INTRODUCTION TO COMPUTERS.

Definition of a Computer:

- A **Computer** is an electronic device that operates (works) under the control of programs stored in its own memory unit.
- A computer is an electronic machine that processes raw data to give information as output.
- An **electronic device** that accepts data as input, and transforms it under the influence of a set of special instructions called **Programs**, to produce the desired output (referred to as **Information**).

A computer automatically accepts data & instructions as input from an Input device, stores them temporarily in its memory, then processes that data according to the instructions given, and finally transfers the processed data (Information) to an Output device.

Explanations;

- A computer is described as an *electronic device* because; it is made up of electronic components and uses **electric energy** (such as electricity) to operate.
- A computer has an internal memory, which stores data & instructions temporarily awaiting processing, and even holds the intermediate result (information) before it is communicated to the recipients through the **Output devices**.
- *It works on the data using the instructions issued,* means that, the computer cannot do any useful job on its own. It can only work as per the set of instructions issued.

A computer will accept data in one form and produce it in another form. The data is normally held within the computer as it is being processed.

Program:

- A computer **Program** is a set of related instructions written in the language of the computer & is used to make the computer perform a specific task (or, to direct the computer on what to do).
- A set of related instructions which specify how the data is to be processed.
- A set of instructions used to guide a computer through a process.

Data:

Data is a collection of raw facts, figures or instructions that do not have much meaning to the user.

- Data may be in form of numbers, alphabets/letters or symbols, and can be processed to produce information.

TYPES OF DATA.

There are two types/forms of data:

a). Digital (discrete) data:

Digital data is discrete in nature. It must be represented in form of numbers, alphabets or symbols for it to be processed by a computer.

- Digital data is obtained by counting. E.g. 1, 2, 3 …

b). Analogue (continuous) data:

Analogue data is continuous in nature. It must be represented in physical nature in order to be processed by the computer.

- Analogue data is obtained by measurement. E.g. Pressure, Temperature, Humidity, Lengths or currents, etc
- The output is in form of smooth graphs from which the data can be read.

Data Processing:

- It is the process of collecting all items of data together & converting them into information.
- *Processing* refers to the way the data is manipulated (or handled) to turn it into information.

The processing may involve calculation, comparison or any other logic to produce the required result. The processing of the data usually results in some meaningful information being produced.

Information:

Information is the data which has been refined, summarized & manipulated in the way you want it, or into a more meaningful form for decision-making.

- The information must be accurate, timely, complete and relevant.

Comparison between Data and Information.

Data	Information
1. Unprocessed (raw) facts or figures.	**1.** It is the end-product of data processing (processed data)
2. Not arranged.	**2.** Arranged into a meaningful format.
3. Does not have much meaning to the user.	**3.** More meaningful to the user.
4. Cannot be used for decision-making.	**4.** Can be used to make decisions.

Characteristics / Features of a Computer.

Before 20th century, most information was processed manually or by use of simple machines. Today, millions of people are using computers in offices and at home to produce and store all types of information

The following are some of the attributes that make computers widely accepted & used in the day-to-day activities in our society:

1. **Speed**.
   Computers operate at very high speeds, and can perform very many functions within a very short time.

2. **Accuracy:**
   Unlike human beings, computers are very accurate, i.e., they never make mistakes.

   A computer can work for very long periods without going wrong. However, when an error occurs the computer has a number of in-built, self-checking features in their electronic components that can detect & correct such errors.

   Usually errors are committed by the users entering the data to the computer, thus the saying **Garbage in Garbage Out** (**GIGO**).
   This means that, if you enter incorrect data into the computer and have it processed, the computer will give you misleading information.

3. **Reliability**.
   The computer can be relied upon to produce the correct answer if it is given the correct instructions & supplied with the correct data.

   Therefore, if you want to **add** two numbers, but by mistake, give the computer a "*Multiply*" instruction, the computer will not know that you intended to "ADD"; it will multiply the numbers supplied.

4. **Consistency:**
   Computers are usually **consistent**. This means that, given the same data & the same instructions, they will produce the same answer every time that particular process is repeated.

5. **Storage:**
   - A computer is capable of storing large amounts of data or instructions in a very small space.
   - A computer can store data & instructions for later use, and it can produce/ retrieve this data when required so that the user can make use of it.
   - Data stored in a computer can be protected from unauthorized individuals through the use of passwords.

6. **Diligence**:
   Unlike human beings, a computer can work continuously without getting tired or bored. Even if it has to do a million calculations, it will do the last one with the same speed and accuracy as the first one.

7. **Automation**:
   A computer is an **automatic device**. This is because, once given the instructions, it is guided by these instructions and can carry on its job automatically until it is complete.
   It can also perform a variety of jobs as long as there is a well-defined procedure.

8. **Versatile**:
   A computer can be used in different places to perform a large number of different jobs depending on the instructions fed to it.

9. **Imposition of a formal approach to working methods**:
   Because a computer can only work with a strict set of instructions, it identifies and imposes rigid rules for dealing with the data it is given to process.

Review Questions.

1. What is a Computer?
2. Why is a computer referred to as an electronic device?
3. Define the following terms as used in computer science.
   a). Data.
   b). Programs.
   c). Data processing.
   d). Information.
4. **(a)** Briefly explain the two forms of data.
   (b) Give THREE differences between Data and Information.
5. The speed of a computer is measured in _____.
6. What does the term GIGO stands for?
7. List and explain 4 salient features/ properties of a computer.
8. List FIVE advantages of a computerized system over a manual system.

PARTS OF A COMPUTER.

A computer is made up of a collection of different components that are interconnected together in order to work as a single entity.

A Computer consists of the following parts/devices: -

1. The System Unit.
2. Input devices.
3. Output devices.
4. Storage devices.

System Unit.

This is the casing (unit) that houses electronic components such as the '*brain'* of the computer called the **Central processing Unit** (**CPU**) and storage devices.

The components in the System unit include: -

- Central Processing Unit (CPU), which is also referred to as **Processor**.
- Motherboard.
- Power supply unit.
- Memory storage devices.
- Disk drives, which are used to store, record and read data.

Types of System units

There are two makes of System units:

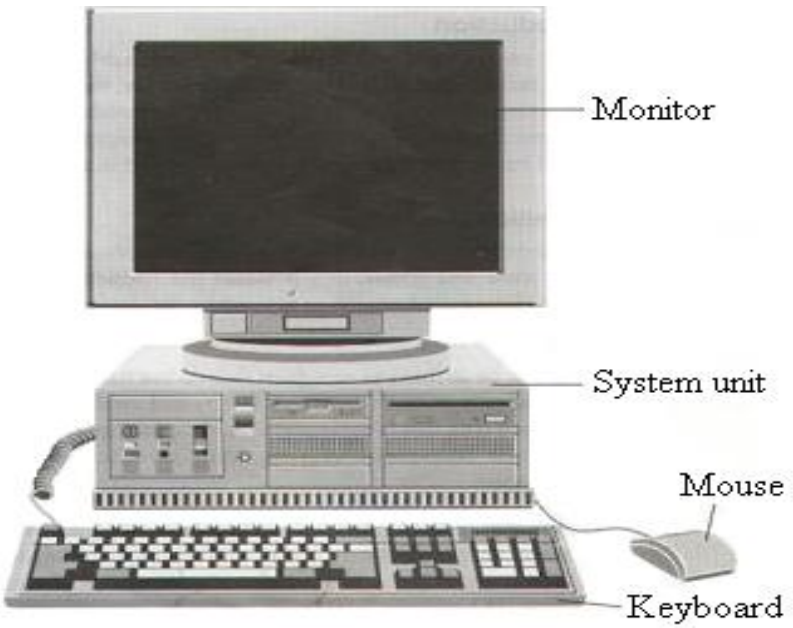
a) *Tower style system unit*

This system unit is made to stand alone. They are designed to be placed on the floor.

- Tower style units have more space for expansion than the typical desktop units.

b) *Desktop system units*

Desktop units lie on the desk with the monitor resting on top of the system unit.



Features of the System unit.

- It houses the CPU.
- It connects to all peripheral devices using ports.
- It has the computer's Power switch.

The Central processing unit (CPU)

This is the brain of the computer, and carries out all the processing within the computer.

Input devices.

These are the devices used to enter/put data into the computer.

- They accept data for processing & convert it into a suitable form that the computer can understand.

Examples: Keyboard, Mouse, Joysticks, Light pen, Scanner, etc.

The Keyboard

The keyboard looks like a typewriter, and has letters, numbers and other keys through which data is entered into the computer.

To enter data & instructions into the computer, the user should press the required keys.

The Mouse

It is a pointing device that enables the user to issue instructions to the computer by controlling a special mouse pointer displayed on the screen.

Output devices.

Output devices are used to give the end results of data that was entered into the computer.

- They extract/ disseminate processed data (information) from the computer.
- They accept data from processing devices & convert it into human sensible form.

Examples: Screens (Monitors), Printers, Graph plotters, Speakers, etc

The Monitor

It is a television like screen used for displaying output. When you type a letter or number on the keyboard, it shows up on the monitor.

Note. The monitor enables the user to monitor/track or see what is going on in the computer.

Printer

Printers are used to create permanent copies of output on paper.

Computer peripherals.

A computer is basically made up of a system unit and other devices connected to the system unit called ***Peripheral devices***.

Peripheral devices are the elements (components) connected to the system unit so as to assist the computer satisfy its users.

Peripheral devices are connected to the System unit using special cables called ***data interface cables*** that carry data, programs & information to and from the processor. The cables are connected to the system unit using connectors called ***Ports***.

Examples of peripheral devices include;

- Monitor,
- Printer.
- Plotter.
- Keyboard,
- Mouse
- Modem.
- Speakers.

Review Questions.

1. List down the components that make up a computer.
2. Clearly draw and label the main physical parts of a simple computer system.
3. What are computer peripherals?
4. **(a).** Name and explain the two main divisions of computer storage.
   (b). Give two common examples of secondary storage devices.
5. Name two output devices.
6. **(a).** Explain the term System unit.
   (b). Name some of the components found in the System unit.
   (c). Give three features of a computer's System Unit.
7. Why is the screen also called a Monitor?
8. What is a Mouse in relation to computing?

DEVELOPMENT OF COMPUTERS.

HISTORY OF COMPUTING.

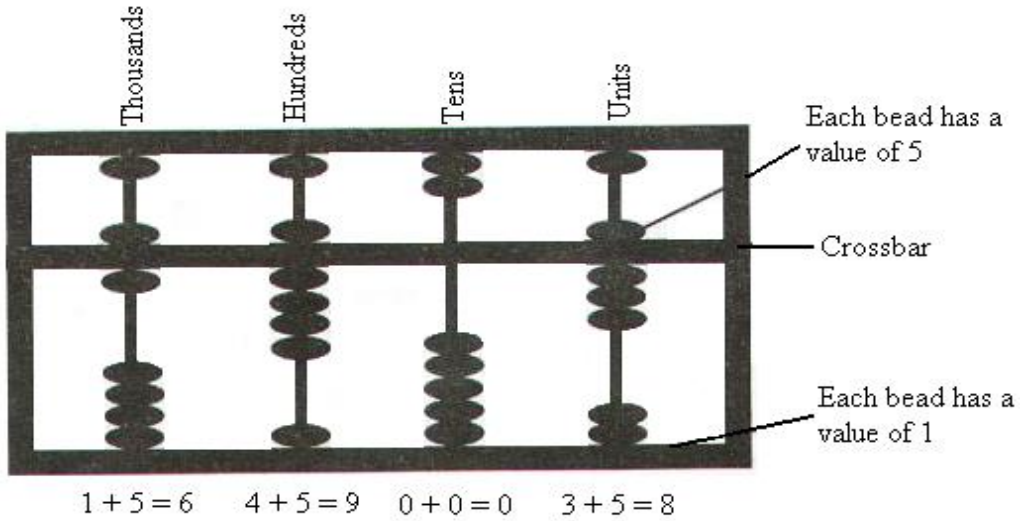
Before 1900, most data processing was done manually using simple tools like stones & sticks to count and keep records.
Around 2000 years ago, Asian merchants came up with a special calculating tool called **Abacus** that could be used to calculate large figures.

An Abacus is made up of a rectangular frame and a crossbar at the middle. It is fitted with wires or strings running across from the frame to the crossbar.

How to represent a number using an Abacus.

Each bead in the lower row has a value of 1, while each bead in the upper row has a value of 5. To represent a number, the bead is moved to the crossbar. Those beads away from the crossbar represent zeros.

The Figure below represents the number 6908 (Six thousand nine hundred and eight).



After Abacus, the first machine that is usually regarded as the forerunner of modern computers was named the **Analytical Engine**, and was developed by an English mathematician called *Charles Babbage*.

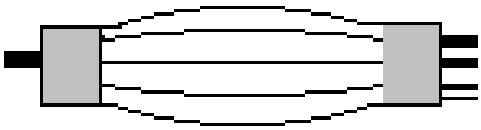
In 1939, *Professor Howard Aken* of Horrard University designed the first computer-like machine named **Mark 1**. Since then, a series of advancements in electronics has occurred. With each breakthrough, the computers based on the older form of electronics have been replaced by a new "generation" of computers based on the newer form of electronics.

COMPUTER GENERATIONS.

A **Computer generation** is a grouped summary of the gradual developments in the computer technology. The historical events are not considered in terms of individual years, but are classified in durations (a period of more than a year).

1ST Generation computers (1946 – 1956).

The 1st generation of computers used thousands of electronic gadgets called ***Vacuum tubes*** or ***Thermionic valves*** to store & process information.



Vacuum tube

The tubes consumed a lot power, and generated a lot of heat during processing due to overheating.

The computers constantly broke down due to the excessive heat generated, hence were short-lived, and were not very reliable.

They also used *Magnetic drum memories*.

Cards were used to enter data into the computers.

Their internal memory capacity was limited. The maximum memory size was approx. 2 KB (2,000 bytes).

The computers used big physical devices in their circuitry; hence they were very large in size, i.e. the computer could occupy several office blocks. For example, ENIAC occupied an area of about $150m^2$ - the size of an average 3-bedroom house.

They were very slow - their speed was measured in **Milliseconds**. E.g., ENIAC (the earliest electronic computer) could perform 5,000 additions per second & 300 multiplications per second.

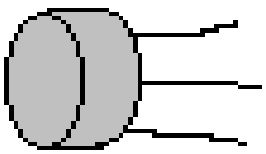
The computers were very costly - they costed millions of dollars.

Examples of 1ST Generation computers:

- **ENIAC** (**E**lectronic **N**umerical **I**ntegrator **A**nd **C**alculator) built in 1946 for use in World War II. It contained 18,000 Vacuum tubes.
- **EDVAC** (**E**lectronic **D**iscrete **V**ariable **A**utomatic **C**omputer) developed in 1945 by Dr. John Von Neumann. It was the first computer that used instructions stored in memory.
- **UNIVAC** (**UNIV**ersal **A**utomatic **C**omputer).
- **IBM 650**.
- **LEO** (**L**yon's **E**lectronic **O**ffice).

2ND Generation computers (1957 – 1963).

The 2nd generation computers used tiny, solid-state electronic devices called ***Transistors***. The transistors were relatively smaller, more stable & reliable than vacuum tubes.



Transistor

The computers consumed less power, produced less heat, were much faster, and more reliable than those made with vacuum tubes.

They used *Magnetic core memories*.

RAM Memory size expanded to 32 KB.

Their operation speed increased to between 200,000 – 300,000 instructions per second. Their speeds were measured in **Microseconds**. E.g., a computer could perform 1 million additions per second, which was comparatively higher than that of the 1st generation computers.

The computers were smaller in size & therefore, occupied less space compared to the 1st G computers.

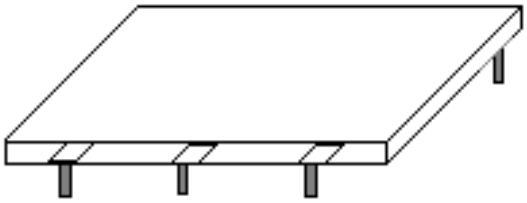
They were less costly than the 1st G computers.

Examples of 2nd Generation computers:

- NCR 501, IBM 300, IBM 1401, IBM 7070, IBM 7094 Series & CDC-6600 Mainframe computers.
- ATLAS LEO Mark III.
- UNIVAC 1107.
- HONEYWELL 200.

3RD Generation computers (1964 – 1979).

Used electronic devices called ***Integrated Circuits*** (**ICs**), which were made by combining thousands of **transistors** & **diodes** together on a semiconductor called a *Silicon chip*.



Integrated circuit

The processing speed increased to 5 Million instructions per second (5 MIPS).

The storage capacity of the computers (i.e., the RAM memory sizes) expanded to 2 MB.

They were smaller in size compared to 2nd generation computers.

The computers used a wide range of peripheral devices.

The computers could support more than user at the same time. They were also able to support remote communication facilities.

Magnetic disks were developed for storage purposes.

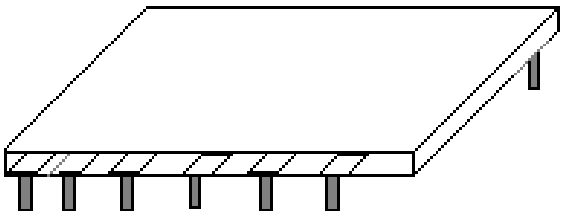
The 1st microcomputer was produced during this period (1974).

Examples of 3rd Generation computers:

- IBM 360, 370;
- ICL 1900 Series;
- 8-bit Microcomputers & PDP-11 Mainframe computers.

4TH Generation computers (1979 – 1989).

The 4th generation computers used **Large Scale Integrated** (**LSI**) circuits & **Very Large Scale Integrated** (**VLSI**) circuits. These circuits were made by compressing more tiny circuits and transistors into even smaller space of the silicon chip.



Very Large integrated circuit

The computers were small, and very fast. Their processing speeds increased to 50 Million instructions per second.

Had large storage capacity, i.e., their memory sizes expanded to several hundred Megabytes.

Memories used included Magnetic disks, Bubble memories & Optical disks.

Examples of 4th Generation computers:

- IBM 308 and 4300;
- Amdahl 580
- Honeywell DPS-88
- Burroughs 7700, and the 16-bit & 32-bit microcomputers. The first microcomputer was called *Apple II.*

5TH Generation computers (1990 – Present).

In this generation fall today's computers.

The technologies used are *Parallel architectures, 3-Dimensional circuit design* & *super conducting materials*.

These technologies have led to the development of computers referred to as *Supercomputers*, which are very powerful, and have very high processing speeds. Their speeds are measured in **Nanoseconds** & **Picoseconds**.

They are able to perform parallel (or multi-processing) whereby a single task is split among a number of processors.

The memory sizes range between 1 Gigabyte & 1 Terabyte.

The computers are designed using **VLSI** and the Microchip technology that has given rise to the smaller computers, known as Microcomputers used today.

The computers have special instruction sets that allow them to support complex programs that mimic human intelligence often referred to as ***Artificial Intelligence***. Such programs can help managers to make decisions and also provide critical expert services to users instead of relying on human professionals.

Review Questions.

1. Briefly describe the history of computers.

2. **(a).** What do you mean by computer generations?
(b). Describe the FIVE generations of computers in terms of technology used and give an example of a computer developed in each generation.
(c). Compare computer memory sizes during the Five computer generation periods.

3. What was the most remarkable discovery during the second computer generation?

4. **(a).** Technology is the basis of computer classification. Based on this, explain briefly the difference between the first three computer generations.
(b). What is so peculiar in the fourth and fifth generation of computers?

5. Match the following generations of computers with the technology used to develop them.

Generation	**Technology**
First generation	**A).** Very Large Integrated Circuit
Second generation	**B).** Thermionic valves (Vacuum tubes)
Third generation	**C).** Transistors
Fourth generation	**D).** Integrated Circuits

6. Give four characteristics of First generation computer.

7. Write the following abbreviations in full:
(a). ENIAC **(c).** IC
(b). VLSI

8. What is Artificial Intelligence?

FACTORS THAT DETERMINE THE TYPE OF COMPUTER.

1) Type of processor (Central processing unit – CPU)

Microcomputers use microprocessors, which are manufactured on a single chip, as their CPU.
In larger computers such as supercomputers, mainframe & minicomputers, the processing is carried out by a number of separate, high-speed components instead of a single processor.

2) Processing speed.

Every computer has a clock that drives its operations.
Larger computers have faster clocks and therefore can process many instructions per second compared to small computers, which have slower clocks.

3) Amount of Main memory (RAM).

All computers have some amount of RAM (**Random Access memory**), which is used to hold the instructions required to perform a task.

Larger computers have more RAM and therefore can handle large volumes of data & also support many and sophisticated programs which might require large memory sizes.

4) Storage capacity of the Hard disk.

The *storage capacity* is the amount of space that is available for storing the instructions required to manipulate data.

Larger computers have higher storage capacities than microcomputers.

5) Cost of the computer.

The cost of computers is directly related to the size. Microcomputers are less costly compared to minicomputers, mainframes or Supercomputers.

6) Speed of Output devices.

The speed of an output device is determined by the amount of information that can be printed in a specified amount of time.

The speed of microcomputer output device is less than that of the larger computers in that:

For a microcomputer, the speed of its output device is measured by the **number of characters printed per second** (**cps**). For larger computers, their output devices are faster and their speeds are measured depending on the **number of lines or pages printed per minute** (lpm / ppm).

7) Number of users who can access the computer at the same time.

Most microcomputers can support only 1, 2 or 3 users at the same time. However, they can be networked to share resources.
Larger computers can support hundreds of users at the same time.

Review Questions.

1. Briefly explain five factors that can be used to determine the type of a computer.

CLASSIFICATION OF COMPUTERS

Computers can be classified according to the following factors:

1. Physical size & processing power.
2. Purpose for which they are designed.
3. Functionality (Method/ mode of operation).

A. CLASSIFICATION ACCORDING TO PHYSICAL SIZE.

Computers can be classified into 5 main groups according to their size as:

- Supercomputers.
- Mainframe computers.
- Minicomputers.
- Microcomputers.
- Portable computers (Laptops, Notebooks & Palmtops).

Supercomputers.

Supercomputers are the fastest, largest, most expensive & also the most powerful computers available.

They are very fast in processing. They can perform many complex calculations in a fraction of a second.

Most Supercomputers use multiple processors. In this case, a single task is split among the processors for faster execution. However, all the processors are controlled by a single central processor.

Supercomputers generate a lot of heat, & therefore require special cooling systems. Sometimes, the whole CPU is deeped in a tank containing **liquid Fluorocarbon** to provide cooling.

Supercomputers are very large & heavy, and are usually kept under special environmental conditions (i.e., in a special room).

They are operated by computer specialists. A Supercomputer can be operated by over 500 users at the same time.

Areas where supercomputers are used:

Supercomputers are mainly used for complex scientific applications that involve many calculations & require a lot of computational power. Some of the applications that use supercomputers include;

- Weather forecasting.
- Petroleum research.
- Defence and weapon analysis.
- Aerodynamic design and simulation.

Note. These tasks use large amounts of data, which need to be manipulated within a very short time.

