17 ORIENTATION OF COMPUTERS

17.1 INTRODUCTION TO COMPUTER

17.1.1 Computer. The *computer* is defined as an electronic device which is used to store and process data to solve different problems according to a set of instructions given to it. The word "computer" came from the word "compute" which means "to calculate".

17.1.2 Capabilities of Modern Computer. The following are the details of capabilities of a modern computer.

Speed. The speed of a computer is defined as the number of instructions processed in one second.

A computer can perform millions of instructions in one micro second. It performs one operation at a time. When a computer performs an operation, the clock of the processor generates electronic pulses at a fixed rate. It generates millions of pulses or signals in one second. The number of pulses generated in one second is called frequency. The unit of frequency is hertz (abbreviated Hz). Hertz is a measure of number of vibrations per second.

The speed of a computer is measured in megahertz (abbreviated MHz) and in gigahertz (abbreviated GHz). Modern personal computers may have the speed more than 3 GHz (1 GHz = 1024 MHz).

Data Storage. A computer can store a large amount of data. It stores the data in its memory and can retrieve it with a high speed. The ability of a computer to store the data and to retrieve it with a very high speed makes it suitable for modern data processing.

Data is defined as a combination of characters, numbers and symbols collected for a specified purpose.

Data Processing. Data processing consists of series of operations performed on the data to achieve the required results.

The main function of a computer is data processing. It includes the arithmetic and logical operations. It also includes the classification of data, arrangement of data and its transmission from one place to another. The results of data processing are called the output or the information.

Accuracy. The computers are very accurate in calculations.

A modern computer can perform millions of operations in one second without any error. The accuracy of calculations depends upon the input data and the program instructions. If the input data and the program instructions are correct, then we expect that the computer will produce accurate result.

Diligence. The computer has the ability to do work for long hours. It never tires. Working for long hours does not affect the accuracy of a computer.

17.2 HISTORY OF COMPUTER

The history of computer and calculator goes back to a very long way. For many centuries, people used their own brain-power to perform arithmetic calculations. The names of three great scientists who contributed in the invention of computer are

1. Abu Jaafar Muhammad Ibn Musa Al-Khwarizmi (780 — 850)
2. Alan Mathison Turing (1912 — 1954)
3. John von Neumann (1903 — 1957)

Blaise Pascal, a mathematician and scientist of France, developed the first mechanical adding machine called "Pascaline" in the 1642. Pascaline performed addition and subtraction. This machine was modified by Baron Gottfried Wilhelm von Leibnitz in 1671. He introduced "Multiplier Wheel" to perform all the basic arithmetic operations such as addition, subtraction, multiplication and division.

The designer of the first computer was Charles Babbage a mathematician of the United Kingdom. He designed a machine called "Analytical Engine" in 1837 Analytical Engine was the first programmable computer. It consisted of the following units.

(*i*) A storage (to store data)

(*ii*) A mill (to perform arithmetic operations)

(*iii*) A control unit (to control all operations and to coordinate the Input/ Output units).

The program (instructions) was given to the Analytical Engine with the help of punched cards.

The Americans were also experimenting to develop a computer. An American scientist working at Harvard University, developed a computer between 1937 and 1943. It was the "Harvard Mark-I"

In 1943, American scientists, J. W. Mauchly and J. P. Ekert developed an electronic computer at Moor School of Engineering, U.S.A. The electronic computer was called Electronic Numerical Integrator and Calculator (ENIAC). Manufacturing of ENIAC was started in 1943 and finally completed in 1946. ENIAC differed in only one significant way from the computer of today that its programs were stored externally on tape. This means that programs could be executed sequentially.

In 1944 John von Neumann suggested that the computer program should actually be stored electronically inside the computer. This was the final breakthrough in computer design.

17.3 TYPES OF COMPUTERS

The computers are of three types:

(*i*) Digital Computer

(*ii*) Analog Computer

(*iii*) Hybrid Computer

17.3.1 Digital Computer. A *digital computer* works with digits. It operates by counting numbers or digits and gives output in digital form. It works with only two signals, 0 and 1. The data and instructions are entered and stored in coded form of 0's and 1's.

These computers are manufactured in wide variety of sizes, speeds and capacities. The digital computers are commonly used in offices and educational institutions. Digital watches, digital thermometers, *etc.*, are the examples of digital computers.

17.3.2 Analog Computer. An *analog computer* does not operate directly with digital signals. It receives input gives output in the form of an analog signal.

The analog computers measure physical quantities to give output on a scale. The output is in the form of graph or a reading on a scale. A dial clock , thermometer and weighing machine are all examples of analog computers. The results achieved are not accurate as compared to those achieved by digital computers.

17.3.3 Hybrid Computer. A *hybrid computer* have features of both analog and digital computers.

The hybrid computers get input and give output either in analog or digital form. Modem is an example of hybrid computer.

