UNIT 1 COMPUTER HARDWARE

Structure

1.1 Introduction

The use of information Technology (IT) is now well recognized everywhere. It has become the nervous system of Business houses as their survival is now directly by

the growing Information Technology trends. Computer is one of the major components of an IT network and is gaining more popularity with every passing day. Today, Computer Technology has penetrated every sphere of modern life. From railway reservations to medical diagnosis, from TV programmes to satellite launching, from match-making to criminal catching- everywhere we witness the elegance, sophistication and efficiency possible only with the help of computers.
In this unit, we will give a brief introduction to the computer hardware technology, how does it work and what exactly it is.

1.2 Objectives

At the end of this unit students will be able to:

- Define what a computer is
- Classify computers
- Understand the different generations of computers
- Understand the applications of computers in different fields
- Understand the job of Central Processing Unit
- Describe primary memory and its usage
- Understand the functions of various Input and Output devices
- Understand the need and use of storage devices.

1.3 What is a Computer

There are many definitions of what a computer is. Let's give a fewer definitions here:

1) Any device capable of processing information to produce a desired result. No matter how large or small they are. Computers typically perform their work in three well-defined steps: (i) accepting input, (ii) processing the input according to predefined rules (programs), and (iii) producing output

2) Any general-purpose machine that processes data according to a set of instructions that is stored internally either temporarily or permanently, including, but not limited to, a general purpose computer, workstation, laptop computer, personal computer, set top box, web access device.

3) A computer is a general-purpose machine that processes data. The data is processed according to a set of instructions known as programs. The computer and all equipment attached to it are called hardware. The computer is a form of hardware and the programs are known as software.

4) Electronic machine capable of performing calculations and other manipulations of various types of data, under the control of a stored set of instructions. The machine itself is the hardware; the instructions are the program or software.

1.4 Types of Computers

Fundamentally, there are two types of computers

- Analog
- Digital

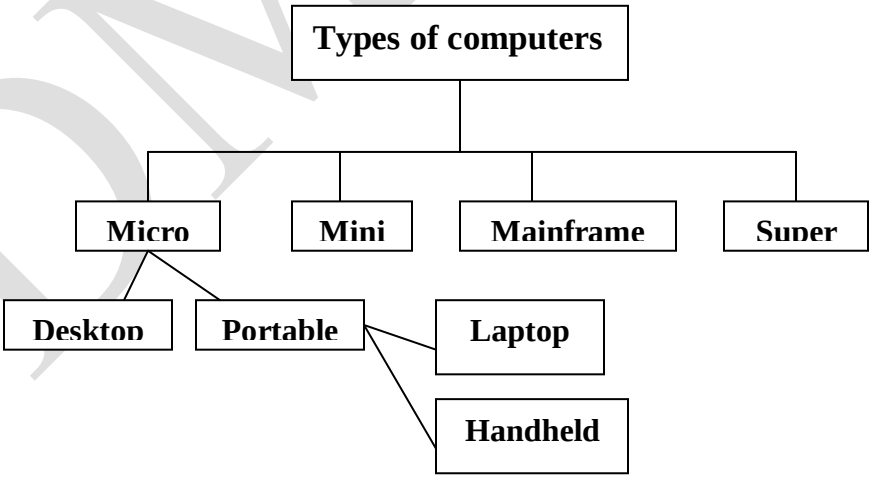
Analog computers solve problems by using continuously changing data such as

- Temperature
- Pressure
- Voltage

Digital computers solve problems by manipulating discrete binary digits (0s and 1s).Digital computers are further classified into four main categories viz

- Microcomputers
- Minicomputers
- Mainframes
- Supercomputers

They differ in size, speed of operation, amount of data that can be stored, and the number of simultaneous users. Micro computers are further divided into Desktop and Portable computers. This is shown in the following diagram.



Classification of computers

- **Microcomputers**- These are of two types namely Desktop and Portable.

- **Desktop** - A Personal Computer that is not designed for portability. The computer is set up in a permanent location. Most desktops offer more power, storage and versatility for less cost.


- **Portable**- These include Laptops and handheld devices (palmtops, PDAs etc).
  - ✓ **Laptop** - These are also called notebooks. Laptops are portable computers that integrate the display, keyboard, a pointing device or trackball, processor, memory and hard drive all in a battery-operated package slightly larger than an average hardcover book.


  - ✓ **Palmtop** – small handheld devices

    - Palmtops are tightly integrated computers that often use flash memory instead of a hard drive for storage
    - These computers usually do not have keyboards but rely on touch screen technology for user input
    - Palmtops are typically smaller than a paperback novel, very lightweight with a reasonable battery life.


- ✓ **Personal Digital Assistant (PDA)** is a handheld computer. Newer PDAs also have both color screens and audio capabilities, enabling them to be used as mobile phones (smart phones), web browsers, or portable media players. Many PDAs can access the Internet, Wi Fi, etc. Many PDAs employ touch screen technology or use a stylus.


- ➢ **Minicomputer- A** class of multi-user computers that lies in the middle range of the computing spectrum, in between the largest multi-user systems (mainframe computers) and the smallest single-user systems (micro computers or personal computers). The class at one time formed a distinct group with its own hardware and operating systems, but the contemporary term for this class of system is midrange computers, such as the higher-end SPARC, POWER and Itanium - based systems from SUN, IBM and HP.