Examples of Supercomputers:

- CRAY T3D, NEC-500.

Mainframe computers.

Mainframes are less powerful & less expensive than supercomputers.

They are big in size but smaller compared to Supercomputers.

Are powerful computers with very high capacities of Main storage. They also have a large backing storage capacity.

Have a very high processing speed, i.e., can process large amounts of data very quickly.

They can support a large number of peripherals of different types (can support between 5–300 terminals).

They can handle hundreds of users at the same time, e.g., they can be operated by 200 users at a time.

Mainframe computers are general-purpose, and can handle all kinds of problems whether scientific or commercial.

Areas where mainframe computers are used:

Mainframe computers are mostly found in government departments, big organizations and companies which have large information processing needs, e.g., they are used;

- In Banks & Hospitals for preparing bills, Payrolls, etc.
- In communication networks such as the **Internet** where they act as Servers.
- By Airline reservation systems where information of all the flights is stored.

Examples of Mainframes:

- IBM 4381.
- ICL 39 Series.
- CDC Cyber series.

Minicomputers.

A Minicomputer is physically smaller than a mainframe. However, it can support the same peripheral devices supported by a mainframe.

A Minicomputer can support several users at a time, e.g., can be operated by 6 users at a time. Several workstations/ terminals are connected to one central minicomputer so that the users connected can share its resources (C.P.U time, storage, etc).

Minicomputers are easier to manufacture & maintain compared to mainframes.
Minicomputers are cheaper than the mainframes, but more costly than the microcomputers.

They handle small amounts of data, are less powerful, & have less memory than the mainframes.

Minicomputers are slow compared to mainframe computers.

Areas where minicomputers are used:

Minicomputers are used mainly in:

- Scientific laboratories & research institutions.
- Engineering plants/factories to control of chemical or mechanical processes.
- Space industry.
- Insurance companies & Banks for accounting purposes.
- Smaller organizations as Network **Servers**.

Example of Minicomputer:

- PDP-8 built in 1965 by **D**igital **E**quipment **C**orporation in U.S.

Microcomputers.

Microcomputers are the PCs mostly found today in homes, schools & many small offices. They are called ***Personal Computers*** (***PCs***) because they are designed to be used by one person at a time.

They consist of very few connected units, i.e. can support very few peripheral devices (usually 1 or 2).

The data processing in microcomputers is done by a **Microprocessor** (a single chip containing the Arithmetic Logic unit & Control unit).

Microcomputers are smaller in size & also cheaper than minicomputers. Their design is based on **Very Large Scale Integration** (VLSI) that confines several physical components into an IC.

They are less powerful than minicomputers & their internal memory is smaller than that of minicomputers.

Areas where microcomputers are used:

Microcomputers are commonly used in:

- ✔ Training and learning institutions such as schools.
- ✔ Small business enterprises, and
- ✔ Communication centres as terminals.

Microcomputers have become very popular because of the following reasons:

1) Are cheaper than both mini & mainframe computers.
2) Are very fast (i.e. have high processing speeds).
3) Small in size, hence they occupy less space in an office.
4) Are more energy efficient (i.e., consume less power).
5) Are more reliable than the early Mainframe computers.

Examples:

- ♦ IBM PCs such as Apple Macintosh, Dells, Compaq, etc.

Laptops & Notebooks.

A Laptop is a PC sufficiently small & light such that a user can use it comfortably on his/her lap. It is designed to be used by placing it on the lap.

- Laptops are very small in size & are portable. They are small enough to fit inside a briefcase; still leaving room for other items.
- A Laptop computer operates mainly on electricity or by rechargeable batteries.
- Laptops normally have in-built disk drives & Flat screens (*Liquid Crystal Displays*).
- Can only support a limited number of peripheral devices.
- Have limited storage capacities.

Note. The smaller computers like Laptops tend to be more expensive than Desktop computers because of the following reasons:

1) The technology of producing smaller devices is expensive.
2) They are convenient because they are portable.
3) They have advanced power management capabilities (they consume less power since a laptop can operate on rechargeable batteries).

Palmtops.

Palmtops are small enough to fit in the pocket, and can be held in the palm when being used.

- Have limited storage capacities.
- Palmtops are mainly used as Personal Organizers, with some minimal programs for calculations, Word processing, Spreadsheets, & E-mail.

Example of a Palmtop; *Personal Digital Assistant* (*PDA*).

Desktop computer.

This is the name given to any computer designed to be used when placed on a desk in an office environment.

- They are not portable.

Examples of desktop computers:

1) Home computer.

This is a low-cost microcomputer of limited capability designed for domestic use. It has programs that are used typically for computer games or controlling family finances.

2) Personal computer (PC).

This is a microcomputer designed for independent use by an individual at work or in the home mainly for business purposes.

- A PC can support only 1 user at a time.
- PCs are mostly used in offices, schools, business premises, and at home for various applications like computer literacy, Games, Database management, Accounting, Word processing, Telecommunications, etc.
- A PC can be connected to a mini & mainframe computer so as to enable the user access the facilities offered by the larger machines.

3) Workstation.

A *workstation* is usually a desktop computer with all the facilities but interlinked to a network.

A typical workstation works in a similar way to a Personal computer. However, it is more advanced than a typical PC in the following ways:

i). It is larger & more powerful than a PC. E.g., workstations use 32-bit microprocessors, while PCs use 16-bit microprocessors.
ii). It has in-built capabilities for its interconnection & operation with other computers, i.e., it is fully connected to a computer network as any other computer on the network in its own right.
iii). It has high resolution graphics.
iv). It has a Multi-tasking operating system, i.e. it is able to run multiple applications at the same time.

An Embedded computer.

This is a computer that is within another device or system but is not accessed directly. E.g., there are embedded computers operating within Petrol pumps, Watches, Cameras & Video recorders.

B. CLASSIFICATION ACCORDING TO PURPOSE.

Digital computers can be classified further according to the tasks they perform either as:

- General-purpose.
- Special purpose
- Dedicated computers.

General-purpose computers.

General-purpose computers are designed to perform a wide variety of tasks. They use specifically written instructions (programs) to carry out the desired processing tasks.

Example;

A single computer can be used to process documents, perform calculations, process the Payroll, simulate the loading on a bridge, process Insurance policies, and play games, among others.

Examples of general-purpose computers: Mainframes, Minicomputers, Microcomputers & Laptops used in most offices & schools.

Special-purpose computer.

A special-purpose computer is designed to handle/accomplish a particular specific task only.

Such computers cannot perform any other task except the one they were meant to do. Therefore, the programs which are used in a special-purpose computer are fixed (hard-wired) at the time of manufacture.

For example;

In a computer Network, the **Front End Processor** (**FEP**) is only used to control the communication of information between the various workstations and the host computer.

A Special-purpose computer is dedicated to a single task; hence it can perform it quickly & very efficiently.

Examples of special-purpose computers:

- Robots used in a manufacturing industry for production only.
- Mobile phones used for communication only.
- Calculators that carry out calculations only.
- Computers used in Digital watches.
- Computers used in Petrol pumps.
- Computers used in Washing machines.
- An Automatic pilot – a computer dedicated to the task of operating an aircraft.
- A Word processor – a special-purpose computer used in the production of office documents, letters, etc.

Reasons why a Mobile phone is regarded to be a computer.

- ✔ It is electronic.
- ✔ Has a screen.
- ✔ It has a Keypad.
- ✔ Has a Memory.
- ✔ It is programmable.

Dedicated computer.

A **Dedicated computer** is a general-purpose computer that is committed to some processing task; though capable of performing a variety of tasks in different application environments. E.g., the computer can be dedicated to carrying out Word processing tasks only.

C. CLASSIFICATION ACCORDING TO FUNCTIONALITY.

Usually, there are two forms of data; **Digital data**, and **Analogue data**. Computers can be classified according to the type of data they can process as either.

- ♦ Digital computers.
- ♦ Analogue computers, or
- ♦ Hybrid computers.

Digital computers.

This is the most commonly used type of computers.

A **Digital computer** is a computer that operates on discrete data only. It can process both numeric & alphabetic data within the computer, e.g., 0, 1, 2, 3…, A,B,C….

Their operation is based on 2 states, "ON" & "OFF" or on digits "1" & "0". Therefore, any data to be manipulated by a digital computer must first be converted to digital form.

Their output is usually in form of numbers, alphabets, & symbols.

Digital computers are usually general-purpose computers; hence, they are widely used in different areas for data processing.

Most of the devices found at homes today are digital in nature.

Digital computers are less accurate, i.e. may not solve all your problems since the facilities provided are generalized.

Examples:

- A Television with a button which is pressed to increase or decrease the volume.
- Digital watches.
- Calculators.
- Microcomputers. They are said to be digital because they posses the ALU.

Analogue computers.

An **Analogue computer** is a computer that operates on continuous data.

They carry out their data processing by measuring the amount of change that occurs in physical attributes/quantities, such as changes in electrical voltage, speed, currents, pressure, length, temperature, humidity, etc.

An Analogue computer is usually a special-purpose device that is dedicated to a single task. For example, they are used in specialized areas such as in:

- Scientific or engineering experiments,
- Military weapons,
- Controlling manufacturing processes like monitoring & regulating furnace temperatures and pressures.
- Weather stations to record & process physical quantities, e.g., wind, cloud speed, temperature, etc.

The output from analogue computers is in form of smooth graphs produced by a plotting pen or a trace on a Cathode Ray Tube (CRT) from which the information can be read.

Note: Analogue computers usually use one characteristic, e.g. a length, to give information about another physical characteristic, such as weight.

Analogue computers are very accurate & efficient since they are dedicated to a single task.

They are very fast since most of them use multiple processors.

Examples of analogue devices:

- **The computer used to control a flight simulator for training pilots.**
  The computer responds to the Cockpit simulator control movements made by the pilot to physically change the environment so that the pilot feels as if he were controlling an actual aeroplane.
- **A Bathroom scale.**
  It uses the weight of a person to move a pointer smoothly/continuously over calibrated scale, which shows the person's weight.
- **Thermometer.**
  It uses a volume of Mercury to show temperature. The Thermometer is calibrated to give an exact temperature reading.
- **Speedometer.**
  In Speedometer, the rotation of the wheel is converted to a voltage, which causes a pointer to rotate over a dial calibrated in Km/h or Miles/h.
- A **Petrol pump** measures the rate of flow of Gasoline (petrol) & converts the volume delivered to 2 readings; one showing the volume & the other showing the cost.
- A **Post-office scale** converts the weight of a parcel delivered into a charge for posting.
- A Monitor with knobs that are rotated to increase brightness.
- A Television with knobs that are rotated to increase or decrease the volume.
- A Radio with a knob that slides in a slot to increase volume.

Hybrid computers.

Hybrid computers are designed to process both analogue & digital data. They combine both the functional capabilities of the digital and analogue computers.

Hybrid computers are designed by interconnecting the elements of a digital computer & analogue computer directly into one processor, using a suitable interfacing circuitry.

Hybrid computers are more expensive.

Example;

In a hospital **Intensive Care Unit**, an analogue device may be used to measure the functioning of a patient's heart, temperature and other vital signs. These measurements may then be converted into numbers and send to a digital device, which may send an immediate signal to the nurses' station if any abnormal readings are detected.

Comparison between a Computer and Calculator.

Computer	Calculators
1. Costly due to the technology used.	**1.** Cheaper – they imitate simple computer technology.
2. Bigger in size.	**2.** Comparatively smaller.
3. Operate at very high speeds.	**3.** Slower than computers.
4. Are more accurate – they give up to over 10 decimal places of accuracy.	**4.** Less accurate – most calculators give up to 8 dp of accuracy.
5. Flexible – can be used in solving any problem.	**5.** Mostly used for numerical calculations involving arithmetic/ mathematical operations
6. Work under the control of programs.	**6.** Calculators are non-programmable, but if programmable, the range is limited.
7. Support a variety of peripherals, e.g. keyboard, mouse, light pen, printer, etc.	**7.** They only use Display units & Keyboards of limited capabilities.
8. Have large internal memory of several KB's.	**8.** their internal memory is very small. Most calculators only use **Registers** for temporary storage during calculations.
9. Support large Backing storage media.	**9.** Some calculators have got some sort of fixed Backing store, though very limited.
10. A computer can support several people at the same time.	**10.** A calculator can serve only 1 user at a time.
11. Have got telecommunication capabilities.	**11.** Have no telecommunication capabilities.
12. Require well-monitored environmental conditions.	**12.** Do not require well-monitored environmental conditions.

Review Questions.

1. State three methods of classifying computers. In each case, list the different types of computers.
2. What is a Personal computer?
3. Differentiate the following types of computers.
   - **a).** Supercomputer and Mainframe computer.
   - **b).** Minicomputer and a Personal computer.
   - **c).** Special-purpose (dedicated) computers and General-purpose computers.
   - **d).** Desktop computers and Laptop computers
4. Briefly describe terms "Analogue" and "Digital computers" as used in computer science.
5. Give three examples of Special-purpose computers.
6. Name any **FOUR** classes of computers based on size and complexity.

ADVANTAGES OF USING COMPUTERS.

Computers have many advantages over other types of office and business equipments that are used for data processing functions. Some of the advantages are:

1) *Computers process data faster*:
The processing speed of a computer when measured against other devices like typewriters & calculators is far much higher.

2) *Computers are more accurate & reliable*:
Computers produce more accurate results as long as the correct instructions & data are entered. They also have the ability to handle numbers with many decimal places.

3) *Computers are more efficient*:
A computer requires less effort to process data as compared to human beings or other machines.

4) Computers can quickly and effectively store & retrieve large amounts of data.

5) They are very economical when saving information, for it can conserve a lot of space.

6) Computers occupy very little office space.

7) Computers help to reduce paper work significantly.

8) *Computers are flexible*:
A computer can perform a variety of jobs as long as there is a well-defined procedure.

9) *Computers are cheap*:
They can be used to perform a number of organizational functions/ activities, which are meant for individual persons, hence reducing the number of employees & the costs.

10) *Computers enhance security & confidentiality*:
Data stored in a computer can be protected from unauthorized individuals.

11) Have made communication easier.

12) *Computers produce better information*:
Computer output is usually tidy and error-free (accurate).

13) Computers reduce the problems of data or information duplication:

14) Computers can operate in risky environments, e.g. volcanic sites, dangerous chemical plants, where human life is threatened:

DISADVANTAGES OF USING COMPUTERS.

1) Computers are very costly in terms of purchase & maintenance.

2) Computers can only be used areas where there is source of power.

3) Requires skilled manpower to operate, i.e., one has to have some knowledge so as to operate a computer.

4) The records are usually kept in a form that is not visible or human-readable. This makes it difficult to control the contents of the computer's master file.

5) A computer, like any other machine can break down.

6) Information stored in computers can easily get lost due to power interruptions or machine breakdown.

7) A computer doesn't have its own intelligence, i.e., it cannot do any useful job on its own, but can only work as per the set of instructions issued.

8) Installation of computers causes retraining or retrenchment of staff/ employees.

9) The computer technology is changing very fast such that the already bought computers could be made obsolete/ out dated in the next few years.

In addition, this rapid change in the computer technology makes computers & related facilities to become outdated very fast, hence posing a risk of capital loss.

10) The emergence of computers has increased the rate of unemployment since they are now being used to perform the jobs, which were done by human beings.

11) Computers have led to increase in computer crimes especially in Banks. The computer criminals steal large amounts of funds belonging to various companies by transferring them out of their company accounts illegally. In addition, they destroy vital data used in running the companies.

AREAS WHERE COMPUTERS ARE USED.

The following are some of the areas where computers are used:

1. Supermarkets.

- Supermarkets and other retail stores use computers for stock control, i.e., to help them manage their daily activities.
  The stock control system keeps record of what is in store, what has been sold, and what is out of stock. The Management is automatically alerted when a particular item or items are running out of stock and need to be reordered.
- For calculating customer's Balance.
- For production of receipts.
- It can be used as a barcode reader.

2. Industries.

The use of computers has made Industries more productive & efficient. They are used:

- To monitor and control industrial processes. The industries use remote controlled devices called **Robots**. A *Robot* is a machine that works like a human being, but performs tasks that are unpleasant, dangerous, and tedious to be done by human beings.
- For management control, i.e. to keep track of orders, bills and transactions.
- By companies as a competitive tool. E.g., they are used to assist in defining new products & services. They also help industries form new relationships with suppliers and therefore, enable the producers maintain a competitive edge against their competitors.
- For advertisement purposes, which enable an industry to attract more customers.

3. Banks/Insurance industries

Computers are used by Banks & Insurance industries:

- To manage financial transactions. They use special cash dispensing machines called **Automated Teller Machines (ATMs)** to enable them provide cash deposit & withdrawal services.
- For processing of Cheques.
- For preparation of Payrolls.
- For better record keeping and processing of documents.
- To provide electronic money transfer facilities.

4. Process control.

Computers are used in production environments such as factories to control chemical & mechanical processes. The computers are usually loaded with specialized programs & each computer is designed to do a specific job.

5. Hospitals.

Computers are used in hospitals:

- To keep & retrieve patient's medical records.
- For automatic diagnosis of diseases like Cancer, electro-cardiogram screening & monitoring.
  They are used to get a *cross-sectional view of the patient's body* that enables physicians to properly diagnose the affected part of the body with high levels of accuracy.
- In medical equipments, e.g. blood pressure monitors, blood analyzers, etc.
- To control life-supporting machines in the **Intensive Care Units** (**ICU**).
- To enable medical experts in different countries to share their expertise or labour, thus reducing the transportation of patients & professionals.

6. Offices.

- For receiving & sending of messages through e-mails, fax, etc.
- Production of documents.
- Keeping of records.

7. Government Institutions.

Computers are used in government ministries & agencies:

- To store/keep records and improve the efficiency of work within the Civil service.
  If computers were not used, the large number of files in government registries would make information recovery extremely difficult.
- To produce bills & statements.

8. Education.

Computers are widely used in the teaching & learning process. Learning and teaching using computers is referred to as *Computer Aided Learning* (*CAL*) and *Computer Aided Teaching* (*CAT*).

- Computers are used in learning institutions (schools & colleges) as teaching aids, i.e. to help in teaching various subjects.
  E.g., they are used to demonstrate experiments in subjects like Chemistry or Physics using a special program that can illustrate them on the screen through a process called **Simulation**.
- To assist the Long distance learning in universities usually referred to as the *Open University Concept*.
- To analyze academic data.
- Computers are used in Aviation for training of pilots. **Flight simulators** are used to monitor the control movements made by the pilot while the computer is used to physically change the environment so that the pilot feels as if he were controlling an actual aircraft.

9. Research.

Computers can be used for research in various fields. They are used by:

- Scientists to analyse their experimental data, e.g., in weather forecasting.
- Engineers & Architects to design & test their work.
- Computers have greatly assisted in space exploration.
  - They are used to study the movement of stars.
  - They have made manned & unmanned space exploration possible – they are used to launch space vehicles and monitor the flights & activities both onboard and around them.

10. Communication industry.

The integration of computers & telecommunication facilities has made the transmission and reception of messages very fast and efficient.

- They are used in telephone exchanges to switch incoming & outgoing calls.
- For sending & receiving electronic messages, e.g. fax and e-mails, if connected to a computer network.

11. Transport industry.

Computers are used in:

- Automobile traffic control, e.g., to monitor vehicle traffic in a busy town.
- Railway corporations to co-ordinate the movement of their goods & wagons.
- Shipping control. The computers are used for efficient management of fleets & communication.
- Airports (Airline industry). The computers are used;
  - To control the movement of aircrafts, take off & landing through the use of radar equipment.
  - Making reservations (booking purposes).
  - Storing flight information.

12. Police (Law enforcement agencies).

- Computers are widely used in fighting crime. The Police use computers to keep databases on fingerprints and also analysed them.
- The Police also use computers for face recognition, scene monitoring & analysis, which help them to arrest traffic offenders and criminals.

The information held in computers such as fingerprints, photographs and other identification details helps law enforcers to carry out criminal investigations speedily.

13. Defence.

- Computers are used in electronic news gathering, efficient communication, detecting and tracking of targets; in radar systems, warning systems & in guided missile systems.
- Computers are used in military defence equipments, e.g. Fighter jets, Rockets, Bombers, etc.

14. Multimedia applications.

- Computers are used to prepare business presentations for advertisement purposes.
  The presentations are done using overhead projectors attached to computers running slide shows & digital video clips taken using a ***Camcorder***. An overlaid voice is used to describe the product.
- Computers are used in music related equipment such as **Synthesizers.**
- In entertainment (i.e., games & movies), computers are used to add stereo sound & digital video clips, which make games more realistic.
- In Education & Training, Multimedia discs are used as teaching aids for all types of subjects.

15. Domestic and Entertainment systems.

Computers are used at homes:

- For watching movies, playing music and computer games.
- For storing personal information.
- For calculating and keeping home budgets.

- For shopping purposes. They provide people with lists of shopping items as well as their prices. They also provide electronic money transfer facilities.
- In household items, such as, Microwave ovens, Televisions, etc.

16. Library services.

Computers can be used in a library:

- To enable the library personnel to easily access & keep updated records of books and other library materials.
- To search for book titles instead of using the manual card catalogue.

17. Employment.

The emergence of computers has provided employment opportunities to very many people.

Review Questions.

1. Explain exhaustively the importance of computers in the following areas:
   i). Industries.
   ii). Hospitals.
   iii). Education
   iv). Research.
   v). Communication industry.
   vi). Law enforcement agencies.
   vii). Domestic and Entertainment.

2. Explain various ways computers have been mostly used in our country.

3. List down and explain 6 uses of computers in our society.

4. Explain the similarities and differences between human beings and computer systems.

COMPUTER LABORATORY.

Definition:

A *Computer laboratory* is a room that has been specially prepared to facilitate installation of computers, and provide a safe conducive environment for teaching & learning of Computer Studies.

SAFE USE & CARE OF COMPUTERS (COMPUTER HYGIENE)

Computer systems are expensive to acquire & maintain, and should therefore be handled with great care. Most computer breakdowns are caused by failure to follow the correct instructions on use of equipment, carelessness, and neglect.

Computer hygiene involves keeping the computers in good care & order.

Factors to consider when preparing a computer laboratory.

The following factors must be considered when preparing a computer laboratory:

1. Security of the computers, programs and other resources.
2. Reliability of the source of power.
3. Number of computers to be installed, and the amount floor space available.
4. The maximum number of users that the laboratory can accommodate.

Requirements of a Computer Laboratory.

i). Standard and Enough furniture.
ii). Good ventilation.
iii). Reliable & Enough source of power supply.
iv). Free from Dust and Moisture.
v). Enough floor space.
vi). Proper cabling of electric wires.
vii). Fire fighting equipment.
viii). Good lighting equipment.
ix). Strong rooms & doors for the security of computers.

Review Questions.

1. Define a computer Laboratory.
2. Give three factors to be considered when preparing a computer laboratory.
3. What are the requirements of a computer laboratory?

SAFETY PRECAUTIONS & PRACTICES IN A COMPUTER LABORATORY.