17.4 CLASSIFICATION OF COMPUTERS

The computers are manufactured in a wide variety of sizes, speeds and capacities. In computer terminology, size refers to the amount of data a computer can handle. Generally a computer with a high processing speed is called a big computer. Depending upon their speed and memory size, the computers are classified into the following different groups

(*i*) Micro Computers (*iii*) Mainframe Computers

(*ii*) Mini Computers (*iv*) Super Computers

17.4.1 Micro Computers. The *micro computers* or *personal computers* are designed to be used by one user at a time. These are commonly used in offices, at homes and in educational institutions. These computers have processing speed of the order of millions of instructions processed per second (MIPS). The peripherals used in these systems include keyboard, monitor, character or page printer and a mouse.

The micro computers are small in size and are mainly used in accounting, database, word processing and graphics, *etc*. Laptop and notebooks are micro computers.

17.4.2 Mainframe Computers. The *mainframe computers* are very large computers. The mainframe computers have very high processing speed. These computers are used by large business organizations like banks, insurance companies, scientific research institutes and weather forecasting bureaus. The largest IBM *S*/390 mainframe, for example, can support 50,000 users while executing more than 1,600,000,000 instructions per second.

17.4.3 Mini Computers. The *mini computers* released in 1960s got their name because of their small size compared to the other computers of the day. They are smaller version of the mainframe computers. Like the mainframes, mini computers can handle much more data than personal computers. These are used for maintaining details of a large business organization, to analyse the results of experiments or to control and maintain the production activity in factory.

The mini computers have large memory and faster input/output devices. They are more expensive and have more processing speed than micro computers. The most powerful mini computer can serve the input and output needs of hundreds of users at a time. The mini computers cost anywhere from $ 18,000 to $ 500,000 and are ideal for many organizations and companies that cannot afford or do not need mainframe systems.

17.4.4 Super Computers. The *super computers* are the most powerful computers made, and physically they are some of the largest. These systems are built to process huge amounts of data, and the fastest super computers can perform more than 1 trillion calculations per second.

Some super computers such as the Cray T90 system can house thousands of processor. This speed and power make super computers ideal for handling large and highly complex problems that require extreme calculating power. These computers are used by Nuclear scientists

to create and analyze models of nuclear fission and fusion, predicting the action and the reactions of millions of atoms as they interact. These computers are also being to map the human genome, or DNA structure. The super computers can cost tens of millions of dollars and consume enough electricity to power dozens of homes.

17.5 HARDWARE AND SOFTWARE

17.5.1 Hardware. The physical parts of the computer are called *hardware*. It includes all physical devices or units that make up a computer. The examples of hardware are: CPU, monitor, mouse, keyboard, *etc*.

17.5.2 Software. The set of instructions given to the computer to solve a problem or to control the operation of the computer is called *software*. The, software is prepared in computer programming languages. The examples of *software* are: Microsoft Word, Excel, Corel Draw, Photoshop, *etc*.

17.6 HARDWARE COMPONENTS OF A PERSONAL COMPUTER

The computer itself, the hardware, has many parts, but the critical components fall into one of four categories.

