CHAPTER 1

CONCEPTS AND COMPUTER FUNDAMENTALS

1.1 Introduction

The extraordinary development of information technology during the past few decades has changed the way business is done in the real world. In the early years of IT development, very few big corporate houses were capable of buying computers and using them because they were very costly and their implementation required a unlimited technical and professional skills and aptitude to operate them. Nowadays the situation is reversed: computer systems, which were costly, have become affordable even for a middle-class family. Large computer systems have been reduced in size and only require a small amount of desktop space.

Previously, computer programming and operations required hard work, time, and professional help to learn, but today, thanks to the invention of the graphical user interface (GUI), users can easily operate any software. With the introduction of wireless technology, the utility of a computer system has been further enhanced as wiring requirements have been significantly reduced and with the availability of the laptop, it is possible to carry a system from one place to another. During transit it is very easy for the user to communicate with their clients and complete pending work.

Introduction of low-cost computer systems and a lower-cost Internet has helped in the prevalence of computer systems in a wider section of society. In the present era, information technology has the potential to influence the lives of ordinary citizens as much as it influences business, education, and government. The high penetration of smartphones, computers,

and the Internet, is changing the lives of people across the globe. The information superhighway (bringing IT, entertainment, and the communication industry onto one platform), which was a concept in the nineties is now a reality because of the availability of smartphones. Today, a PC is no more considered a device to be used by only IT professionals, rather it's considered essential to a household.

1.2 Data, Processing, and Information

Data: Data can be defined as *a collection of raw facts and figures which in itself has no meaning.* Take for example, "10, 15." The 10 and 15 can be two numbers, two weights, two distances, the height of any two persons or they can be the measurement of any two liquids. Thus, one can say that data has no meaning unless and until it has been given a shape of some meaningful result.

Processing: Processing is done on raw data which gives it a meaningful form. In a computer, four types of processing activities can be performed. They are:

Calculation	This includes addition, subtraction, multiplication, and division
Comparison	This includes comparisons like >, >=, <, <=, <> etc.
Decision Making	This includes making decisions on a basis of a condition
Logical Branching	This means, based on the decision made, jumping from one part of the computer program to another

Information: Information can be defined as the processed data that has meaning.

For example: Add the numbers 10 and 15.

In this example the data is the numbers 10 and 15. Processing is the addition of these two numbers; and the information is 25, which is the result of this addition.

Can We Say Data and Information Are Interchangeable?

Yes, data and information are interchangeable. What is considered information in one instance may be considered data in another. For example, the grades of all the students in a class in all subject areas are *data*. When these

grades are calculated to find out a percentage, the percentage marks are the *information*. But when a teacher is willing to find out the percentage result of his class, all the individual percentage marks of all the students is called *data*. When the teacher adds these percentage marks of all the students and divides them by the total number of students, the obtained result is *information*, such as a class percentage.

Why There Is a Need for Data and Information

In today's world, business organizations are facing cut-throat competition in the marketplace. It has become very difficult to survive and to secure the relevant market share; it is becoming harder to *maintain* the market and the market share. Only proper access to data and the information generated from that data can help business organizations make quick and relevant decisions. These decisions not only help business organizations in retaining their market shares, but they also help in keeping track of their competitors' activities in the marketplace.

In today's business organizations, data and information are no longer treated as mere tools for conducting business, rather they are considered important assets, which help them in making proper and timely decisions at various levels of management. For example, decision support systems at the middle level of management, and executive support systems at the top levels of management which processe data to generate information.

1.3 Defining The Computer System

A *computer system* can be defined as an electronic device and thus has two states, one when current flows in circuits, represented as "ON" and second, when current *does not* flow in circuits, represented as "OFF." These two states in a computer system are represented by a binary number system which consists of two digits: "1" and "0." The "ON" state is represented by "1" and the "OFF" state is represented by "0." A computer system performs four tasks for the user as follows:

- It accepts data.
- It stores the data.
- It does the processing.
- It gives the output or result to the user.

A computer system accepts data in the form of alpha numeric characters for example 2A/127 Govind Nagar Agra-282004, or in numeric digits for example 100, 250, 6285 or in alphabetic form, for example "Robert Smith."

A computer system can also be called an information processing system because it:

- manages voluminous data perfectly,
- provides confirmation of the validity of data and transaction.
- performs the complex processing of data and multidimensional analysis,
- helps in quick search and retrieval of related data,
- provides mass storage,
- provides timely information to the user, and
- it is adaptable, as per changing needs of individual users and corporations.

A railway reservation system is a perfect example of this, as it handles millions of reservations daily, and checks for the data entered such as the correct train name, date, gender of customer, etc. It processes thousands of reservations across the country simultaneously, searches the status of millions of tickets in virtually no time, and provides the latest updates to travelers, thus providing all the information required by users.

1.4 Computer Classification

A computer system can be classified into the following types:

On Purpose Basis: On the basis of *purpose*, computers can be classified as:

- **General Purpose Computers:** Computers that perform regular work such as data analysis, accounting, generating bills and receivables, billing payables, stock management, etc. Computers used in offices for commercial, educational, and other applications are included in this category.
- **Special Purpose Computers:** Computers that perform special tasks such as weather forecasting, space applications, medical diagnostics, etc.

On Technology Basis: On the basis of the *technology*, a computer system can be grouped into three categories:

- **Analog Computers:** Analog computers are those computers that measure quantities such as current, voltage, frequency, pressure, temperature, speed, etc.; and convert them into their numeric equivalent. For example:
  - A thermometer that measures the rise in mercury level and converts it into its numeric equivalent.
  - Machine gasoline pump that measures the flow of liquid and converts it into its numeric equivalent.
- **Digital Computers:** Digital computers are those computers in which all the processing is done in binary digits (0's and 1's).
- **Hybrid Computers:** Hybrid computers are those computers which process analog signals and convert them into digital signals and vice-versa. Hybrid computers are mainly used in artificial intelligence (robotics) and computer-aided manufacturing (e.g., process control).

