3. Pointing devices are the input devices by which we can point out and select items rapidly from the multiple options displayed on the screen. These devices can also be used to create graphic elements on the screen such as lines, curves and freehand shapes. The common types of pointing devices available are the mouse, trackball, joysticks, touch screens and light pens.
4. Mouse is a small hand-held pointing device which can be used to input commands or information. It contains two or three buttons and by pressing one of the buttons, the mouse either marks a place on the screen or makes selections from the data on the screen. Common types of mouse action available are pointing, click, double-click, right-click and drag and drop.
5. A trackball is an upturned mouse, with a movable ball on the top of a stationary base. It is used to control the cursor movements and the actions on a computer screen. It allows the user to perform each of these tasks separately.
6. Joystick is a device that moves in all directions and controls the movement of the pointer. It activates the computer with different parts and is used to control the cursor on the screen.
7. Using a light pen, one can select the objects on the monitor by directly pointing to the objects. It is useful for identifying a specific location. Since the light pen is a passive device with a sensor only, it provides no information when held over a blank part of the screen.

8. A touch screen is a type of display screen device that is placed on the computer monitor in order to allow direct selection or activation of the computer when somebody touches the screen. It registers the input when a finger or other object touches the screen. It consists of three main components: a touch sensor, a controller and a software driver.
9. Trackpad (also referred to as touchpad) is a stationary pointing device that works by sensing the movement of fingers across a small sensitive surface (1.5 or 2 inches) and translating them into the pointer movement on the screen.
10. Speech recognition is the technology by which sounds, words or phrases spoken by humans are converted into digital signals, and these signals are transformed into coding patterns where the meaning has been assigned. It is more generally called as sound recognition.
11. Digital camera records images in an electronic form, that is, the image is represented in computer's language of bits and bytes. It is a long string of 1s and 0s that represent all the tiny coloured dots or pixels that collectively make up the image.
12. A webcam is a portable video camera, which captures live video or images that may be viewed in real time over the network or the Internet.
13. A scanner is a device that scans an image and transforms the image to ASCII codes. These images can be edited, manipulated, combined and then printed. The common types of scanners are: handheld and flatbed.
14. The optical character recognition (OCR) software translates the bitmap image of text to the ASCII codes that the computer can interpret as letters, numbers and special characters.
15. The optical mark recognition (OMR) is the process of detecting the presence of intended marked responses. A mark registers significantly less light than

the surrounding paper. Optical mark reading is done by a special device known as optical mark reader.

16. A magnetic ink character reader (MICR) is used to recognize the magnetic ink characters; it reads the characters by examining their shapes in a matrix form.

17. Bar codes are machine-readable codes, represented in parallel vertical lines with varying widths. By the combination of these vertical lines (bars) and the spacing between them, bar codes represent the alphanumeric data. For reading these bar-coded data, a device is used, which is known as a bar code reader.

18. An output device is an electromechanical device, which converts machine-readable data or information into human-readable form. The printed form of output is referred to as hard copy while the form of output displayed on the screen is referred to as soft copy.

19. Based on the hard copy and soft copy outputs, the output devices are classified into: hard copy and soft copy output devices. Printers, plotters and microfilms are the most commonly used hard copy output devices while monitors, voice response systems, projectors, electronic whiteboards, and headphones and headsets are some commonly used soft copy output devices.

20. A printer is a device that prints information from the computer on to paper. The two major categories of printer technologies are impact printers and non-impact printers.

21. An impact printer forms characters and graphics on a piece of paper by striking a mechanism against an ink ribbon that comes into physical contact with the paper. It includes dot matrix printers, daisy wheel printers and drum printers.

22. Printers that form characters and images without making direct contact be-

tween printing mechanism and paper are called non-impact printers. They are categorized as ink-jet printers and laser printers.

23. Hybrid document reproduction apparatus (HYDRA) printer, popularly known as all-in-one printer, is a device that consolidates the capabilities of multiple devices in one machine. It may include some or all of the devices like printer, scanner, photocopier and fax machine. Plotters are special-purpose drawing devices, which reproduce graphic images on paper using a pen whose movements are controlled by the computer. The lines drawn by these devices are continuous and very accurate. Plotters are classified as pen plotters and electrostatic plotters.
24. Computer output microfilm is an extremely high-speed, low-cost process, which records computer-generated information directly from the computer tape or cartridge to a miniaturized microfilm media. The microfilm product is in fiche or roll format, which can be duplicated rapidly and inexpensively.
25. Computer monitor is used to display the keyed data on the screen and to receive messages and processed information from the computer.
26. Cathode ray tube (CRT) is the most common type of monitor for the office and the home. In a CRT, an electron gun is used which fires electrons at groups of phosphor dots coating the inside of the screen. When the electrons strike the phosphor dots, they glow to give the colours.
27. In liquid crystal display (LCD) screen, the backlight passes through the first of two polarizing filters. The polarized light then passes through a layer that contains thousands of liquid crystal blobs aligned in tiny containers known as cells. Electric leads around the edge of the LCD create an electric field that twists the crystal molecule, which lines the light up with the second polarizing filter and allows it to pass through.
28. Although CRT and LCD displays are the most commonly used, other kinds

of displays also exist. Two of them are plasma display and thin-film electro-luminescent display.

29. The standard computer system can talk with the addition of two components: a speech synthesizer and a screen reading software. A speech synthesizer is a software that converts text information into spoken sentences. Screen reading software enables the user to control the synthesizer. It allows a user to access, or view text that is present on the screen.

30. Screen image projector is an output device, which is used to project information from a computer on to a large screen, so that it can be simultaneously viewed by a large group of people. Projectors are mainly of two types: LCD projectors and DLP projectors.

31. Electronic whiteboard is an interactive presentation device that works electronically to display digital images, drawings, and text in different colours. The whiteboard is generally mounted on the wall and is connected to a computer (through USB, serial port or wireless technology like Bluetooth) and projector.

32. Headphone is an audio device equipped with a pair of speakers which are attached via a headstrap worn by the users. A headset is a combination of one or two speakers and a microphone with both the speakers and the microphone attached to a headstrap.

33. Computer terminals, also called as display or video display terminals, enable a computer to receive or deliver data through input and output devices, respectively.