- ➢ **Mainframes** computers used mainly by large organizations for critical applications, typically for large data processing such as census, industry and consumer statistics, Enterprise Resource Planning (ERP), and financial transaction processing.


- ➢ **Supercomputer**- This type of computer usually costs hundreds of thousands or even millions of dollars. Although some supercomputers are single computer

systems, most are comprised of multiple high performance computers working in parallel as a single system. The best known supercomputers are built by Cray Supercomputers.


1.5 Generations of Computers

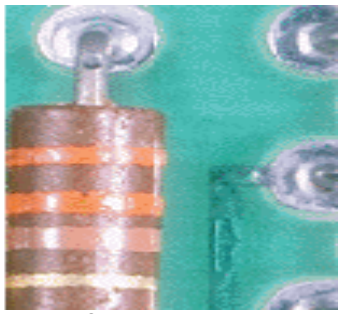
A generation refers to the state of improvement in the development of a product. This term is also used in different advancements of computer technology. With each new generation, the circuitry became smaller and more advanced than the previous generation. As a result of the miniaturization, speed, power, and memory of computers have proportionally increased.

First Generation (The Vacuum Tube):

The first generation computers were huge, slow, expensive, and less reliable. Eckert and Mauchly built the ENIAC (Electronic Numerical Integrator and Calculator) computer which used vacuum tubes instead of the mechanical switches of the Mark I. The ENIAC used thousands of vacuum tubes, which took up a lot of space and gave off a great deal of heat just like electric bulbs do. The ENIAC led to the development of other vacuum tube based computers like the EDVAC (Electronic Discrete Variable Automatic Computer) and the UNIVAC I (Universal Automatic Computer).

The purpose of Vacuum tube was to act like an *amplifier* and a *switch*. Without any moving parts, vacuum tubes could take very weak signals and make the signal stronger (amplify). Vacuum tubes could also stop and start the flow of electricity instantly (*switch*). These two properties made the ENIAC computer possible. The ENIAC gave off so much heat that they had to be cooled by large air conditioners. However even with these huge coolers, vacuum tubes still overheated regularly and many of them would burst.

Second Generation (The Transistor):



John Bardeen, William Shockley and Walter Brattain working at AT&T's Bell Labs invented the transistor which functions like a vacuum tube in that it can be used to relay and switch electronic signals. The transistor was faster, more reliable, smaller, and much cheaper to build than a vacuum tube. One transistor replaced the equivalent of 40 vacuum tubes. These transistors were made of solid material, some of which is silicon; therefore they were very cheap to produce. Transistors were found to conduct electricity faster and better than vacuum tubes. They were also much smaller and generated much less heat compared to vacuum tubes.

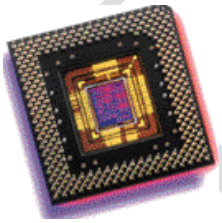
Third Generation: (Integrated Circuits):

Transistors were a tremendous breakthrough in advancing the computer. However no one could predict that thousands or even now millions of transistors (circuits) could be compacted in such a small space. The integrated circuit (IC), or as it is sometimes referred to as semiconductor chip, packs a huge number of transistors onto a single wafer of silicon. Placing such large numbers of transistors on a single chip vastly increased the power of a single computer and lowered its cost considerably.

Since the invention of integrated circuits, the number of transistors that can be placed on a single chip has increased exponentially, shrinking both the size and cost of computers even further and further enhancing its power. Most electronic devices today use some form of integrated circuits placed on printed circuit boards- thin pieces of bakelite or fiberglass that have electrical connections etched onto them.

These third generation computers could carry out instructions in billionths of a second. The size of these machines got reduced to the size of small file cabinets.

Fourth Generation (The Microprocessor):



This generation can be characterized by the invention of the microprocessor (*a single chip that could do all the processing of a full-scale computer*). By putting millions of transistors onto one single chip more calculation and faster speeds were achieved by computers.

Ted Hoff of Intel invented a chip the size of a pencil eraser that could do all the computing and logic work of a computer. The microprocessor was made to be used in calculators, not computers. It however led to the invention of personal computers.

Fifth Generation: Present and Future (Artificial Intelligence)

The dream of creating a human-like computer that would be capable of reasoning has existed since long. Such computers would learn from their mistakes and possess the skill of experts.

The various characteristics of these generations are tabled below.

Generation	Characteristics
1st	-vacuum tube based -punched tape input or output -large, occupied more space -generated large amounts of heat, so air-conditioning was required -very expensive and consumed large amount of electricity -about 1,000 circuits per cubic foot Examples: Mark I,ENIAC ,EDSAC
2nd	-used transistors and were smaller in size -computational speed reduced to microseconds from milliseconds -more reliable and less prone to hardware failures -more portable and generated less amount of heat -about 100,000 circuits per foot Examples: UNIVAC 1107,IBM 7030,IBM 7070
3rd	-used integrated circuit technology -computational speed reduced to nanoseconds -easily portable and more reliable -consumed less power and generated less heat -smaller and failed rarely -10 million circuits per square foot Examples: IBM System/360, System 3,UNIVAC 9000 series
4th	-microprocessor based (LSI,VLSI,ULSI) -very small in size (PC, Desktop) -Generate negligible amount of heat and need no air-conditioning -negligible hardware failure -low cost and commercially available -GUI and pointing devices used -billions of circuits per cubic foot Examples: IBM System 3090, IBM RISC 6000, HP 9000
5th	-extremely large scale integration -parallel processing -high speed logic and memory chips -high performance, micro-miniaturization -voice/data integration; knowledge-based platforms -artificial intelligence, expert systems -virtual reality generation -satellite links