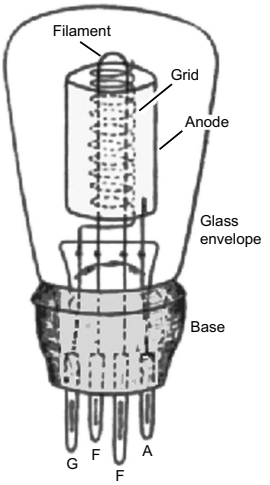
On the Basis of Memory Size and Capacity: According to the size and *memory/storage capacity*, there are four types of computers:

- **Microcomputer:** Microcomputers are also known as desktop PCs or personal computers and serve a single user at any given time. They are also known as "stand-alone systems" and consist of a main chip called a microprocessor. A microprocessor is a chip that consists of an arithmetic and logic unit (ALU) and a control unit (CU). A company called INTEL makes microprocessor chips. The extended technology of "(XT)" PCs have various versions of the microprocessors with names like 8086, 8087, 8088. The advanced technology of "(AT)" PCs include versions 80486, P1, P2, P3, and P4. The P# series is known as the Pentium series. As of today, the line-up of INTEL Core processors include the Intel Core i9, Intel Core i7, Intel Core i5, and Intel Core i3, along with the Y-Series Intel Core CPUs.
- **Minicomputers:** Minicomputers serve multiple users at the same time and are general-purpose systems. They have more processing power and are more expensive than the microcomputers. Unlike microcomputers, minicomputers have a single central processing unit (CPU) and have various terminals attached. A terminal consists of a monitor, keyboard, mouse, and sometimes a printer. For example, see the IBM 9375, PDP-1.

- **Mainframe:** Mainframe systems can support thousands of users at a time. They are similar to minicomputers but with greater storage and processing capabilities. Identifying numbers of terminals supported by a mainframe are much higher in comparison to the minicomputers. For example, the IBM system/370, IBM 4300 series are mainframe systems.
- **Supercomputers:** Supercomputers are designed to process complex scientific applications and are the most powerful and the most expensive computers. They are based on the principle of parallel processing which is also known as a "Non_Von Neumann Design." In parallel processing there is one main processor and to it are attached various coprocessors and all work simultaneously. Main usages of supercomputers are in the field of climate forecasting, petroleum exploration, nuclear energy research, defense, etc. For example, CRAY-3, CRAY-2, ETA-10, PARAM are supercomputers.

On the basis of the generations of a computer: On the basis of *development*, a computer can be classified into the following generations:

- **First Generation (1940-1956):** First-generation computers were built before the 1960s. These computers used thermionic valves or vacuum tubes for the purpose of making circuits. These computers were not reliable as they consumed large amounts of electricity, and the vacuum tubes that were used in these computers generated a enormous amounts of heat causing frequent breakdowns. They used magnetic drums for memory. Some examples of first-generation computers are the UNIVAC and the ENIAC.



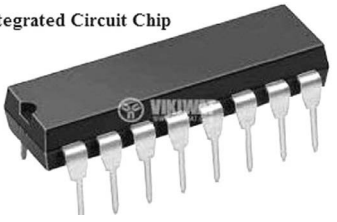
Thermionic Valve/Vacuum Tube

- **Second Generation (1956-1963):** In the second generation of computers, thermionic valve/vacuum tubes were replaced by transistor technology. The development of the transistor technology helped in the development of a smaller, faster, and more reliable computer system. This development also resulted in the improved efficiency and storage capacity of a computer system. It was this development that made the computer system more popular and reduced the prices. Assembly language replaced the binary language during this period.

Transistor

- **Third Generation (1964-1971):** Individual components were interconnected in the first and second generation of computers to form the circuits, but with the introduction of integration technology it became possible to have more than one circuit packed into a single integrated circuit container known as an "IC Chip." This development reduced the size of the computer significantly and increased the data storage and processing capabilities to an enormous level. Punched cards were replaced by keyboards in the third-generation computer as an input device.

Integrated Circuit Chip



- **Fourth Generation (1971-present):** Development of *large-scale integration* (LSI), and *very large-scale integration* (VLSI), further reduced the size of computers and increased the processing speed and storage capabilities. This development made it possible to have thousands of integrated circuits built onto a single silicon chip.

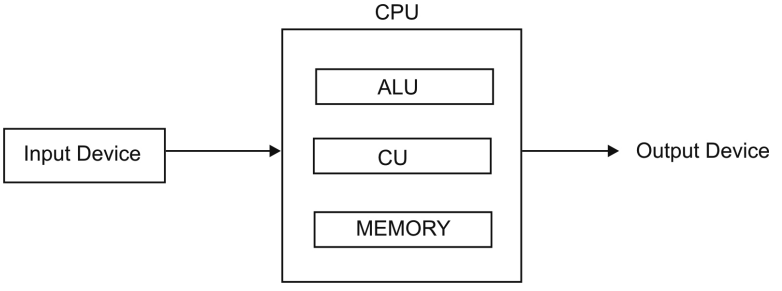
VLSI- Chip

- **Fifth Generation (Artificial Intelligence):** Development of *ultra large-scale* integration (ULSI), led to the dramatic reduction in the size of computers, and increased the processing capabilities of a system beyond imagination. With this technological development, computers

were now capable of supporting a very large storage-capacity hard-disk, optic disk, multimedia, and Internet capability, etc. Parallel processing is now helping to make artificial intelligence a reality.

ULSI- Chip

1.5 Block Diagram



Block Diagram

Data in a computer system is entered with the help of an input device. Once the data reaches the central processing unit, the control unit directs the data into the memory. This means as soon as data is entered in the computer system, it first gets stored in the random access memory (RAM), or primary memory of the system. When a command is given to a system for processing, the data from the memory is transferred to the arithmetic and logical unit for processing. Processing generates the result, which is again directed by the control unit to the memory of a system. Once an instruction is issued to produce the output, this result from the memory is directed to an output device by the control unit. Let us understand this with an example.

```
10 Let A = 15
20 Let B = 25
30 Let C = A + B
40 Print C
50 End
```

As soon as the variables A and B are assigned a value of 15 and 25, a memory location with a name A and B will be opened in the RAM of the system with values of 15 and 25 stored in it. The next instruction is C = A + B. Now the data from the RAM will be transferred to the ALU for processing and the result (which is 15 + 25 = 40) will be stored in another location "C" in the RAM of the system. The next instruction is "print C," the control unit will read the value of the location C in the RAM and will display that on the monitor of the computer system. The command "End" will tell the computer that program is over.