After establishing the computer laboratory, a number of safety precautions, rules, and practices need to be observed in order to avoid accidental injury to the users, damage of computers or lack of a conducive environment for teaching and learning.

The safety precautions and practices include;

1. BEHAVIOUR IN THE COMPUTER LABORATORY.

The following rules must be followed in and around a computer laboratory.

a). Entering the computer room.

- Only authorized people should enter the computer room.
- Remove your shoes before entering the computer room to prevent dust.
- Avoid smoking or exposing computers to dust. This is because; smoke & dust contain small abrasive particles that can damage computer components and cause wearing of the moving parts.

- Do not carry foods such as Toffees, chocolates, chewing gums, & drinks/beverages to the computer room.

  Food particles may fall into the moving parts of the computer and damage them. Liquids may spill into the computer parts causing rusting or electrical faults.
- Collect any waste materials (e.g., paper bits) which might be lying in the computer room & put them into the dustbin.
- Avoid unnecessary movements, because you may accidentally knock down the peripheral devices.
- Computer users should be trained on how to use computers frequently.
- Computer illiterates should not be allowed to operate the computers.
- Shut the door of the computer room properly.

b). Starting and shutting down the computer.

- Always follow the proper procedure for starting & shutting down the computer to avoid loss of data and damage to computer programs.
- Avoid turning the computer **on** & **off** frequently as it is harmful. Every time a PC is turned on, the internal components *get heated* and again *cool down* when the computer is turned off. As a result, the circuit boards expand & contract and this can badly affect the **solder-joints** of the computer.
- Do not open up the metallic covers of computers or peripheral devices without permission and particularly when the computer's power is still on.

2. PROTECTION AGAINST FIRE AND ACCIDENTS.

Fire outbreaks in the laboratory can be caused by either:

a). *Inflammable chemicals*, such as those used for cleaning & servicing the computer equipment.
b). *Electrical faults*, such as open wires or cables.
c). *Smoking.*

- Keep the chemicals away in a store after using them to avoid any accidents.
- Ensure that all electrical wires are properly insulated. Open wires or cables must be properly covered with an Insulating tape or replaced with new ones as they can cause fire leading to damage of equipment.
- The computer room must always have a gaseous fire extinguisher especially those containing **Carbon dioxide** in case of any accidents.

  Note. Water based or Powder extinguishers should not be used in the computer room because; they can cause damage to computer components.

  Water causes rusting of the metallic parts and short circuits, while *Powder particles* normally settle on storage devices and may scratch them during read/write operations.
- Any incidence that may result in damage to equipment should be reported to the person in charge of the laboratory.
- No student should attempt to repair the equipment as this may lead to complete damage of the equipment.

3. INSULATION OF CABLES.

- All power cables in the computer room must be properly insulated and laid away from busy pathways in the room (i.e., preferably along the walls). This prevents the user from stumbling on the cables, which might cause electric shock or power interruptions.
- System cables should be of the best quality & type, and should also be properly clipped (fixed).

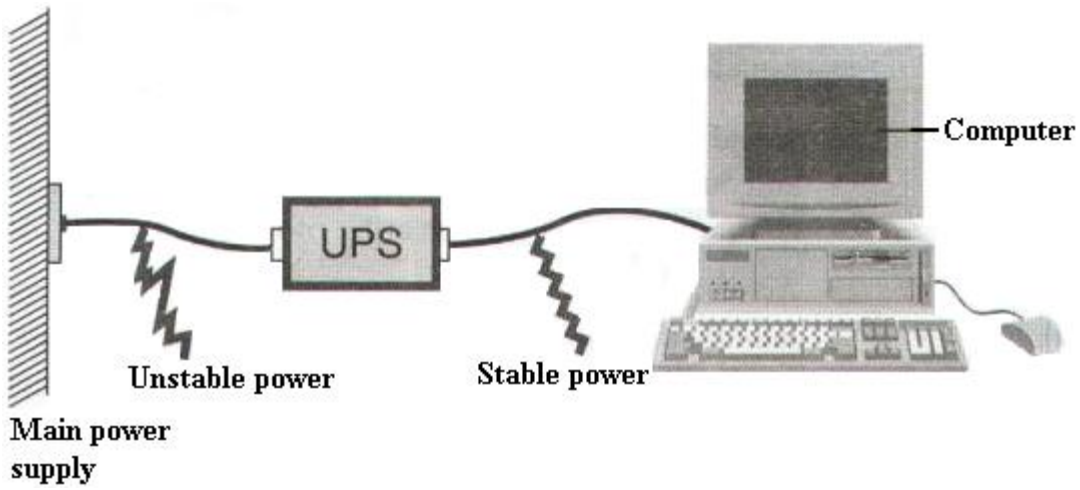
- The cables should be handled carefully especially at the ends to avoid breaking the pins.

4. STABLE POWER SUPPLY.

Computers are delicate devices that require a stable source of power.

- Ensure that there is a steady flow of input power to the computer in order to prevent loss of data or information & also prevent damaging the computer's secondary storage media.

Note. Power from main supply is not always stable and may sometimes experience power surges or under voltage (also referred to as **Brownout**). To protect the computer from being damaged due to power instabilities especially in areas where power fluctuates, avoid connecting it directly to the main supply. Instead, it is important to connect the computer to a special power correction equipment or device such as a **Stabilizer** or **Uninterrupted power supply /source** (**UPS**), then connect the UPS to the main supply.



The UPS gets charged when the main power is on. When the main power goes off, the UPS gives some sound (usually a beep) to alert the user.

Functions of the UPS

1. It regulates power from an unstable power source to the required clean stable voltage.
2. It prevents power surges and brownouts that might destroy the computer.
3. It temporarily provides power to the computer in case of the main power failure. This allows the user to save his/her work and shutdown the computer using the correct procedure.
4. Alerts the user of any power loss (by beeping).

To ensure that work continues even in the absence of main power, organizations that give important services such as banks, schools, & hospitals usually install devices that provide alternative sources of power such as *standby generators, solar panels, rechargeable batteries,* etc that automatically comes on in case of a power failure. Such devices are referred to as **Power backups**.

However, note that, power from a generator must pass through a UPS before being fed to the computer, because it is also not stable.

- Ensure that all power or electrical sockets are firmly fixed.

5. BURGLAR PROOFING.

Physical access to the computer room should be restricted to ensure that only authorized persons get access to the computers.

To prevent unauthorized access to the computer room, the following controls should be implemented:

- Fit strong metallic grills and locks on the doors, windows & roofs (in case the roofing is weak).
- Lock the doors, (i.e., keep the computers in a strong room, which should remain firmly locked when not in use).
- Avoid welcoming strangers into the computer room.
- Use of Personal Identification cards.
- Use of fingerprint identification.
- Install security alarms at strategic access points so as to alert the security personnel in case of a break in.
- Use of special voice recorders that would be able to analyse the voice of a trespasser & check against the database containing the voice patterns of valid users.
- Secure/protect the computers with Passwords to minimize chances of theft.

6. VENTILATION.

Both computers and human beings emit heat energy into the environment. Therefore, the computer room must have good circulation of air to avoid overheating and suffocation.

Proper ventilation enables the computers to cool, and therefore, avoids damaging the electronic parts.

The following facilities can ensure proper ventilation in a room:

- ✔ The room should have large & enough windows & doors.
- ✔ Installing an air-conditioning system.
- ✔ Installing cooling fans.
- ✔ Avoid overcrowding of either machines or people in the room.

7. DUST CONTROL

- ♦ Set up the computer laboratory in a location away from excessive dust.
- ♦ Remove your shoes before you enter the computer room to prevent dust.
- ♦ The computer room should be fitted with special curtains that would reduce entry of dust particles.
- ♦ The floor should be covered with Carpets in order to absorb dust, and also absorb the noise made by chairs.
- ♦ Cover the computer devices with Dust covers when not in use or when cleaning the computer room.

NB: If the environment is dusty, the computers should be regularly serviced to get rid of harmful dust.
The service should include; blowing dust from the System unit, cleaning the floppy drives, cleaning the Keyboard, cleaning the Monitor externally, and also cleaning all peripheral devices such as Printers and Mouse.

8. DUMP CONTROL.

Humidity in the computer laboratory must be regulated to remain at an optimum 50%. If the humidity is low, it allows static electricity to build up and causes damage to sensitive electronic components. Similarly, high humidity of over 70% causes rusting of the metallic parts of the computer system.

To eliminate low humidity, place humidifiers in the room, while high humidity can be controlled by installing dehumidifiers in the room.

9. HANDLING OF MATERIALS & EQUIPMENT.

Computer devices must be handled with a lot of care as they are extremely fragile and can easily get damaged. Dropping or bumping can cause permanent damage on the device, e.g., to transport the System unit always handle it on its frame.

- Always use the manufacturer's shipping carton when transporting the devices.
- Do not place heavy objects on the computers.
- Protect the computer devices especially the Monitor & the disks from any electrostatic discharge.
- The computer devices should not be exposed to direct sunlight or warm objects. This causes the internal components of the computer to get heated, and as a result, effects the computer's solder-joints.
- Students should only perform operations on the computer that they are sure of and under supervision. If in doubt, the student should ask to ensure that no damage is caused due to lack of proper knowledge.
- Computer equipment should be regularly checked and serviced.

Floppy disk management.

Floppy disks are used to store data, and if properly taken care of, they reduce the likelihood of destroyed or corrupted data.

Note. Data is very difficult & expensive to reconstruct, unlike application software, which can easily be re-loaded.

Handling precautions for diskettes.

1). Insert the diskette in the drive with the correct side up & in the correct direction. The diskette should slide in easily (with no force at all) until it locks in the drive. To remove the diskette out of the drive, press the **Eject** button.

2). Don't touch the exposed surface of the diskette when inserting or removing it.

3). Don't remove the diskette from the drive if the drive light is shining. This indicates that the diskette is in use, and removing it might damage the files on the diskette.

4). Never leave the diskette in the computer after finishing its job.

5). Ensure that all your diskettes are labelled carefully using meaningful names that indicate the right contents of the diskette. The labels should be applied at the slightly depressed region at the top surface of the diskette.

Labelling prevents confusing the data in the different diskettes, and also mixing diskettes that are used everyday with those used for long-term storage of important data.

6). Use a soft writing material such as a soft felt pen to write on the diskette.

7). Use the shutter at the bottom of the diskette to write-protect it in order to protect the data stored in it.

Note. To write-protect the diskette, the shutter is pushed up until the hole is covered & no data can be written to the diskette. To write to the diskette, the hole must be left open.

8). Avoid overusing the diskette. If used for long (usually over 6 months), its surface wears out.

9). Never place heavy objects on the diskette to avoid damaging it.

10). Keep your disks safely away from extreme temperatures or direct sunlight, i.e., avoid placing the diskette near possible heat sources, e.g. on top of monitor displays.

11). Keep floppy disks away from any magnetic media, e.g., near power supplies & magnets. They can corrupt the data.

12). Never carry disks in loose bags or in pockets to prevent dust from getting in & harming them.
Store your diskettes in disk banks or a proper storage jacket. Use envelopes or enclosed polythene when carrying them.

13). Always store the disks vertically in the storage box/container.

14). Never use clips or staples to hold the disks to avoid damaging them.

15). Do not bend the diskette, or leave it lying on top of the desk.

16). Protect the diskettes against computer viruses, i.e. you should not use foreign diskettes in your computer, especially if you suspect that they might have viruses in them.

Use of Printers.

1. Different printers have different sensitivity to *printing papers*. Using the wrong quality paper in a particular printer can make the paper get stuck.
2. Printers are very specific to manufacturer's *cartridges* & *ribbons*. Use of clones or imitations (i.e., the wrong make & model) can damage the printer mechanism.
3. Avoid refilling of cartridges or re-inking of Ribbons. This can spoil the printer due to leakage or use of poor quality materials.

10. LABORATORY LAYOUT.

- The computer laboratory should have enough floor space to facilitate free movement from one place to another.
- The laboratory furniture must be well arranged to prevent accidents.
- Your working surface must be large enough to hold the computer equipment & any other additional items required. This prevents squeezing the devices together & also minimizes breakages.
- The sitting arrangement of users should be proper.

11. STANDARD FURNITURE & POSTURE.

- The table/bench on which a computer is placed must be strong and wide enough to bear the weight and accommodate all the peripheral devices.
- The seat for the user must be comfortable, and have a straight backrest that allows someone to sit upright. This prevents muscle pains & backaches caused by poor sitting posture.
- Adjust the furniture to meet your needs for comfort.

  For example;
  - Adjust the height of the chair or working surface so that your forearms are parallel with the floor and your wrists are straight.
  - The seat must be high enough relative to the table to enable the user use the hands on the keyboard comfortably.
  - The eyes must be at the same level with the top of the screen when the user is seated upright.
- You should be able to maintain your proper arm position and place your feet firmly flat on the floor.
- Adopt a relaxed, upright working posture. Avoid slouching (bending) forward or leaning far backwards.
- The Chairs should have low back support & footrest and should also be adjustable.

Keyboard, Mouse and Input devices.

Place frequently used work materials within easy reach.

For example;

- The Keyboard, Mouse & other input devices should be positioned such that your hands are in a relaxed, comfortable position.
- Position the Keyboard directly in front of you. This makes it possible to type with your shoulders relaxed and your upper arms hanging freely at your sides.
- Position the Mouse at the same level as the keyboard.

12. LIGHTING & VISION CARE.

A computer room must be well lit to avoid eyestrain that eventually leads to headaches, stress, and fatigue. Similarly, when you work at your computer for long periods of time, your eyes may become irritated. Therefore, special care should be given to your vision.

- Tilt the computer so that the display faces away from the windows. This will minimize glare (or bright reflections) on the screen.
- Position the lighting equipment or sources of light such that glare (or bright reflections) on the display are minimized. Where necessary, use indirect lighting to avoid bright spots on the display.
- Use/fit *radiation filter screens* that are specially *tinted* to reduce the light that reaches the eye.
- Avoid using a *flickering monitor*. This causes extreme eyestrain that can damage your eyesight.
- The wall paints used should not be very bright as they reflect too much light causing eyestrain.
- Use the brightness & contrast controls on the Monitor to adjust the brightness of the computer monitor until the eyes feel comfortable, and also to improve image quality of your display.
- Turn off the screen when not in use or reduce its brightness in order to prevent screen burnout.
- If the room has windows, use blinds or shades to control the amount of daylight in the room.
- Take frequent breaks and rest your eyes.
- You should have glasses that are specifically suited for working with the computer display.
- Keep your glasses and the display clean.
- Have your eyes examined regularly by a vision care specialist.
- The distant between the user & screen should be between 450 – 500 mm.

Review Questions.

1. List down THREE safety precautions one should observe when entering a Computer laboratory.
2. Why must foods and beverages be kept out of the computer room?
3. Discuss TWO main causes of fire or accidents in the computer laboratory and give the precautions that should be taken to guard against them.
4. **(a).** Give Six safety precautions you should take when handling diskettes.
   (b). Where should the arrow on a diskette point when being inserted into the floppy drive.
5. List THREE things that can spoil a Printer if they are not of the correct specification, and explain what damage may be caused.

6. Why are powder based and water-based fire extinguishers not allowed in the computer room?
7. Identify three facilities that will ensure proper ventilation in a room.
8. Give THREE reasons why it is important to regularly service the computer.
9. Explain precisely how the Keyboard, mouse, and other Input devices should be arranged to avoid strain while working on the computer.
10. (a). What name is given to alternative sources of power in a computer.
(b). Name any THREE sources of power in a computer system.
11. State two reasons why a computer needs to be connected to a stable power supply.
12. State two functions of the UPS.
13. State two reasons that are likely to cause eye-strain in the computer room.
14. Identify three proper sitting postures while using the computer.

STARTING-UP (BOOTING) A COMPUTER.

1. Before switching on a computer, make sure that all the components are properly connected, and that the computer is connected to an active power source.
2. Turn on the switch at the **source of the power supply**. If your computer is connected to a constant voltage **Stabilizer** or an **Uninterrupted power supply** (**UPS**), turn it on after switching the main supply.
3. Turn on the switches on the System unit and the Monitor. Switch on the power button on the Monitor first, then followed by that of the System unit.

After the power is on, the computer automatically goes through a process called Booting. **Booting** is a term used to describe the starting up of a computer. It is the entire process that makes the computer ready for use.

Types of Booting.

There are 2 types of booting, namely;

a). Cold booting.
b). Warm booting.

Cold booting.

This happens when a computer that was originally off is switched on by pressing the power button on the system unit.

Warm booting.

This happens when a computer that was originally on is forced to restart by pressing the *Restart* button on the System unit or by pressing a combination of keys on the keyboard (**Ctrl+Alt+Del**).

In Windows operating systems, one can use the **Restart** option on the Shutdown dialog box to perform a warm boot.

When Power is switched on, the computer starts by checking all its components to determine whether they are available for use and whether they are functioning correctly. It does this by executing a small program called the **Power-On-Self-Test (POST)** that is permanently stored in ROM.

POST prepares the computer for use by instructing it to perform a number of diagnostic tests when booting up. It instructs the computer to check the *memory* (*RAM*) to make sure it is operating correctly; check the *CMOS* (*BIOS*), *Hard disk controller*, *Floppy disk drive controller* & the *Keyboard*.

During this process, some monitors display information showing the status of each device being tested. If a problem is found, e.g., in case one of the devices is faulty or missing, the process will halt and display an appropriate error message on the screen indicating to the user where the problem is located. Sometimes, an error code is displayed with the message, or an abnormal number of beeps are sounded.

The special program that directs the POST process is called the ***Basic Input Output System*** (***BIOS***).

Shutting down a computer.

After finishing working with the computer, the user must follow the correct procedure of shutting down the computer in order to ensure that loss of data, damage of programs and computer components does not occur.

1. Save all the work done on the computer, and close all programs that may be currently running.
2. Remove any floppy disk you might have inserted in the computer.
3. Follow the proper shut-down procedure required before switching off the computer.

For example;

To turn off any computer running Windows operating systems:

a). Click the **Start button** on the screen, then select **Shut Down** from the list.

b). In the prompt that appears, select **Shut down**, then press the **Enter** key on the keyboard.

c). After a few seconds, the message "*It is now safe to turn off the computer*" appears on the screen. Switch off the System unit, then the Monitor.

Note. Some system units switch themselves off automatically. In such a case, press the button on the Monitor to turn off the screen.

4. Press the button on the monitor to turn off the screen.

5. Switch off your Printer and any other output devices.

Review Questions.

1. **(a).** What is meant by the term 'booting up'?
(b). Differentiate between cold booting and warm booting.

2. Write down the procedure to be followed when switching on a computer.

3. Complete the abbreviation 'POST' in computer technology and explain briefly its purpose.

4. List down the steps that must be followed before switching off the computer.

KEYBOARD.

The **Keyboard** is a computer input device by which data & instructions is typed into the computer memory.

It enables the user to enter data & instructions into the computer by pressing its keys.

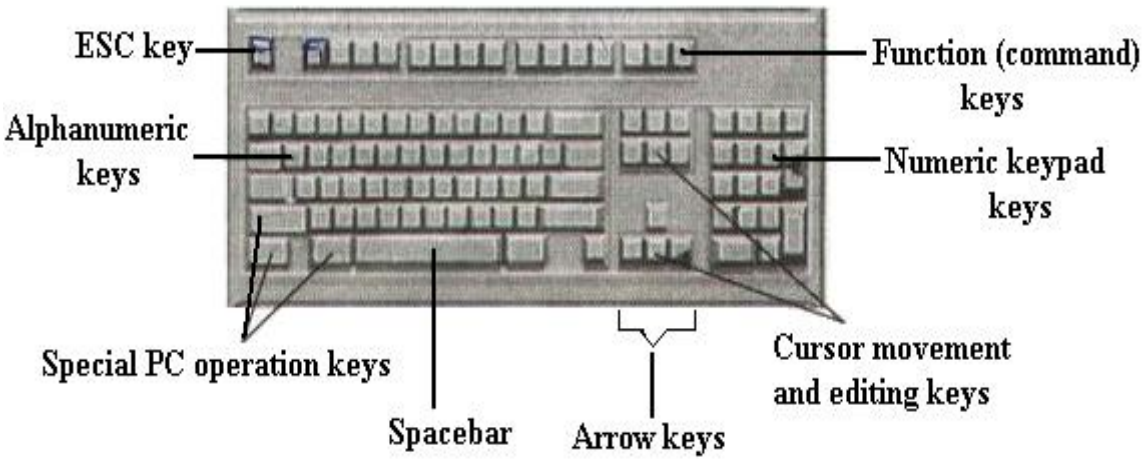
Types of Keyboard.

1. Standard Keyboard – has 99 keys.

2. Enhanced Keyboard – has between 102 & 105 keys.

KEYBOARD LAYOUT.

The Keyboard of a computer consists of keys similar to those of a typewriter. It contains the usual range of alphabetic characters (A – Z), digits 0 – 9, and other symbols frequently used to represent data items. However, it has some *command keys* for giving special instructions to the computer.



Data & programs are input into the computer by pressing the appropriate keys. When you type data into the Keyboard devices, it converts it into machine-sensible forms.

SECTIONS OF THE KEYBOARD.

Most Keyboards have a total of 101 keys, which are divided into 5 different groups: -

(a). Function/ Command keys.

These are the keys located along the top of the Keyboard marked F1 up to F12. They are used to issue commands into the computer.

Each of these keys is used to perform a special function in various application packages, e.g., **F1** is used in most applications for **help**.

Function keys are used differently by different applications, i.e. their functions vary with different programs, and are therefore sometimes called **Programmable Keys**.

(b). Alphanumeric keys.

This section consists of alphabetic & numeric keys. Alphanumeric keys are mostly used for typing of text.

It has the 26 letters of the English alphabet marked on them in capital letters, and Number keys arranged in their natural order from 0 – 9. Along with these keys are *Punctuation marks* (comma, full-stop, etc) and some Symbols.

At the bottom of the alphanumeric keys, is the **Space bar**, which is used to separate words or sentences from each other (or to create a blank space after typing each word).

(c). Numeric Keypad keys.

It is on the rightmost part of the Keyboard. It has keys with digits (numbers) 0 - 9 marked on them in rows from the bottom upwards.

The keypad also has some mathematical symbols marked on its keys. They include: the multiplication sign (*), subtraction sign (-), addition sign (+), division sign (/) & the decimal point (.).

The Keypad is used for fast entry of numeric data into the computer.

Note. The numbers on the Numeric keypad can only be used when the **Num Lock** key is turned on.

(d). Directional (or Cursor positioning) keys.

They are used to move the Cursor (insertion point) within the window of an application.

They include; *Page Up, Page Down, Home, End,* & the four *Arrow Keys*.

- ***Arrow keys:***

  To move the cursor one character to the right in a Word processing document, press the *Right arrow* key; to move the cursor one character to the left, press the *Left arrow* key.

  To move the cursor one line up, press the *Up arrow* key; to move the cursor one line down, press the *Down arrow* key.

- ***Page Up & Page Down:***

  To move the cursor up one page in case the document has many pages, press the *Page Up* key; to move the cursor down one page, press the *Page Down* key.