1. Central Processing Unit (CPU)
2. Main Memory
3. Input/ Output Devices
4. Secondary Storage

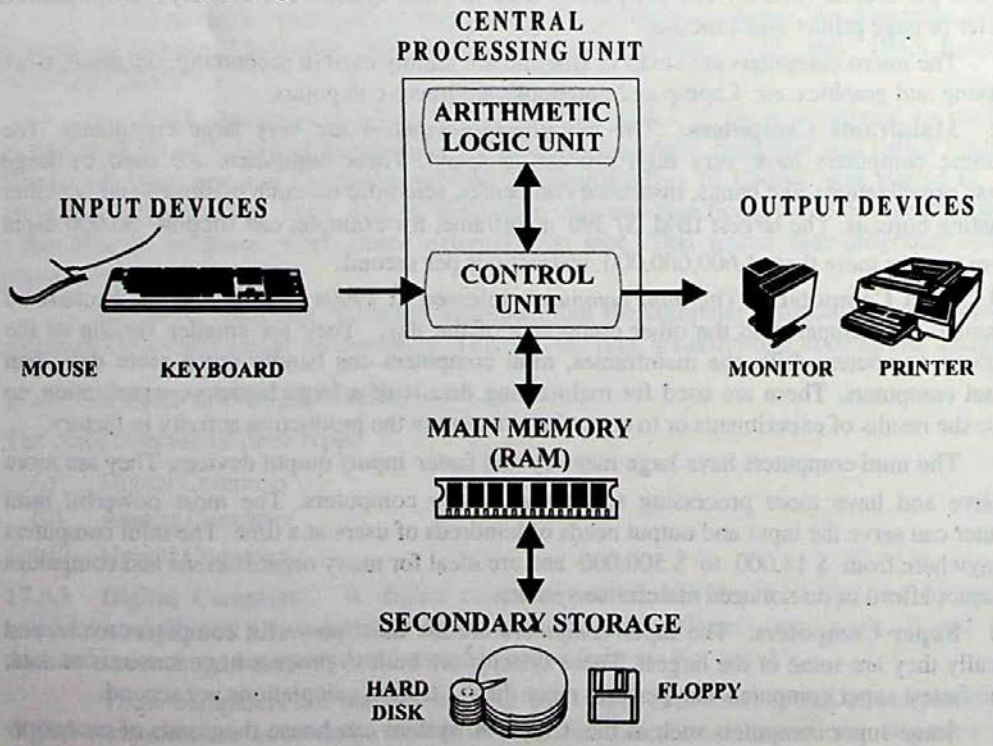


Fig. 17.1 Hardware Components of Personal Computers

17.6.1 Central Processing Unit (CPU). The *central processing unit* is the brain of the computer, the place where data is manipulated. In large computer systems, such as super computers and mainframe computers, processing tasks may be handled by multiple processing chips. (Some powerful computers systems use hundreds or even thousands of separate processing units). In average micro computer, the entire CPU is a single chip called a micro processor. The CPU has at least two basic parts:

(*i*) Control Unit

(*ii*) Arithmetic Logic Unit (ALU)

Control Unit. All the computer's resources are managed from the control unit. Think of the control unit as a traffic cop directing the flow of data through the CPU, and to the other devices The control unit is the logical hub of the computer.

The CPU's instructions for carrying out commands are built into the control unit. The instructions, or instructions set is expressed in macrocode a series of basic direction tells CPU how to execute more complex operations.

Data will have to be first transferred from the input device or secondary storage to the main memory and taken from there to the ALU for processing. Instructions on what to do with the data must be given to the ALU. Then the results have to be transferred to the main memory and from there to the output device. For these and many more such tasks we need a sort of manager. It is the control unit which takes care of all these activities.

One of the most important function of the control unit is the handling of program steps. Each basic instruction such as 'add' , 'subtract' or 'store' is in the form of code. Only the control unit understand each code and gets the instruction executed. In that process it may move data from an input device to the memory, from the memory to the ALU, from the ALU back to the memory, from memory to an output device and so on. The control unit is like the nervous system of the body and supervises all the operations of computer

***Arithmetic Logic Unit* (ALU).** The arithmetic logic unit is a part of the processor in which all arithmetic and logical operations on the data are performed.

Arithmetic section of the ALU performs basic arithmetic operations such as addition, subtraction, multiplication and division.

A logical operation is one in which data is compared. For example, whether the *first number* is greater than the *second number*, or it is less than, equal to, not equal to, grater than or equal to, *etc*. The logic section of ALU performs logical operations.

Arithmetic Operations		Logical Operations	
+	add	=, ≠	equal to, not equal to
+	subtract	>, ≯	greater that, not greater than
×	multiply	<, ≮	less than, not less than
÷	divide	≥, ≱	greater than or equal to, not greater than nor equal to
^	raised by a power	≤ ≰	less than or equal to, not less than nor equal to

The ALU includes a group of registers high speed memory locations built directly into the CPU that are used to hold the data currently being processed. For example, the control unit might load two numbers from memory into the register in the ALU. Then it might tell the ALU to

divide the two numbers (an arithmetic operation) or to see whether the numbers are equal (a logical operation)

17.6.2 Main Memory. The main memory, also called RAM (Random Access Memory) or primary storage contained in the processor unit of the computer temporarily stores data and programme instructions when the are being processed.

The main memory has many storage locations. Each memory location has a Storage Address, like a Post Box number. The computer stores or retrieves data using the address. The computer always keeps a list of data items and corresponding addresses. This is, of course, done automatically and we need not worry about it.

When the computer retrieves data from a location, it merely reads what is stored and transfer them elsewhere. It does not destroy the stored data. On the other hand, when it stores new data in a location, the previous contents in that location are lost.

The most common measurement unit for describing a computer's memory is bytes, the amount of memory it takes to store a single character, such as a letter of the alphabet or numerical.

The measurement for Computer Memory and Storage

Unit	Abbreviation	Pronounced	Approximate value (bytes)	Actual values (bytes)
Kilobyte	KB	KILL-uh-bite	1,000	1,024
Megabyte	MB	MEHG-uh-bite	1,000,000 (1 million)	1,048,576
Gigabyte	GB	GIG-uh-bite	1,000,000,000 (1 billion)	1,073,741,824
Terabyte	TB	TERR-uh-bite	1,000,000,000,000 (1 trillion)	1,099,511,627,776

Today's personal computers commonly have from 1 GB to 4 GB of memory. Some computers improve their processing efficiency by using a limited amount of high speed RAM memory between the CPU and main memory. High-speed memory used in this manner is called cache (pronounced cash) memory. Cache memory is used to store the most frequently used instructions and data. When the processor needs the next program instructions and data, it first check the cache memory. If the required instruction or data is present in cache (called a cache bit), the processor will execute faster than if the instructions or data has to retrieve from the slower main memory.