Various devices of a computer system form a BLOCK DIAGRAM:

- **Input Device:** The input devices are used to enter data and instructions into a computer system. These devices act as a linking point for the external environment of a computer system to its internal environment. These input devices accept the data in English or any other language from the user and then convert the data entered by the user into the machine code, which a computer can understand. The most commonly used input device is the keyboard.
- **Central Processing Unit:** The central processing unit (CPU) is also termed the brain of a computer system. As in humans, the brain controls all of the activities; similarly in a computer system, it is the CPU that controls all of the processing functions. It has the following main parts:
  - **Arithmetic and Logic Unit:** The arithmetic and logic unit (ALU) is a place where all the functions are performed. The ALU not only executes the mathematical calculations, but it also performs the logical comparison and decision making. Logical comparison and decision making are the functions that make a computer system different from a calculator.

  - **Control Unit:** The control unit (CU) acts as a supervisor of the system. It is the responsibility of the CU to synchronize and coordinate all the activities performed by a computer system. The CU acts as a traffic policeman and directs the transfer of data from one part of the CPU to another and vice versa.

- **Memory:** Memory, which stays inside a central processing unit, is known as a primary memory. It is in the form of a silicon chip in which data is stored in the form of electronic pulses. The presence of current is shown as "1" and absence of current is shown as "0." Data in this memory is stored in the form of 0's and 1's.
- **Output Device:** After processing the data, the result is generated and it is directed to a device called an "*output device*." This device may be a monitor (visual display unit) or a printer attached to a computer system, or a hard disk, an optical disk, etc.

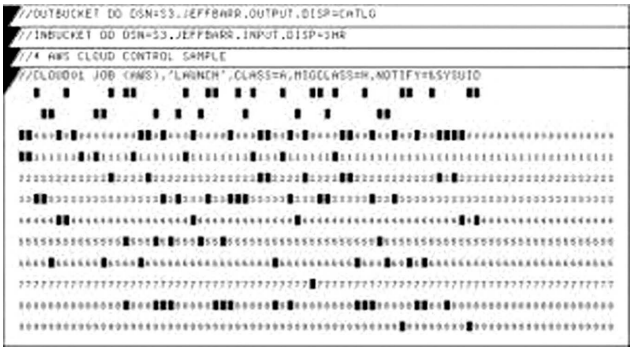
1.6 Hardware Versus Software

All the physical components of a computer system that a user can touch are termed as the *hardware* of a computer system, for example, the keyboard, the monitor, CPU, mouse, the printer, etc. However, *software* is that part of a computer system that we cannot touch and we can only see, such as an Internet browser, Microsoft Office, etc. Software can be defined as the program that instructs a computer how to process the data and generate required output.

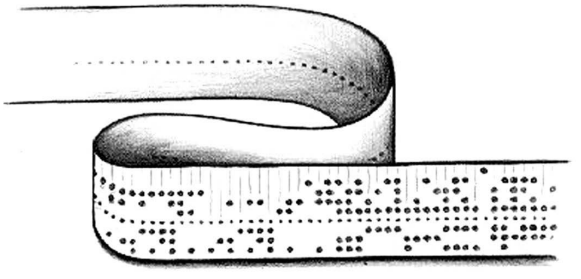
1.7 Input Devices

Input devices are used to enter data into a computer system. Much development has taken place in input devices. In the first generation of computers, expert knowledge was required to punch data into a computer system, but now input devices give great ease to the user while they enter data into a system. The various kinds of input devices used with a computer system evolved as follows:

- **Punched Card:** In a punched card, information is punched as holes. They consist of 80 columns and each column consists of 12 positions, which can be punched. They are inexpensive, but expert knowledge is required to work with punched cards and it is very difficult for a common user to maintain and control them.

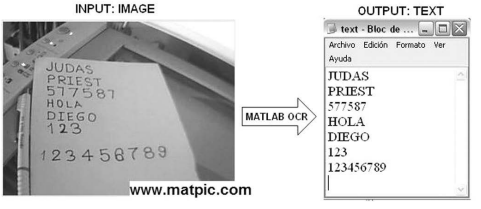


- **Paper Tape:** Paper tape and punched card work on the same concept. The difference is that a paper tape is a continuous strip of paper, whereas a punched card is in the form of a small card. Characters are formed in a paper tape using a code, which consists of circular holes made across the width of the tape.



- **Optical Mark Reader:** Every competitive examination makes use of an *optical mark reader* (OMR) sheet. In OMR, marks (in the form of an oval or a circle) are made with the help of a pencil or a pen. Evaluation is done by throwing a light on the OMR sheet and the reflected pattern is matched with the correct pattern, which is already available in the system.

- **Optical Character Reader:** OMRs were only able to detect the presence or the absence of the marks, and this drawback of OMR was removed with the development of the *optical character reader* (OCR). An OCR is able to identify any character. OCRs read each character with the help of a photoelectric device that determines the outline and shape. The shape is read and then compared with a shape that is already stored in the system. OCR is advantageous as the sheet can be read directly by a reader, and the input goes straight into the computer system for processing.



- **Magnetic Ink Character Recognitions (MICR):** MICR is used mainly by banks. Using this method, the documents with characters marked with ink are passed through a magnetic field where the ink-coded characters magnetize the reader's head due to the magnetic ink. MICR helps in the faster processing of the instrument.

- **Bar Code:** A bar code consists of a series of black bars and white spaces in between those black bars. The bars are of varying widths, and they are printed on labels to uniquely identify items. The bar code labels are read with a scanner, which measures reflected light and interprets the code into numbers and letters that are passed onto a computer. These codes are specific codes, some of the more common being the Universal Product Code (UPC) and European Article Number (EAN). Bar codes are especially used in labeling numerous consumer products and books.

- **Keyboards:** Keyboards resemble a typewriter and are the most widely used input devices. They consist of keys that represent digits, alphabets, and special symbols. They also have function keys from F1 to F12, the use of which varies depending on the software being used. Most companies use a keyboard with 104 keys.

- **Mouse:** The drawback of earlier input devices (movement restriction) were removed with the introduction of the *mouse*. With the use of GUI, there arises a need for an input device that can help with the inputting of data by selecting an option on the desktop. With the help of a mouse it became possible for a computer user to have a 360-degree rotation facility on the screen, which was otherwise not possible. A mouse comes in two varieties: One includes a tracking ball that generates the signal to move a pointer on the screen, and the other is an optical mouse that senses the movement and moves the pointer on the screen.