# Exercises

## Fill in the Blanks

1. Mouse and light pen are examples of .....input devices.
2. Two basic methods used for optical character recognition (OCR) are ..... and
3. .....is a machine-readable code in the form of parallel vertical lines.
4. MICR stands for .....
5. The bar-coded data represent the .....and a device, which is used for reading the bar-coded data, is known as .....
6. The most used layout of a keyboard is .....
7. The printed form of output is referred to as..... and the form of output, which is shown on a display screen, is referred to as.....
8. An impact printer, which gives only alphanumeric output, is called.....
9. ..... plotters are computer graphics devices that use drum or flatbed paper holder.
10. A non-impact printer that forms an image by spraying ink from a matrix of tiny jets is called .....
11. The mouse may be classified as ..... or .....
12. ..... is the oldest printing technology.
13. The quality of the monitor is generally judged by considering four basic terms ....., ....., ....., and .....
14. The number of bits used to describe a pixel is known as .....

15. A computer can talk to persons through a device known as.....

## Multiple-choice Questions

1. is the most commonly used input device.

   (a) Keyboard

   (b) Mouse

   (c) Joystick

   (d) Scanner

2. Mouse, trackball and joystick are the examples of .....

   (a) Scanning devices

   (b) Storing devices

   (c) Pointing devices

   (d) Multimedia devices

3. Which of the following is not a computer terminal?

   (a) Intelligent

   (b) Smart

   (c) Both (a) and (b)

   (d) None of these

4. Which of the following technique is best suited for bank cheques?

   (a) OCR

   (b) OMR

   (c) BAR

   (d) MICR

5. Choose the most suitable device among the following for playing computer games.

   (a) Hand-held scanner

   (b) Joystick

   (c) Optical Mark Reader

   (d) Digital Camera

6. Light pen is frequently used in .....

   (a) Computer Aided Design

   (b) Word Processing

   (c) Presentation

   (d) Spreadsheet

7. Choose the odd one out.

   (a) QWERTY

   (b) SULTRY

   (c) AZERTY

   (d) DVORAK

8. Which of the following is not a pointing device?

   (a) Scanner

   (b) Trackball

   (c) Light Pen

   (d) Mouse

9. Which of the following is not an output device?

   (a) Printer

(b) Keyboard

(c) Monitor

(d) Plotter

10. With the combinations of ....., ..... and.....colours, other colours can be shown.

(a) Red, Black, Blue

(b) Yellow, Blue, Green

(c) Red, Blue, Green

(d) Black, White, Yellow

11. Which of the following is used for both input and output?

(a) Computer Terminals

(b) Pen Plotter

(c) Dot Matrix Printer

(d) None of these

12. The..... is also called as letter quality printer.

(a) Dot Matrix Printer

(b) Ink Jet Printer

(c) Daisy Wheel Printer

(d) Laser Printer

13. The..... terminal is referred to as non-programmable terminal whereas ..... terminal is referred to as user-programmable terminal.

(a) Dumb, Intelligent

(b) Dumb, Smart

(c) Smart, Intelligent

(d) None of these

14. An individual small dot, which one sees on the computer screen is called .....

(a) Font

(b) Character

(c) Screen Point

(d) Pixel

15. LCD stands for .....

(a) Liquid Colour Display

(b) Light Colour Display

(c) Lithium Crystal Display

(d) Liquid Crystal Display

## State True or False

1. Any hardware item that is attached to the CPU is referred to as peripheral device.
2. Impact printers are slower as compared to non-impact printers.
3. The speed of a printer is measured by character per minute.
4. Audio response is a soft copy output.
5. Dot pitch can be changed by the user.
6. Plotters are best suited for desktop publishing.
7. Bank cheques are an example of bar code marking.

8. QWERTY is the most popular keyboard layout.
9. A speech recognition system converts the computer text and commands into human spoken words.
10. More pixels per square inch mean better resolution.
11. A digital camera's photographs can be stored in a computer's hard disk.
12. The most common aspect ratio used in computer monitors is 4:4.
13. Raster scan monitors draw a picture one line at a time and for this reason they are referred to as vector displays, stroke-writing, or calligraphic displays.
14. Ultrasonic acoustic waves are one of the most commonly used touch screen techniques.
15. 16-bits colour allows up to 256 colours.

## Descriptive Questions

1. Why are input and output devices necessary for a computer system?
2. What are pointing devices? Discuss some of the commonly used pointing devices.
3. What is a touch screen device? Explain with their advantages and disadvantages and give some typical applications for which touch screen is most suitable as an input device.
4. What is a speech recognition system? Explain its types and give logical reasons. Why do currently available speech recognition devices have limited success?
5. What do you mean by optical scanning devices? Explain any four such devices.

6. Explain the different types of printers. Make a clear difference between them in terms of speed, cost and method of operation, and suggest suitable applications.

7. Describe the application areas where plotters are useful. Discuss the various types of plotters.

8. What is speech synthesizer? How does it function? Give some of its typical applications.

9. What is LCD? Differentiate between CRT and LCD monitors.

10. Write short notes on the following:

    (a) Resolution

    (b) Aspect ratio

    (c) Dot pitch

    (d) Refresh rate

    (e) Colour depth

# Chapter 3

# Computer Programming and Languages

This chapter introduces the reader with the fundamentals of computer programming and languages. A computer program refers to the set of instructions needed for performing a particular task. Computer or programming language refers to the vocabulary and set of grammatical rules that are required to instruct a computer to perform a specific task. The chapter begins with the life cycle of program development and various programming tools which are essential for making a computer program. The discussion continues with various programming control structures and programming paradigms. Next, the chapter explains the evolution of various programming languages and generations of programming languages. The reader is also familiarised with the working of languge translators, namely, assembler, compiler, and interpreter.

## 3.1 Introduction

The computer has emerged as the most useful machine in recent times. It can perform a variety of tasks like receiving data, processing it and producing useful results. However, being a machine, the computer cannot perform on its own. A computer needs to be instructed to perform even a simple task like adding two numbers. Computers work on a set of instructions called computer program, which clearly specify the ways to carry out a task. An analogy of this may be thought of as the instructions given by the manager or team leader to its team. The team members follow those instructions and accordingly perform their duties. Similarly, a computer also takes instructions in the form of computer programs to carry out the requested task.

Now the question that arises is how human beings instruct computers. We, as human beings, use natural languages such as English, Spanish or French to communicate. Similarly, a user communicates with the computer in a language understood by it. Note that human beings cannot interact directly with the computer using natural languages because thus far we have not developed such computers that can comprehend natural languages. Rather, the instructions, provided in the formof computer programs, are developed using computer or programming languages. This chapter provides some of the most prominent concepts related to computer programming and languages.

### 3.1.1 Developing a Program

As discussed earlier, a program consists of a series of instructions that a computer processes to perform the required operation. In addition, it also includes some fixed data required to perform the instructions and the process of defining those instructions and data. Thus, in order to design a program, a programmer must

determine three basic rudiments:

- The instructions to be performed.
- The order in which those instructions are to be performed.
- The data required to perform those instructions.