1.6 Applications of Computers

Nowadays computers have become so common that there is hardly any field where computers are not used. Following are some of the applications of computers:

1) In offices and homes for preparing documents and perform other data processing jobs
2) To prepare salary slips and salary cheques in offices, factories

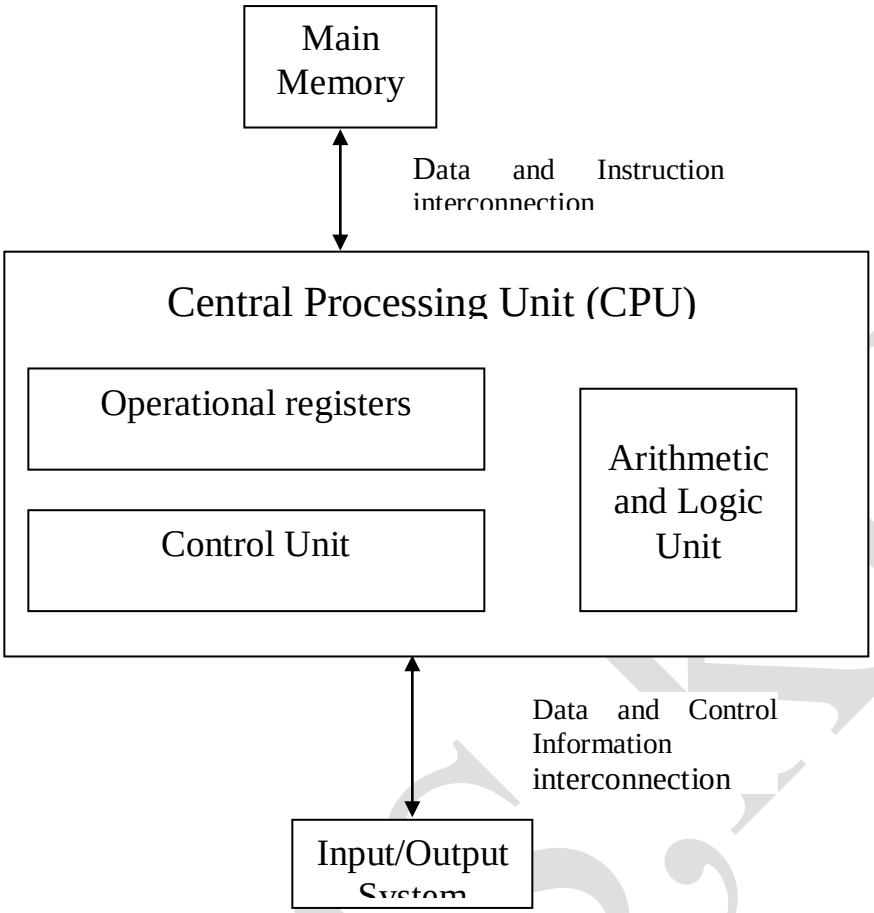
3) To maintain accounts and transfer funds in Banks
4) To store and retrieve large amount of information in offices
5) To send and receive E-mail/ Voice mail
6) To search and retrieve information from other computers
7) To reserve tickets in railways, airlines etc
8) To regulate traffic lights on roads and to control machines and robots in factories
9) To design automobiles, buildings, dams and to forecast weather
10) To create animations/ Cartoon movies and compose music
11) To control aero planes, trains, automobiles etc
12) To control electronic appliances such as air conditioners, TVs etc
13) To do online banking, buy and sell merchandise, shares etc
14) To control and simulate defense equipment
15) For scientific and industrial research
16) In post offices and hospitals
17) In playing games, music (Audio/Video) etc
18) Last but not least in Education (Online tutorials, Virtual classrooms etc)

1.7 Computer Hardware- Configuration and Applications

The apparent hardware composition of a computer is depicted in the Diagram of a computer given on the next page.
As shown in the diagram, the basic architecture (known as Von Neumann Architecture) of a computer consists of:

- A CPU which includes ALU, CU and some registers
- A Main Memory System
- An Input/Output System

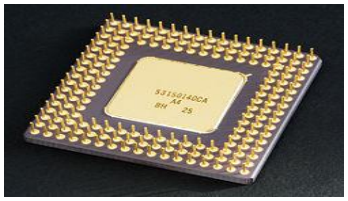
We will be discussing each of these components in detail in the following sections.



Block Diagram of Computer

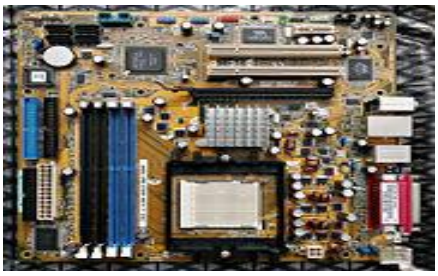
1.7.1Central Processing Unit

The central processing unit, or CPU, is that part of a computer which executes programs written in some computer language. In older computers this circuitry was formerly on several printed circuit boards, but in PCs is a single integrated circuit (IC). Nearly all PCs contain a type of CPU known as a microprocessor. The microprocessor often plugs into the motherboard using one of many different types of sockets.