- **Speech Synthesizer:** In a speech synthesizer data is entered in a system in the form of a human voice with the help of a microphone. The system converts this data into electronic signals. These signals are then matched with patterns that are already available in a computer system. One problem faced by the speech synthesizer is that if one changes the way one speaks, the computer may not recognize the pattern of the input voice.
- **Scanner:** Scanners are handheld devices, and are used to scan complicated diagrams, pictures, and graphics that are otherwise difficult to draw with the help of other input devices. Flatbed scanners are now easily available and are very easy to operate and can also scan large pictures. Nowadays, printers with inbuilt scanners are also available. An example of a scanner is the HP M1005 all-in-one printer.

- **Light Pen:** A light pen has a photocell at its tip. It is moved on the screen and to touch the required option. The light pen senses the light coming out from that option and executes the file behind that option. The light pen is mainly used for the graphical work and in computer-aided designing (CAD). Light pens are widely used during football telecasts, during which the commentators draw free-hand lines on the TV screen.

- **Touch Screen:** Invention of the touch screen has been considered a revolution in the field of input devices. Touch screens are extensively used in smartphones, ATMs, railway enquiry systems, and many other places. They are very easy to operate. Users just need to touch the option they want to select. Touching the option breaks the light beam emitted, and thus the position of the option is recorded and the program behind that option is executed.

1.8 Output Devices

These devices show the *output* of the processing of a program. A computer can generate two kinds of outputs, one known as *soft copy* and is in the form of a computer file, which can be either stored in any storage device or displayed on the monitor of a system. The second is in the form of a *hard copy*, also known as a computer printout. Various types of output devices are as follows:

- **Printers:** Printers are used to produce hard copy of output and are divided into two categories, one is an *impact printer* and second is a *nonimpact printer*:

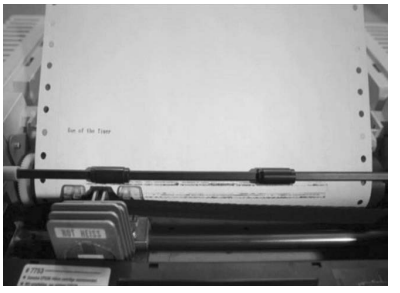
  - **Impact Printers:** Impact printers work similar to a typewriter. In a typewriter, characters are formed on the paper when an arm with a character embossed strikes the ribbon and forms the impression; similarly in an impact printer there is a head that consists of a number of pins (usually nine or twenty-four) that strikes the ribbon, which in

turn forms the impression of a character on the paper. Impact printers are also called *dot matrix* printers. Dot matrix printers can be divided into following categories:

– **Character Printers** are printers that print single characters one at a time from left to right, and then from right to left.

– **Line Printers** are printers that print a complete line at a time from left to right, and then from right to left.

– **Page Printers** are printers that print a full page at a time.



- **Nonimpact Printers:** These printers never touch the paper. They form the image of a character on the paper with the help of heat or a laser. Nonimpact printers can be divided into the following categories:
  - **Thermal Printers:** They work on the concept of heat. The papers, which are sensitive to heat, are used and characters are formed in dotted form. Some drawbacks of this printer are that a special kind of a paper is required, and they cannot print multiple copies at a time.
  - **Laser Printers:** Laser technology is used by these printers for the purpose of printing. The laser beam charges the drum on which the ink powder (called toner) is thrown and gets deposited on the characters formed on the drum. When the paper rotates on the drum, these characters are printed on the paper. The initial cost of a laser printer is high, but the per page printing cost is comparatively low.
  - **Inkjet Printer:** Inkjet printers are low in cost in comparison to the laser printer, but the cost of printing is more. This printer uses the

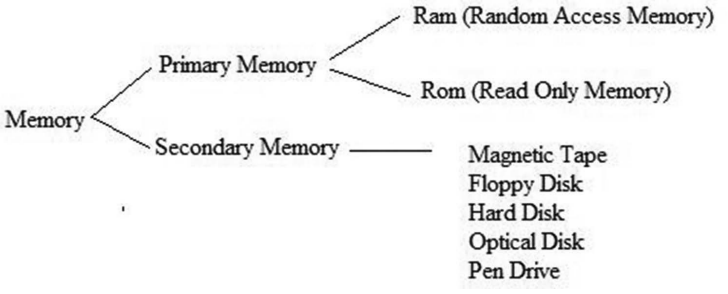
electric field and throws the ink from the nozzles on the paper. The paper absorbs the ink and forms the characters.

- **Plotters:** Plotters consist of an arm that can rotate 360 degrees and can print. Plotters are used mainly for the printing of technical designs used in computer-aided designing (CAD) or in computer-aided manufacturing (CAM).

- **Monitor (Visual Display Unit):** A monitor resembles a TV screen and is used for showing output.

1.9 Computer Memory

Memory is a place where the data and the instructions are stored in a computer system. The memory of a computer system can be divided into two categories: *primary memory* and *secondary memory*.



Primary Memory: Primary memory is the memory that is found inside a computer system. Data in the primary memory is stored in the form of electronic charges, and that is why this memory is temporary in nature. The moment the computer is switched off, data written in primary memory will be wiped out. The measurement unit of the memory is bits and bytes and can be defined as follows:

A Bit = 0 or 1

A Byte = any combination of 8 bits.

1024 Bytes = 1 Kilo Byte (KB)

1024 Kilo Bytes = 1 Mega Byte (MB)

1024 Mega Bytes = 1 Giga Byte (GB)

1024 Giga Bytes = 1 Tera Byte (TB)

In a computer system one character needs one byte of memory space for the purpose of storage. For example, if one wants to store "RED" in a

computer system, then one needs three bytes of memory space. Primary memory can be further divided into two categories.

ROM: ROM stands for "*Read Only Memory*," and as the name suggests in ROM we can only read. We can neither write nor erase whatever is written in a ROM chip. A ROM chip is required to execute instructions, which are very frequently executed by a computer system. Because of this, these programs and instructions cannot be stored in RAM as it is volatile in nature; hence these are permanently stored in a ROM chip and are placed inside the CPU. The program, which is usually stored in a ROM chip, is the part of the operating system called the *basic input-output system* (BIOS program). It starts as soon as the computer is switched on and makes the computer ready to load the rest of the operating system in the memory of a computer so it is ready to work.