To perform a task using a program, a programmer has to consider various inputs of the program along with the process, which is required to convert the input into desired output. Suppose we want to calculate the sum of two numbers, A and B, and store the sum in C; here A and B are the inputs, addition is the process, and C is the output of the program (see Figure 3.1).

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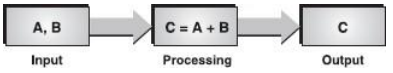


**Figure 3.1:** Program Performing a Task

### 3.1.2 Program Development Cycle

Before starting the process of writing a program (coding), the programmer has to determine the problem that needs to be solved. There are different approaches to problem solving. One common approach is to use the program development cycle, with the number of steps that may vary according to the person who has formalized the development. Often the process runs in a loop, for example, as the current process is completed, new demands appear and the development process

commences again. Illustrated in Figure 3.2 is the development cycle of a program, which includes the following phases.

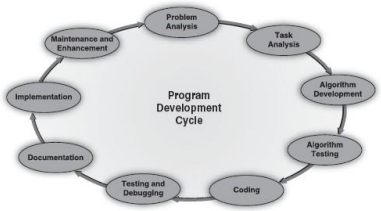


**Figure 3.2:** Program Development Cycle

- **Problem Analysis:** The problem is analysed precisely and completely. Based on understanding, the developer knows about the scope within which the problem needs to be developed.
- **Task Analysis:** After analysing the problem, the developer needs to develop various solutions to solve the given problem. From these solutions, the optimum solution is chosen, which can solve the problem comfortably and economically.
- **Algorithm Development:** After selecting the appropriate solution, an algorithm is developed to depict the basic logic of the selected solution. An algorithm depicts the solution in logical steps (sequence of instructions). Further, an algorithm is represented by flowcharts, decision tables and pseudocodes. These tools make the program logic clear and they eventually help in coding.
- **Algorithm Testing:** Before converting the algorithms into actual code, it should be checked for accuracy. The main purpose of checking the algorithm is to identify major logical errors at an early stage because logical errors are often difficult to detect and correct at later stages. The testing also ensures that the algorithm is a "true" one and it should work for both normal as well as unusual data.

- **Coding:** After meeting all the design considerations, the actual coding of the program takes place in the chosen programming language. Depending upon the application domain and available resources, a program can be written by using computer languages of different levels such as machine, assembly or high-level languages (HLL).

- **Testing and Debugging:** It is common for the initial program code to contain errors. A program compiler and programmer-designed test data machine tests the code for syntax errors. The results obtained are compared with results calculated manually from these test data. Depending upon the complex- ity of the program, several rounds of testing may be required.

- **Documentation:** Once the program is free from all the errors, it is the duty of the program developers to ensure that the program is supported by suitable documentation. These documents should be supplied to the program users. Documenting a program enables the user to operate the program correctly. It also enables other persons to understand the program clearly so that it may, if necessary, be modified, or corrected by someone other than the original programmer.

- **Implementation:** After documentation, the program is installed on the end user's machine and the user is also provided with all the essential documents in order to understand how the program works. The implementation can be viewed as the final testing because only after using the program the user can point out the drawbacks (if any) and report them to the developers. Based on the feedback from users, the programmers can modify or enhance the program.

- **Maintenance and Enhancement:** After the program is implemented, it should be properly maintained by taking care of the changing requirements of its users and the system. The program should be regularly enhanced by

adding additional capabilities. This phase is also concerned with detecting and fixing the errors, which were missed in the testing phase. Since this step generates user feedback, the programming cycle continues as the program is modified or reconstructed to meet the changing needs.

## 3.2 Algorithm

Algorithms are one of the most basic tools that are used to develop the problem-solving logic. An algorithm is defined as a finite sequence of explicit instructions that when provided with a set of input values produces an output and then terminates. To be an algorithm, the steps must be unambiguous and after a finite number of steps, the solution of the problem should be achieved. However, algorithms can have steps that repeat (iterate) or require decisions (logic and comparison) until the task is completed.

Different algorithms may accomplish the same task, with a different set of instructions, in more or less the same time, space and efforts. For example, two different recipes for preparing tea: one “add the sugar” while boiling the water and the other “after boiling the water” produce the same result. However, performing an algorithm correctly does not guarantee a solution, if the algorithm is flawed or not appropriate to the context. For example, preparing the tea algorithm will fail if there are no tea leaves present; even if all the motions of preparing the tea are performed as if the tea leaves were there. We use algorithms in our daily life. For example, to determine the largest number out of three numbers A, B and C, the following algorithm may be used.

Algorithm: To Determine Largest of Three Numbers

1. Start
2. Read three numbers A, B, C
3. Find the larger number between A and B and store it in MAX_AB
4. Find the larger number between MAX_AB and C and store it in MAX
5. Display MAX
6. Stop

The above-mentioned algorithm terminates after six steps. This explains the feature of finiteness. Every action of the algorithm is precisely defined, hence there is no scope for ambiguity.

Once an algorithm has been designed, it can be represented as a flowchart, pseudocode or decision table, which are further expressed in programming language to develop computer programs.

## 3.3 Flowchart

A flowchart is a pictorial representation of an algorithm in which the steps are drawn in the form of different shapes of boxes and the logical flow is indicated by interconnecting arrows. The boxes represent operations and the arrows represent the sequence in which the operations are implemented. The primary purpose of the flowchart is to help the programmer in understanding the logic of the program. Therefore, it is always not necessary to include all the required steps in detail. Flowcharts outline the general procedure. Since they provide an alternative, visual way of representing the information flow in a program, program developers often find them very valuable.

### 3.3.1 Flowchart Symbols

Flowcharts can be compared with the blueprint of a building. Just as an archi- tect draws a blueprint before starting the construction of a building, a programmer draws a flowchart before writing a computer program. As in the case of the drawing of a blueprint, the flowchart is drawn according to defined rules and using standard flowchart symbols prescribed by American National Standard Institute (ANSI). Some standard symbols that are frequently required for flowcharts are shown in Figure 3.3.

### 3.3.2 Benefits of Flowcharts

A flowchart helps to clarify how things are currently working and how they could be improved. It also assists in finding the key elements of a process by drawing clear lines between the end of one process and the start of next one. Developing a flowchart establishes a common understanding among the participants about the process. Flowcharts help in revealing redundant or misplaced steps. They also help in establishing important areas for monitoring or data collection and to identify areas for improvement or increase in efficiency. The reasons for using flowchartsas a problem-solving tool are given below.