17.6.3 Input/ Output Devices. Computers would be useless if they did not provide interaction with users. They could not receive or deliver the results of their work. Input devices accept data and instructions from the user or from another computer system (such as a computer on the internet). Output devices return processed data back to the user or to another computer system.

Input Devices. Before processing unit can work, the data and programme must be entered into the computer memory, this is done by means of input devices. The most common input devices are keyboard, mouse, scanners and digital cameras.

Output Unit. There are various devices to present information in a particular manner or to deliver it at appropriate speed., *e. g.*, video display units, line printer and COM (Computer Output Microfilm).

17.6.4 Secondary Storage. A computer can function with only processing unit, memory, input and output devices. To be really useful, however, it also need a place to keep programme files and related data when it is not using them. The purpose of storage is to hold data.

It is important to understand the difference between how a computer uses main memory and how it uses secondary storage. Main memory, also called primary storage or RAM, temporarily stores programmes and data being processed. *Secondary storage*, also called auxiliary storage, stores programmes and data when they are not being processed.

The physical components or materials on which data is stored are called storage media. The hardware components that write to, and read it from, storage media are called storage devices. Two main categories of storage technology used today are magnetic storage and optical storage. Although most storage devices and media employ one technology or other, some use both.

The primary types of magnetic storage are as follows;

(*i*) Diskettes
(*ii*) Hard disks (both fixed and removable)
(*iii*) High-capacity floppy disks
(*iv*) Disk cartridges
(*v*) Magnetic tape

The primary types of optical storage are as follows;

(*i*) Compact Disk Read-Only Memory (CD-ROM)
(*ii*) Digital Versatile Disk Read-Only Memory (DVD-ROM)
(*iii*) CD-Reeordable (CD-R)
(*iv*) CD-Re Writable (CD-RW)
(*v*) Photo CD

The most common storage medium is the magnetic disk. A disk is a round, flat object that spins around its centre. Read/ write heads , which are similar to the heads of tape recorder or VCR, are used to read data from the disk or write data onto the disk. Depending on the type of disk, read/ write heads may float just above the disk's surface or may actually touch the disk.

17.7 INPUT DEVICES AND OUTPUT DEVICES

17.7.1 Input Devices. *Input devices* consist of hardware that translate data into a form the computer can process. The people readable form may be words like the ones in these sentences, but computer readable form consists of '0' and '1' or "off" and "on" electrical signals. Input hardware devices are categorized as three types

(*i*) Keyboards
(*ii*) Pointing devices
(*iii*) Source data entry devices

17.7.2. Keyboard. Keyboard is a device that converts letters, numbers and other characters into electrical signals that are machine readable by the computer processor. The keyboard may look like a type writer keyboard to which some special keys have been added. Keyboard has 3 types of keys, namely

(*i*) Alphabet keys (A, B, C, · · ·, Z, a, b, c, · · ·, z)

(*ii*) Numeric keys (1, 2, 3, 4, 5, 6, 7, 8, 9, 0)

(*iii*) Special keys (F1, F2, · · ·, F12, Alt, Ctrl, Shift, Tab, Capslock, Enter, · · ·, etc)

The standard keyboard has 101 buttons on it and now a days the keyboards with 104, 106, 110 buttons are available in the market.

17.7.3. Pointing Devices. *Pointing devices* control the position of the cursor or pointer on the screen. Pointing devices include.

(*i*) Mouse (*ii*) Light pens, *etc.*

Mouse. A mouse is a device that is rolled about on a desktop and direct a pointer on the computer's display screen the mouse has a cable that is connected to the micro computer's system unit by being plugged into a special port or socket. It has two/ three buttons, a wire or wireless. On the bottom side of the mouse is ball that translates the mouse movement into digital signals. Depending upon the software, many commands that you can execute with a mouse can also be performed through a keyboard. The following are the functions of a mouse.

(*i*) ***Point.*** Move the pointer to the desired spot on the screen, such as over a particular word or object.

(*ii*) ***Click.*** Press and quickly release, the left mouse button twice as quickly as possible.

(*iii*) ***Drag.*** the pointer to another location

(*iv*) ***Drop.*** Release the mouse button after dragging

(*v*) ***Right click.*** To make a selection using the button on the right side of the mouse which usually brings up a pop up menu

Trackball. The trackball is movable, on top of a stationery device, that is rotated with fingers or palm of the hand. Trackballs are specially suited to portable computers, which are often used in confined places such as on airplane tray, tables. Trackballs may appear on the keyboard centred below the space bar.

Joystick. A joystick is a pointing device that consist of vertical handle like a gearshift lever mounted on a base with one or two buttons

Touch pad The touch pad is a small, flat surface over which you slide your finger, using the same movement mouse.

Light Pen. The light pen is a light sensitive stylus, or pen like device connected by a wire to the computer terminal the user brings the pen to a desired point on the display screen and presses the pen button, which identifies that screen location to the computer.

17.7.4 Output Devices. The devices that are used to receive data from the CPU in binary code and convert it into readable form are called *output devices*. The output devices enable CPU to transfer information to the user and other devices.