ROM has a few variants as follows:

- **PROM** is known as *programmable read-only memory* in which data can be written once and then it cannot be altered. PROM is sold as empty, and can then be filled with a program by the user. Once filled with the program, the contents of PROM cannot be removed.
- **EPROM** is known as *erasable programmable read-only memory* in which data can be rewritten many times, and for this purpose the EPROM chip has to be removed from the CPU and exposed to ultraviolet rays so that new data can be written onto it.
- **EEPROM** is known as *electrically erasable programmable read-only memory* that can be reprogrammed using special electronic pulses a number of times without removing it from the CPU.

RAM stands for *random access memory*, and as the name suggests in RAM we can read, we can write, and we can erase whatever is written into it. RAM is also known as read/write memory because data can be read from a ram chip and can also be written onto it. It is a volatile memory, and as soon as the computer is switched off the data written in the RAM is wiped out. Various types of RAM on a PC are:

- **DRAM (*Dynamic RAM*):** It needs to be refreshed periodically by the CPU so that the data contained in them is not lost.
- **SRAM (*Static RAM*):** In it data contained remains stored properly; therefore it does not need to be refreshed by the CPU. This type of RAM has a higher speed than DRAM and is costly, too.

- **EDO RAM (*Extended Data-out RAM*):** It is basically used in the Pentium systems and is suitable for having bus with speeds up to 66 MHz.
- **SDRAM (*Synchronous Dynamic RAM*):** It can be considered as an extension of DRAM, but has a higher speed than DRAM. It is suitable for a system bus with speeds up to 100 MHz.
- **RDRAM (*Rambus Dynamic RAM*):** is a type of memory that is faster and more expensive than SDRAM. This memory is used on systems that use the Pentium 4.

Secondary Memory: *Secondary memory* is a permanent memory and remains outside a computer system. In this memory data is stored in the form of magnetic particles on hard disk, floppy disk, magnetic tape, and in the form of pits on the optical disk.

1.10 Storage Devices: DASD/ SASD (Direct Access Storage Devices/Sequential Access Storage Devices)

Storage devices are referred to by a variety of names such as auxiliary storage, auxiliary memory, secondary storage, and backup storage. They are capable of storing large amounts of data. They are used as an online extension to the main memory; and are also used for offline storage of programs and data.

Differences between DASD and SASD

The workings of *direct access storage devices* (DASD) and *sequential access storage devices* (SASD) can be understood as follows:

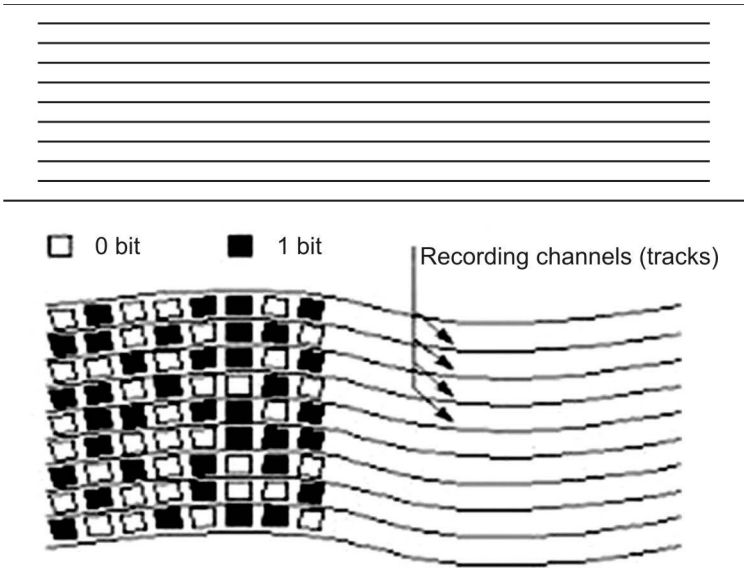
DASD: These devices allow the user to access any record directly. Examples of these types of devices are floppy, CD, DVD, hard disk, etc.

SASD: These devices do not allow the user to access any record directly. For example, if a user needs to read and record the number 50, they have to first bypass record 49, only after that they would be able to read the desired record. It works like a cassette of a tape recorder. An example of this type of device is *magnetic tape*.

Various storage devices are described in the following sections.

1.10.1 Magnetic Tape

Magnetic tape was used as offline storage for large amounts of data because it is inexpensive.



A magnetic tape is similar to an audio tape. A metal foil called a marker indicates the beginning of the tape. Data is stored one character at a time; either 7 or 9 bits format is used for each character and they are recorded in parallel across the width of the tape. Data on the tape is saved in the form of records separated by a gap called *inter record gap* (IRG). The tape always remains in motion and is only stopped when a record gap comes below the read/write heads. The tape motion is stopped only when the read data is to be transferred to the memory of the system. During the time the tape is transferring the data into the memory any further reading process is not completed. So the IRG is given to allow the tape to attain its normal speed before the beginning of next record is reached. A group of related records is called a file, and a file marker identifies the beginning of the file. It is a specially coded record preceded by a gap longer than the record gap. The first record following the file mark may be used as a header or identifier for this file, and the last record may be used as a trailer or end for this file.

*		Record		Record		Record		*
*		d	IRG	d	IRG	d		*
*		1		2		3		*

In the nine tracks format a set of nine heads are mounted to read/write information on tape. Each head operates independently and stores information along one track of the tape. While eight tracks are used to record a byte of data, the ninth track is used to record a parity bit for each byte. The parity bit checks if the data has been read/written accurately or not. The recording density is measured in bits per inch, that is, bits per track of the tape. For example on one inch of a 9-track tape having a recording density of 1600 bits per inch the total number of bits stored is = 1600*9 = 14,400 bits. The tape travels at a speed of 100 inches per second, and during the time the tape takes to accelerate to its full speed, no recording takes place.

If the record size is of lesser length than the block fixed for it, the rest of the block is left blank. Because of this a lot of space is wasted. To reduce this gap on tape, records can be blocked together and in place of *inter-record gap* (IGR) we will have *inter-block gap* (IGB). For example, in a blocking factor of 3, three records per unit are recorded.