- **Makes Logic Clear:** The main advantage of using a flowchart to plan a task is that it provides a pictorial representation of the task, which makes thelogic easier to follow. The symbols are connected in such a way that they show the movement (flow) of information through the system visibly. The steps and how each step is connected to the next can be clearly seen. Even less experienced personnel can trace the actions represented by a flowchart,that is, flowcharts are ideal for visualizing fundamental control structures employed in computer programming.

| Symbol | Symbol Name | Description |
|---|---|---|
|  | Flow Lines | Flow lines are used to connect symbols. These lines indicate the sequence of steps and the direction of flow of control. |
|  | Terminal | This symbol is used to represent the beginning (start), the termination (end) or halt (pause) in the program logic. |
|  | Input/Output | This symbol represents information entering or leaving the system such as customer order (input) and servicing (output). |
|  | Processing | This symbol is used for representing arithmetic and data movement instructions. It can represent a single step (“add two cups of flour”), or an entire sub-process (“make bread”) within a larger process. |
|  | Decision | This symbol denotes a decision (or branch) to be made. The program should continue along one of the two routes (IF/ELSE). This symbol has one entry and two exit paths. The path chosen depends on whether the answer to a question is “yes” or “no”. |
|  | Connector | This symbol is used to join different flow lines. |
|  | Off-page Connector | This symbol is used to indicate that the flowchart continues on the next page. |
|  | Document | This symbol is used to represent a paper document produced during the flowchart process. |
|  | Annotation | This symbol is used to provide additional information about another flowchart symbol. The content may be in the form of descriptive comments, remarks or explanatory notes. |
|  | Manual Input | This symbol represents input to be given by a developer/programmer. |
|  | Manual Operation | This symbol shows that the process has to be done by a developer/programmer. |
|  | Online Storage | This symbol represents the online data storage such as hard disks, magnetic drums, or other storage devices. |
|  | Offline Storage | This symbol represents the offline data storage such as sales on OCR and data on punched cards. |
|  | Communication Link | This symbol is used to represent data received or to be transmitted from an external system. |
|  | Magnetic Disk | This symbol is used to represent read from or write to a magnetic disk. |

**Figure 3.3:** Flowchart Symbols

- **Communication:** Being a graphical representation of a problem-solving logic, flowcharts are a better way of communicating the logic of a system to all concerned. The diagrammatical representation of logic is easier to communicate to all the interested parties as compared to actual program code as the users may not be aware of all the programming techniques and jargons.

- **Effective Analysis:** With the help of a flowchart, the problem can be analysed in an effective way. This is because the analysing duties of the programmers can be delegated to other persons, who may or may not know the programming techniques, as they have a broad idea about the logic. Being outsiders, they often tend to test and analyse the logic in an unbiased manner.

- **Useful in Coding:** The flowcharts act as a guide or blueprint during the analysis and program development phase. Once the flowcharts are ready, the programmers can plan the coding process effectively as they know where to begin and where to end, making sure that no steps are omitted. As a result, error-free programs are developed in HLL and that too at a faster rate.

- **Proper Testing and Debugging:** By nature, a flowchart helps in detecting the errors in a program, as the developers know exactly what the logic should do. Developers can test various data for a process so that the program can handle every contingency.

- **Appropriate Documentation:** Flowcharts serve as a good program documentation tool. Since normally programs are developed for novice users, they can take the help of the program documentation to know what the program actually does and how to use the program.

### 3.3.3 Limitations of Flowcharts

A flowchart can be used for designing the basic concept of the program in pictorial form but cannot be used for programming purposes. Some of the limitations of the flowchart are given below.

- **Complex:** The major disadvantage in using flowcharts is that when a program is very large, the flowcharts may continue for many pages, making them hard to follow. Flowcharts tend to get large very quickly and it is difficult to follow the represented process. It is also very laborious to drawa flowchart for a large program. You can very well imagine the nightmare when a flowchart is to be developed for a program, consisting of thousands of statements.

- **Costly:** Drawing flowcharts are viable only if the problem-solving logic is straightforward and not very lengthy. However, if flowcharts are to be drawn for a huge application, the time and cost factor of program development may get out of proportion, making it a costly affair.

- **Difficult to Modify:** Due to its symbolic nature, any changes or modification to a flowchart usually requires redrawing the entire logic again, and redraw-ing a complex flowchart is not a simple task. It is not easy to draw thousandsof flow lines and symbols along with proper spacing, especially for a large complex program.

- **No Update:** Usually programs are updated regularly. However, the corresponding update of flowcharts may not take place, especially in the case of large programs. As a result, the logic used in the flowchart may not match with the actual program's logic. This inconsistency in flowchart update defeats the main purpose of the flowcharts, that is, to give the users the basic idea about the program's logic.

## 3.4 Pseudocode

*Pseudocode* is made up of two words: pseudo and code. Pseudo means imitation and code refers to instructions, written in a programming language. As the name suggests, pseudocode is not a real programming code, but it models and may even look like programming code. It is a generic way of describing an algorithm without using any specific programming language-related notations. Simply put, pseudocode is an outline of a program, written in a form that can be easily converted into actual programming statements. Pseudocode uses plain English statements rather than symbols to represent the processes in a computer program. It is also known as *PDL* (program design language), as it emphasizes more on the design aspect of a computer program or structured English, because usually pseudocode instructions are written in normal English, but in a structured way.

Pseudocode strikes a fine balance between the understandability and informality of a natural language like English and the precision of a computer program code. It is somewhat halfway between English and a programming language. If an algorithm is written in English, the description may be at such a high level that it may prove difficult to analyse the algorithm and then to transform it into actual code. If instead, the algorithm is written in code, the programmer has to invest a lot of time in determining the details of an algorithm, which he may choose not to implement (since, typically, algorithms are analysed before deciding which one to implement). Therefore, the goal of writing pseudocode is to provide a high-level description of an algorithm, which facilitates analysis and eventual coding, but at the same time suppresses many of the details that are insignificant.

Pseudocode uses some keywords to denote programming processes. Some of them are as follows.

- **Input:** READ, OBTAIN, GET and PROMPT

- **Output:** PRINT, DISPLAY and SHOW
- **Compute:** COMPUTE, CALCULATE and DETERMINE
- **Initialize:** SET and INITIALIZE
- **Add One:** INCREMENT

Since pseudocode is detailed yet readable, it can be inspected by the team of designers and programmers as a way to ensure that actual programming is likely to match the design specifications. It is better to catch errors at the pseudocode stage rather than correcting them in later stages as it would prove expensive. Once the pseudocode is accepted, it is transformed into actual program code using the vocabulary and syntax of the chosen programming language. The benefit of pseudocode is that it enables the programmer to concentrate on the algorithms without worrying about all the syntactic details of a particular programming language. In fact, you can write pseudocode without even knowing what programming language you will use for the final implementation. Often computer textbooks use pseudocode in their examples so that all programmers can understand them, even if they do not know the same programming languages.