The output device receives data from CPU in computer code and converts it into a form that a user can understand or which is readable to the other devices. For example, the binary string 01000001 from CPU represents letter '*A*' on the screen. The output is divided in two categories:

(*i*) The output that is sent to the secondary storage, *e. g.*, magnetic tape disk, *etc.* This output can be used by the CPU as input for further processing.

(*ii*) The output that can be read and used by people. This output is further divided into:

(*a*) ***Softcopy Output.*** It is the output that is temporary and is erased when the computer is switched off, *e. g.* display on the computer screen.

(*b*) ***Hardcopy Output.*** It is the output that is permanent and is always available for use, *e. g.*, print out on the paper.

Softcopy Output Devices. Softcopy output devices are used to display output on the screen. They are also called Visual Display Units (VDU). The most commonly used softcopy device are;

(*i*) Monitors

(*ii*) Pc Projectors

(*iii*) Sound Systems

Hardcopy Output Devices. The computer user usually needs output printed on the paper for permanent record. The output received from the computer on the paper is called hardcopy. The devices used to produce a hardcopy are two types

(*i*) Printer

(*ii*) Plotter

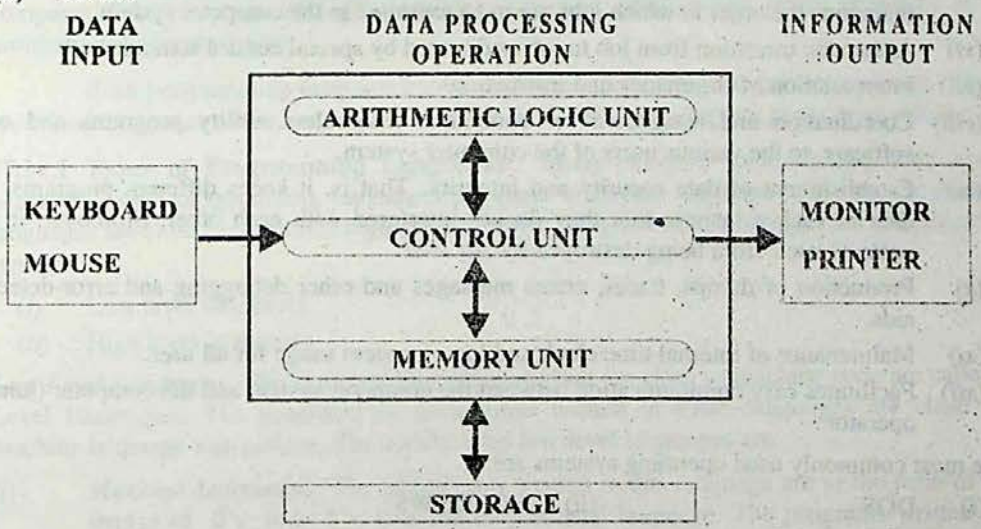


Fig. 17.2 Information Processing System

17.8 SYSTEM SOFTWARE

System software consists of all programs including the operating system that are to control the operations of the computer equipment. Some of the functions that system software perform include: starting up the computer; loading, executing, and storing application programs; storing and retrieving files; and performing a variety of functions such as formatting disks, sorting data files, and translating programs instructions into machine languages. System software can be classified into three major categories; operating systems, utilities, and language translators.

17.9 OPERATING SYSTEM

An operating system (OS) is an integrated set of programs that is used to manage the various hardware resources of computer system. Its prime objective is to improve the performance and efficiency of a computer system and increase facility, the ease with which a

system can be used. Each time a computer is turned on, or restarted the operating system is loaded into the computer and stored in the computer's main memory.

17.9.1 Functions of Operating Systems. The following are the functions of operating systems.

(*i*) Processor management, that is, assignment of processors to different tasks being performed by the computer system

(*ii*) Memory management, that is, allocation of main memory and other storage areas to system programs as well as user programs and data.

(*iii*) Input/ Output management, that is, coordination and assignment of the different input and output devices while one or more programs are being executed.

(*iv*) File management, that is, the storage of files on various storage devices and transfer of these files from one storage device to another. It also allows all files to be easily changed and modified through the use of text editors or some other file manipulation routines.

(*v*) Establishment and enforcement of job priority system. That is, it determines and maintains the order in which jobs are to be executed in the computer system.

(*vi*) Automatic transition from job to job as directed by special control statements.

(*vii*) Interpretation of commands and instructions.

(*viii*) Coordination and assignment of compilers, assemblers, utility programs and other software to the various users of the computer system.

(*ix*) Establishment of data security and integrity. That is, it keeps different programs, and data in such a manner that they do not interfered with each other. Moreover, it also protects itself from being destroyed by any user.

(*x*) Production of dumps, traces, errors messages and other debugging and error-detecting aids.

(*xi*) Maintenance of internal time clock and log of system usage for all user.