*		Record		Record			*
*		1, 2, 3	IBG	4, 5, 6	IBG		*
*							*

1.10.2 Floppy Disk

Mylar plastic coated with magnetic oxide is used for making a floppy. This flexible material is cut into circular pieces of 5.25 inches or 3.5 inches in diameter. Because of the flexible material used during production, they are called *floppy disks*. These were small, low in cost, and could be very conveniently carried from one place to another. In a floppy disk, data is stored in the form of magnetic particles on the tracks. A hub in the center is used for mounting the disk into the disk drive. Because there is a long slit in a floppy provided for the read/write head to access the data, there are many chances of the disk becoming unusable because of its exposure to dust, scratches, etc. Data could easily be stored and retrieved with the help of the floppy disk. The floppy disk had a longer life in comparison to magnetic tape, but the data is less secure.

For a standard IBM formatted double-sided, high-density 5.25 inch floppy diskette, the following properties applied:

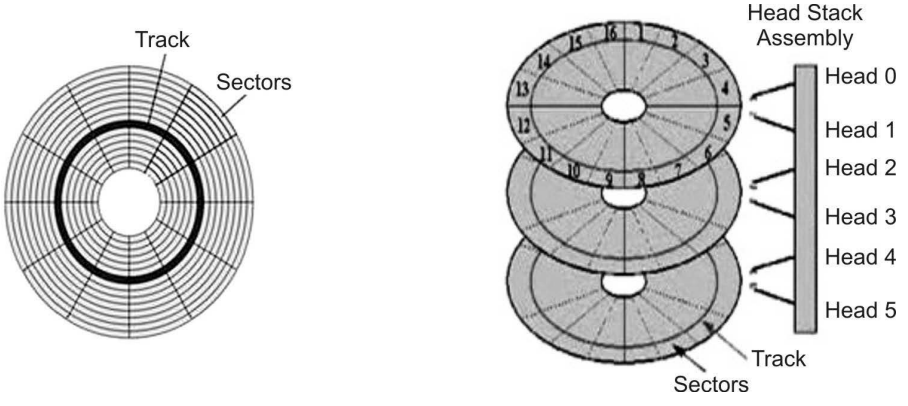
- Data is recorded on two sides of the disk
- Single-sided, 9 sectors/track: 180 KB
- Double-sided: 360 KB
- High-Density (HD): 1.2 MB

For a standard IBM formatted double-sided, high-density 3.25-inch floppy diskette, the following properties applied:

- Data is recorded on two sides of the disk
- Each side has 80 tracks
- Each track has 18 sectors
- Each sector holds 512 bytes (0.5 KB)
- Each floppy disk holds 2880 sectors (2 * 80 * 18), for a total of 1440 KB or 1.44 MB

1.10.3 Hard Disk

Magnetic disks or the "hard disk" or Winchester disk were first introduced in 1956 for the purpose of bulk data storage. A hard disk contains circular platters that are made of any metal or aluminum and are coated with magnetizable material. The number of platters depends on the disk capacity. The higher the number of platters, the higher the data-storage capacity of the disk. To be able to store data on the disk, it is essential to format it first. Formatting the disk creates magnetic tracks and sectors where data is stored in the form of magnetic particles. A conducting coil called the *drive head* is used to store/retrieve data from the disk. When a user tries to read/write data onto the disk, the head remains stationary while the platter rotates beneath it. Data is stored on both sides of the disk on concentric rings called *tracks*. Each track is of the same width as that of the head. To minimize errors due to the interference of the magnetic field, adjacent tracks are separated by gaps called *intratrack gaps*.

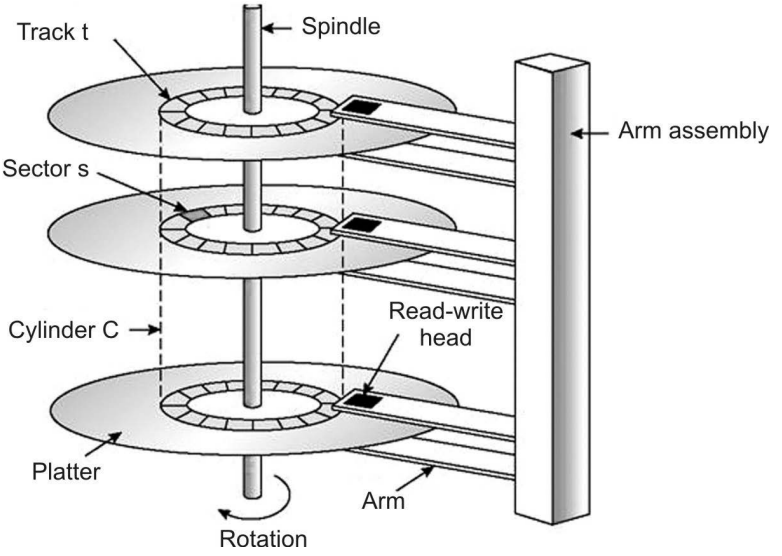


Data is stored and read from the disk in blocks called *sectors*. The heads are mounted on a rigid arm that can be extended or retracted across all the tracks and are either fixed or movable. The speed of disk rotation is 7,200 revolutions per minute. Nowadays, disks can rotate at a speed of 10,000 revolutions per minute. The higher the speed of the rotation of the disk, the higher the rate of the transfer of data into the computer memory. This increases the chances of the disk becoming heated which will result in a shorter life of the hard disk.

All the platters rotate at a constant speed around the spindle. The drive head, while positioned close to the center of the disk, reads from a

surface that is passing by more slowly than the surface at the outer edges of the disk. Because of this, tracks toward the outer side of the disk are less densely populated with data in comparison to the tracks are toward the center of the disk. This results in the reading of same amount of data over the same period of time, either from the outermost track or from the innermost track.