### 3.4.1 Benefits of Pseudocode

Programming can be a complicated process when the program requirements are complex in nature. Pseudocode provides a simple method of developing the program logic as it uses everyday language to prepare a brief set of instructions in the order in which they appear in the completed program. It allows the programmer to focus on the steps required to solve a program rather than on how to use the computer language. Some of the most significant benefits of pseudocode are as follows.

- Since it is language independent, it can be used by most programmers. It allows the developer to express the problem logic in plain natural language.
- It is easier to develop a program from a pseudocode rather than from a flowchart or decision table. Programmers do not have to think about syntaxes; they simply have to concentrate on the underlying logic. The focus is on the steps to solve a problem rather than on how to use the computer language.
- The words and phrases used in pseudocode are in line with basic computer operations. This simplifies the translation from the pseudocode to a specific programming language.
- Unlike flowcharts, pseudocode is compact and does not tend to run over many pages. Its simple structure and readability makes it easier to Modify.

### 3.4.2 Limitations of Pseudocode

Although pseudocode is a very simple mechanism to simplify problem-solving logic, it has its limitations. Some of the most notable limitations are as follows.

- It does not provide a visual representation of the program's logic.
- There are no accepted standards for writing pseudocodes. Programmers use their own style of writing pseudocode.
- It is quite difficult for the beginners to write pseudocode as compared to drawing a flowchart.

## 3.5 Programming Languages

Previously, we discussed that a computer needs to be instructed using computer programs to perform all its tasks. To write computer programs, a computer or pro-

gramming language is required, as computers do not understand natural languages (like English). A programming language consists of a set of characters, symbols and usage rules that allow the user to communicate with computers just as natural languages are used for communication among human beings.

You might be wondering why natural languages are not used to instruct the computers. There are mainly two reasons behind it. Firstly, the natural languages (English, Spanish) are ambiguous, vaguely structured, and have very large (and ever changing) vocabularies. In contrast, computer languages have relatively few, exactly defined rules for composition of programs, and strictly controlled vocabularies in which unknown words must be defined before they can be used. Secondly, in case of natural languages, we can understand even while using poor grammar and vocabulary. However, in the case of programming languages, the rules are very rigid and the programmer has to follow all the specified rules to create an accurate program and to obtain the desired results.

### 3.5.1 Types of Programming Languages

Computers understand only one language and that is binary language or the language of 0s and 1s. In the initial years of computer programming, all the instructions were given in binary form only. Although these programs were easily understood by the computer, it proved too difficult for a normal human being to remember all the instructions in the form of 0s and 1s. Therefore, the computer remained a mystery to a common person until other languages such as assembly and HLL were developed which were easier to learn and understand. These languages use commands that have some degree of similarity with English (such as “if else”, “exit”). Programming languages can be divided into three major categories:

- **Machine Language:** It is the native language of computers. It uses only 0s and 1s to represent data and instructions.

- **Assembly Language:** It correspondences symbolic instructions and executable machine codes and was created to use letters instead of 0s and 1s.
- **High-level Language:** These languages are written using a set of words and symbols following some rules similar to a natural language such as En-glish. The programs written in HLL are known as source programs and these programs are converted into machine-readable form by using compilers or interpreters.

**Note:** Together, machine and assembly language are also known as low-level languages.

## 3.6 Generations of Programming Languages

Since early 1950s, programming languages have evolved tremendously. This evolution has resulted in the development of hundreds of different languages. With each passing year, the languages become user-friendly and more powerful. We can illustrate the development of all the languages in five generations.

First generation languages are machine languages, in which instructions are particular sequences of 0s and 1s that digital computers can understand. Second generation languages, assembly languages, allow programmers to use meaningful abbreviations for machine-specific instructions in place of the incomprehensible 0s and 1s form. Each instruction in an assembly language translates directly to a machine language instruction using a tool called an assembler. Programming became somewhat easier, but many users still wanted floating-point numbers and array indexing. Since these capabilities were not supported in hardware, HLL had to be developed to support them. The next few sections discuss the five generations of languages and how they revolutionized the computer industry.

### 3.6.1 First Generation: Machine Language

The first language was binary, also known as machine language, which was used in the earliest computers and machines. We know that computers are digital devices, which have only two states, ON and OFF (1 and 0). Therefore, every instruction and data should be written using 0s and 1s. Machine language is also known as the computer's "native" language as this system of codes is directly understood by the computer.

### 3.6.2 Second Generation: Assembly Language

The complexities of machine language led to the search of another language: the assembly language, developed in the early 1950s and its main developer was IBM. However, Jack Powell, Bob Nevelen, Clement and Michael Bradly also helped in the development of the assembly language. It was a stepping-stone for all subsequent language development. Assembly language allows the programmer to interact directly with the hardware. This language assigns a mnemonic code to each machine language instruction to make it easier to remember or write. It allows better human-readable method of writing programs as compared to writing in binary bit patterns. However, unlike other programming languages, assembly language is not a single language, but a group of languages. Each processor family (and sometimes individual processors within a processor family) has its own assembly language.

### 3.6.3 Third Generation: High-level Language

During 1960s, computers started to gain popularity and it became necessary to develop languages that were more like natural languages, such as English, so that a common user could use the computer efficiently. Since assembly language re-

quired deep knowledge of computer architecture, it demanded programming as well as hardware skills to use computers. Due to the computer's widespread usage, the early 1960s saw the emergence of the third generation programming languages (3GL). Languages such as COBOL, FORTRAN, BASIC and C are examples of 3GLs and are considered HLL.

HLL are similar to the English language. Programs written using these languages can be machine independent. A single high-level statement can substitute several instructions in machine or assembly language. Unlike assembly and machine programs, high-level programs may be used with different types of computers with little or no modification, thus reducing the re-programming time.

In a high-level language, programs are written in a sequence of statements to solve a problem. For example, the following BASIC code snippet will calculate the sum of two numbers.

```
LET X = 10
LET Y = 20
LET SUM = X + Y
PRINT SUM
```

The first two statements store 10 in variable X (memory location name) and 20 in variable Y, respectively. The third statement again creates a variable named SUM, which will store the summation of X and Y value. Finally, the output is printed, that is, the value stored in SUM is printed on the screen.

**Translating High-level Language into Machine Language:** Since computers understand only machine language, it is necessary to convert the high-level language programs into machine language codes. This is achieved by using language translators or language processors, generally known as compilers, interpreters or other routines that accept statements in one language and produces equivalent statements in another language (see Figure 3.4).