(*xii*) Facilitates easy communication between the computer system and the computer (human) operator

The most commonly used operating systems are:

(*i*) DOS (*ii*) WINDOWS

(*iii*) OS/ 2 (*iv*) UNIX

(*v*) LINUX

17.9.2 DOS. DOS stands for *Disk Operating System*, the most widely used operating system on personal computers. Several slightly different but compatible versions of DOS exist. The two most widely used, MS-DOS and PC-DOS were both originally developed by Microsoft Corporation in 1981.

MS-DOS is the text driven user interface, that is, the user types a line of text as a command. The computer then executes the command. These commands can be used to format disk, copy, and surname, delete backup files and organize and manage files on disk. MS-DOS versions 2.0 and up incorporated a tree structured hierarchical file management scheme. In this scheme, files can be managed into groups, which are known as directories. MS-DOS version 4.0 and above added additional enhanced commands and support for network and added a user interface called DOS shell with pull down menus. A ***shell*** program usually provides a limited graphic interface and certain utility functions file maintenance

17.10 APPLICATION SOFTWARE

Application software consist of programs that tell a computer how to produce information. When you think of the different ways that people uses computer in their careers or in their personal lives, your are thinking of examples of application software. Business, scientific, and educational programs are the examples of application software. The most widely used personal computer application softwares are:

(*i*) Word processing
(*ii*) Desktop publishing
(*iii*) Spreadsheet
(*iv*) Database
(*v*) Presentation graphics
(*vi*) Communications
(*vii*) Electronic mail
(*viii*) Personal information management
(*ix*) Project management

17.11 PROGRAMMING LANGUAGES

A programming language is a way of communication between the user and the computer. With the help of a programming language, programmer writes programs to solve problems with the computer.

Each programming language has its own rules for writing a computer program. The rules are called the *syntax* of the language. The process of writing a computer program is called *coding*.

17.11.1 Types of Programming Languages. Many computer programming languages are available. Some programming languages are close to human language and some programming languages are close to machine language. Therefore, programming languages are divided into two types:

(*i*) Low level languages
(*ii*) High level languages

Low Level Language. The programming language that are close to machine code are called Low Level Languages. The programs or instructions written in these languages are close to the machine language instructions. The mainly used low level languages are:

(*i*) ***Machine Language***. The instructions written in this language are in the form of binary strings of 0's and 1's. It is the fundamental language. The programs written in this language are executed directly by the computer.

(*ii*) ***Assembly Language***. It is similar to the machine language. In this language, symbolic codes are used instead of binary codes. The symbolic codes are also called mnemonic. The program written in this language is translated to machine code with the help of an assembler. This language is also known as *symbolic language*.

High Level Language. The programming languages that are close to human languages are called high level languages. The programs or instructions written in high level languages are close to English language. Each high level language has its own rules (syntax) and character set. Some of the commonly used high level languages are:

ALGOL: Algol stands for ALGOrithmic Language.
BASIC: Basic stands for Beginners All-purposes Symbolic Instruction Code.
COBOL: Cobol stands for Common Business Oriented Language.

PASCAL: This language is named in the honour of French mathematician Pascal, who invented the first mechanical calculator.

FORTRAN: Stands for FORmula TRANslation.

C: It is a general purpose language. It is widely used language in scientific and all other fields.

17.12 LANGUAGE PROCESSORS AND TRANSLATORS

The program that converts a source program, written in the programming, into the machine code, *i. e.*, in the form of strings of 0's and 1's is called language processor or translator. There are three types of language processors or translators:

(*i*) Assembler

(*ii*) Interpreter

(*iii*) Compiler

17.12.1 Assembler. An assembler translates a program written in an assembly language into machine code.

17.12.2 Interpreter. The language processors that execute a source program by translating and executing one instruction at a time are called interpreters.