- ***Home & End keys:***

  To move the cursor to the beginning of the current line, press the *Home* key; to move the cursor to the end of the current line, press the *End key*.

Editing keys.

They are used to delete or insert characters in a document. These are:

i). <u>Backspace key.</u>

It has a backward arrow (←) marked on it.

√ Used to erase characters to the left of the cursor (i.e., from right to left on the same line).

When pressed, it makes the cursor move one space backwards and the immediate letter or number to the left is erased.

ii). Delete (Del) key.

It is used to erase characters to the right of the cursor, (i.e., from left to right).

iii). Insert (Ins) key.

√ Used in a word processor to switch between the **Insert mode** & **Overtype mode**. When pressed, it helps the user to insert text in the middle of a sentence or replace a character at the cursor position (i.e., overwrite the text).

(e). Special PC operation keys.

They are used in combination with the other keys or on their own to perform special functions/tasks, or to give special instructions to the computer.

Examples; Esc, Tab, Caps Lock, Shift, Ctrl, Alt, Enter, Num Lock, Scroll Lock.

TAB key ( ).

It is used in certain programs such as Word processors to move the text cursor or a certain text at set intervals on the same line to the required position on the screen, e.g., 10mm, 20mm, etc.

A **Cursor** is a blinking underscore (__) or a vertical beam (**I**) that shows where the next character to be typed will appear.

CAPS Lock.

Used to switch between capital (uppercase) letters & small (lowercase) letters.

When pressed ***on,*** an indicator with a Green light appears on the top-right hand corner of the Keyboard, and all the text typed will appear in capital letters. When pressed ***off***, all the text typed will appear in small letters.

SHIFT key ( ).

This special key works in combination with other keys.

√ It can be used to get single capital letters. Hold down the *SHIFT key* & press an alphabet key to get the letter in its capital form.

√ It is used to get the punctuation marks on top of the Number keys or the symbols on top of certain keys especially on the alphanumeric section.

To get the punctuation mark on top of a number key or the symbol on top of a certain key; press & hold down the **SHIFT key** before pressing the required key.

ENTER key (↵).

√ It is used as a *RETURN* key. When pressed at the end of a text line or paragraph in a word processor, it forces the text cursor to move to the start/ beginning of the next line or paragraph.

√ It is used to issue completion commands to the computer. It is used to instruct the computer to carry out (execute) a command that has been typed or selected on the screen.

ESCAPE (ESC) key.

It generates special code for the computer. In some programs, it is used when you want to quit doing some task, i.e. escape from or to cancel a task.

CONTROL (CTRL) key.

It controls various functions in combination with other keys, e.g. **CTRL**+"**S**" is used to give the command for saving the text/object.

Commonly confusing keys.

Some key shapes cause much confusion. If you use the wrong key, the process you are working on may not work as expected, but it may be very difficult to determine what is wrong.

The I, 1, l and o, O, 0 keys.

Look closely to spot the difference between capital "**I**", one (**1**) and "**l**" (lowercase "L"), and between small "**o**", capital "**O**" and zero "**0**".

The Slash (/) and Backslash (\) keys.

The **slash** ("/") is used as:

- A division symbol when writing a formula.
- A command key to get into the menus in Lotus 1-2-3.
- To separate parts of a path in a UNIX file name.

The **backslash** ("\") is used:

- In Lotus 1-2-3 to fill a cell with a character.
- In MS-DOS to separate parts of a path in a file name.

The Space, Hyphen (-) and Underscore (_) Keys.

The **Space** is entered using the *Spacebar* on the keyboard.

Note. A blank space is a printing character; it takes up memory, has an ASCII code, and is printed on the screen in the same manner as any other character.

The **Hyphen key** (dash or minus) & the **Underscore** (underline) are on the same physical key top. To get the underscore, use the SHIFT.

The Underscore is often used in places where a space is needed to separate individual words, but is not legal in the context. E.g., the filename TAX 1990 is illegal in MS-DOS because of the blank space between TAX and 1990, but TAX_1990 is legal. The Underscore takes the places of the blank space.

Single & Double quote, Accent grave, and Tilde.

Single quote (**'**) & **Double quote** (**"**).

Both symbols are on the same physical key top. To get the double quote, use the SHIFT.

Accent grave (**`**) & **Tilde** (**~**) are found on the same key top. The Tilde is used in Mathematics, foreign languages, or in UNIX operating system to indicate the home subdirectory.

The Parenthesis ( ), Square brackets [ ], & Curly braces { }

Each of these symbols is used differently depending on what program you are running.

Mathematical symbols (+, -, *, /, ^).

Slash (*/*) - used for division,
Asterisk (*****) - for multiplication,
Plus (**+**) symbol - for addition,
Minus (**-**) symbol - is used for subtraction,
Up carat (^) - indicates exponential (raising to a power).

Practical Keyboard skills.

When using the keyboard, observe the following typing rules:

1). Sit upright with both feet firmly on the ground, maintaining an alert posture.
2). Place the material to be typed on your left in a position you can read without strain.
3). Rest both hands on the keyboard with fingers resting on the Home keys.

Home keys are the keys on which fingers rest during typing in readiness to press other keys. The home keys for the left hand starting with the small finger are A, S, D, F with the thumb on the Spacebar, while those of the right hand are the apostrophe (‘), semicolon (;), L, K with the thumb on the Spacebar.

4). Start typing the text slowly at first, making sure you are using all the ten fingers, and that you press the key nearest to the home keys with the closest finger, e.g., to press Q, use the small finger on the left hand, while to press J, use the index finger on the right hand.

Descriptive Questions.

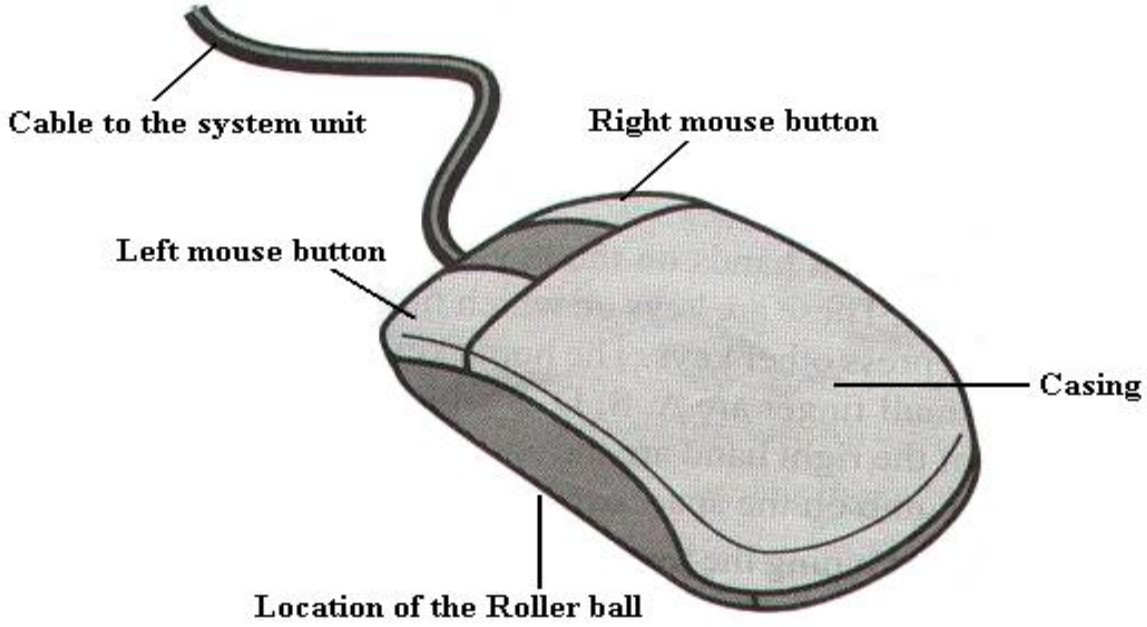
1. Define a Keyboard.
2. **(a)**Give the TWO types of Keyboards found in the current market.
(b) State and briefly explain the functions of five categories of keys found on a standard keyboard.
3. State the use of each the following section or combination of keys on the keyboard:
a). Function keys.
b). Numeric keypad.
c). Arrow keys.
d). Control key.
4. Name 3 main sections of the Keyboard that are used in typing.
5. What is the difference between Function keys and Special PC operation keys?
6. State the functions of the following keys on the keyboard.
i). Caps Lock.
ii). Spacebar.
iii). Shift Key.
iv). Enter Key.
v). Backspace.
vi). Delete.
vii). Escape.
viii). Num Lock.
7. Give two uses of the SHIFT key.

MOUSE.

A **Mouse** is a pointing device that enables the user to issue instructions to the computer by controlling a special mouse pointer displayed on the screen.

A Mouse consists of 4 parts: -

1). A **Casing** - to assist in holding the mouse in the hand.
2). A **Roller ball** – used to slide/move the mouse on a flat surface. It also enables the cursor to move on the screen as required.
3). The **Sensor Buttons** (**Right** & **Left**) – used for making selections.
4). A **Cable** - connects the mouse to the System unit.



Using the Mouse.

To use a mouse, hold it in your hand and move it across a flat surface or on top of a table. When you move the mouse, an arrow-shaped pointer called the **Mouse pointer** moves across the computer screen in the same direction. The pointer is usually controlled by moving the mouse.

To select an option/ item on the screen;

- ☞ Position the tip of the pointer (cursor) over the item to be selected;
- ☞ Press a button on the mouse to make your selection.

When using the mouse, observe the following rules:

a). Place the mouse on a flat smooth surface.
b). Gently hold the mouse with your right hand, using the thumb and the two rightmost fingers.
c). The index finger should rest on the left button, while the middle finger rests on the right button.

Terminologies associated with the use of a Mouse.

Point: - this means moving the mouse until the tip of the pointer on the screen is over the item you want to select.

To select an item on the screen, point the item, then press a mouse button. Use the **Left button** (Primary button) for most tasks or the **Right button** (Secondary button) to quickly accomplish common tasks.

Clicking: - pressing & releasing the left mouse button once. A click usually selects an object/item on the screen.

Double-clicking: - pressing the left button twice in a row (in a quick succession) without moving the mouse. Double-clicking usually opens a file or starts a program.

Right-clicking: - pressing the right mouse button once (or, selecting an item by use of the right mouse button).

A right click usually displays a list of commands from which the user can make a selection. This list of commands is called a ***Shortcut menu*** or ***Context-sensitive menu***. This is because; the commands on this menu apply to the specific item that has been right-clicked.

Shortcut menu:

- ♦ A list of commands that appears when you right-click an object.
- ♦ A menu that shows a list of commands specific to a particular right-clicked item.

Drag and drop: This is whereby the user moves an item from one location on the screen to another.

To move an item on the screen by dragging;

1. Point to the item you want to drag.
2. Press & hold down the left mouse button.
3. Slide the mouse until the pointer reaches the desired position on the screen while still holding down the mouse button.
4. Release the mouse button to 'drop' the item in its new location.

Review Questions.

1. What makes a mouse move a pointer on the screen?
2. State THREE advantages of using a Mouse instead of a keyboard.
3. Explain the meaning of the following terms associated with the use of a mouse:
   (a). Mouse pointer.
   (b). Clicking.
   (c). Double-clicking.
   (d). Right-clicking.
   (e). Drag and drop.
4. Distinguish between:
   (a). Click and right-click.
   (b). Double-clicking and dragging.
5. What is a Shortcut menu?

COMPUTER SYSTEMS.

The term ***System*** can be defined as a collection of independent entities that collectively work together to achieve a desired goal.

All things can be viewed as being made up of small independent components (subsystems) that come together to form a bigger more complex system.

For example;

(1). A School can be seen as a system with students, teachers, Accounts department, and the Administration as subsystems. The school system itself is a subsystem of the ministry of education.

COMPUTER SYSTEMS.

What is a Computer system?

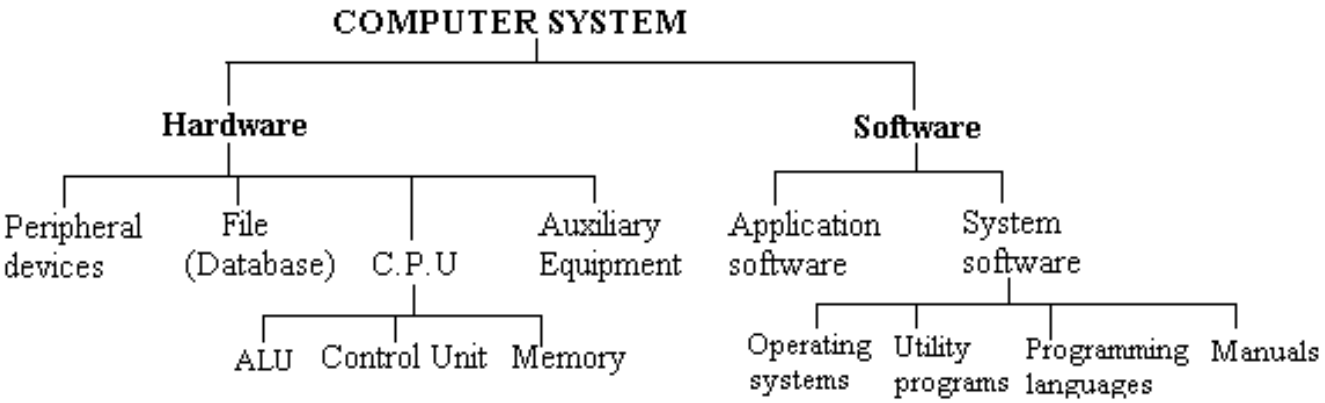
- The term **Computer system** refers to the complete set of devices required to use & operate the computer.
- Computer system is the complete set of devices that make a computer work as one unit.
- A collection of entities that work together to process and manage information using computers.

A computer system consists of the computer itself & supporting devices for input, output, processing & storage of data such as disks, Monitors, Printers, etc

FUNCTIONAL ORGANIZATION OF THE ELEMENTS OF A COMPUTER SYSTEM.

A Computer system consists (or is made up) of 4 basic elements that are interrelated and work in unison. The four elements are:

(1). Hardware.
(2). Software.
(3). Liveware (Computer user).



HARDWARE.

Hardware is a term used to describe all the physical & tangible devices that make up a computer system, i.e. it consists of the parts that can be touched and felt.

Hardware include all mechanical & electronic elements found in the computer, e.g., the System Unit, Transistors, Diodes, bus systems such as electronic paths (channels), the Input devices (e.g., Keyboard, Mouse), Output devices (e.g., Monitor) & the Storage devices.

Hardware devices enable the user to enter information into a computer, view the output on screen, print out our work, store and process the work.

The hardware elements of a computer are generally grouped/ sub-divided into 4 major categories:-

1). Input devices.

Input devices are used to communicate with a computer. They enable the computer user to enter data, information & programs into the computer. They also let the user issue commands to the computer.

An Input device converts the input information into machine-sensible/ readable form.

Examples.

***** Keyboard.
* Key-to-disk.
***** Scanner.
* Trackball
***** Graphics pads (Tablets).
***** Speech Recognition devices.
* Voice input devices, e.g. Microphones.
***** Mouse.
* Key-to-Tape.
***** Light pen.
***** Video digitizers.
***** Joystick / Game paddles.
* Digital & Web cameras.
***** Document readers, such as, *Magnetic Ink Character Reader* (MICR), *Optical Mark Reader* (OMR) & *Optical Character Reader* (OCR).
*Point Of Sale terminals, such as, *Bar code readers*, *Kimball Tag readers*, *Card readers*, & *Badge readers*.

2). Central Processing unit – CPU (Processor).

The CPU is composed of the *Main Memory*, the *ALU* & the *Control unit*.

The CPU performs the necessary operations on the data held within the memory. It interprets & processes all the instructions from the Input devices.

The CPU is housed in the computer casing (**System Unit**), which contains all the major components of a computer system.

3). Output devices.

Output devices are used to extract/ disseminate processed data from the computer. They display the results of all the information that has been processed.

They also convert machine-coded output results from the Processor into a form that can be understood by people.

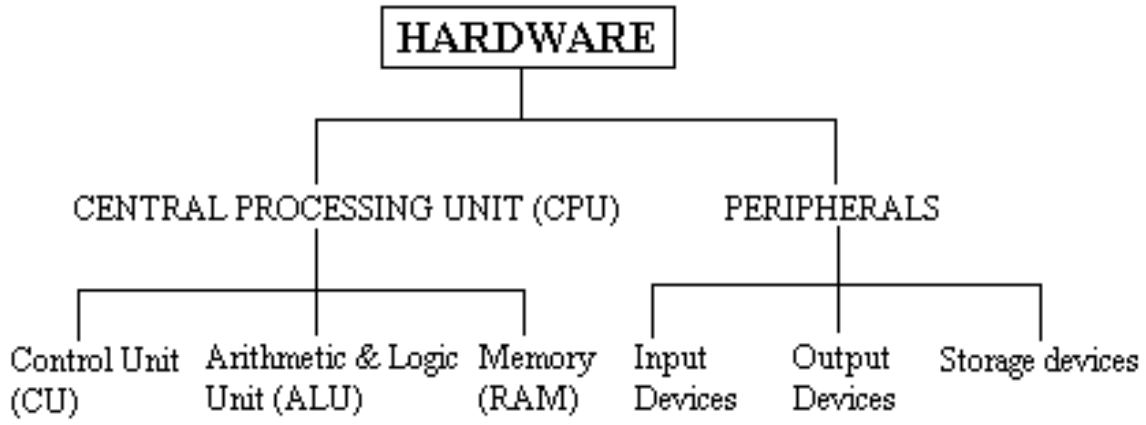
Examples.

***** Screen (Monitor/ Visual Display unit – VDU).
***** Audio Response units.
***** Sound output devices, e.g. Speakers.
***** Printers
***** Graph Plotters.
***** Microforms.

4). Storage devices.

These are devices used to store data & programs in computers. They include; Hard disks, Floppy disks, Magnetic tape drives, Cassette Tapes, Optical disks (CD-ROMs), and Random Access Memory (RAM).

Note. All these storage devices differ in the *way (technology) they store data* & the *capacities of data they can hold*.



Hardware Classification

Characteristics of Computer Hardware.

1. Hardware consists of parts that one can touch and feel.
2. Hardware determines what software will be used in the computer.
3. Computer hardware is expensive to acquire.
4. Hardware devices can only be made by specialist hardware engineers.
5. Not easy to change particular hardware components.

SOFTWARE.

- These are the programs & data used in a computer system that enable it perform a no. of specific functions.
- **Software** is a set of computer programs that guides the computer in each and every activity that happens inside the computer during data processing operations.

Software also includes the associated documentation (descriptions of the programs).

When used in a computer, Software instructs the computer to carry out specific processing tasks, e.g. produce the year end Balance sheet.

Characteristics of Computer Software.

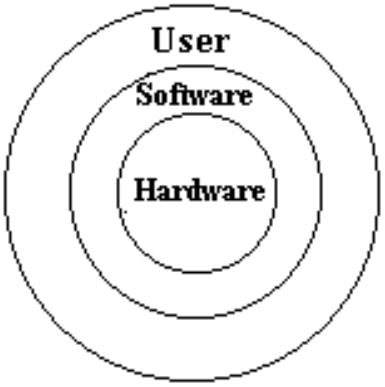
1. They are the programs & data used in a computer system.
2. A **Computer Program** is usually a set of computer instructions written in any of the computer programming languages, e.g. BASIC, PASCAL, etc.
3. It is not possible to see a program in memory as it exists in magnetic spots, however, you can see & touch a listing of the program on the computer screen.
4. Software enable computer hardware to operate effectively. In other words, software is meant to put 'life' into the hardware.
5. Software is flexible, i.e., the software used in a particular computer is relatively easy to change.
6. Software is cheaper compared to hardware devices.
7. Computer software can be written by the user, a Programmer or a Software house.

LIVEWARE

Liveware is a term used to refer to the computer end-user. They are the people who coordinate the various activities, which are necessary to get a computer system to perform useful tasks.

They include; Data entry operators, Computer Operators, Programmers, System Analysts, Data Processing Managers, Database Administrators, Computer Librarians, and the other staff directly or indirectly involved in the running of the system operations.

Apart from the hardware and software elements, the user is also seen as an integral part of the computer system as shown in the figure below;



ELECTRONIC COMPONENTS OF A MICROCOMPUTER SYSTEM.

A microcomputer consists of 4 electronic parts:

1). Input devices.
2). Central Processing Unit (CPU), also called the **Processor**.
3). Output devices.
4). Memory storage devices, which consist of Main memories & Secondary memories.

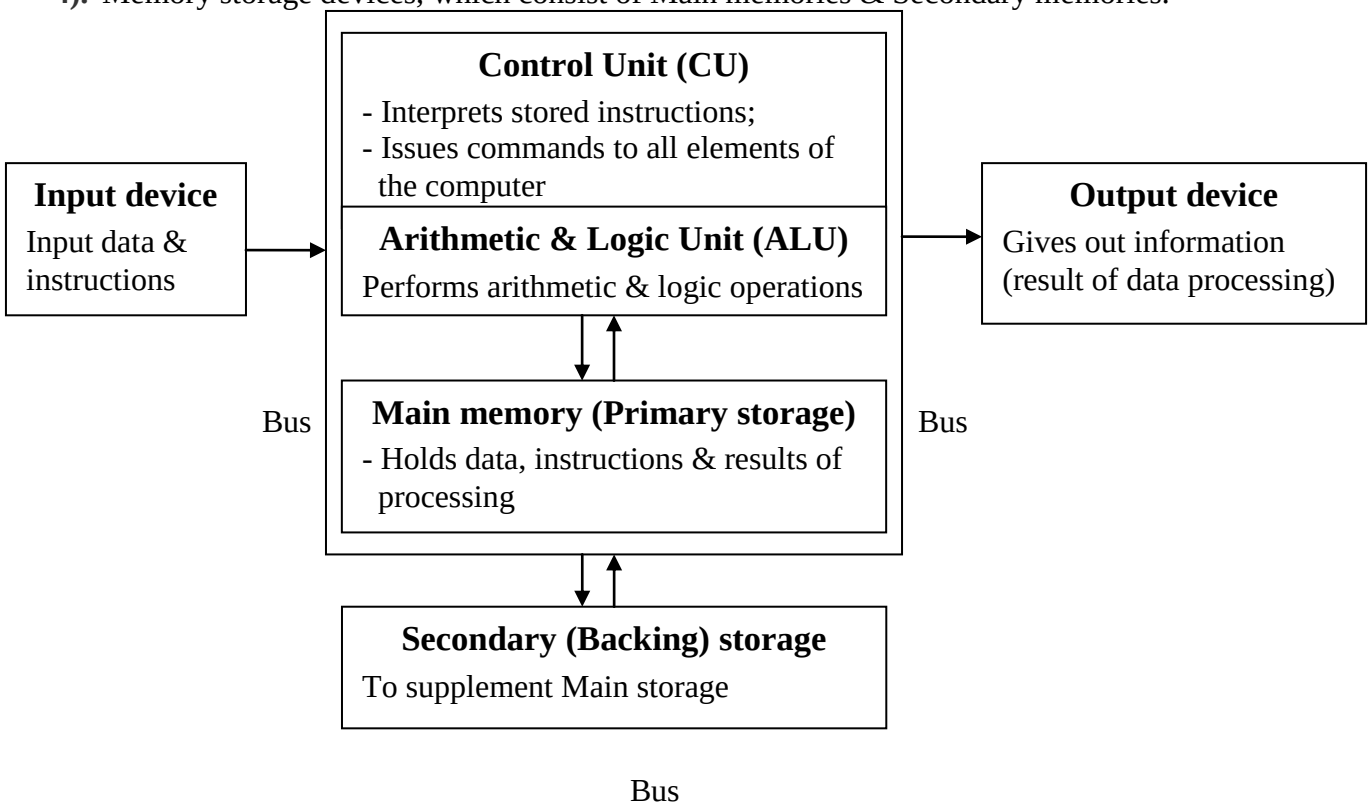


Fig. 1.2: ***A computer model***

- ☞ Data & instructions to be processed are supplied to the computer memory by the user with the help of Input devices.
- ☞ The CPU performs the desired operations on the data and the results of calculations/ processing are communicated to the user through the Output devices.