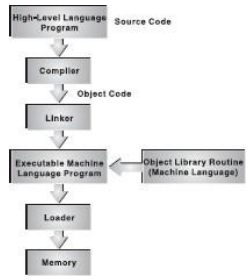


**Figure 3.4:** Program Translation Hierarchy

**Compiler:** A compiler is a kind of translator that translates a program into another program, known as target language. Usually, the term compiler is used for language translator of high-level language into machine language. The compiler replaces a single high-level statement with a series of machine language instructions. A compiler usually resides on a disk or other storage media. When a program is to be compiled, its compiler is loaded into main memory. The compiler stores the entire high-level program, scans it and translates the whole program into an equivalent machine language program. During the translation process, the compiler reads the source program and checks the syntax (grammatical) errors. If there is any error, the compiler generates an error message, which is usually displayed on the screen. In case of errors, the compiler will not create the object code until all the errors are rectified.

Once the program has been compiled, the resulting machine code is saved in an executable file, which can be run on its own at any time. To be precise, once the executable is generated, there is no need for the actual source code file. Anyway, it is worthwhile to keep the source file(s) because if the source code is modified, it is necessary to recompile the program again to regenerate the executable file containing amendments.

**Interpreter:** Unlike compilers, an interpreter translates a statement in a program and executes the statement immediately, before translating the next source language statement (see Figure 3.5). When an error is encountered in the program,

the execution of the program is halted and an error message is displayed. Simi- lar to compilers, every interpreted language such as BASIC and LISP has its own interpreters.

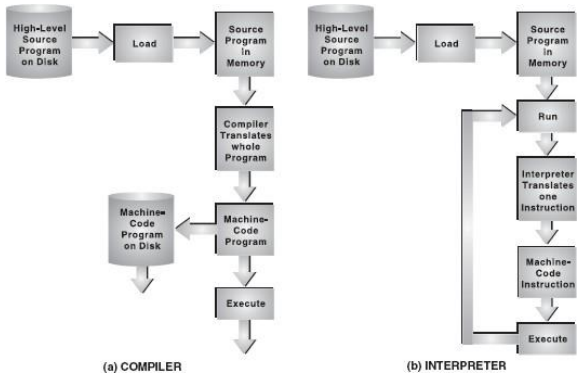


**Figure 3.5:** (a) Working of a Compiler (b) Working of an Interpreter

### 3.6.4 Fourth Generation

Fourth generation languages (4GLs) have simple, English-like syntax rules, commonly used to access databases. The 3GLs are considered as procedural languages because the programmer must list each step and must use logical control structures to indicate the order in which instructions are to be executed. 4GLs, on the other hand, are non-procedural languages. The non-procedural method is simply to state the needed output instead of specifying each step one after another to perform a task. In other words, the computer is instructed what it must do rather than how a computer must perform a task.

The non-procedural method is easier to write, but has less control over how each task is actually performed. When using non-procedural languages, the methods used and the order in which each task is carried out is left to the language itself; the user does not have any control over it. In addition, 4GLs sacrifice computer efficiency in order to make programs easier to write. Hence, they require more computer power and processing time. However, with the increase in power and

speed of hardware and with diminishing costs, the uses of 4GLs have spread.

4GLs have a minimum number of syntax rules. Hence, common people can also use such languages to write application programs. This saves time and allows professional programmers for more complex tasks. The 4GLs are divided into three categories:

- **Query Languages:** They allow the user to retrieve information from databases by following simple syntax rules. For example, the database may be requested to locate details of all employees drawing a salary of more than $10,000. Structured Query Language (SQL) and IBM's Query-By-Example (QBE) are examples of query languages.
- **Report Generators:** They produce customized reports using data stored in a database. The user specifies the data to be in the report, the report's format, and whether any subtotals and totals are needed. Often report specifications are selected from pull-down menus, making report generators very easy to use. Examples of report generators are Easytrieve Plus by Pansophic and R&R Relational Report Writer by Concentric Data Systems.
- **Application Generators:** With application generators, the user writes programs to allow data to be entered into the database. The program prompts the user to enter the needed data. It also checks the data for validity. Cincom System's MANTIS and ADS by Cullinet are examples of application generators.

### 3.6.5 Fifth Generation: Very High-level Languages

Fifth generation languages are just the conceptual view of what might be the future of programming languages. These languages will be able to process natural languages. The computers would be able to accept, interpret and execute instruc-

tions in the native or natural language of the end users. The users will be free from learning any programming language to communicate with the computers. The programmers may simply type the instruction or simply tell the computer byway of microphones what it needs to do. Since these languages are still in their infancy, only a few are currently commercially available. They are closely linked to artificial intelligence and expert systems.

# Let us summarize

1. A computer needs to be instructed to perform all its tasks. These instructions are provided in the form of a computer program. Programming involves many stages such as problem definition, task analysis, developing algorithm, testing algorithm, coding, program testing, documentation, implementation, and maintenance and enhancement.

2. An algorithm is defined as a finite sequence of explicit instructions that when provided with a set of input values produces an output and then terminates. Algorithms can be represented as flowchart, pseudocode or decision table.

3. A flowchart is a pictorial representation of an algorithm in which the steps are drawn in the form of different shapes of boxes and the logical flow is indicated by interconnecting arrows. The boxes represent operations and the arrows represent the sequence in which the operations are implemented.

4. Pseudocode is a generic way of describing an algorithm without the use of any specific programming language-related notations. It is an outline of a program, written in a form, which can easily be converted into real programming statements. Pseudocode uses plain English statements rather than symbols to represent the processes in a computer program.

5. Program statements that affect the order in which statements are executed, or that affect whether statements are executed, are called control structures. They affect the flow of simulation code since a control structure evaluates statements and then executes code according to the result.

6. Programming language is a language that a user employs to interact with the computer. It can be divided into three major categories: machine, assembly and high-level language.

7. First generation language is the machine language in which instructions are in the form of 0s and 1s. Second generation language is the assembly language in which mnemonic code is assigned to each machine language instruction to make it easier to remember and write. 3GLs are machine independent, use HLL to write programs, and thus need language translators to translate the high-level code into machine code. 4GLs, also called as non-procedural languages, use minimum syntax rules and are categorized into query languages, report generators and application generators. Fifth generation language is in the development stage. The computer will be able to accept, interpret and execute the instruction in the natural language of the user.

8. Linker is a program that links together several object modules and libraries to form a single, coherent executable program. Loader is a program that brings an executable file residing on a disk into a memory. It is also responsible for performing basic tasks such as linking, loading and relocation.

9. A good programming language should be easier to use and be portable. It should incur the minimum cost and provide concurrent support.