Motherboard

The motherboard, also referred to as system board or main board, is the primary circuit board within a personal computer. Many other components connect directly or indirectly to the motherboard. Motherboards usually contain one or more CPUs, supporting circuitry - usually integrated circuits(ICs) - providing the interface between the CPU



memory and input/output peripheral circuits, main memory, and facilities for initial startup of the computer immediately after power-on (often called booting). In many portable and embedded personal computers, the motherboard houses nearly all of the PC's core components. Often a motherboard will also contain one or more peripheral buses and physical connectors for expansion purposes. Sometimes a secondary Daughter Board is also connected to the motherboard to keep scope for further expansion or adding more devices.

1.7.2 Primary/Main Memory

Random Access Memory (RAM) and Read Only Memory (ROM) fall in the category of Primary Memory, also known as Main Memory.

Random Access Memory (RAM)

Random access memory or *RAM* most commonly refers to computer chips that temporarily store dynamic data to enhance computer performance. By storing frequently used or active files in random access memory, the computer can access the data faster than if it is to retrieve it from the far-larger hard disk. Random access memory is also used in printers and other devices.

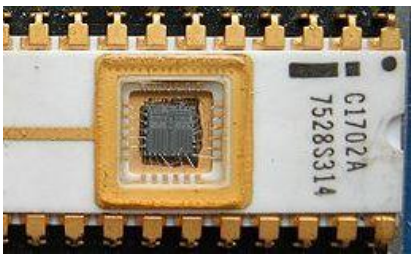
Random access memory is volatile memory, meaning it loses its contents once power is cut. This is different from non-volatile memory such as hard disks and Flash Memory, which do not require a power source to retain data. When a computer shuts down properly, all data located in random access memory is committed to permanent storage on the hard drive or flash drive. At the next boot-up, RAM begins to fill with programs automatically loaded at startup, and with files opened by the user.

There are several different types of random access memory chips which come in the form of a "stick." A *stick of RAM* is a small circuit board shaped like a large stick. Sticks of RAM fit into "banks or slots" on the motherboard. Adding one or more sticks increases RAM storage and performance.

Random access memory is categorized by architecture and speed. As technology progresses, RAM chips become faster and employ new standards so that RAM must be matched to a compatible motherboard. The motherboard will only support certain types of random access memory, and it will also have a limit as to the amount of RAM it can support. For example, one motherboard may support dual-channel Synchronous Dynamic Random Access Memory (SDRAM), while an older motherboard might only support Single In-line Memory Modules (SIMMS) or Dual In-line Memory Modules (DIMMS).

Since random access memory can improve performance, the type and amount of RAM a motherboard will support becomes a major factor when considering a new computer. If there is a faster, better random access memory chip on the market, the buyer will want to consider purchasing a motherboard capable of using it.
RAM varies in cost depending on type, capacity and other factors. Random access memory often comes with a lifetime guarantee at a competitive price.

Read Only Memory (ROM)



Read-only memory (ROM), also called Firmware are chips that store permanent instructions. Firmware boots up computerized or digital devices, as ROM chips are non-volatile, meaning they do not require a power source to hold their contents. This differentiates firmware from random access memory (RAM), which loses stored data at shutdown. Perhaps the most familiar firmware is the *basic input output system (BIOS)* chip. The BIOS chip on a computer motherboard holds instructions that, upon powering up, initialize the hardware, ensure components are working, and finally bring in the Operating System to take over the control of the system.
In the past, firmware chips could not be rewritten. When the BIOS became outdated, the only option was to buy a new motherboard. New firmware would understand the latest hardware so that the user would not be limited to older drives and other legacy technologies when facing inevitable upgrades.
It became clear that a new type of firmware chip that could be updated would be extremely beneficial. This became possible with Flash Memory chips. With the BIOS written to this type of chip, a user could connect to the manufacturer's website, download a firmware upgrade to diskette and *flash* the BIOS chip during boot-up to install a new set of instructions. All quality motherboards today feature a flash BIOS, or Upgradeable Firmware.
Firmware is at the heart of virtually every popular digital device. Portable Audio players, cell phones, personal digital assistants, digital cameras and gaming consoles are just some of the devices that use firmware. Upgradeable firmware has extended the life of countless electronic devices, adding new functionality. However, flashing firmware is also risky, as the device will not boot if the flashing process is interrupted or becomes corrupted.

1.7.3 Input Devices

As depicted in the Block diagram of a computer, one of the important components of a system is the Input module used to give input to the computer so that the given input is processed and output generated. For this several input devices are used. Some of the important ones are described below.