☞ The data and/or instructions not being used immediately by the computer are held permanently in the Backing storage, for retrieval any time it is required by the user.

INPUT DEVICES.

Before a computer can process any data, it must be given the data & program instructions by use of an **Input device**.

Input is a term used to describe all that goes into the computer memory (usually the raw data & instructions) to await processing.
Input involves entering data & instructions into the computer by use of suitable devices.

FUNCTIONS OF INPUT DEVICES.

An input device performs the following functions/ tasks:

1. Accepts data & instructions from the user into the computer system.
2. Read data from the medium on which it is stored.
3. Converts the human-readable data into electronic/machine-readable form (i.e. a form that can be understood by the computer)
4. Accepts commands for running, halting or aborting a program from the user.
5. Data input can either be **Online** or **Off-line**.

Once the data is entered into the computer, it finally enters the *Main storage*.

Exercise.

1. Give THREE main functions of a computer input device.
2. State four examples of input devices you know.

Classification of Input devices.

Input devices can be classified according to how they are used to enter data into a computer. These include.

(a). Keying devices.
(b). Pointing devices such as the Mouse, Trackball, etc.
(c). Scanning and other data capture devices, e.g., Scanners, Digital cameras, etc.
Data capture devices are those devices that automatically capture data from the source.
(d). Speech recognition or Voice input devices such as Microphones.
(e). Touch screen and Digitizers.

KEYING DEVICES.

Type of keying devices

- Traditional keyboard
- Flexible keyboard
- Ergonomic keyboard
- **keypad.**

POINTING DEVICES.

These are the input devices that enter data or instructions by controlling a pointer on the screen.

Examples of pointing devices are; Mouse, Trackball, Joystick, and Light pen.

MOUSE.

A mouse is a pointing device that rolls on a small ball and is used to control the movement of the cursor (or, a pointer) on the computer screen.

Types of mouse

- Traditional mouse
- Optical mouse
- Cordless mouse

The mouse is mostly used with **Graphical User Interfaces** (**GUIs**). It issues commands to the computer by activating certain simple graphic images called **Icons** displayed on the screen.

Advantages of using a Mouse.

1. The mouse is easy to learn & convenient to use. This is because; it is used to select options (icons) displayed on the screen.
2. It is inexpensive.
3. Most modern software includes an option to use it.
4. It performs operations much easier & much more quickly than a keyboard. It is very fast to work with as it lets the user provide simple "point" & "click" instructions to the computer.
5. Can be used in art and design work because; it allows diagrams to be drawn & modified easily.

Disadvantages of using a Mouse.

1. The mouse cannot be used to input text easily.
2. It is relatively slow for selecting menu options. A user who is familiar with the keyboard commands can select the options more quickly.
3. It is not very accurate for drawing purposes.
4. The mouse requires a flat surface to operate.

TRACKBALL.

A Trackball works just like the mouse, but instead of moving it on a flat surface, it has a ball fixed on its top which is rolled using the index finger.
As the ball rotates, it moves a pointer on the screen. The user can then click its button to execute the selected command.

The advantage of a trackball over the mouse is that, a Trackball doesn't require a flat surface for movement.

Note. Today some computers come with a trackball on top of a Keyboard and a Mouse.

LIGHT PEN.

A **Light Pen** is a hand-held device similar in shape to a ball-point pen, and has a light sensitive point. It consists of a pen-like device called a ***stylus*** connected by a cable to a computer terminal.

A Light pen is used together with a graphic VDU that is able to sense light shining on the screen using special hardware & software. A Light pen does not emit light but instead, it reacts to the light emitted by the display using a photosensitive detector at its base.

When the pen is moved across the screen, its position is sensed because of the light it produces.

- √ A Light pen provides a *direct input mode*. It can be used to read data directly from the source document. It allows the user to point directly to an object on the screen, thus identifying it to the screen.
- √ Light pens can be used to read bar-codes on the different items.
- √ It can also be used to select items from a given list of 'menus' displayed on the screen by simply pointing the pen at the item required & then pressing a button on the pen.

√ Light pens are usually used as design aids - they can be used to draw images on the screen, which can be printed. They can also be used to indicate a point on a screen or pad, for example, to select options for drawing.

TOUCH-SENSITIVE SCREENS.

A Touch-sensitive screen uses the human finger as the input medium, (i.e. one can select items or options from a given list by touching the screen with a finger).

This method of input is usually used with a VDU, which is able to sense the touched points on the screen.

When the user touches the screen with a finger, it blocks out the light emitted from that portion of the screen. The computer detects the position of the finger. The screen can then determine which part is being touched, and therefore, which selection is required.

Touch screens are mostly used in public places like banking halls, hotels, in airports (to provide guidance information), etc.

Notes.

- Both the Light pen & the Touch provide fast input modes.
- There is no typing or printing required; however, they operate under the influence of complex programs.

JOYSTICKS / GAME PADDLES.

These are hand-held Input devices, which enable the user to interact with a program. They are used for playing computer games.

A **Joystick** is an input device that looks like a car gear lever. It is an analogue-to-digital converter where the input involves moving the control lever sideways, upwards or downwards to control the movement of the cursor on the screen.
Just like the mouse, it has a button which is used for selecting an item. It is commonly used in playing video games.

A **Game paddle** may consist of a button, which can be pressed by the user to input data to the program. When the program senses that the button has been pressed, it takes the appropriate action, such as, firing a missile or reversing the direction of a tank.

A Game paddle can also consist of a dial which when rotated; it conveys information to the program. The program must immediately act on the information supplied by the dial setting, e.g. a goalkeeper may be moved across the face of the goal to intercept a shot.

Note. Data processing should be very fast.

DIGITIZERS.

The **Digitizers** are input devices that convert graphical drawings or images on the paper or other material into digital data and convey them to the computer memory.

Digitizers are slow, but easy to handle and errors are hardly present.

1. GRAPHICS PADS/ TABLETS.

Graphic Tablets are used for entering drawings directly into the computer.

A **Graphics tablet** consists of a pad or tablet (that is sensitive to touch) & a pointing device, which is similar to a ball-point pen called a *stylus*.

A paper is placed on the graphic pad & the user can trace lines and draw pictures using the pen. As the stylus moves on the tablet, the tablet senses the pressure on it & translates it into digital signals giving its corresponding position on the screen. It then converts this 'pressure'

into x-y co-ordinates, which describe what is being drawn. This data is then relayed to the computer, which can display the drawings on the screen or have them printed.

Uses of Graphic Tablets.

Graphic tablets are mostly used;

(a). In Engineering & Architectural design as it lets the user create his/her own images. It is very easy for the user to 'try out' different designs.

(b). In Computer-Aided Design work as diagrams & maps can be traced or drawn & transferred into the computer memory to be further worked on using Graphics programs.

(c). By Banks & Insurance companies to verify signatures. A signature written on a pad is compared against another formerly stored in the computer.

(d). Pads are also good at detecting forgeries.

2. VIDEO DIGITIZERS.

These consist of special hardware & software, which converts video signals frame-by-frame into a digital representation in computer memory, which can be saved on disk, if necessary. A sequence of frames can have graphics, cartoons, text added, etc.

DIGITAL CAMERAS.

A Digital camera stores its images in digital form. These images can then be streamed (entered) directly into a computer for editing or printing by connecting the camera to a computer using a special cable.

There are 2 types of digital cameras; one that can take still (motionless) images, i.e., photographs, and another that takes motion pictures (video).

VOICE INPUT DEVICES (Speech Recognition Devices - SRD).

Voice recognition is a type of input method where a Microphone connected to a computer system (through some extra circuitry) is used to enter data in form of spoken words into the computer.

The SRD accepts spoken commands & convert them into electronic pulses/ signals, which can be processed by the computer.

The user must train the system to recognize his/her voice by repeating each word in the vocabulary several times. Each word is analyzed & filed for identification.

Uses of Voice Input devices.

(a). Voice input is a fast & easier method mostly suitable for the handicapped especially those with impaired hands.

(b). In *Security & Access control* – Each person has a unique 'Voiceprint' that can be used for identification. This approach could be used in; -
- Electronic Money transfer.
- House/ Car security using voice activated locks.
- Office security for room access.

(c). In *Voice-activated toys* & *games*.

(d). In *Quality control & automation* (computerization/mechanization) *in factories*.
A checker whose hands are busy does not have to stop working to make entries in log books, instead he/she can simply give a running (spoken) comments on the goods he/she is examining. For example, in Japan, speech input is used to order robots about.

(e). In *Automated materials handling* – in airports, handler's give spoken commands that direct the luggage to the appropriate conveyor belt.

(f). In *Computer-Aided Design (CAD)* – A designer, e.g. of buildings, working at a terminal can call up design patterns which are frequently used, instead of having to punch catalogue nos. into a Keyboard.

Limitations (disadvantages) of Speech Input/Recognition devices found Today.

1. Homophones – some words have same sounds.

2. Word separation.

The speech must be "***clipped***" i.e. each word must be followed by a short period of silence. This enables the device to recognize the end of each word. If this is not done, the device might not be able to tell the difference between '*Command*" and "*Come and*", depending on the accent of the speaker.

3. Speaker variability.

The speed, tone (quality of sound), accent, loudness and pronunciation of an individual speaker can vary

Voice input is complex to develop, and it does not take care of speech related problems such as accents and tone. This implies that the device must learn the unique speech of an individual.

4. Limited vocabulary understood & the no. of speakers they can recognize.

Most speech systems can recognize a limited, standard vocabulary of spoken words. The simplest SRD can recognize the voice of only one speaker. .
The device must also be 'taught' the voice patterns of the speaker. For example, if a device can store a vocabulary of 25 words, the user will speak the 25 chosen words into the device. The device then stores the patterns for the spoken words. Later, when the user speaks a word, the device compares the pattern of the word spoken with those patterns it had previously stored. If a match is found, the word is recognized. If not, the speaker may be requested to repeat the word or use a *synonym* (a word that means almost the same thing).

5. The response rates of these devices are still relatively slow.

When you compare the no. of words in English & the total no. of words that can be said at a given point, show that speech recognition is slow.

6. Speech input is complex to develop & is still at the early stages of development.

Review Questions.

1. Explain briefly how the following types of devices work.
- **(a).** Speech recognition.
- **(b).** Graphic (digitizing) tablet.
- **(c).** Touch sensitive screen.
- **(d).** Light pen.

2. State TWO advantages and TWO disadvantages of using Speech recognition devices.

SCANNING DEVICES.

These are devices that enter (capture) data into the computer directly.

IMAGE SCANNERS.

A Scanner is used to input pictures or photographs into the computer. This is because a Keyboard or a Mouse cannot perform these tasks.

Scanners are usually used to capture existing documents in an electronic form into the computer for further processing or incorporating into other documents.

It converts text & graphics into machine sensible format. Once the text & graphics are scanned, the images can be manipulated by changing the colors, the sharpness and contrast.

There are 2 main types of Scanners: -

(a). Page scanner:

This is a desktop machine that looks like a small photocopier. It scans a whole page at a time. An example is the ***Flatbed scanner***.

Using this scanner, one can scan text, a real object or a picture by placing it on a glass plate exactly the way a photocopying machine works. The text or the picture scanned is displayed on the screen or saved so that one can edit or print it.

(b). Hand scanner:

A Hand scanner is held in the hand and passed over a document.

Scanners are very useful when large amounts of existing documents need to be converted into electronic form for feeding into a computer system.
For example, if the contents of the Bible are to be entered into a computer system, you can either type everything using a Word-processor, or scan each of the pages and import them into a word-processor, which is faster and also more accurate.

Each character is compared to all known shapes or patterns so that the appropriate code can be entered into the computer.

Scanner Problems.

1. The scanner is on but there is no image when you scan.
- ♦ Make sure the DMA, IRQ and Address jumper settings on the interface board matches the settings you selected in the *Scan Mate* installation program.
- ♦ Check the brightness control dial on your Scanner. If the dial is at the brightest settings, you may not be able to see the image.

2. The light on the scanning window cannot turn off.
This shows that there is a conflict with resident software on DMA channel.

3. The images printed look blotchy (discoloured/ spotted).
To prevent this, do not rescale the image. If you scale the image, you will lose some of the details when you print. If the image is too big, scan at lower resolution.

4. The Scanner turns off as soon as you start scanning.
This shows there might not be enough RAM to scan the images.

5. The scanned image on the screen is much larger than the original.
This occurs if your image is displayed at a lower resolution than you scanned.

Note. The Size of your screen image depends on your Monitor's size & your **VGA** card.

DOCUMENT READERS.

A ***Document reader*** is an input device, which can read data directly from source documents, such as bank cheques, & convey it to the computer in form of electronic signals.

Types of codes on documents that can be recognized by a Document reader: -
(i). ***Marks*** – short lines made by hand, usually in pencil on a document.
(ii). ***Characters*** – hand-written (e.g. on meter-reading) or printed in magnetic ink on cheques.
(iii). ***Printed lines*** – e.g. the bar codes.

Document readers can be classified into; **Optical readers** and **Magnetic Readers**.

Optical Readers.

Optical readers use the principles of light to sense the document contents or to capture data. A special type of concentrated beam of light is passed over the object, image or text which needs to be entered into the computer. The reader converts the data into digital form, and then passes it to the computer for processing.

There are 2 types of Optical readers: **Optical Character Reader** (**OCR**) & **Optical Mark Reader** (**OMR**).

Magnetic Readers.

They use the principles of magnetism to sense the document characters that have been written using magnetized ink.

Example; **Magnetic Ink Character Reader** (**MICR**).

OPTICAL CHARACTER READER (OCR).

Optical Character Recognition (**OCR**) is a data capture technique, which enables the computer to read printed or hand-written documents directly.

The characters are formed onto the document by a Typewriter or computer Printer using a special type font. Handwriting can also be recognized if the characters have been carefully/well formed.

The reading is done by OCR, which can be connected directly to the computer. An OCR is able to distinguish one character from another by its shape.

As the OCR reads/ scans the document, each character reflects different amounts of light, which is sensed by the OCR using a **photoelectric device** & converts the shape sensed into electronic signals. These signals represent a particular pattern.

Note. The Reader has a memory that stores reference patterns for a given character set or font.

The sensed pattern is then compared with the stored patterns of the characters, which the reader can recognize. If a match is found, the character sensed is identified; otherwise, the document may be rejected by the reader.

Uses of Optical Character Recognition devices.

OCR devices are used by companies that do a large amount of processing on a regular basis. For example, Public utility companies, Insurance companies, Airlines, Banks & the Postal service (for reading postal codes).

- Public utilities – OCR is used to process documents produced as output and which can be re-used as input by the computer. For example, an Electricity bill has a returnable slip, which is printed with all the information required for re-input into a computer, i.e., customer code and amount owing. If the customer pays the exact amount stated, the returned portion of the bill is used for direct input to the computer.
- Used in *Sales Order forms*.
  The forms can be printed by the computer with standard data, e.g. Stock codes, Account code, etc. The Salesman then enters details of the order form and returns it for OCR processing.
- Used in *Stock-taking sheets*.
  The computer can print out stock sheets in OCR characters. The stock checker then enters the actual stock quantities on the form in careful handwriting. The sheet can then be optically read into the computer for amending the stock records.

Disadvantages of OCR.

(i). The document should be handled carefully (e.g. it should not be folded or creased) for accurate reading.
(ii). Document size & type area may be limited for accurate reading.
(iii). It requires special typing & character formation and a paper with the required quality.
The user must make sure that characters are well-formed; if they are not, reading errors may arise, making output results unreliable.

OPTICAL MARK READER (OMR).

The documents are pre-printed with predefined data positions. These positions can then be marked by, let say, a pencil.

The OMR detects the presence or absence of a mark on a form by sensing the reflected light of these positional marks. The reader is then used to convert the marks into computer-readable data & send the value of the sensed data into the computer in form of electronic signals.

The accuracy of an OMR depends on the marks being made properly. If a mark is too light or not solid enough, it may be misread, giving rise to errors.

Uses of OMR.

OMR forms are used in situations where the data to be input is simple, or the volume of data is large enough since using other methods would be more expensive.

- Used in marking Multiple-choice examination papers where the answers are filled in a form with special pencils.
  The OMR can sense the presence of a pen or pencil mark. The person taking the test makes a pencil mark in the box, which he/she thinks corresponds to the answer. An 'OMR' is then used to 'read' the answers given by sensing the marks made. This data is then relayed to the computer, which can then check the answers given and grade the paper.
- In Insurance premium collection.
- To read marked research questionnaires.
- In Supermarkets for stock recording.
- Traffic surveys.

Comparative advantages of OMR vs OCR.

(i). Speeds up data input. They ensure faster & more accurate processing of data.
They read data directly from the source document & enable data to be given directly to the computer for processing.
With an OCR it is possible to read up to 10,000 A4 sized documents in 1hr.
(ii). They read data directly from the source document & therefore, no data preparation is required.
(iii). Errors are easily corrected.
(iv). The documents can be re-used, thus saving on stationery.
(v). The contents of the documents are both human & machine sensible, hence reliable.
(vi). The sensitivity of an OMR can be altered to allow for different surface, pencils and inks.
(vii). OMR has a better recognition rate than OCR.
(viii). With an OCR, no typing or transcription/recording process is involved & therefore, not prone to transcription errors.

Comparative disadvantages of OMR and OCR.

(i). They are expensive methods of input, because they require specialized techniques & equipment.
(ii). Verification of marked data is difficult.
(iii). Documents may be difficult to design, understand and fill in.
(iv). The document reader will have to be reprogrammed for each new document design.

MAGNETIC INK CHARACTER READER (MICR).

Magnetic Ink Character Recognition (MICR) is the machine recognition of characters printed with Magnetic Ink.

The document characters are typed or printed in ink containing ***Iron (II) Oxide*** that gives them a magnetic property.
After forming the characters onto the document, the inked characters are magnetized by passing the document under a strong magnetic field.

During the reading process, the magnetized characters cause current to flow through the read head depending on the magnetized surface area occupied by individual characters.

The reader differentiates characters depending on the magnetic patterns that bring different amount of currents. The MICR recognizes these patterns & conveys them into the computer in form of electrical signals.

Uses/ applications of MICR.

- **Magnetic Ink Character Recognition** (**MICR**) is used in banks to process the many cheques being written each day.

  The MICR mostly uses a font known as **E13B**, which consists of 14 characters (i.e. digits 0-9, & four special characters).

  A cheque is usually pre-printed with the **Identification number** of the bank, the **Account number** of the customer, **Serial number** of the cheque, **Branch number**, using a special ink containing particles of *Iron Oxide* (*Magnetic Ink*). When the cheque is presented for payment, the **amount** is written on the cheque in magnetic ink, using a special device. The cheque can then be read by a MICR. The data read is then transmitted directly to the CPU for immediate processing, or can be stored on magnetic disk for latter processing.
- In Local Authorities for payment of rates by installment.

Advantages of MICR over OCR.

(i). An MICR can read data faster & accurate since the information on the document is usually pre-printed.
(ii). Difficult to forge.
(iii). Document can still be read when folded, written on, etc. This means that, MICR is more 'robust'.
(iv). A wider range of fonts can be used, including hand printing & normal type. However, there is no standard-type font.
(v). Faster than OCR. It is possible to read about 2,400 A4 sized documents 1 minute.

POINT-OF-SALE (Pos) TERMINALS.

This is a general class of Input devices of which a *Bar-code reader* is an example.

A POS terminal can be used as an Input device when online processing is required. Data arising out of a transaction (e.g. the purchase of an item) is entered on the terminal and is immediately processed by the computer.

POS terminals are widely used in the Banks & computerized Wholesale or retail industries, such as Supermarkets.
Each item in the store has a code; **Universal Product Code** (**UPC**) printed on it, that identifies the item.

The POS terminal consists of a Numeric keypad & a few Control (Functional) keys for entering data, a Screen and a Printer to print out the list of items and price for the customer.

The ***Item code***, ***Quantity*** & ***Price*** of the goods purchased by the customer is entered into the POS terminal directly by the operator. The terminal produces the customer receipt. The details of the sales are then entered directly into a backing storage device and the **Stock level** is also automatically decreased.

A **Bar code reader**, a **Credit card** or a **Kimball tag Reader** could be attached to a POS terminal to reduce the data entry.

BAR-CODE READER.

This is a device used to read the bar-codes printed on many items in ***Supermarkets*** & ***Pharmacies***.

Each item is given a code known as ***Bar-code*** (a ***Bar-code*** is a set of parallel bars of varying thickness & spaces of varying widths representing a number code). A space represents a "0" while a bar represents a "1". The coded data can be read by using the principles of light.
A computer is used to store the ***code of the items***, ***item description***, ***price***, ***amount in stock***, etc.

When a Bar-code reader is moved across the bars by the Cashier, the reader scans the bar codes printed on the item using a laser beam, which generates electrical pulses corresponding to the reflected light received. The bar code is then converted to a number (which is the code for the item).
The interpreted data is sent to the computer memory in form of signals. These pulses are compared with standard codes stored in the computer and is used to look up the price of the item. The details of the price & description are printed out on a receipt for the customer. The Store Inventory may also be updated at the same time.

Bar codes are also used in ***Library lending Systems***. Each user is given a library card, which is coded with his library User Number. The relevant details of the user; let say, ***Name***, ***Address***, ***Telephone number***, ***category of user*** (e.g., Staff or Student), ***No. of books borrowed***, ***date of expiry of the card***, etc are stored in a file on a disk.

When the user wishes to borrow a book, a Bar-code reader 'reads' his card, and transmits the code to the computer. The computer uses the code to retrieve the user's record from disk.
The Library Assistant will then update the user's record by entering the relevant information such as the name (or number) of the book, the date borrowed & the date on which it is to be returned.

Note. Bar-codes cannot be used on goods such as *Fresh Fruits* & *Vegetables.*

Advantages of using a Bar-code reader.