# Exercises

## Fill in the Blanks

1. The sequence of instructions that instruct the computer to carry out a specific task is called.....
2. An algorithm can be represented as.....or.....
3. Broadly, programming can be classified into.....,.....and..... approaches.
4. A program that translates the assembly language code into machine language code is called.....
5. The part of operating system that brings an executable file residing on disk into memory and start running is.....
6. Compiler and interpreter are also called.....
7. The two-part forms of machine language instructions are.....and.....
8. The two categories of loader are.....and.....

9.language is very close to the hardware.

10. COBOL, FORTRAN and C are examples of.....

## Multiple-choice Questions

1. The semantic and syntax errors in the program are checked in.....

   (a) Coding Phase

   (b) Testing Phase

   (c) Implementation Phase

   (d) Analysis Phase

2. Choose the odd one out.....

   (a) Abstraction

   (b) Encapsulation

   (c) Inheritance

   (d) Linking

3. Flow lines in a flowchart are used to connect.....

   (a) Two Terminals

   (b) Two Connectors

   (c) Two Input/Output

   (d) All of these

4. Programming tools helps in.....

   (a) Producing readable code

   (b) Making the program logic easier

   (c) Reducing the size of programs

   (d) None of these

5. A high-level language is a programming language that is.....

   (a) Easier to use

   (b) Considered a first generation language

   (c) Considered a third generation language

   (d) Both (a) and (c)

6. What consists of instructions written as a series of 1s and 0s?

   (a) Query Language

   (b) Assembly Language

(c) Machine Language

(d) None of these

7. Which of the following was a disadvantage of the first generation language?

(a) Machine dependency

(b) Less efficient

(c) Need for more disk space

(d) All of these

8. Good programming language has the following features:.....

(a) Portable, Safe

(b) Reliable, Good Performance

(c) High Cost

(d) Only (a) and (b)

9. Query languages comes under.....

(a) Third Generation

(b) Fourth Generation

(c) Fifth Generation

(d) None of these

10. Which of the following program control structure allows the program to make a choice between two alternate paths depending upon the condition?

(a) Sequence

(b) Loop

(c) Selection

(d) None of these

## State True or False

1. The graphical representation of an algorithm is called flowchart.
2. The generic way of describing an algorithm without the use of programming language is known as program.
3. The keyword, DETERMINE, used in a pseudocode is an input operation.
4. The terminal symbol in a flowchart represents start of program logic.
5. Programming is the art and science of creating computer programs.
6. A program that links several object modules and libraries to form a single, coherent program is called linker.
7. The language translator that translates the programs written in high-level language into its corresponding machine code is called assembler.
8. Machine language is also called low-level language.
9. Pseudocode can be compiled by a program compiler.
10. The diamond-shape symbol in the flowchart signifies processing.

## Descriptive Questions

1. Explain the program development cycle with the help of a block diagram.
2. Define an algorithm. List the characteristics of a good algorithm.
3. Define a flowchart. List some important reasons for using flowcharts.
4. What are the advantages and disadvantages of using a pseudocode?
5. Explain the features of a good programming language.
6. Describe the classification of programming languages.

7. Write short notes on the following.

   (a) Compiler

   (b) Interpreter

   (c) Loader

   (d) Linker

# Chapter 4

# Practical Notes

## 5.1 Microsoft Office Word 2003

- Word processing is the manipulation of characters, words, text, numbers, sentences, and paragraphs in the document so that they are error-free and looks attractive.
- To open Microsoft Word, click start, point to All Programs, and then select Microsoft Word.
- To get help, click the Microsoft Word
- Help button (images) on the Standard toolbar. Alternatively, select Microsoft Office Word Help from the Help menu.
- To create a new document, click on New Blank Document button (images) on the Standard toolbar. Alternatively, select New from the File menu.
- To open an existing document, click on the Open button (images) on the Standard toolbar. Alternatively, select Open from the File menu.
- To save the document, Microsoft Word provides two menu options, namely,

Save and Save As. By default, Microsoft Word document files are saved with .DOC extension, although it can also be saved in other file formats like .TXT, .RTF, and .HTML.

- To close the document, select Close from the File menu.
- Formatting is the process of determining how the typed text will appear on a printed page. It is applied by altering the appearance of text by setting the font type and font size, line spacing, and colour. To format the text, first select the text to be formatted and then use various buttons on the Formatting toolbar. Text can also be formatted by using the Font dialog box, which can be displayed by selecting Font from the Format menu.
- To highlight the text use the Highlight button (images) from the Formatting toolbar. In case you want to change the colour of the text, use the Font Color button (images) from the Formatting toolbar.
- To align or indent a paragraph, use the appropriate buttons on the Formatting toolbar. A paragraph can also be formatted using the Paragraph dialog box, which can be displayed by selecting Paragraph from the Format menu.
- A style is a set of formatting specifications that can automatically be applied to the text. To apply a style, place the cursor in the paragraph where the style is to be applied. Then click the Style drop-down box on the Formatting toolbar and select a style by clicking on it.
- The Format Painter is a time-saving feature for quickly copying the format of a block of text. This tool can be used by clicking the Format Painter button (images) on the Standard toolbar.
- To move the text, choose Cut from the Edit menu. To copy the text, choose Copy from the Edit menu. To paste the cut or copied text or image, choose Paste from the Edit menu.

- To find and replace text within the document use the Find and Replace dialog box, which can be displayed by selecting Find from Edit menu.

- To undo the last action, select Undo from the Edit menu. To redo the last undo action, select Redo from the Edit menu. You can also use the Undo button (images) and Redo button (images) from the Standard toolbar.

- To use bullets and numbering, first select the text you want to format. Next, use the Bullets (images) or Numbering (images) button on the Formatting toolbar.

- Headers are text that appears at the top of every page, and footers contain text that appears at the bottom of each page. To create a header and footer in a document, select Header and Footer from the View menu, or double-click on the header area of the document.

- Tables can be created by using the Insert Table dialog box, which can be displayed by selecting Insert and then Table from the Table menu. Another way of creating a table is to click the Insert Table button (images) on the Standard toolbar and then dragging the mouse along the grid to highlight the number of rows and columns for the table.

- Microsoft Word automatically checks the spelling and grammar as you type the text and provides visual clues about the spelling and grammar. Mis-spelled words are underlined in red, while sentences with grammatical flaws are underlined in green.

- Microsoft Word has the Thesaurus feature to replace a word with its synonym or antonym. This feature can be used by selecting Language and then Thesaurus from the Tools menu.

- To add a picture from an existing file, use the Insert Picture dialog box, which can be displayed by selecting Picture and then From File from the Insert

menu.

- Microsoft Word comes with its own set of pictures in the Clip Gallery. This gallery includes a wide variety of clip art that makes it easy for you to enhance your documents with professionally designed images. To add a Clip Art from the Clip Gallery use the Insert ClipArt dialog box, which can be displayed by selecting Picture and then Clip Art from the Insert menu.