17.12.3 Compiler. A compiler is a translator that coverts a program written in a high-level language.

17.13 BASIC IDEA OF WRITING AND RUNNING A COMPUTER PROGRAM

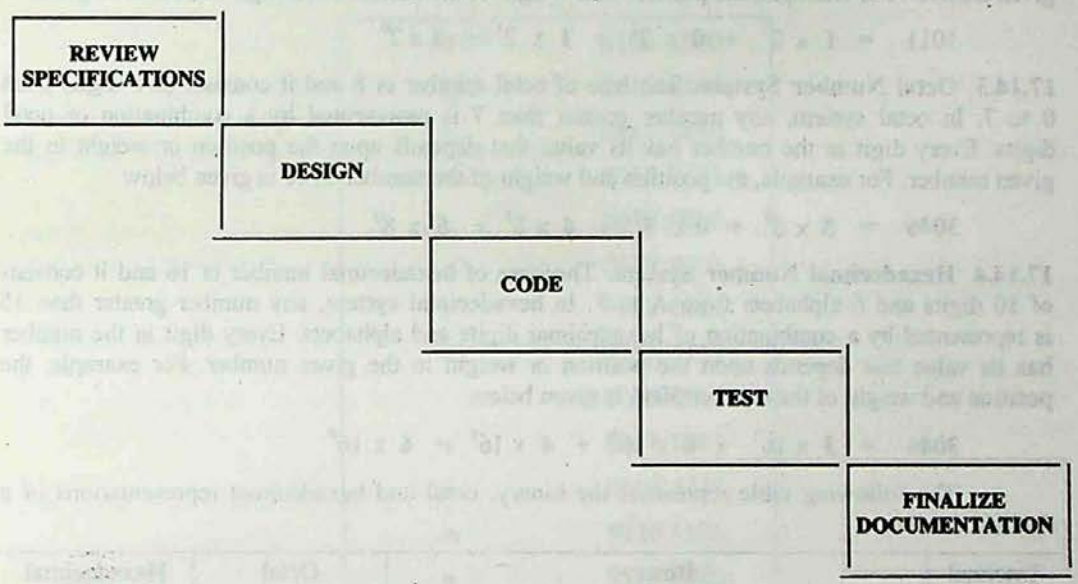
17.13.1 Computer Program. The *computer program* is a detailed set of instructions that directs a computer to perform the tasks necessary to process data into information. These instructions usually written by computer programmer, can be coded (written) in a variety of programming languages. A computer program is also known as software.

17.13.2 Computer Program Development. The program development is a process of producing one or more programs to perform specific tasks on a computer. The process of program development has evolved into a series of five steps most experts agree, should take place when any program is developed

1. ***Review specification.*** The programmer reviews the specification created by system analyst during the system design phase.
2. ***Design.*** The programmer determines and documents the specific action the computer will take to accomplish the desired tasks.

3. ***Code.*** The programmer writes the actual program instructions.
4. ***Test.*** The written programs are tested to make sure they perform as intended.
5. ***Finalize documentation.*** Throughout the program development process, the programmer documents, or writes, explanatory information about program steps 1 through 4 is brought together and organized.

Five Steps of Program Development



17.14 NUMBER SYSTEM

A set of digits, symbols and rules used to express quantities for counting, comparing amount, performing calculations, making measurements, representing values, *etc.* is called number system. A number system is named after the base of the system. The total number of digits in a number system is called its base. The most commonly used number systems are:

1. Decimal Number System.
2. Binary Number System.
3. Octal Number System.
4. Hexadecimal Number System.

The most common number system is the decimal number system. It is used in normal every day life. High level computer language nowadays use only decimal number system. Earlier programming languages required writing of long strings of numeric digits. Different number systems were used as shortcut for writing these strings. These number systems are no longer in use. However, their knowledge is necessary for understanding data representation inside the computer.

17.14.1 Decimal Number System. The base of decimal number is 10 and it consists of 10 digits from 0 to 9. In decimal system, any number greater than 9 is represented by a combination of decimal digits. Every digit in the number has its value that depends upon the

position or weight in the given number. For example, the position and weight of the number 3046 is given below

$$3046 = 3 \times 10^3 + 0 \times 10^2 + 4 \times 10^1 + 6 \times 10^0$$

17.14.2 Binary Number System. The base of binary number is 2 and it consists of 2 digits 0 and 1. In binary system, any number greater than 1 is represented by a combination of binary digits. Every digit in the number has its value that depends upon the position or weight in the given number. For example, the position and weight of the number 1011 is given below

$$1011 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

17.14.3 Octal Number System. The base of octal number is 8 and it consists of 8 digits from 0 to 7. In octal system, any number greater than 7 is represented by a combination of octal digits. Every digit in the number has its value that depends upon the position or weight in the given number. For example, the position and weight of the number 3046 is given below

$$3046 = 3 \times 8^3 + 0 \times 8^2 + 4 \times 8^1 + 6 \times 8^0$$

17.14.4 Hexadecimal Number System. The base of hexadecimal number is 16 and it consists of 10 digits and 6 alphabets from A to F. In hexadecimal system, any number greater than 15 is represented by a combination of hexadecimal digits and alphabets. Every digit in the number has its value that depends upon the position or weight in the given number. For example, the position and weight of the number 3046 is given below

$$3046 = 3 \times 16^3 + 0 \times 16^2 + 4 \times 16^1 + 6 \times 16^0$$

The following table represents the binary, octal and hexadecimal representations of a decimal number.