(i). They are very fast & accurate provided that the bar-code has been printed clearly. For example, if the bar-code is soiled by dirty hands or has broken bars, errors may occur when an attempt is made to read the code.
(ii). It is a cost-saving method.
(iii). Saves time. The prices do not have to be attached to each item in the store because the items details are already held in a master file.
(iv). Does not require special skills to operate.
(v). It improves customer convenience.

Disadvantages of using a Bar-code reader.

(i). Requires standby facilities.
(ii). Requires very expensive equipments.
(iii). The prices are not stamped on the product, and therefore, high chances of incorrect data being entered.

KIMBALL (PUNCHED) TAGS.

Some manufacturers use **Kimball tags**; small paper punched cards attached to clothes or other commodities on sale mostly in supermarkets. The data is incorporated in the small punched holes. The holes alternate with spaces to represent data in binary digits.

An optical scanning method is used to read the Kimball tag and extract the product code & price from it. The tags are removed at point of sale and transferred to the data processing department for their contents to be used in updating the stock files.

Note. POS terminals, Bar-code readers & Kimball tags speed up customer service & also ensure accuracy. They may also be used to manage inventory, accounts & maintain up-to-date sales information.

Advantages.

(i). Data is already coded, hence easy to process.
(ii). No transcription requirements.

Disadvantages.

(i). Difficult to handle because they are small.
(ii). Store small volume of data.

CARDS / BADGES.

These are small rectangular cards made of plastic that incorporate data in both machine-sensible & human-sensible forms, e.g. Credit cards.

Ways of Coding data onto badges: -

- ❖ Magnetized marks, e.g. a short strip of magnetic tape sealed into the card's surface.
- ❖ Optical marks.
- ❖ Punched holes.

The cards are read using **Badge readers**. The data recorder machine records data on these badges automatically, once manually inserted, using magnetized marks, optical marks or punched holes.

For reading, the badge is slotted into the reading unit where the converter machine (the reader) accepts the contents of the badge and conveys them directly to the computer as input for processing.

The badges are used in banks as Credit and Service cards, e.g., in the Automated Teller Machine.

The Badge contents are usually static, though some cards contents can be altered by the reader, e.g., Phone credit cards whose currency value keeps on changing until zero currency value is left.

(a). SMART CARDS.

A *Smart card* is a special type of badge whose data can be changed by a special badge reader.
A Smart card can be used as a form of electronic money. As the customer purchases an item, the badge reader can deduct units from the card. This process continues until the card has no more currency units left.

(b). CREDIT CARDS.

A Credit card has a strip of magnetic tape fixed on it. The tape contains coded information, which is usually the owner's code. The card is inserted into a slot where magnetic data may be picked. Details of the transaction are then recorded against the credit card no. & the owner's account is credited with the transaction.

Uses of Cards / Badges.

- In *Car parks* – badges are used to raise car barriers, allowing entry to or exit from a car park.
- In *Banks* – Credit and Service cards, i.e. **Automated Teller Machines** (**ATMs**) give out cash automatically when customer inserts a plastic card & follows the instructions issued.
- In *Access control* – Access control cards are used in many offices to control access to buildings or rooms for security reasons.
- In *Production control* – Punched cards can be used to hold data in a factory such as employee's details, etc, which is used for production scheduling (arrangement), stock control and job costing.

DIRECT INPUT FROM INSTRUMENTS.

Sensors are devices that can be connected to computers & are used to record physical quantities like Temperature, light, humidity.

Examples of direct input instruments: -

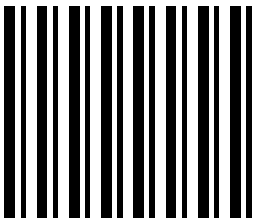
(a). *Sensors* used to record temperature, light, humidity in a Green house to ensure the best conditions for plant growth.
(b). *Thermostats* connected to a Central heating system controlled by a computer in order to monitor temperature & to help save electricity.
(c). *Pressure pads* on a road connected to computer-controlled traffic lights to speed traffic flow.
(d). The continuous logging of temperature data in order to monitor & subsequently control a chemical process. The automatic capture of data for use in such processes is usually known as **Data logging.**

Advantages of using devices, which can read data directly from source documents.

(i). They ensure faster & accurate processing of data. This is because the data is read directly from the source document, and no data preparation is necessary.
(ii). No typing or recording required, and therefore, not prone to transcription errors.
(iii). The documents can be re-used, thus saving on stationery.
(iv). The contents of the documents are both human & machine sensible, hence reliable.
(v). Errors are easily corrected.
(vi). Difficult to forge.

Review Questions.

1. **(a).** What are document readers?
(b). Describe various kinds of document readers.
2. **(a).** What is the difference between OCR and OMR?
(b). State two advantages & two disadvantages of each.
3. The diagram below shows coded data that could be input into a computer.



(i). What is the name given to the above method of input?
(ii). State TWO applications that would use this method.
(iii). For one of the applications you have given, state TWO items of information that might be represented by the coded data.
(iv). State what hardware is needed to enter the coded information into a computer and briefly describe how this hardware works.

4. Explain the advantages and disadvantages of the following:
(i). OCR.
(ii). OMR.
(iii). MICR.

Interactive whiteboard

CENTRAL PROCESSING UNIT (CPU) / PROCESSOR.

The CPU is described as the computer's 'brain' that monitors all the computer operations. It is the unit inside the computer where all software instructions, math and logic operations are carried out.

In Microcomputers, the CPU is implemented in a single silicon device called a **Microprocessor** (**Computer chip**), which is made by combining a very large no. of transistors together using a technology referred to as **Very Large Scale Integration** (**VLSI**).

Notes.

- ❖ The CPU is one of the most expensive components of the Motherboard & also a very delicate piece of equipment.
- ❖ The CPU has a label, such as "**486**" or "**Pentium**" to show its type, and the chip manufacturer's logo on it.
- ❖ It has a large fan (known as the **Heat sink)** screwed on top of it, that keeps the CPU cool while the system is on. This is because the CPU gets very hot when it is in operation.

Functions of the Processor (Central processing unit).

1. To control the use of the Main memory in storing of data & instructions.
2. To control the sequence of operations within the computer.
3. To give commands to all parts of the system.
4. To carry out data processing.

Basic features (functional elements) of a Microprocessor system.

The Processor is made up of 3 major/ main components;

(i). Control Unit (CU).
(ii). Arithmetic Logic Unit (ALU).
(iii). Main Memory Unit (MMU).

Other components include;

√ Registers.
√ Accumulator.
√ Buses.

Note. The elements making up the Computer system communicate through electronic paths called **Buses**. The buses carry data, instructions, information, control commands and power between the communicating elements.

CONTROL UNIT (CU).

The CU acts as the manager of the computer. Its main work is to control, supervise & co-ordinate all the activities of the various units of the computer, enabling the machine to perform useful tasks.

The CU is usually described as the ***Nerve centre*** of a computer system. It co-ordinates & controls the activities of the different components of the computer system in the same way that the brain directs the actions of the body.

The CU carries out the fetching, decoding & execution of the instructions. It fetches/ selects the required instruction from Main storage, stores it in a no. of special Registers, interprets the instructions, and causes the instruction to be executed by sending appropriate signals to the appropriate hardware devices.

In order to execute an instruction, the CU must do the following:

- ♦ **Fetch** (get) the instruction from the Memory.
- ♦ **Decode** the instruction, i.e., determine what the instruction is saying. For example, whether to ADD or COMPARE two numbers.
- ♦ Get the data required by the instruction. E.g., the two numbers.
- ♦ Activate the right circuits for the instruction to be obeyed, e.g. call into action the circuits which perform addition.

Note. The CU automatically repeats this cycle of operations until either it is instructed to stop or the last instruction has been executed.

In order to enable the Control Unit to carry out the various functions, certain registers are used.

(a). Sequence Control register (also known as the **Program Counter**).

It controls the order in which the instructions are carried out.

It contains the address of the next instruction in the computer program to be executed.

For the next instruction to be executed, it must be brought from the memory into the Processor. When an instruction has been fetched from memory, the Program Counter is increased by 1, and is then ready to find the next instruction.

Therefore, the **Sequence Control register** sequentially points to the address of the instruction to be carried out, reads it into the Instruction Register, and automatically moves to the next instruction in the processing sequence.

(b). Instruction Register.

It stores a copy of the instruction being processed.

Note. An instruction has 2 parts;

- Operation part, e.g., Multiplication.
- Address part.

The Instruction Register is connected to the **Instruction Decoder**.

(c). Instruction Decoder.

It decodes (interprets) the instruction received from the **Instruction Register** & sends signals to the control switches of the computer.

(d). Address Registers.

Each location in a memory has its own address, which allows us to get directly to any program instruction or item of data stored within the memory.

Address – A label, name or a number identifying a storage location, or a device from which information is received or to which it is transmitted.

Address Registers are 16-bit registers used for the storage of addresses. They are connected to the **Address Bus**.

The Address part of the instruction goes to the Address Register, which retrieves the required data item in the address indicated and copies it in the ALU so that the operation instruction may be executed.

Address modification – the process of changing the address part of a machine instruction by means of coded instructions.

(e). System Clock.

In order to be able to fetch & execute instructions, the CU uses a timing signal provided by a **System Clock** attached to the CPU. The Clock is an electronic system that is used to control the Processor on when to fetch the next instruction from the Main memory.

The Clock sorts out all the internal paths inside the Processor to make sure that data gets from the right place & goes to the right place.

The clock is an Oscillator that generates timing pulses (at a frequency of several **Megahertz)** to synchronize the computer's operations & ensure that the operation occurs at the right time.

The CU performs 1 step of the instruction in 1 clock pulse. The speed of processing will depend on:

(i). CPU Frequency, i.e., time duration of 1 clock pulse.
(ii). The no. of steps involved in executing a full instruction.
(iii). The Access time of the computer, i.e., the time required to access any one memory address.

Functions of the Control unit.

1. It co-ordinates & controls various parts of the computer system, namely; Main memory, ALU & the Peripheral devices.
2. It maintains order & controls all the operations or activities inside the Processor.
   The CU controls the activities of all the other units of the computer by using the appropriate control signals. For example, it instructs the ALU on which arithmetic or logical operations are to be performed.
3. It connects the required circuits to enable the ALU to process the data in storage, as specified by the program.
4. It directs sequence of operations, i.e., it generates synchronization signals & manages commands exchanged between the ALU, I/O units & the Memory.
5. It retrieves and interprets instructions from the Main storage & makes the computer to execute these instructions by giving commands to the rest of the computer elements.
6. It controls the transfer of unprocessed data to the Main storage & results from the Main storage.
7. It stores the results in the memory.
8. It determines the location of the memory that contains the next instruction to be retrieved.
9. It monitors the CPU operations & identifies problems, such as equipment malfunction, illogical instructions or erroneous data finding its way into the system, and flashes them on the computer screen.

ARITHMETIC LOGIC UNIT (ALU).

This is the part of the Processor that performs all the **arithmetic operations**, such as adding or multiplying figures, & **logical operations** needed to solve a particular problem.
For example, if two numbers are to be added or multiplied, this is done by the ALU.

The ALU also performs **Logic Functions,** e.g., AND, NOT, OR, TRUE, FALSE & IF.

Functions of the ALU.

The ALU has 2 main functions:

1. It carries out the Arithmetic operations.
2. It performs logical operations and comparison on data.

Other minor functions include;

√ It performs output of variable (logical) functions.
√ It performs branching of prefixed conditions.

ACCUMULATOR.

- ❖ It is a storage device in the A.L.U, where all the answers from both arithmetic & logical operations are stored temporarily before being transferred to the memory.
- ❖ A Register in the ALU in which operands are placed, and in which arithmetical results are formed.

COMPUTER BUS.

A computer bus consists of a set of parallel wires connecting the Processor to the other devices of the computer.

- ❖ It is a communication path/medium within the computer that allows different elements of the computer to communicate with each other.
- ❖ An electrical connection linking internal sections of a computer, such as Processor, Expansion cards, and peripherals such as Keyboard and other Input devices.
- ❖ A parallel collection of conductors that carry data and control signals from one unit to another.

There are 3 major types of computer buses:

(i). Data Bus.

It is a bi-directional (2-way) bus that carries information & data to and from the Processor, i.e., it carries data from the Processor to the memory during Write operations & from memory to the Processor during Read operations.
The Data bus usually carries data for processing.

It consists of 4, 8 or 16 lines each carrying 1 bit at a time.

Note. The Data Bus determines the **Bus Width** of the microprocessor. Its size indicates the moving capability of information of the chip.

(ii). Address Bus.

It is a unidirectional (1-way) bus from the Processor to the external devices. It usually contains the address of the memory location or device to be acted on by the Processor (i.e. it conveys addresses).

The Address bus is wide (usually between 4 – 32 lines) to enable it to address as many devices as possible.

The size of the Address Bus tells you how much memory the chip can handle.

(iii). Control Bus.

It's a unidirectional (1-way) bus that carries command (i.e. timing & control) signals from the Processor. These signals are necessary to coordinate the activities of the entire system. For example, the command for the Printer to prepare to receive data is a control signal from the processor.
They usually have 3 – 10 lines.

Note. Buses are implemented as actual communication lines. They may be **Internal buses**, which are usually laid down as a circuit on the chip itself, or they may be **External buses**, implemented as cables.

CLASSIFICATION OF MICROPROCESSORS.

There are 2 basic factors (parameters/ considerations) used to classify Microprocessors.

1. Clock speed.
2. Width of the Data Bus.

Clock Speed.

Every Microprocessor has a clock that drives its operation. **Clock speed** is the speed at which the processor runs.

Microprocessor speed refers to its Clock speed, which is measured in **Megahertz** (**MHz** – 1 million cycles per second).

The Clock speed varies from one processor to another. Microprocessors with faster clocks perform operations much faster compared to those with slower clocks. Therefore, the speed of a microprocessor gives its power – the higher the speed, the more powerful the microprocessor.

Note. The speed at which a computer can process data is also affected by the speed at which the memory can work.

Bus Width.

The size of the Data Bus determines the **Bus Width** of a microprocessor. It indicates the moving capability of information of the chip.

Higher Bus widths provide higher computer performance. For example, fetching a 16-bit instruction from memory using a Data bus width of 16 bits would require a single fetch operation, whereas an 8-bit Data bus would require 2 cycles to fetch the same instruction; hence slowing the execution of the instruction.

TYPES OF PROCESSORS.

(i). Microprocessors.
(ii). RISC (Reduced Instruction Set Computer) processors.
(iii). CISC (Complete Instruction Set Computer) processors.

MICROPROCESSORS.

The Microcomputers use **Microprocessors**, which usually have all the required functions on one chip.

Some of the manufacturers who make microprocessor chips include;

- **Intel Inc.**, **AMD** (**A**merican **D**evice **M**anufacturers) & **Cyrix** who manufacture microprocessors for IBM compatible microcomputers.
- **Motorolla** for Apple computers.

MICROPROCESSOR TRENDS.

The following are some of the Microprocessors manufactured by **Intel Inc**:

Processor	Year	Speed (MHz)	No. of Transistors	Data Bus width (Bits)	Size of Internal Registers (Bits)	Maximum addressable memory	No. of memory Address Lines
8088	1979	5 - 8	__	8	16	1 MB	20
80286	1982	10	130,000	16	"	16 MB	24
80386	1985	12 -16	275,000	32	32	4 GB	32
80486	1989	33 - 66	1 Million	"	"	"	"
Pentium 75	1993	90 –200	3 Million	64	"	"	"
Pentium Pro	1995	180 –200	5,500,000	"	"	64 GB	36
Pentium MMX	1997	166 –233	7,500,000	"	"	"	"
Pentium II Xeon	1998	233 –300	"	"	"	"	"
Pentium III	1999	500 –550	"	"	"	"	"

Pentium MMX has Multimedia instructions such as 3-D bitmap manipulation built in them. The Pentium III Multimedia instructions are 4 times more powerful than those of Pentium MMX Microprocessors.

ADVANCED CPU's.

Larger computers such as Supercomputers, Mainframes & Minicomputers use Processors made of separate, high speed sophisticated components. That is, the CPU components in large computers are not all on one chip.

RISC Processors.

The RISC processors are used in manufacture of Minicomputers.

RISC machines are much faster than Micro-processor based machines, i.e. in RISC machines, the time required to execute an operation is much shorter compared to the time a Micro-processor would take to execute the same operation.

RISC chips generally use 128 or fewer instructions to execute their tasks. This means that, the processor has few instructions to locate. They can execute these instructions more quickly & are therefore very fast.

Again, each instruction is exactly 32 bits long. So, the processor does not waste any power determining where the instructions begin or end. This makes RISC processors more superior.

They are also cheaper to produce.

Most of the 64-bit RISC machines are manufactured by: -

- **D**igital **E**quipment **C**orporation (**DEC**).
- Sun Microsystems.
- Hewlett-Packard, and
- IBM (**I**nternational **B**usiness **M**achine Corporation).

CISC Processors.

CISC chips use between 200 – 300 instructions. Therefore, the processor has more instructions to look up.

The instructions are usually between 8 -120 bits long. This means that, a CPU devotes at least part of its circuit time determining where instructions begin and end, making them run slowly.

Factors that affect the performance of a Processor.

- Overheating.
- Incorrect configuration (construction / arrangement).
- Failed components.
- Running the processor at the wrong speed.
- Jammed or clogged or too small heat-sink / cooling fan.
- Incompatibility.
- Processor inserted the wrong way.

Exercise (a).

1. Draw a well-labeled diagram showing the components of a computer Hardware model.
2. Compare with the aid of a diagram, the physical appearance and the electronic components of a Microcomputer.
3. **(a).** What is the Central Processing Unit?
(b). What parts make up the Central processing unit?
4. **(a).** Define the acronym A.L.U.
(b). Identify TWO functions of the above unit.
5. Write short notes on the following:
(i). Control unit.
(ii). Arithmetic logic unit (A.L.U).
(iii). Main memory.
6. **(a).** Define Registers.
(b). List THREE types of Registers and state their functions.
7. **(a).** What is a Computer Bus?
(b). List 3 types of computer buses and explain their functions.
8. Explain briefly the Microprocessor operation cycle.
9. State TWO factors that determine the type of processor.

Exercise (b).

1. Name and explain 3 main parts/ components of the Processor.
2. What is the function of registers in a processor?
3. List the electronic components of a Microcomputer.
4. Draw a block diagram for a simple Microcomputer showing its four main parts. Say what each part does.
5. Describe the functions of each of the following in a Processor:
   (a). Control unit.
   (b). Arithmetic Logic unit.
   (c). Accumulator.
   (d). Internal Registers.
6. Draw a carefully well labeled diagram showing the architecture of a typical Microprocessor.
7. Explain in a sentence the function of each of the following components in a Control unit.
   (a). Clock.
   (b). Program Counter.
   (c). Instruction Register.
8. Name the 3 stages/ phases of the computer processing cycle.

Exercise (c).

1. **(a).** Give the meaning of the initials CPU, and state its other name.
   (b). Describe the 3 main components of the CPU.
   (c). State two functions of the Central processing unit.
2. Outline the FIVE main processes under which data undergoes to become information.

MEASURING THE MEMORY SIZE OF A COMPUTER.

The size of a computer's memory is the no. of '*units of storage*' it contains. The unit of storage can be a **Bit**, a **Byte**, or a **Word**.

A **Bit** is the smallest unit of storage & can be used to store a 0 or a 1.

A **Byte** is the amount of storage needed/ required to store 1 character.

A **Character** is any letter, digit or symbol, which can be obtained by pressing a key on the Keyboard.
Note. 1 Byte can be used to store 1 character.

A **Word** is a collection of bits. It can also be described as a group of bits or characters considered as an entity and capable of being stored in one storage location.

The no. of bits in a word is called the **Word Size**. The most common Word sizes are 16, 32 & 64.
On a given computer, a **Word** is the amount of storage normally needed to store an instruction.

Memory sizes.

			Characters
1 Byte	A group of 8 bits		1
1 Kilobyte (KB)	1,000 (a thousand) bytes	10^3	1,024
1 Megabyte (MB)	1,000,000 (a million) bytes	10^6	1,048,576
1 Gigabyte (GB)	1,000,000,000 (a billion) bytes	10^9	1,073, 741,824
1 Terabyte (Tera)	1,000,000,000,000 (a trillion) bytes	10^{12}	1,099,511,627,776

A computer memory is made up of many storage cells called **Bytes**. Each cell (byte) is capable of storing **8 bits** (binary digits) and has a unique numeric address.

Generally, the memory size of a computer is usually measured in **Bytes**. The prefix **K** is taken to be **1,024 bytes**.
For example, when the size of a computer memory is quoted as being, say, 256 Kbytes, this implies that, there are 262,144 memory cells or the computer has (**256 x 1,024**) = 262,144 bytes of memory.

Exercise (a).

1. How is information stored in a computer?
2. **(a).** Differentiate between a 'Bit' and a 'Byte'.
   (b). How many bytes would be required to store the following statement?
   COMPUTERS ARE FUN TO USE!
3. Define the term 'Character' as used in computing.
4. **(a).** What is a Megabyte?
   (b). How many Kilobytes and how many characters make a Megabyte?
5. The size of a computer memory is quoted as being 256 Kbytes.
   (a). How many bytes can that computer hold in its memory at a particular time, if K is taken to be 1,024 bytes?
   (b). Calculate the precise number of characters that could be stored in the computer. Explain your answer.

Exercise (b).

1. What is a Byte?
2. Name 2 standard 8-bit codes used internationally to represent information in computers.

CLASSIFICATION OF COMPUTER MEMORY.

Computer storage is divided into 2:

1. Main memory (Primary memory).
2. Secondary storage (Backing/ Auxiliary storage).

MAIN MEMORY.

It can also be described as the **Primary storage**, **Internal Memory**, **Immediate Access storage**, **Semi-conductor memories, Core memory**, etc.

This is the storage (memory) found within the computer itself.

It is used to hold data, programs & instructions required immediately (or currently being used) by the Processor.

A computer can only obey data and program instructions that are stored in the Main memory.

It is **Online** (very close) to the central Processor, and therefore, any data within the Main memory is directly accessible to the Processor.

The Primary storage generally consists of the following functional areas:

(a). Program storage area.

Holds instructions from both System software & Application programs, which enter the central processor from an Input device.

(b). Working storage area.

Is used to hold the data being processed as well as the intermediate results of such processing.

(c). Input storage area.

It temporarily holds data that has been read from an Input device. Since Input devices operate at slower speed than the Processor, part of the Input storage area serves as a **Buffer**. A Buffer helps free the CPU to get on with other work while the slower I/O operations are completing.

(d). Output storage area.

Holds the finished results of processing unit released to the user.

General features/ characteristics of the Main memory.

(i). Its operation is wholly electronic, and therefore, very fast, accurate and reliable.
(ii). Data must be transferred to the Main storage before it can be acted on by the Processor.
(iii). It provides direct data access, i.e., data is instantly accessible from the Main memory & the Processor can act directly on the data.
(iv). It is of low/ limited storage capacity.
The Internal memory of the computer is designed in such a way that it reaches a capacity beyond which it cannot extend.
(v). It is volatile.
For example, the RAM (the section of the Main memory that stores the user programs, application data, instructions and intermediate results during processing) loses its contents immediately when the power is switched off.
The Main memory is therefore, used to store temporary programs and data.
(vi). The speed of the processor depends on the Main memory.
(vii). It is very expensive, due to the technology involved & the elements used in making them.