1.7.2.1 Keyboard

In computing, a keyboard is an arrangement of buttons that each correspond to a function, letter, or number. They are the primary devices of inputing text. In most cases, they contain a series of keys specifically organized with the corresponding letters, numbers, and functions printed or engraved on the button. They are generally designed around an operators language, and many different versions of keyboards exist for different languages. In English, the most common layout is the QWERTY layout, which was originally used in typewriters. They have evolved over time, and have been modified for use in computers with the addition of function keys, number keys, arrow keys, operating system specific keys and more recently the Multimedia controlling keys. Often, specific functions can be achieved by pressing multiple keys at once or in succession, such as inputing characters with accents or opening a task manager. Programs use keyboard shortcuts very differently and all use different keyboard shortcuts for different program specific operations, such as refreshing a web page in a web browser or selecting all text in a word processor.

1.7.3.2 Mouse: A Mouse on a computer is a small, movable device that users hold and slide around to point at, click, and sometimes drag objects on screen in a graphical user interface(GUI) using a pointer on screen. Almost all Personal Computers have mice. It may be plugged into a computer's rear mouse socket, or as a USB device, or, more recently, may be connected wirelessly via a USB antenna or Bluetooth antenna. In the past, they had a single button that users could press down on the device to "click" on whatever the pointer on the screen was pointing to. Now, however, many Mice have two or three buttons; a "right click" function button on the mouse, which performs a secondary action on a selected object, and a scroll wheel, which users can rotate using their fingers to "scroll" up or down. The scroll wheel can also be pressed down, and therefore be used as a third button. Different programs make use of these functions differently, and may scroll horizontally by default with the scroll wheel, open different menus with different buttons, among others.

Mice traditionally detected movement and communicated with the computer with an internal "mouse ball"; and use optical encoders to detect rotation of the ball and tell the computer where the mouse has moved. However, these systems were subject to low durability and accuracy. Modern mice use optical technology to directly trace movement of the surface under the mouse and are much more accurate and durable. They work on a wider variety of surfaces and can even operate on walls, ceilings or other non-horizontal surfaces.

1.7.3.3 Scanner

A **scanner** is a device that optically scans images, printed text, or an object, and converts it to a digital image. Common examples found in offices are variations of the *desktop (or flatbed) scanner* where the document is placed on a glass window for scanning. *Hand-held scanners*, where the device is moved by hand, have evolved over time. Mechanically driven scanners that move the document are typically used for large-format documents, where a flatbed design would be impractical.

Modern scanners typically use a charge coupled device (CCD) or a contact image sensor (CIS) as the image sensor, whereas older *drum scanners* use a photomultiplier tube as the image sensor. A *rotary scanner*, used for high-speed document scanning, is another type of drum scanner, using a CCD array instead of a photomultiplier. Other types of scanners are planetary scanners, which take photographs of books and documents, and 3D scanners, for producing three-dimensional models of objects.

Another category of scanner is digital camera scanners. Due to increasing resolution and new features, digital cameras have become an attractive alternative to regular scanners. While still having disadvantages compared to traditional scanners (such as distortion, reflections, shadows, low contrast), digital cameras offer advantages such as speed, portability, gentle digitizing of thick documents without damaging the book spine. New scanning technologies are combining 3D scanners with digital cameras to create full-color, photo-realistic 3D models of objects.

1.7.3.4 Other Input Devices

Apart from the primary input devices mentioned above, computers have many more alternate input devices used to give different kinds of input to the machine. Some of these include cameras, Light pens, Touch panels, Mike, Joystick, Data Glove, Bar code reader and Digitizers etc.

1.7.4 Output Devices

The processed input is produced in the form of output to be displayed to the user on some output device. Some of the output devices have been discussed here.

1.7.4.1 Monitor (Visual display unit)

A visual display unit (also called monitor) is a piece of electrical equipment, usually separate from the computer case, which displays viewable images generated by a computer without producing a permanent record. A computer display device is usually either a cathode ray tube (CRT) or some form of flat panel such as a TFT LCD. The monitor comprises the display device, circuitry to generate a picture from electrical signals sent by the computer, and an enclosure case. The images from monitors originally

contained only text, but as Graphical User Interfaces (GUI) emerged and became common, they began to display more images and multimedia content.

- **Cathode Ray Tube (CRT)**
  - Raster scan computer monitors, which produce images using pixels. These were the most popular display device for older computers.
  - Vector displays, as used on many scientific and radar applications, and several early machines.
  - Television sets were used by most early personal and home computers, connecting composite video to the television set using a modulator. Resolution and image quality were strongly limited by the display capabilities of television.

The CRT or cathode ray tube is the *picture tube* of a monitor. The back of the tube has a negatively charged cathode. The electron gun shoots electrons down the tube and onto a charged screen. The screen is coated with a pattern of phosphor dots that glow when struck by the electron stream. Each cluster of three dots, one of each color (RGB), is one pixel.

The image on the monitor's screen is usually made up from at least tens of thousands of such tiny dots glowing on command from the computer. The closer together the pixels are, the sharper the image on screen can be. The distance between pixels on a computer monitor screen is called its dot pitch and is measured in millimeters. Most monitors have a dot pitch of 0.28 mm or less.

There are two electromagnets around the collar of the tube which deflect the electron beam. The beam scans across the top of the monitor from left to right, is then blanked and moved back to the left-hand side slightly below the previous trace, scans across the second line and so on until the bottom right of the screen is reached. The beam is again blanked, and moved back to the top left to start again. This process draws a complete picture, typically 50 to 100 times a second. The number of times in one second that the electron gun redraws the entire image is called the Refresh Rate and is measured in hertz(cycles per second).