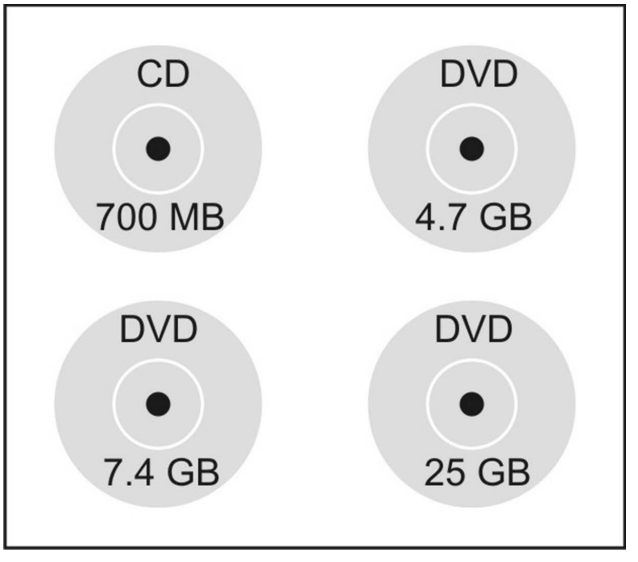
Position of the read/write head is at a fixed distance from the platter allowing an air gap. The read/write process always starts at the sector boundaries. A sector can store a maximum of 512 bytes. If the lesser number of bytes are to be stored in a sector, the rest of the sector is padded (filled) with the last byte recorded. For the purpose of storage, in a hard disk clusters are always allotted. A cluster consists of a number of sectors that are always an exponent of 2. The only odd number of sectors a cluster could consist of is 1 (2^0=1). For example, if there is a file with a size of 1,000 bytes, one cluster (two sectors) would be allocated to the file on a disk, later, if data is appended to the file and its size grows to 1.600 bytes, another two clusters are allocated, storing the entire file within four clusters. If adjacent clusters are not available, the second two clusters may be written elsewhere on the same disk or within the same cylinder or on a different cylinder—wherever the file system finds two sectors available. A set of corresponding tracks on all surfaces of the disk pack equidistant from the spindle is called a *cylinder*.



The hard disk allows the direct access of records. That is why they are also known as the *direct access storage devices* (DASD). To read/write data, the cylinder number, the surface number and the sector count must be known.

1.10.4 Optical Disk

The latest developments in hardware and enhanced processing speed of systems generated a need for quick and fast storage. Data is stored in the form of the magnetic particles in earlier data storage devices, but with the development of optical technology it is now possible to store data in the form of tiny particles called pits (created by a laser beam). Data is stored on the optical disk in the form of light particles which do not generate a magnetic field, thus they can be stored very close to one another. In optical disks, streams of digital data in the form of tiny pits are burned onto a thin coating of metal or other material deposited on a disk. A beam of laser light is used to read these pit patterns. When it encounters a pit, the intensity of the reflected light of the laser changes. The change is detected by photo sensors and converted into a digital signal. The disk can store up to 600 MB of data and can be addressed by track and sectors.



Optical disks are available in the following forms:

- **CD/CD-ROM (*Compact Disc* or CD-Read-Only Memory**): This is a very commonly used term and usually refers to non-writable discs.
- **CD-R (*Writable Discs* or CD Recordable**): This means that a user can only burn (store) data a single time on it, or multiple times when using multisession mode until it reaches the disk capacity. Once data is written it cannot be overwritten or erased.
- **CD-RW (*Rewritable* Discs/CD Rewritable)**. This means that a user cannot only write data, but can also erase the data written on the disc and can write new data on it.
- **DVD/DVD-ROM (*Digital Versatile* Disc/DVD Read-Only Memory)**. Basically the same as CD-ROM, however, a DVD typically has a six times greater capacity than a CD.
- **DVD-R/DVD+R (*Writable DVD* or DVD Recordable)**. Basically the same as CD-R with greater capacity.
- **DVD-RW/DVD+RW (*Rewritable* DVD/DVD Rewritable)**. Basically the same as CD-RW with greater capacity.
- **DVD DL** (***Double* or Dual Layer**). Double-layer discs have twice as much disc space as standard DVDs.
- **BD-R (*Blu-Ray* Disc Recordable)**. It is a Blu-ray disc on which data can be written only once.
- **BD-RE (*Blu-ray Disc Rewritable*)**. It is a Blu-ray disc recordable erasable (BD-RE), which can be recorded on and erased any number of times.

Blu-ray is a digital optical-disc data-storage format that has a data storage pattern that supersedes the DVD format. Blu-ray discs are capable of storing hours of video in high-definition and ultra high-definition resolution.

1.10.5 Pen Drive

A pen drive is a portable storage drive that can be carried easily from one place to another and is a very popular storage device among users (popularly called PD by users). A pen drive is very easy

to operate; the user simply needs to put it into the Universal Serial Bus (USB) port and it is ready to use. A pen drive works on the principle of EEPROM.

1.10.6 Flash Memory

Flash memory can be defined as a nonvolatile memory that can be erased and reprogrammed in units of memory called blocks. It works on the concept of an EEPROM and the only difference is that in EEPROM data is erased at a byte level, whereas in flash memory it is done at a block level making flash memory faster. Flash memory is often used to hold control code such as the basic input/output system (BIOS) in a personal computer. When BIOS needs to be changed (rewritten), the flash memory can be written to in block (rather than byte) sizes, making it easy to update. However, flash memory is not as useful as random access memory (RAM) because RAM needs to be addressable at the byte level and not at the block level. Flash memory gets its name because the microchip is organized so that a section of memory cells are erased in a single action or a "flash." Flash memory is used in digital cellular phones, digital cameras, LAN switches, PC cards for notebook computers, digital set-up boxes, embedded controllers, and other devices.

1.11 Basic System Configuration

A *Basic system configuration* is something that all users should understand before buying or working on a computer system. If not properly configured, a system will give problems to its users while working. It means working out the details of all the parts as per the user's requirements that need to be assembled to complete a computer system. Types of parts used to assemble a system greatly affect the working of a com-

puter. Basic system configuration encompasses full details of main memory (RAM), hard disk drive, card reader, microprocessor, DVD drive, monitor, networking requirements and details of an operating system. A user should not randomly buy things offered on the market. Instead they need to research their requirements. If a user needs the system for software development, then the requirements would be different. However, if the user needs the system only for general purpose work like working on the Internet or using MS Office, then the requirement of system configuration would be on the lower side. Hardware like the monitor, keyboard, mouse, and speakers should be configured wisely for better performance. Properly configuring a computer requires a lot of thinking, and the user needs to know what they are actually taking home might affect the performance of the system. The answer to a question such as "What is the configuration of your computer?" would be based on the points that follow:

1. What is the type of processor (CPU) do you have?
2. How much memory (RAM) is in the system?
3. What is the capacity of the hard-disk drives (HDD)?