Question. Identify the advantages and disadvantages of Primary storage.

Functions of the Main memory.

1. It stores data awaiting processing.
2. It stores instructions waiting to be obeyed.
3. It holds the program instructions & the data currently being processed.
4. It stores intermediate results of processing awaiting transfer to the output devices, i.e. it stores data awaiting output.
5. The size of the Main memory affects the speed, power & capability of the computer.
6. All inputs & outputs are transmitted through the Main memory.

Ideally, the Main memory is used to store all data requiring processing in order to achieve maximum processing speed.

Classification of Primary Memory.

The Main memory can be classified into 3 different sections:

(i). The fast Microprocessor Internal Registers.
(ii). Read-only memory (ROM).
(iii). Random Access memory (RAM).

READ-ONLY MEMORY (ROM).

This is a memory that can only be read, but cannot be written to, i.e., the user can only read the information in it.

ROM provides permanent storage of data, i.e., the contents in ROM cannot be changed at will. This is because the program instructions and the associated data stored in the ROM are developed & installed during the manufacture of the computer hardware by the computer

manufacturers & therefore, they cannot be changed during normal computer operations; thus the term "**Read only**".

ROM is a **Non-volatile memory -** its contents are retained (remain intact) when power is switched off. Therefore, it cannot be affected by switching the computer on & off.

ROM forms a small proportion of main storage – it contributes to about 30% of Internal memory.

ROMs are used in situations where the data or instructions must be stored/ held permanently. It is used to store vital data & programs, which need to be held in the Main memory all the time. For example, they are used to store essential files especially those the computer uses while booting (starting) up.

Common uses of ROMs.

The main functions of the ROM are:

(i). It stores **Firmware** (**bootstrap programs**) –i.e., the essential files the computer uses while booting (starting) up.

(ii). It stores the system data & instructions that are necessary for the normal functioning of the computer system hardware.
For example, it stores the Operating system program, which is necessary for the initial co-ordination of the hardware & the other OS programs.

(iii). It stores **Control programs**, used for the operation of the computer & peripheral devices.
For example, the **BIOS** is stored on ROM because the user cannot disrupt the information.

(iv). It stores **Translation programs** (**Code converters**)**,** used for converting a user's program into Machine language.
E.g., TURBO PASCAL, which translates Pascal programs written by users.

(v). It stores **Special functions** (**facilities**) peculiar to a given machine.

(vi). It stores **Character generators** for Printers and Video displays.

(vii). It stores **ROM Lookup tables**.

Types of ROM memories.

1. Masked ROM.
2. PROM (Programmable Read only memory).
3. EPROM (Erasable Programmable Read only memory)

Masked ROM.

This is a ROM that can only be produced by the manufacturer.

The bit patterns corresponding to the desired contents of this memory must be supplied by the user in a standard format. .

Programmable ROM (PROM).

This is a ROM that can be programmed or "*customized*" directly by the user using a special PROM programmer to suit the needs of a particular task.

Customizing is the process by which a standard product is adapted for use in a particular situation.

Erasable Programmable ROM (EPROM).

This is a ROM that can be reprogrammed a no. of times.

There are 2 main types of EPROMS:-

(a). The UV-Erasable Programmable ROM.

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(b). Electrically Erasable Programmable ROM (EEPROM).

It is also called **Flash BIOS**. This ROM can be rewritten through the use of a special software program, that uses electrical pulses.

Note. This is the way Flash BIOS operate, allowing users to upgrade their BIOS.

RANDOM ACCESS MEMORY (RAM).

It is a type of main memory, which is used by the computer to store data & programs temporarily during the times when they are needed in the Main memory.

The term "***Random Access*"** means that, data in any area of the RAM can be reached or accessed in the same amount of time.

RAM provides "**Read and write**" facilities, i.e., it allow instructions to be written & read out, and also to be changed at will. Therefore, the computer user/ programmer can control or manipulate the data stored in RAM.

For example, it is this memory that is accessed during installation of programs; deleting, moving & copying of files.

Read refers to the retrieving (recovering) of information from memory, while **Write** refers to the storing of information in memory.

RAM is a **Volatile memory**, i.e. the contents of RAM are usually lost (rubbed off) when the power supply or the computer is switched off.

RAM forms the major proportion of Main storage – it contributes about 70% of the Internal memory. It is the memory used in large quantities in Main memory, and every computer must specify its size.

Uses of RAM.

The functions of the RAM are:

(i). It stores data & instructions awaiting processing.
(ii). It also stores the instructions which are being obeyed or whose parts have been obeyed by the computer.
(iii). Stores the intermediate results - the results of computer working/ calculations, before they are communicated to the users through the Output units.

Note. The RAM are usually stores **Application programs** (computer user developed instructions for solving specific tasks), such as Word processing or Spreadsheets.

It also stores user **data**, to be manipulated by the computer using the user input Application programs. Therefore, the RAM of the Internal memory serves the user.

Types of RAM.

(a). Static RAM (SRAM).

A Static RAM is able to maintain its data as long as power is provided to the memory chips.

It does not need to be re-written periodically. In fact, the only time the data on the memory is refreshed or charged is when an actual "***Write***" command is executed.

SRAM is very fast & is currently being used in the Main Processor as a small amount of high-speed memory called the **Cache memory**.

(b). Dynamic RAM (DRAM).

A Dynamic RAM uses **capacitors** to store information. The information is stored in the Capacitors as a charge. Like any charge, the electrical charges in individual memory capacitors of a DRAM will drive away (leak) causing the data to either be lost or changed within a few milliseconds.

This means that, unlike SRAM, a DRAM must undergo the **Refreshing** process, i.e., it must be re-written continually in order for it to maintain its data. This is done by placing the memory on a ***Refresh circuit*** that re-writes the data several hundred times per second.

Refreshing involves reading the information out of, and then writing it back into the memory, thus restoring a full charge.

DRAM is used widely for most computer memories because it is cheap & small.

Advantages of Static RAM over Dynamic RAM

(i). SRAM is much faster than DRAM & it able to keep pace with the Main Processor.
(ii). It doesn't require refresh cycles like DRAM – can retain its data forever.

Disadvantages of Static RAMs.

(i). They are of low data density, i.e. it stores less data bits.
(ii). SRAM chips are physically large & much more expensive than DRAM chips.

Advantages of Dynamic RAM over Static RAM

(i). DRAM has a much higher packing density than SRAM, i.e., a DRAM chip is able to store more information than a SRAM chip of the same size.
(ii). DRAM chips are small in size.
(iii). A DRAM can store a lot of information in a very small space, and therefore cheaper (less expensive) that SRAM. This is the main reason why DRAM is the memory used mostly (or in large quantities) as the Main memory in Microcomputers.

Disadvantages of a Dynamic RAM.

(i). It is much slower than SRAM & is not able to keep pace with the Main Processor.
(ii). It requires refreshing in order to retain the information in its memory cells.

The charge stored in the capacitor of a DRAM leaks & most of the charge cannot be retained for long or may be lost within a few milliseconds. To preserve the information, the charge must be refreshed every 1 or 2 milliseconds by use of a Refresh circuit, which can be incorporated within the CPU.

Exercise (a).

1. Outline THREE characteristics of Main storage.
2. **(a).** What are the functions of the Main memory of the computer?
(b). Why do we say that the Main memory slows down the computer's processing speed?
3. Distinguish between the two types of Primary memory, stating clearly where each one is used.
4. **(a).** What is a RAM? What is it used for?
(b). State 3 important facts about RAM.
(c). What is meant by "*Random access*?"
(d). Briefly describe the two types of RAM, and state where each one is used.
5. **(a).** What does ROM mean? What is it used for?
(b). Give 3 important facts/characteristics of ROM.
(c). What programs are stored in ROM?
6. Define the term "*Volatile*" in the context of computer memory.
7. Identify THREE reasons why Dynamic RAMs are the most widely used memories in microcomputer systems compared to Static RAMs.
8. Define and explain the following terms:
(i). RAM.
(ii). ROM.
(iii). PROM.
(iv). Co-processor.

Exercise (b).

1. Identify the TWO types of Primary memories found in the Central Processing unit.
2. State how RAMs and ROMs are used in the computer system.
3. Carefully distinguish between ROM, PROM and EPROM.
4. What type of memory is used to store the boot up program (the first program to be executed on switching on a computer)?
6. State the main differences between Main memory and Backing storage.

Since the memory chips are too small, they must be combined and put on a medium that can be worked with and added to a system. To achieve this, the designers place the memory chips on a small fiberglass card to create the **SIMM** (**Single Inline Memory Module**) or **DIMM** (**Double Inline Memory Module**).

These cards are placed in a socket on the motherboard, and then fastened/ bolted in. This design eliminated problems of the past, and made upgrading memory a simple task.

SECONDARY STORAGE (also called **Auxiliary** or **Backing memory)**.

Secondary memory is used by the computer to hold programs, data files & backup information that is not needed immediately (not currently in use) by the Processor.
However, contents in a secondary storage media can be quickly transferred into the computer's Main memory for processing when required.

It is also used by the computer to supplement the computer's main (internal) memory in case of mass storage purposes.

This storage is provided by less expensive devices such as:

(i). Magnetic disks (Hard disks &Floppy diskettes).
(ii). Winchester disks.
(iii). Magnetic tapes.
(iv). Cassette tapes.
(v). Punched cards.
(vi). Zip disks.
(vii). Optical disks, which include **CD-ROMs** & **WORM (Write once Read Many) disks,** and
(viii). Digital Video Disks (DVDs), which can be connected to the computer.

Most of these storage media are magnetic based, i.e., they use the principles of magnetism to store data and instructions in form of binary.

The data is stored permanently in **Disk drives**. The disk drives can either be fixed inside the computer, as in the case of Hard disks, or inserted anytime you want to read or write in them.

What is a Disk drive?

- A Disk drive is a computer device for reading or writing data from or into a storage media.
- A Disk drive is a hardware on which files can be stored.
- A Disk drive is a unit that houses a disk.

Examples;

- Hard disk drive (HDD or drive C:).
- Floppy disk drive (FDD or drive A:).
- CD-ROM drive.
- DVD-ROM drive.
- Tape drive.
- Zip drive.

A Disk drive can be used as an Input device, Output device or Secondary storage device.

Characteristics of Secondary storage devices.

(i). They provide slow access of information – they process data very slowly compared to primary storage.

Modern secondary storage devices normally operate in **milliseconds**. It can take between 25 – 50 milliseconds to locate information in a disk drive.

(ii). They have high data storage capacity.
Disks & Tapes can store large amounts of data and instructions; however, the amount of storage is limited by the no. of disk packs or tapes you buy.

(iii). The devices are cheap.

(iv). They are non-volatile. Secondary storage units store data permanently.

(v). Used for mass storage of data & program files not currently being operated on, but which will be transferred to the main storage when required.

Question. Identify the advantages of secondary storage devices.

THE NEED FOR SECONDARY STORAGE IN COMPUTERS.

1. The amount of storage needed on a typical Microcomputer system might be greater than the storage space available in the Main memory. This requires the use of backing storage devices, which can be used to store large quantities of information.

2. Whatever is in memory is lost when the computer is switched off. Thus, there is a need to store programs & data in secondary storage devices from which it can be retrieved when needed.

3. Primary storage is expensive, thus the need for secondary storage devices which are cheaper.

FUNCTIONS OF SECONDARY STORAGE DEVICES.

(i). Used to store backup data & instructions that is not needed immediately (or not currently in use) by the CPU. This helps in creating space for another data to be stored in the memory.

(ii). Used for transportation & distribution of data & software, i.e., for transferring files from one machine to another.

(iii). Used to back up files (keep copies of data & programs) for safe-keeping.
Whatever is in memory is lost (or can be corrupted) when the computer or the power supply is switched off. Disks can therefore be used to store programs & data, which can be retrieved when needed.

(iv). Used to install new software.

Exercise (a).

1. **(a).**What is meant by 'Secondary Storage'?
(b). Explain 3 reasons why it is necessary for a computer system to have secondary storage facilities.
(c). Outline 3 basic characteristics of Secondary storage devices.

2. **(a).** State THREE differences between Primary storage and Secondary storage.
(b). Give TWO reasons for using secondary storage devices instead of using Primary storage.

3. **(a).** Give two examples of secondary storage devices.
(b). State 4 functions of secondary storage devices in computer systems.

Exercise (b).

1. Explain the salient features of computer secondary storage.

2. Why do we need secondary storage on a computer system?

3. **(a).** State any four advantages of secondary storage over main memory.
(b). State one primary storage device and one secondary device.

MAGNETIC DISKS.

A **Magnetic disk** is a round platter made of a plastic or a metal & coated with a magnetic material, which is used for storage of information.

Magnetic disks can be used:

(i). Store backup data that is not being used currently.
(ii). To install new software.
(iii). To transfer/ transport files from one machine to another.
(iv). To back up small amounts of files for safekeeping.

Magnetic Disk storage – A storage device or system consisting of magnetically coated disks, on the surface of which information is stored in the form of magnetic spots arranged in a manner to represent binary data. The data are arranged in circular tracks around the disks and are accessible to reading and writing heads on an arm which can be moved mechanically to the desired disk and then to the desired track on that disk.

Data recorded on a magnetic disk can be read/ retrieved in 2 ways: -

(a). Sequentially or Serially – whereby data from a given track are read or written sequentially as the disk rotates.
(b). Directly.

Illustration.

Suppose there are 5 records stored on track 0, and 5 records on track 1.

In **Sequential access/ retrieval**, the records from track 0 are read, followed by the records from track 1, and so on until all records have been retrieved.

In **Direct data access/ Retrieval**, the records are accessed *directly*, in any order, moving the Read/write heads to the track that contains the data required.

For example, suppose you want to read record 99, followed by record 20, then followed by record 43. If the records are located on tracks 19, 3 & 8 respectively, then the read/write head will move to track 19, then back to track 3 & then to track 8.
In order to read record 99, there is no need to access records 1 to 98; the head can proceed directly to where record 99 is located.

The storage capacities of disks are commonly expressed in terms of the *no. of bytes of data they can hold.*

A Magnetic disk can be of 2 forms: -

(i). Floppy diskettes (Soft disks).
(ii). Hard disks.

FLOPPY DISKETTES.

A **Floppy disk** is a disk that can be inserted in & removed from a disk drive.

The 3.5-inch disk is inserted via a slot in front of the System unit/ cabinet.

Floppy disk units are single-drive units able to hold a single disk. The disk unit is incorporated physically into the body of PCs. Such disk drives are called **Internal disk drives**.

A Floppy disk is made from a thin, flexible plastic circular material. The plastic material is coated with a magnetic substance (usually **Iron Oxide**), which enables data to be recorded on the disk.

The plastic disk is protected in a rigid smoothly lined plastic envelope; that safeguards the recording surface against external influences, e.g., touch and dust accumulation onto the recording surface.

Floppy diskettes can bend easily.

The diskettes are relatively cheap and conveniently handled. However, they are only suitable as storage media in Microcomputer systems because, they store relatively low volumes of data and have a short life.

The storage capacity is influenced by the *no. of sides of the plastic base coated with magnetic materia*l & the *storage density*, measured in bytes. The common storage capacities are 360, 720, & 1,440 bytes.

In single-sided disks, data can only be recorded on one side, whereas in double-sided disks, data can be stored on both sides.

The disks come in different densities. The **Low density** (single-sided) disks, which hold 720KB of data & **High-density** (double-sided) disks, which usually hold 1.44MB of data.

Uses of Floppy diskettes.

Floppy diskettes are used: -

(i). To distribute software on microcomputers.
(ii). To collect or input data for subsequent transfer and input to another system.
(iii). As backup media for small hard disks.

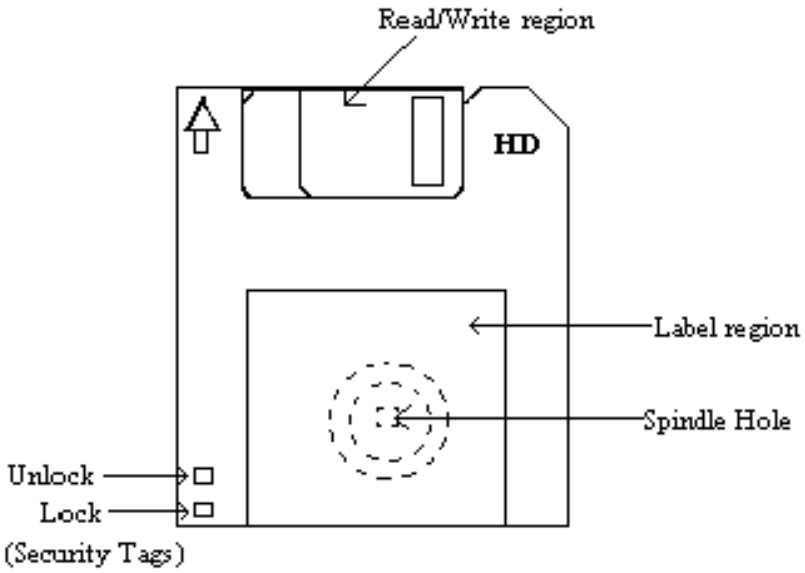
Common types of Floppy drives.

The diskettes come in different sizes.

1). 3.5-inch drives, which accept the small 3.5" disks.
2). 5¼-inch drives, which accept the big 5¼" disks.
3). 8-inch drives.

The 3.5" & 5.25" diskettes are used in Microcomputers, while the 8" diskette is normally used in Minicomputers & Mainframe computers not for storage but as a data collection/capture medium.

The diskettes can only be read by drives that are designed to read/write onto them, i.e., a low-density 3.5-inch drive will only read and write the low-density diskettes.
However, most high-density drives are able to read and write both low-density & high-density diskettes.



Physical Appearance of a 3.5-inch Floppy disk.

(i). Permanent label.

- It is incorporated on the diskette when it is bought.
- It has on it an arrow indicating the direction of inserting the diskette into its drive, information about the diskette, such as the no. of tracks per inch, the version of the diskette, e.g., Single-sided Single density (1S1D) & the trade name of the diskette.

(ii). Temporary label.

This is the label, which is attached onto the diskette by its user to specify, e.g. the name of the owner, name of programs maintained on the diskette, etc.

(iii). Security tags.

Are used to safeguard the contents of the diskette. When the hole is covered by the shutter (a plastic band), the diskette cannot be written to or its contents altered.

(iv). Spindle hole.

It is the hole used by the disk drive to hold/ clump the diskette over its turntable for the drive motor to spin the diskette past the Read/Write heads so that the reading or writing operations can be performed on the recording surface(s) of the diskette.

(v). Read/Write region (Read/write head slot)

This is where the diskette's recording surface is exposed. It is used to give the heads of the disk drive access to the disk.

Comparison between 5¼-inch and 3½-inch diskettes.

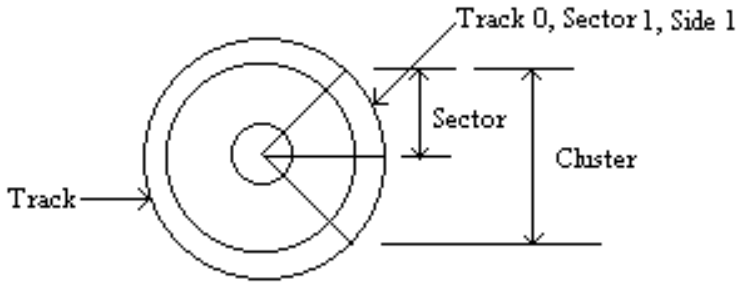
	5.25-inch Floppy B:		**3.5-inch Floppy A:**	
Densities	Low-density	High-density	Low-density	High-density
Capacity (Bytes)	360KB	1.2MB	720KB	1.44MB
Tracks	40	80	80	80
Sectors	9	15	9	18
Heads	2	2	2	2
Type	Flexible	Flexible	Rigid	Rigid

DS – Double-Sided. **HD** - High-Density.

- Both types are either of low density or High density.
- The 5.25 inch diskettes are flexible, while the 3.5 inch are rigid.
- 5.25 inch diskettes have a max. of 15 sectors, while 3.5 inch diskettes have a max. of 18 sectors.
- The 3.5-inch disks store more data, and are better protected. They have now replaced the 5.25-inch diskettes, which are only used on existing 8088 PCs.

The disk surface is divided into concentric circles called **Tracks**. The Tracks are further sub-divided into **Sectors**, which are used for data storage. Data or information is recorded on the Tracks & sectors. Typically, each sector is 512 bytes.

The tracks are described as concentric, because they allow the moving around one track from a given start point and end up at the starting position.



HARD DISK.

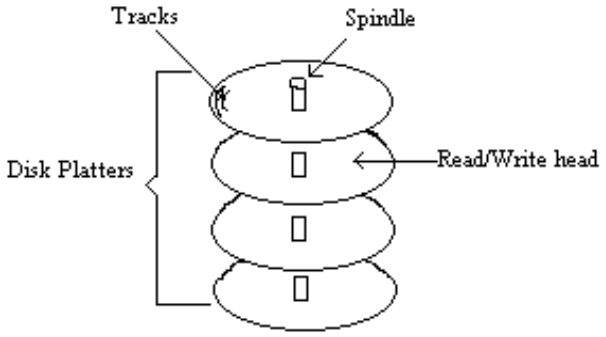
Hard disk is made of metal & is usually rigid/ firm.

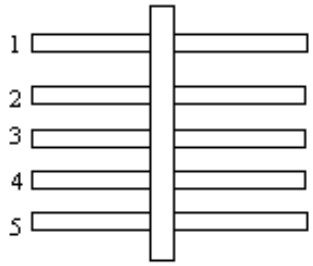
Hard disk is not removable like the floppy disk, but it is fixed inside the computer. However, it works on the same basic principles as the floppy disk.

A hard disk is made up of one or more **platters** (disk plates), arranged one on top of the other to form a ***disk pack***. The platters are made from a metallic material, usually an **Aluminum alloy** or **Glass** in order to make them light.
The glass platters have enough *Ceramic* within it to resist cracking & also they can better resist the heat produced during operation.

Each platter is coated on both sides with a magnetic material, usually **Iron Oxide,** which enables data to be recorded on the platter. This is why many platters are *brownish orange* in colour.

The mixture (of the magnetically sensitive substance) is poured on the platter, then spinned to evenly distribute the film over the entire platter.





The disk pack plates are held on a rotational **Spindle**, which is used by the **drive motor** to rotate the plate surfaces past the Read/write heads in order for the read & write operations to be performed on the recording surfaces.

Data is written on & read from the disk using **Read/write heads** in the disk drive, under the influence of the computer's command signals.

The heads are attached to a device or an access arm called the **Head Actuator**, which is used to move the read/write heads across the platters to the destination track.