- **Liquid Crystal Display (LCD).** Two types of LCDs are the mostly used as display devices for new computers.
  - Passive LCD produce poor contrast, slow response, and other image defects. These were used in most laptops until the mid 1990s.
  - Thin Film Transistor (TFT) LCDs give much better picture quality in several respects. Nearly all modern LCD monitors are TFT.

A TFT monitor uses *thin-film transistor* technology for the ultimate LCD display. LCD monitors, also called flat panel

displays, are replacing the old style cathode ray tubes (CRTs) as the displays of choice. Nearly all LCD monitors today use TFT technology.
The benefit of a TFT monitor is a separate, tiny transistor for each pixel on the display. Because each transistor is so small, the amount of charge needed to control it is also small. This allows for very fast re-drawing of the display, as the image is re-painted or refreshed several times per second.
Prior to TFT, *passive matrix* LCD displays could not keep up with fast moving images. A mouse dragged across the screen, for example, from point A to point B, would disappear between the two points. A TFT monitor can track the mouse, resulting in a display that can be used for video, gaming and all forms of multimedia.
A typical 17-inch TFT monitor has about 1.3 million pixels and 1.3 million transistors. That leaves a significant chance for a malfunctioning transistor or two on the panel. Upon delivery, a TFT monitor can have "dead pixels" for this reason. A dead pixel is a pixel whose transistor has failed, thereby creating no display image. On a solid black background, dead pixels will stand out as tiny dots of red, white or blue.
A TFT monitor delivers crisp text, vibrant color and an improved response time for multimedia applications. If interested in gaming, video editing or other multimedia applications, look for a TFT monitor with a response rate of 16ms or less.

1.7.4.2 Printers

In computing, a **printer** is a peripheral which produces a hard copy (permanent human readable text and/or graphics) of documents stored in electronic form, usually on physical print media such as paper or transparencies. Many printers are primarily used as local peripherals, and are attached by a cable or, in most new printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as **network printers**, have built-in network interfaces, and can serve as a hardcopy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.
In addition, a few modern printers can directly interface to electronic media such as memory sticks or memory cards, or to image capture devices such as digital cameras, scanners; some printers are combined with a scanner and/or fax machine in a single unit. Printers that include non-printing features are sometimes called Multifunction Printers (MFP), Multi-Function Devices (MFD), or All-In-One (AIO) printers.
Printers are designed for low-volume, short-turnaround print jobs; requiring virtually no setup time to achieve a hard copy of a given document. However, printers are generally slow devices (30 pages per minute is considered fast; and many consumer printers are far slower than that), and the cost-per-page is relatively high.

Printing technology

Printers are routinely classified by the underlying print technology they employ; numerous such technologies have been developed over the years. The following printing technologies are routinely found in modern printers:

Toner-based printers

Toner-based printers work using the Xerographic principle that is at work in most photocopiers: by adhering toner to a light-sensitive print drum, then using static electricity to transfer the toner to the printing medium to which it is fused with heat and pressure.

The most common type of toner-based printer is the laser printers, which use. Laser printers are known for high quality prints, good print speed, and a low (Black and White) cost-per-copy; they are the most common printer for many general-purpose office applications. They are far less commonly used as consumer printers due to a high initial cost, although this cost is dropping. Laser printers are available in both color and monochrome varieties.

Liquid inkjet printers

Inkjet printers operate by propelling variably-sized droplets of liquid or molten material (ink) onto almost any sized page. They are the most common type of computer printer for the general consumer due to their low cost, high quality of output, capability of printing in vivid color, and ease of use.

Thermal printers

Thermal Printers work by selectively heating regions of special heat-sensitive paper. Monochrome thermal printers are used in cash registers, ATN's, gasoline dispensers and some older inexpensive fax machines. Colors can be achieved with special papers and different temperatures and heating rates for different colors.

Dot-matrix printers

In the general sense many printers rely on a matrix of pixels, or dots, that together form the larger image. However, the term DMP is specifically used for impact printers that use a matrix of small pins to create precise dots. The advantage of dot-matrix over other impact printers is that they can produce graphic images in addition to text.

Line printers

Line printers, as the name implies, print an entire line of text at a time. Three principal designs existed. In drum printers, a drum carries the entire character set of the printer repeated in each column that is to be printed. In chain printers (also known as *train printers*), the character set is arranged multiple times around a chain that travels horizontally past the print line. In either case, to print a line, precisely timed hammers strike against the back of the paper at the exact moment that the correct character to be

printed is passing in front of the paper. The paper presses forward against a ribbon which then presses against the character form and the impression of the character form is printed onto the paper. *Comb* printers represent the third major design. These printers were a hybrid of dot matrix printing and line printing.

Line printers were the fastest of all impact printers and were used for bulk printing in large computer centers. They were virtually never used with PC's and have now been replaced by high-speed laser printers.

Printing speed

The speed of early printers was measured in units of **characters per second**. More modern printers are measured in **pages per minute**. These measures are used primarily as a marketing tool, and are not well standardized. Usually pages per minute refer to sparse monochrome office documents, rather than dense pictures which usually print much more slowly.

1.7.4.3 Projectors


Video Projectors use CRT, LCD, DLP or many other technologies to send light through air to a projection screen.