Decimal numbers	Binary representation		Octal representation	Hexadecimal representation
0	0000		00	0
1	0001		01	1
2	0010	one 2, no units	02	2
3	0011		03	3
4	0100		04	4
5	0101	one 4, no twos, one unit	05	5
6	0110		06	6
7	0111		07	7
8	1000		10	8
9	1001	one 8, no fours, no twos, one unit	11	9
10	1010		12	A
11	1011		13	B
12	1100		14	C
13	1101		15	D
14	1110		16	E
15	1111		17	F
16	10000	one 16, no eight, no fours, no twos, no unit	20	10

17.15 HOW COMPUTERS REPRESENT DATA

To a computer, every thing is a number. Numbers are numbers; letter a punctuation marks are numbers; sounds and pictures are numbers. Even computer's own instructions are numbers. When you see letters of the alphabet on a computer screen, you are seeing just one of the computer's ways of representing numbers. For example, consider this sentence: ***Here are some words.*** It may look like a string of alphabet characters to you, but to a computer it look the string of ones and zeros shown in the following table

H	0100 1000
e	0110 0101
r	0111 0010
e	0110 0101
	0010 0000
a	0110 0001
r	0111 0010
e	0110 0101
	0010 0000
s	0111 0011
o	0110 1111
m	0110 1101
e	0110 0101
	0010 0000
w	0111 0111
o	0110 1111
r	0111 0010
d	0110 0100
s	0111 0011

17.16 BINARY SYSTEM AS A FOUNDATION OF COMPUTER PROGRAMMING

In computer, however, all the data is represented by the state of the computer's electrical switches. A switch has only two possible states "on" and "off" so it can represent only two numeric values. To a computer when a switch is off, it represents a 0; when a switch is on, it represents a 1. Because there are only two values, computer are said to function in base 2, which is also known as binary number system (*bi* means " 2 " in Latin). Why we go for binary numbers instead of decimal numbers? The reasons are as fellows:

1. The first and foremost reason is that electronic and electrical components, by their very nature, operate in binary mode. Information is handled in the computer by electronic / electrical components such as transistors, semiconductors, wires, *etc.*, all of which can

only indicate two states or conditions on (1) or off (0). Transistors are either conducting (1) or non-conducting (0); magnetic materials are either magnetized (1) or non-magnetized (0) in one direction or in the opposite direction; a pulse or voltage is present (1) or not present (0) in wire. All information is represented within the computer by presence or absence of these various signals. The binary number system, which has only two digits (0 and 1), is the most suitable and conveniently used to express the two possible states.

2. The second reason is that computer circuits only have to handle two binary digits rather than ten decimal digits. The result is that the internal circuit design of computers is simplified to great extent. This ultimately results in less expensive and more reliable circuits for computers.

3. Finally, the binary number system is used because everything that can be done with base of 10 can also be done in binary.

The reason why the octal number system is used with computers is because it can represent binary values in a more compact form and because the conversation between the binary and the octal number system is very efficient.

The primary reason why the hexadecimal number systems is used with computers is because it can represent binary values in a more compact form and because the conversation between the binary and the hexadecimal number system is most efficient. An eight-digit binary number can be represented by a two-digit hexadecimal number

Exercise 17.1

1. (*a*) How are computers generally classified? What are the four major categories of computers?

   (*b*) What is CPU? Why is it called the brain of the computer?

2. (*a*) Explain the working of Arithmetic Logical Unit (ALU).

   (*a*) Explain the Control Unit.

   (*c*) What is secondary storage? How it differ from a primary storage?

3. (*a*) Describe the various input and output devices with examples.

4. (*a*) What is computers software?

   (*b*) What are the functions of a system software?

5. (*a*) What do you know about DOS?

   (*b*) What does application software do and what are its generic types?

6. (*a*) What are computer languages and their types?

   (*b*) What is an assembler?

   (*c*) What is a compiler?

7. (*a*) What is Binary Number System? Why is it used in computer?.

◆

Exercise 17.2
Objective Questions

1. Fill in the blanks.

(*i*) ———— is commonly used input device. (*keyboard*)

(*ii*) 1 MB equals ———— bytes. (1,048,576)

(*iii*) Screen output is considered as a ————. (softcopy)

(*iv*) CD-ROM is a type of ————. (Optical disk)

(*v*) ———— is a set of electronic instructions. (Software)

(*vi*) The most common type of computer memory is called ————. (RAM)

(*vii*) A high speed memory that is built into the processor is called ————. (cache memory)

(*viii*) RAM is called ———— storage. (primary)

(*xi*) Arithmetic operations are carried out by ———— unit (ALU)

(*x*) The ———— is the TV type screen that you view your programs on. (monitor)

(*xi*) The ———— allow you to type information into the computer (keyboard)

(*xii*) Keyboard, mouse, scanner are the ———— devices (input)

2. Mark off the following statements as true or false.

(*i*) 1 Kb = 1000 bytes. (true)

(*ii*) Plotter is an input device to draw the graphs of the output (false)

(*iii*) A complete computer system has two parts: hardware and software. (true)

(*iv*) The keyboard and monitor are examples of output devices. (false)

(*v*) UNIX is a application software (false)

(*vi*) The purpose of a storage device is to hold data (true)

(*vii*) Base 2 is another name for the decimal number system (false)

(*viii*) A CD-ROM is an example of a magnetic storage device (false)

(*ix*) A hard disk may also be referred to as secondary storage device. (true)

(*x*) The central processing unit (CPU) contains a Control Unit that performs arithmetic and logic operations. (false)

(*xi*) All computers work on a binary number system (true)

(*xii*) FORTRAN is a low-level language (false)