- To use AutoShapes, select Picture and then AutoShapes from the Insert menu. Alternatively, use the AutoShapes menu from the Drawing toolbar.

- To use WordArt, select Picture and then WordArt from the Insert menu. Alternatively, use the WordArt button (images) from the Drawing toolbar.

- Page margins determine the distance between the text and the edge of the paper. To specify the margins in the document use the Page Setup dialog box, which can be displayed by selecting Page Setup from the File menu.

- Print preview is a way to review the appearance of the printed document on-screen before printing the final output. To view the document in print preview mode, choose Print Preview from File menu or click the Print Preview button (images) on the Standard toolbar.

- To print a document, click the Print button (images) on the Standard toolbar. Alternatively, use the Print dialog box, which can be displayed by selecting Print from the File menu.

## 5.2 Microsoft Office Excel 2003

- Microsoft Excel is a spreadsheet program that allows you to perform various calculations, estimations, and formulations with data. It is the electronic counterpart of a paper ledger sheet, which consists of grid of columns and rows.
- To open Microsoft Excel, click Start, point to All Programs, then point to Microsoft Office, and then select Microsoft Office Excel 2003.
- To create a new workbook, click on New button (images) on the Standard toolbar. Alternatively, select New from the File menu.
- To open an existing workbook, click on the Open button (images) on the Standard toolbar. Alternatively, select Open from the File menu.
- To save the workbook, Microsoft Excel provides two menu options, namely Save and Save As.
- To close the workbook, select Close from the File menu.
- To find and replace text within the worksheet use the Find and Replace dialog box, which can be displayed by selecting Find and Replace from the Edit menu.
- To undo the last action, select Undo from the Edit menu. To redo the last undo action, select Redo from the Edit menu. You can also use the Undo button (images) and Redo button (images) from the Standard toolbar.
- In Excel, numerical data can be easily converted into a chart for graphical presentation of the data. Charts provide more visual clarity than tables of data and, therefore, have more impact.

- One of the simplest and easiest methods to create a chart is by using the Chart Wizard. This wizard helps in creating a chart by displaying a series of dialog boxes.

- Print preview is a way to view the printed workbook on-screen before printing the final output. To view a worksheet in the print preview mode, choose Print Preview from File menu or click the Print Preview button (images) on the Standard toolbar.

- To print a worksheet, click the Print button (images) on the Standard toolbar. Alternatively, use the Print dialog box, which can be displayed by selecting Print from the File menu.

## 5.3 Microsoft Office PowerPoint 2003

- Microsoft PowerPoint 2003 is powerful, yet easy-to-use presentation software. Its primary purpose is to help you design professional-style presentations quickly and easily.
- Click Start, point to All Programs, then point to Microsoft Office, and then select Microsoft Office PowerPoint 2003.
- A new presentation can be created using the AutoContent wizard, Design Template, and Blank presentation.
- To open an existing presentation, click on the Open button (image) on the Standard toolbar. Alternatively, select Open from the File menu.
- To save a presentation, Microsoft PowerPoint provides two menu options, namely Save and Save As. By default, Microsoft PowerPoint files are saved with .PPT extension.
- To close the presentation, select Close from the File menu.
- PowerPoint provides different types of screen layouts for constructing presentation in addition to the Slide Show. View is a way in which one can see and work with the presentation and slides.
- A presentation is created using the slides, which contains text, graphics, animations, and so on. PowerPoint is designed in a way to give a consistent appearance to your slides. There are two ways in PowerPoint, which help you to choose the look of your slides: design template and masters.
- Design templates contain colour schemes, slide and notes masters with custom formatting, and fonts, all designed to create a desired look.

- Masters in PowerPoint are used to control many facets of the slides such as backgrounds, font typeface, font size, colours, bullets and locations for all the main components, tab, and indent. PowerPoint has three masters, namely Slide Master, Notes Master, and Handouts Master.

- Slides can be added in the outline view or in the slide view. To insert slide, select New Slide from the Insert menu, or click the New Slide (images) button on the Standard toolbar. This displays New Slide dialog box from which you can choose the desired layout.

- In PowerPoint, you can navigate to the next and previous slides by following any of the five view options, that is, Normal, Outline, Slide View, Slide Sorter, and Slide Show.

- You can change the appearance of your slide background by changing its colour, shade, pattern, or texture. PowerPoint contains a number of predefined backgrounds or, if needed, you can create your own background.

- There are a number of ways in which the text can be added into the slides. Text can be added using text placeholder, text box, an AutoShape, and WordArt.

- Formatting is the process of determining how the typed text will appear on a printed page. It is applied by altering the appearance of text by setting the font type and font size, line spacing, and colour. To format the text, firstselect the text to be formatted, and then use various buttons on the Formatting toolbar. Text can also be formatted by using the Format menu.

- In PowerPoint 2003, graphical elements can help you create eye-catching slides for a presentation. Graphics are frequently used with text to add emphasis and visual impact. PowerPoint 2003 gives you the option of adding AutoShapes, WordArt, and ClipArt.

- A presentation can be made more interactive and interesting by adding multimedia effects such as animations, video, and sound effects to the slides. This helps in capturing audience's attention as multimedia content can often communicate more information than a slide, which contains only few sentences.

- Animation effects are added to grab the audience's attention as well as to reinforce the point that needs to be highlighted. Animation can be special sound or visual effects which can be added to the text or other objects such as a chart or picture.

- Transition effects are used to insert effects between slides. They are also used to indicate a new section of a presentation or to emphasize a certain slide. You can choose from a variety of transitions, which are present in PowerPoint 2003.

- After you have finished with creating slides, working with text and graphics, adding transition and animation effects to the slides, the next thing is to view all the slides collectively as a presentation. PowerPoint 2003 provides a number of ways to review and deliver presentations so that they are well designed and look professional. You can view the presentation as a slide show in the Slide view.

- You can add time between the slides in the slide show. This may be required when there is some narration over the slides, or there is some graphical representation, which requires a proper explanation.

- Sometimes, presentation may be created for business or professional use. For example, you may create a presentation, which is to be delivered at some conference. To give a presentation all you have to do is bring your presentation file with you. This approach is suited for small presentations, but it may not work that well for larger presentations especially one with lots of graphics.

PowerPoint contains a useful feature called Package for CD, which solves the above problem.

- To print a presentation, click the Print button (images) on the Standard toolbar. Alternatively, use the Print dialog box, which can be displayed by selecting Print from the File menu.
- PowerPoint provides four options while printing–Slides, Handouts, Note Pages, and Outline View.