LCD projectors are systems that display or *project* information or video onto a surface. LCD projectors are the technological descendants of overhead and slide projectors, older systems which serve the same purpose. LCD projectors are most commonly used for displaying images in presentations or lectures, but are also used in home theater applications.

Video signals are comprised of three colors: red, green, and blue (RGB). LCD projectors contain a separate glass panel for each. Each panel consists of two plates of glass with a layer of liquid crystal between them. When a charge is applied, the crystals open to allow light through or close to block it. This opening and closing of pixels is what forms the image.

LCD projectors use mirrors to split the light from the input source into red, green, and blue components. Each then passes through the corresponding panel, where pixels form an image. The three colors are then recombined in a prism before being projected through a lens. LCD projectors use separate panels for each color because it results in better color saturation than using a single panel for all three.

LCD projectors are priced based on several factors, especially resolution. The right amount of brightness, measured in Lumens, depends on the lighting conditions the

projector will be used under, as well as audience size. A darkened home theater requires less brightness than a fully lit conference room.
Other factors in considering LCD projectors are portability, Computer connectivity, and input options. LCD projectors with higher resolution weigh more and are therefore less portable. LCD projectors are frequently compared to digital light processing (DLP) projectors. These use circuit boards with thousands of tiny mirrors to project an image. Their chief advantages over LCD projectors include smaller size because they do not use multiple LCD panels and no pixilation effect like that sometimes seen on LCD projectors. However, LCD projectors are still known for having better color saturation. Generally, DLP is more popular for home theater use.
A Digital Light Processing (DLP) projector is a revolutionary technology that uses an optical semiconductor to digitally manipulate light. It incorporates a reliable, all-digital display chip that delivers the very best picture quality available. A DLP projector system can be used in a variety of products, including projectors used for business or home entertainment, large screen digital televisions and digital cinema.

1.7.4.4 Other O/p Devices

Besides these devices described above, computers have some more output devices used to display the output generated by the system. Some of these include Plotters, Speakers etc.

1.7.5 Storage Devices

Computers store data permanently for future use. This data is stored in various storage devices with their pros and cons. Some common storage devices are described here.

1.7.5.1 Floppy

Floppy disks are small, removable, media storage devices. They record data onto a thin, circular magnetic film encased in a flat, square plastic jacket. Floppy disks are rarely used now, having been replaced by memory sticks and re-writable CD storage devices.
Original floppy disks were 8-inch floppies used in 1970s, but the first floppy disks that were widely used commercially were 5.25-inch disks. These floppy disks were quite flexible and required a 5.25-inch *floppy drive*. The disks could store up to 360 kilobytes (KB) of data. Later *high-density* floppy disks held 1.2 megabytes (MB) of data.
As the technology of floppy disks improved, the next generation was smaller and eventually held more data. The newer 3.5-inch floppy disks had hard shell cases for protection. The term *floppy disk* was still used for many years, however. Some 3.5-inch floppy disks only utilized one side of the internal magnetic mylar film for recording data, with a capacity of 744 KB. High-density 3.5-inch floppy disks used both sides, doubling the capacity to 1.44 MB. In fact there were several configurations, including single or double sided (SS or DS), and single or double density (SD or DD). Today most 3.5-inch

floppy disks are high-density and referred to simply as "diskettes." The term *floppy disks* is rarely used.
Various technologies have been used since 1991 in the attempt to extend the life of floppy disks by increasing capacity to 2.88 MB (*extended density* or ED), and even 120 MB and 240 MB.
Today other storage devices that are more convenient and robust, such as compact disks and memory sticks, have largely replaced floppy disks. A CD can hold more than 600 MB, and even the smallest capacity memory stick holds several hundred times the amount of a single floppy disk. Some memory sticks now compete with smaller hard drives for disk capacity, making them ideal for transferring files, programs etc.

1.7.5.2 Hard Disk

A hard drive, also known as a hard disk drive or HDD, is a fundamental part of modern computers. The hard drive is where all our programs and files are stored, so if the drive is damaged for some reason, we lose everything on our computer system Hard Disks are generally of Two types viz. Movable Head Disks and Fixed Head Disks.
Hard drives contain round, mirror-like platters that are covered some magnetic recording medium. The platters inside a hard disk drive are usually made of glass or aluminum. It is the polished magnetic material on the surface that makes the platter appear shiny, like a mirror. A clean, polished surface is critical to the proper functioning of the hard drive — even the smallest spec of dust can cause irreparable damage or disk crash.
Just as a head inside a cassette player reads the data on the tape, a head inside the hard disk drive reads and writes data to the platters. This head is on an arm that is attached next to the platters, so that it can move back and forth over the platters (in Movable head disks). The time taken by the R/W head to move to a track to read/write data is called Seek time. This time is not involved in Fixed head disks where we have one R/W head for each track.
The average modern hard disk drive has several platters inside of it, stacked one on top of the other. There is a small gap between each platter, which allows each platter's head to pass over it. The heads are all on the same arm, which has a separate branch for each head.
When we turn on the computer, the platters immediately begin to spin. The platters in a desktop computer hard disk drive typically get up to about 7,200 rotations per minute (rpm), while the hard drives in laptop computers usually run at 5,400 rpm. The time taken by a Sector to come under the R/W head so that data can be read or written is called Rotational Delay.
When the computer is on but we don't read or write anything to the memory, the platters in the hard disk drive are always spinning. The arm with the heads on it, however, only begins to move when we run a program or open, save, or delete a file. This arm can move back and forth across the surface of the platter as many as 50 times in a single second,