Other details like the size and type of monitor, keyboard, mouse, etc., can be defined to complete the description of the system configuration. A user can find the configuration of its system by following these steps:

- Click on the "System and Security" icon in the control panel and under it, select the "System" option. The user can right-click on the "My Computer" icon on the computer's desktop to find information about which version of Windows (Operating System) is on the computer, what kind of processor (CPU) it has, and how much of memory (RAM) is installed.
- Another way of obtaining the details of the configuration of the computer system is by first clicking on the "Start" option that appears on the status bar of Windows and then typing "msinfo32" in "search programs and files" option.
- Information about the hard-disk capacity can be obtained by double-clicking on the "My Computer" icon on the desktop. A window will be opened and will provide the details of all the hard-disk partitions and their storage capacity.

1.12 Processing Speed

There are mainly two factors that affect the performance of a computer system; one is the number of bits processed at a time, and the second is the clock speed of a computer system. The number of bits processed at one time depends on the bus and is explained as follows:

Computer Buses: A bus is used to carry people from one place to another. In a computer, a *bus* is a special circuit that connects the various parts of the computer and allows the transfer of data between these parts. There are various kinds of computer buses operating in a PC. They are:

- ***Address Bus*:** A set of address wires that give the memory address used by the data, and is referred to as an address bus.
- ***Data Bus*:** A set of wires that transfers the input/output data from and to the memory is known as the data bus.
- ***Control Bus*:** A set of wires that controls the read/write operations is known as the control bus.

The processing speed of a computer is controlled by the number of bits it can process at a time. If the data bus contains 8 wires, it can process 1 byte or 8 bits at a time and is called an 8-bit processor. If there are 16 wires then the data bus can process 2 bytes or 16 bits at a time and is called a 16-bit processor. There are 32-bit and 64-bit processors with an ultra-high speed. Thus one can say that one factor that affects the performance of a PC is the number of bits processed at a time.

***Clock Speed*:** It is defined as a speed with which data is transferred inside the CPU from one place to another. It is measured in mega or gigahertz. Higher the clock speed, the faster will be the processing of a system.

1.13 Uses of a Computer System

Computers are extensively used in any or every field now a day. A few of the prominent areas where a computer system has significant uses are:

- **Education:** Educational institutions across the world cannot even think of operating without using a computer system. Whether it is a library or a classroom setting, or an office, computers are extensively used at

all levels in an educational institute. With moving focus on information and communication technology (ICT), all the renowned universities and institutes are launching online courses for students or executives who otherwise are not able to join them on a full-time basis.

- **Science and Technology:** Science and technology is another field in which computers are used extensively. Computers' fast and complex processing abilities are used in most research and development in the field of science and technology. Problems, which were previously highly complex in nature and were considered very difficult to resolve, have been rendered possible by using a computer. Architects and engineers use computers regularly in their work. Satellite communication has become a reality today only because of the role played by computers in it. With the help of computers users are able to communicate in remote areas where telephonic communication is not available. Simulation techniques are effectively provided by computers. Simulation is a process by which an artificial environment is created and is a replica of an actual environment in which a user needs to work or compute. For example, astronauts training on Earth can use a space-like environment.
- **Medicine:** Medical research and diagnosis is an area that is extremely influenced by the use of computers and the tools provided by it. Be it the development of new medicine, new techniques, or records of patients to be maintained in hospitals, the entire administrative work, which includes imparting information about the number of rooms' available, detailed information about the patients, etc., is computerized. Computers are also used in preparation of certain medical reports like ECG, CAT-SCAN, etc. Robotics is used for conducting complex surgeries on the patients.
- **Law and Order:** Another field where computers have found their beneficial usage is law and order. With the help of video conferencing, the court can hear the cases of criminals without moving them from jail to court. In some countries, CCTV cameras are installed at sensitive places to keep a close watch on the movement of people. These CCTVs are monitored and controlled with the help of computer systems and are helping in maintaining the law and order in many cities. Supreme Court, High Court, and Lower Court are all computerized. One can log into the court site and find the status or resulting judgment of a case. Lawyers use computers for recording their cases and

retrieving information about a particular case. Computers have proved to be very useful in crime detection techniques like fingerprint identification.

- **Business:** Businesses are undergoing a revolution in the way in which they perform. Today, even a grocery-shop owner has a website through which the user can buy household items without going to the shop. Computers are used extensively in the designing and manufacturing of products with the help of CAD and CAM. All business functions such as production, sales, payroll, inventory management, dispatch, etc., are now computerized. Computers are used broadly for doing sales analysis, forecasting, generating reports, and most recently in customer relationship management. Various routine clerical tasks such as maintenance of files, ledgers, etc., have been taken over by computers. Computers are also used for booking online tickets for cinema, railways, airlines, for online banking transactions, paying online bills, etc.

Thus one can say that there is hardly any field of any business application that is not influenced by computers. The impact of computers is such that if anybody refuses to accept computers, they are soon bound to become outdated.

Test Your Knowledge

1. What do you understand about data, processing, and information? Explain with an example.
2. Explain the meaning of the term "processing."
3. Are the words data and information interchangeable? If yes, then explain with an example.
4. Why is there a need for data and information? Explain.
5. What meant by a "computer system"?
6. Can a computer system be called an information processing system? Explain your answer.
7. Discuss the various types of a computer system.
8. Discuss the various generations of a computer.

9. Discuss the various components of a digital computer system.
10. Discuss the basic architecture of CPU and its functions.
11. Discuss the block diagram of a computer system.
12. What do you understand about input devices? What are the various input devices, and which of them can be used for the purpose of entering data into a computer system?
13. What do you understand about output devices? What are the various output devices, and which are used for the purpose of showing output of a computer system?
14. What is meant by auxiliary storage or auxiliary memory? Discuss the various storage devices used in a computer system.
15. What do you understand about offline storage devices? What are the various devices used for the purpose of storage?
16. What do you understand about the backup storage devices? Explain in detail.
17. What do you understand about memory? How many types of memory are there? Explain.
18. What do you understand about the peripherals used in a personal computer?
19. What do you understand about the processing speed of a computer system? What are the factors that influence the performance of a PC?
20. Can a PC be described as a virtual office? Explain your answer with an example.
21. Explain the factors that govern the processing speed of a computer system.
22. What are the various usages of a computer system for the purpose of business?