causing it to appear as a blur. Because everything in the hard disk drive moves so quickly, the head never actually touches the platters, instead skimming just barely above them, supported by a cushion of moving air that is generated by the platters' spinning.
The rapid motion of the platters and heads inside the hard disk drive make it susceptible to "head crash," which is where the heads crash into the platters. Several different things can cause head crash. If dust gets into the hard drive and settles on the platters, it can actually cause the arm to bounce as the disk operates. The magnetic recording medium is extremely fragile, and is often ruined when the heads crash into the platters.

1.7.5.3 Optical Devices (CDs)

An optical disk is a compact disk or CD. The formatting of the optical disk will dictate whether it is a DVD, CD, read-only or rewritable. Optical disks have replaced Magnetic tapes, videotapes and floppy disks.
The optical disk became the preferred medium for music, movies and software programs because of its many advantages. Compact, lightweight, durable and digital, the optical disk also provides a minimum of 650 megabytes (MB) of data storage. A double-layered and double-sided DVD optical disk holds up to 16 gigabytes (GB) of data.
The optical disk is so named because its technology is based on light. As the disk spins, a Laser beam follows a spiral trail of pits and lands in the plastic material of the disk. The pits reflect light differently than the lands, while a device translates the reflective difference to **bits** of "on/off" or 1 and 0.
A standard optical disk measures 120 mm in diameter and 1.2 mm in thickness. The master optical disk is made from glass.
Notwithstanding music, movies and digital photographs, the optical disk is increasingly being used for data storage such as back up and archiving. Instant access to files and the ability to use a built-in DVD player all make the optical disk a superior choice over legacy tape backup units for the computer user.
A blank optical disk can be purchased in many formats. The least expensive will be an audio CD, as these are single-sided, single layered, and not rewritable. DVDs are more expensive, with a double-sided, double-layered optical disk being the most expensive.

1.7.5.4 Other storage devices

Other storage devices include Magnetic Tapes, Pen drives, Memory cards etc that can also be used for storage and Backup purposes.

1.7.6 Communication Devices

Communication is one of the important applications of computers and to communicate computers need various devices. Some of the devices needed are described below.

1.7.6.1 Modem

Computers need to talk to other computers over a Network or Internet. As we know that computer is a digital device whereas a telephone is an analog device. To enable the two different systems to work together, we need a device to convert data between the two formats. This is what the Modem does. Digital information from the computer is converted (Modulated) to analog and analog data from telephone is converted (Demodulated) to Digital. These two terms Modulate and Demodulate combine to give Modem its name. Modems can be Internal or External and they work at different speeds like 28 kbps, 56 kbps or higher.

1.7.6.2 Hub/Switch

Generally, a hub is any device that connects two or more network segments or supports several different media. Hubs broadcast whatever they receive from a transmitting device on a network. Switches are said to be intelligent Hubs as they send the received packets to the destination node only instead of broadcasting it on the whole network. Switches can be cut-through switches or Hybrid switches.

1.7.6.3 Bridge

A bridge interconnects two or more individual LANs or LAN segments. They can also connect networks using either the same or different type of architectures. Bridges are of different types like transparent bridges, Source routing bridges and Spanning tree bridges.

1.7.6.4 Router

A device responsible for determining the appropriate path a packet takes to reach its destination. Sometimes it is referred to as a gateway machine. A gateway is an application that converts between different protocols in a router.

1.8 Exercise

Q1 Fill in the Blanks

1) 3rd Generation Computers were based on _____technology
2) ULSI stands for_____
3) S/w embedded in H/w is called _____
4) A hand held computer is also called _____
5) The super computer developed by India is named_____
6) The three main components of a CPU are _____,_____and _____
7) Keyboard is a _____ special device

8) ALU works on the data and instructions held in _____
9) The time taken by R/W head to move to a track is called _____
10) Computers are broadly classified as _____ and _____
11) A modem is a _____ device
12) A switch is an _____ hub
13) A router routes_____
14) An application that converts between different protocols is called _____
15) A device that broadcasts packets on a network is called _____

Q2 Answer the following Questions

1) Briefly explain the different types of Computers?
2) What is a Computer? What are its characteristic features?
3) Illustrate and Explain the Block diagram of a computer?
4) Explain various generations of computers?
5) Differentiate between RAM and ROM?
6) Discuss the applications of computers in various fields?
7) Explain any two Input Devices?
8) Explain the following:
   a) Firmware
   b) Seek Time
   c) Rotational Delay
   d) Types of Hard Disk
9) Explain different types of Monitors?
10) Differentiate between a switch and a hub?
11) Explain some communication devices in computers?
12) How is a router different from a bridge?

1.9 Suggested Readings

1. Introduction to Information Technology, ITLES, Pearson Education

2. Introduction to Computer Science, ITLES, Pearson Education

3. Introduction to Computers, Peter Norton, Tata McGraw Hill

4. Modern Computer Hardware Course, Lotia and Nair, BPB Publications