There is usually 1 Read/write head on each side of a platter & all the heads are attached to a single actuator shaft so that the heads move in unison. Each head has springs to force it into the platter it reads.

When off, the heads float between the surfaces of the platters, which are held in a vacuum that enables it to spin/ rotate around very quickly.

When the **drive** is running, the platters rotate causing air pressure that lifts the heads slightly off the platter surface. The disk rotates & the heads can move in & out over the surface to record or read data on the various tracks.

Notes.

- The Read/Write heads do not touch the disk plate's recording surface. They fly over to avoid the R/W head's 'crash', which may result in the wearing away of the magnetic coating over the recording surfaces that may cause loss of the recording property of the magnetism.
- The distance between the head & the platter is very small such that the drive must be assembled & repaired in a very clean room because one dust particle can throw the whole drive off.

DATA STORAGE IN A HARD DISK.

The surface of each disk is divided into a no. of concentric circles called **Tracks,** each track being divided into **Sectors**.

The storage capacity of a hard disk is much higher than that of a floppy disk, & is therefore able to store much more data than a floppy disk of the same size because of technical differences.

The storage capacity of the hard disk is determined by the *no. of recording surfaces, no. of tracks per surface* & the *recording density*.

The computer identifies the record sought for by using its track no., or cylinder no. & the sector no. for its direct retrieval.

HARD DISK ACCESS MECHANISMS.

In order for a drive to read or write to a disc, it must be spinning at a constant speed. Floppy disk drives only begin rotating whey they are required to read or write data. However, Hard disks spin continuously, often at 3,000 revolutions per second.

The Read/write heads are capable of crossing the disk surface from one track to another very fast, making it possible to locate a data file or even a particular record/item within a file on the disc very quickly.

Terms used to define Access Times in Hard disks.

The Hard disk is a ***Direct Access Storage Media*** (**DAS/m**). Its **Access Time** is obtained in same manner as that for the diskette. However, the Access Time is influenced by:

- The arrangement of the Read/Write heads.
- The rotational speed, which is faster than that of the diskette.

If the disk pack is removable from the unit, the disk drive or unit is referred to as an **Exchangeable Disk Unit** (**EDS**). If the disk pack is permanently held in a unit, the disk drive or unit is referred to as a **Fixed Disk Unit** (**FDU**).

Disk unit - is the device in which the disk pack is placed.

Features of a Fixed Disk unit.

√ The unit houses a no. of non-removable disks.
√ It has a motor that rotates the drive at a high contact rate.
√ In a **Fixed-Head drive,** there is usually 1 read/write head for each track on a given surface.
For example, if there are 200 tracks per recording surface, then there will be 200 R/W heads serving each surface, such that, when accessing data, there is no head movement in reading data from one track followed by data from another track. This means that during the Read and Write operations, the R/W heads doesn't have to move in order to locate the right track because, each track is already located, hence the seek time is zero. This implies that the access time for the disk pack of a fixed head drive is reduced.
√ Fixed head drives are more expensive than moving head drives.

Moving Head Drive.

♦ The recording surface of each disk plate is supplied by only 1 Read/Write, regardless of the no. of tracks the surface contains. Therefore, during the read and write operations, the R/W head servicing the surface must move in order to locate the right track containing the contents requested.

Example:

Suppose the R/W head is positioned over track 20 & the data required is on track 20. Then this data can be read as the disk rotates past the head.

Suppose the data required is on track 64. Then the access arm must first move the R/W head from track 20 to track 64. Once the head is positioned over track 64, the data is then read.

♣ After the head is positioned over the desired track, it has to wait for the right sector. The time taken for the disk to rotate from its present position to the position on the track at which the data starts is called **Rotational delay** (**latency**) & is measured in *Milliseconds*. The faster the hard drive spins, the shorter the rotational latency time.

- ♣ The time taken to read & transmit the data to the computer is called the **Transmission Time**.

For a moving head drive, the time taken to access data (i.e., **Access Time**) usually ranges between 25 – 100 Milliseconds for a hard disk system & 100 – 600 milliseconds for a floppy disk system.

Advantages of Magnetic Disks.

Magnetic disks (Floppy disks & Hard disks) are the most commonly used medium for online secondary storage in microcomputer systems because of the following reasons: -

(i). They are cheap **(Low cost).**

Although disk drives are expensive, the use of removable disk packs enables storage capacity to be increased very cheaply.

E.g., to improve the storage capability of a floppy disk system, you simply need to buy additional disks at low cost.
The cost of Hard disks has decreased making them to be widely used on microcomputers.

(ii). Have relatively fast access times for data stored anywhere on the disk.

For hard-drives, the data Transfer rate between memory & disk is 300,000 – 2 million characters per second, while that of floppy disks is between 30,000 – 150,000 cps.

(iii). Have high storage capacities.

Hard disks can store tens of millions to hundreds of millions of characters while floppy disks can store between 100KB – 2 MB of data.

(iv). They are re-usable - the disk space can be re-used by simply recording new data over old data. Also, the data stored in a magnetic disk can be easily corrected or updated.

(v). They are Non-volatile - information is stored permanently.

Disadvantages of Magnetic Disks.

(i). Data stored on magnetic disk is not human-readable, i.e., to verify the accuracy of data stored on the disk, a computer run has to be made, which reads the contents on the disk.

(ii). A disk is susceptible (prone) to dust, stroke & magnetic fields; which can distort (deform/disfigure) data on the disk causing disk-reading errors.

(iii). Require enough skills to manage the disks effectively.

Differences between Hard disks & Floppy diskettes.

Floppy diskette.	**Hard disk.**
1). Can be inserted in & removed from a disk drive. It can also be transferred between computers.	**1).** It is not removable like the floppy disk, but permanently housed in a disc unit inside the computer.
2). Made of a flexible plastic material & can bend easily.	**2).** Made of a metal & is usually rigid/ firm.
3). Consists of a single platter/ disk.	**3).** Made of more than 1 platter arranged one on top of the other to form a disk pack.
4). Cheaper.	**4).** Relatively expensive than floppy disks.
5). Floppy disk drives only begin rotating when they are required to read or write data.	**5).** Hard disk drives spin continuously, i.e., they start rotating when a computer is switched on.
6). Have a spindle hole.	**6).** Have a rotating spindle that holds the disk plates together in a disk pack & is used to rotate the disk pack when reading or writing onto the disk.

7). Low storage capacities compared to hard disks, e.g. a Floppy disks store between 100KB – 2MB of characters. **8).** Slower access times, e.g. the data transfer rate between memory & the disk is between 30,000 – 150,000 characters per second.	**7).** Hard disks have a much higher storage capacity than floppy disks, e.g. can store between 10 - 80 million characters. **8).** Have faster access times for data stored in it than a floppy disk, e.g. the data transfer rate between memory & the disk is between 300,000 – 2 million cps.

ZIP DISKS.

Zip drives act as either external or internal devices.

- The Zip disk is found in a hard plastic case, and like the diskette, it uses a magnetic material for double-sided recording & reading.
- Zip drives are larger & their read/write heads can operate more efficiently than those on a regular floppy disk drive.
- Zip disks are usually portable.
- Each disk can hold up to 100 MB.

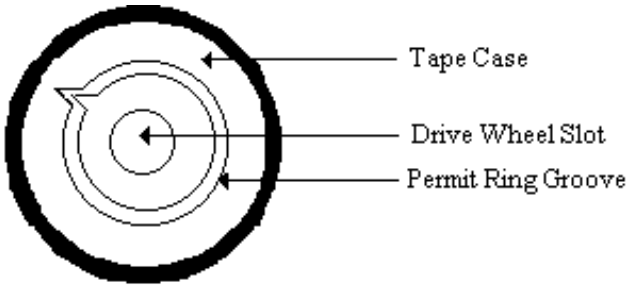
MAGNETIC TAPES.

These are the storage media mostly used in Mini and Mainframe computers.

A Magnetic Tape reel is made of a plastic ribbon/ band coated on one side with a magnetic material that enables data & instructions to be recorded/ stored on the tape.

Magnetic Tape – a tape with a magnetic surface on which data can be stored by selective polarization of portions of the surface.

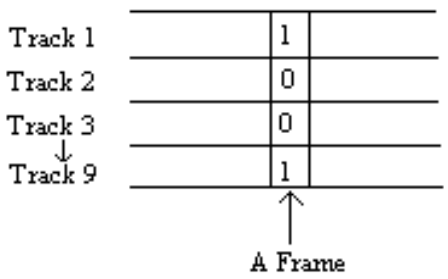
The reels of the Tape are stored in a protective case, which safeguards the recording surface of the reel from environmental destructions, e.g., touch, dust, direct sunlight radiations, etc.



Magnetic Tape in its case

Usually, a plastic ring (the **Permit ring**) is affixed on the **Permit Ring Groove**, which is on the case, before the tape is mounted in its deck. The Permit ring is used to protect/ safeguard the contents of the tape.

If the permit ring is affixed, the tape surface can be written to & read from, hence it is possible to alter the contents of the tape. If the permit ring is not affixed onto its groove, the tape surface can be read but cannot be written to; hence the tape user cannot alter the tape contents.



The width of the tape is divided into **Tracks**, while the length is divided into vertical columns called **Frames**. Each frame is made up of 7 storage unit areas (bit positions). These frames are used to store individual characters across the tape width.

The recording surface of a tape has 7 or 9 tracks running along its length. Each recording position on a track can be magnetized to represent a '**1**', while that which is not magnetized represents a **0**. Thus for a 9-track tape, each frame contains 9 bits & is used to represent 1 character.

A tape is usually ½ (0.5) inch wide & 2,400-feet long. The characters are recorded across the tracks on the tape.

Advantages of Magnetic Tapes as secondary storage medium.

(i). Tapes have a high storage capacity (or high data recording density), i.e. they can store lot of information in a small space.
Usually 1-inch of the tape can store between 1,600 – 6,400 characters. This also means that, a tape can allow a complete hard disk to be backed-up without the need to change media during the process.

(ii). Tapes are cheaper compared to other removable storage media.

(iii). Have high data transfer rates.
Reels of a magnetic tape have a transfer rate of approx. 10,000 – 1 million cps, whereas in cassette tapes, the transfer rate is about 1,000 cps.

(iv). Tapes are re-usable. When information on a tape is no longer required, it can simply be '*written over*' with new information.

(v). The domestic cassettes can also be used as storage media in small home computers where the speed of retrieval is not a necessity and the volume of the capacity of the cassette is enough. This is because domestic cassettes operate on the same principles as the magnetic tapes.

Disadvantages of storing records on Magnetic Tapes.

(i). Data stored on a tape must be read/ accessed sequentially, one record after another.
E.g., if you need to update the 100^{th} record, all the previous 99 records must be read, pass under the Read/Write head (or at least skipped over) to reach the record the user is searching. Hence, slow data, instruction and information retrieval.

This means that, if you need to process records in a different order, let say, record 100 followed by record 5, followed by record 50, the processing would be slowed down a lot because the tape would have to move back & forth. However, if the records have to be processed in sequence, i.e. from the first to the last, it would be fast.

(ii). Data stored on magnetic tape (& disk) is not human-readable.
E.g., if you wish to verify the accuracy of data stored on the tape, a computer run would have to be made, in order to read the contents on the tape and print it.

(iii). Tapes have short life spans (average of about 2 yrs).

(iv). A tape is susceptible (prone) to dust, stroke & magnetic fields; which can distort (deform) data on the tape causing tape-reading errors.

(v). Tapes do not fully use their recording surface.
An inch of tape may hold 1,600 - 6,400 characters & the IRG may be 0.5-inch. This means that, almost a ⅓ of the unused space on the tape is wasted.

MAGNETIC TAPE CARTRIDGE & CASSETTE TAPES.

They operate on the same principle as ½-inch reel-to-reel tape.

The domestic Cassette tapes are very similar to magnetic tapes. The only difference is that Magnetic tapes are wider & longer than the domestic cassettes.

Many cartridges are designed to overcome the bother of loading and unloading tapes.

A tape cartridge gives greater protection against dust & dirt and then makes the tape trouble-free. Tape cartridges provide an effective way to copy the contents of disks to guard against data loss.

On cassettes tapes, characters are stored **serially** down the length of the tape, one at a time. This slows down the processing speed of the information stored on the tape.

Advantages of Cassette Tapes.

(i). They are very cheap & convenient, making them to be a widely used form of secondary storage in many home computers.

(ii). It can store hundreds of thousands of bytes of data.

(iii). Can be re-used.

(iv). An ordinary cassette player can be used to record & play back the data on the tapes. Therefore, no expensive Input/Output device needs to be bought.

COMPARISON BETWEEN MAGNETIC DISKS & MAGNETIC TAPES.

Similarities.

(i). Both are coated with magnetic materials.
(ii). Have high data storage capacities, i.e. can store hundreds of thousands of bytes of data.
(iii). Have high data transfer rates.
(iv). Hold data permanently, i.e. are Non-volatile.
(v). Cheap and convenient; hence, the reason why they are mostly used for secondary storage in PCs.
(vi). Require drives in order to read or write data from or into a disk or tape.
(vii). Data stored a magnetic tape & disk is not human readable, i.e., to verify the accuracy of data stored on the tape or disk, a computer run would have to be performed.
(viii). Both are adversely affected by dust, stroke & magnetic fields, which can distort data stored in them causing data reading errors.
(ix). Tapes or disks do not fully use their recording surfaces. The **Inter-Block Gaps** in tapes occupy a large space; while in disks, a space has to be left for purposes such as copying & moving of files, defragmentation of the disk, etc.
(x). Both tapes & disks are re-usable. When information on a tape or disk is no longer required, it can simply be "written over" with new data.
(xi). Data in them can be read sequentially, e.g., when playing music or watching a movie on a disk.

Differences.

Magnetic Tape	Magnetic Disk
1). Consist of a strip of plastic, i.e., reels of tape.	**1).** Consist of round platters made of plastic or metal.
2). Only 1 side of the tape is coated with a magnetic material for recording data.	**2).** Both sides of the platters can be coated with a magnetic material for recording data.
3). 1 track of the tape is not used for data storage, but for *parity check*, i.e., to ensure that data recorded & transmitted is accurate.	**3).** The whole disk surface can be used for recording data. However, in hard disks, the top most surface of the 1st plate & bottom most surface of the last plate are not used for recording data as they can easily be scratched.
4). Requires tape drives to write information to & read data from the tape.	**4).** Require disk drives to read or write data in the disks.
5). Data is stored on a tape in form of records that are organized in blocks.	**5).** Data is stored on the disks in files, folders or directories.

6). Have Inter-Block/Record Gaps (blank spaces) separating two successive blocks or records.	**6).** Have no blank spaces between the tracks on the recording surfaces. However, they use a recording method known as **Tunnel Erasure**; which is used to keep each track of data separate from the others.
7). The records on a tape are read sequentially, i.e. one record after another in the order they occur on the tape.	**7).** Data recorded on a disk can be read sequentially or directly.
8). Data is recorded across the tracks on the tape or serially down the length of the tape.	**8).** Data is recorded on concentric circles on the disks called **tracks.**

PUNCHED CARDS & PUNCHED PAPER TAPES.

These are paper media, which were used as storage media by the early computers.

They been replaced by the magnetic media, due to the following reasons:

(i). They are bulky.
(ii). Provide slow input.
(iii). They are non-reusable.
(iv). They can be destroyed due to dust.
(v). Costly to produce - the punching & verification are tedious and expensive.

OPTICAL DISKS.

Optical disks use **Lasers** to read or write data. When writing, a laser beam is used to align a permanent data pattern on the disk surface. When reading, the data contents are sensed by the pattern of light reflected from the beam by the data on the disk surface.

There are 2 types of Optical disks:

1. CD-ROMs (Compact disc Read-Only Memory)
2. WORM (Write Once Read Many) discs.

CD-ROMs (Compact Disc Read Only Memory).

What is CD-ROM (Data CD)?

A **CD-ROM** (also known as a **data CD**) is a compact disc used to store computer data.

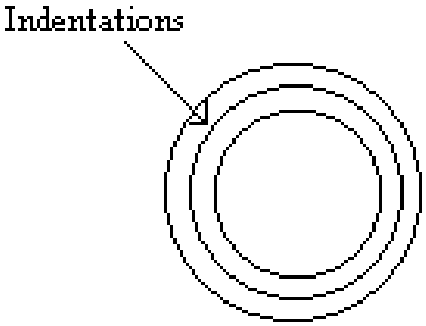
- CDs (**Compact discs**) were originally developed for the music industry. They use small disks identical to the ones that hold music to hold computer information.
- They have higher storage capacities than traditional Magnetic disks.
  The current CDs can hold about 650 MB of data compared to the 3.5" floppy diskette, which can only hold 1.44 MB of data.
  This storage capability enables programmers and other data distributors to write more sophisticated programs for computer users, because they are no longer limited by data storage space.

The CD-ROM Technology

A CD is made by having information burnt into the ***Polymer*** material using a laser. The indentations appear as fine circular tracks in the CD.

Data is written on the CD in a continuous spiral running from the center of the CD to its outside rim. All the bits in a file are written one after the other from beginning to end, then the next file is written, and so on.
A logical format (or file system) structures the raw bits on the CD in a virtual tree of directories and files, which makes it easier for both humans and computers to use the information.

ISO 9660 is a worldwide standard specifying the logical format for files and directories on a CD-ROM.



To use the CD-ROM discs, a **CD-ROM drive** is needed.

The devices in a CD-ROM drive are only able to read back pre-recorded sound or data by using a laser and detecting the pattern of light reflected from its beam.

The current CD-ROM drives use *Multi-session* & *Multi-speed technologies* due to the intense requirements of most multimedia applications. The Multi-session technology allows data to be written to a CD again & again until it reaches its maximum capacity (650MB).
The Multi-speed technology increases the rotational speed of the disk, thus increasing the data transfer rate of a CD-ROM drive.

Uses of CD-ROMS (CDs).

Typical uses for CD-ROMs include:

(i). Archiving data.
(ii). Backing up a hard drive or other media.
(iii). Creating a test copy of a CD before having it factory-duplicated.
(iv). Disseminating information to field offices.
(v). CDs are the primary methods of installing software.
Most software companies distribute application software in CD-ROMs.
(vi). CDs are used in **Multimedia** (the integration of text, motion video, graphics, & sound).
Programmers pack Multimedia in the CD-ROMs enabling consumers to enjoy the work of multimedia inventions.
(vii). To provide reference works, catalogues, directories, encyclopedias, software front descriptions, graphical images and sound.

Types of Compact Discs:

There are 2 types of Compact Discs (CD-ROMs): -

- CD-Recordable (CD-R) discs.
- CD-ReWritable (CD-RW) discs.

CD-R (**Recordable**).

A CD-R holds data permanently, i.e., once written, it cannot be erased or overwritten.

CD-R can be used to store or backup a lot of data (about 650MB), thus making it suitable for businesses that need to record/ store a lot of information.

Advantages of CD-R

(i). Good for permanent data storage.
(ii). Less expensive per disc than CD-RW disc (CD-R discs are cheaper compared to CD-RW).
(iii). Readable on virtually all CD-ROM and CD-R drives.
(iv). Use when you do not need to erase the data.
(v). CD-R drives can write faster than most CD-RW drives.

Disadvantages of CD-R.

(i). The disc can only be written once, (i.e. once something has been recorded on a CD-R, it can't be erased or written over again).
(ii). The future of CD-R drives seems to be in doubt since CD-RW drives can accomplish the same thing as CD-R drives.

Note. In a CD-R drive, there are 2 speeds listed.
The faster of the two speeds is the *speed at which the drive reads information from a disc,* while the slower one is the *speed at which the drive records information onto a CD-R.*

CD-RW (ReWriteable).

It is possible to record data on a CD-RW more than once. With CD-RW drive you can also erase the contents of a CD and re-write new information to it.
In addition, CD-RW drives can play audio CDs, use the regular CD-ROMs & read CD-R discs. This makes CD-RW drives very desirable.

Most CD-RW drives can also record to CD-R discs, making it possible to use CD-R discs with a CD-RW drive.

Advantages of CD-RW.

(i). Used when you need to erase the data and re-write new information (e.g., updating files). Data written to a CD-RW is not permanent, i.e. it can be overwritten or erased.
(ii). Used to make a practice CD or to test the contents of a CD before making a permanent one.
(iii). More cost effective for near line data storage requirements than CD-R.

Disadvantages of CD-RW.

(i). CD-RW drives & media are expensive/more costly than CD-R drives.
(ii). CD-RW are slower than CD-R & CD-ROM drives.
It takes about 1hr to format CD-RW discs & about ½ an hour to copy 250 MB of data to the disc, while CD-R discs take a few minutes to format and have the same write time.
(iii). Data can be read and written to CD-RW discs only by CD-RW drives.
(iv). CD-RW drives are currently facing stiff competition from the **DVD-Recordable** (**DVD-R**) because the DVD-R can store more information than CD-RW.

Note. Both CD-RW & CD-R can be read by standard CD-ROM drives.

WORM (Write Once Read Many) discs.

A WORM disc looks like a CD. Also, data is read from the disk in a similar way to that on a CD.

The WORM disc surface has 40,000 Tracks, 25 Sectors and a total storage capacity of 1GB.

Data is written into the disc by burning a permanent pattern into the surface of the disc by means of a high precision laser beam.

The WORM discs are exchangeable.

WORM discs are non-erasable & are less prone to data loss compared to Magnetic disks.
Access speed of a WORM disc is slower than that of Magnetic disks.

To use the WORM discs, a **WORM disk unit/drive** is needed. The drive is similar to magnetic disk unit.

An example of a WORM drive is the CD-R, which uses the same size of disks as CDs and once written using the CD-R drive, it can be read in a CD-ROM disk drive as well as in a CD-R drive.

Uses of WORM disks.

√ WORM drives store large amounts of data.
√ They are used to put data online for reference purposes.

Advantages of Optical discs as secondary storage media.

(i). Have very high storage capacities. This enables them to be used for multimedia applications.
(ii). Have relatively high access speeds.
(iii). Are Non-volatile, i.e. information kept in them is permanent. Therefore, they are more secure against alteration.
(iv). Are cost effective (cheap) especially if used for large storage volumes.
(v). They are robust – they resist temperature, electromagnetic fields, and not affected by water or dust.
(vi). Have very high data transfer rates.
Modern CD-ROM drives have data transfer rates of between 150 – 4,800 KB/second.
(vii). Some Optical discs allow data to be written to them a no. of times, e.g., CD-RW.

Reasons why Optical discs (CD-ROMs) are not mostly used in microcomputer systems as secondary storage media.

1). CD-ROMs require special writers to write to the disk. The CD Writers are usually expensive, thus limiting the utility/ usefulness of CD-ROMs as computer storage devices.
2). Are expensive (not economical) especially if used for low storage volumes.
3). Require CD-ROM drives to use the discs, which are not installed on most desktop computers.
4). Most CD-ROMs are produced by the manufacturer or can only be written once. Therefore, they are not reliable especially for businesses that may need to re-programme the CDs to suit their needs.
5). Are slow to prepare, i.e., it takes time to format & also to copy data into the discs, e.g. CD-RW disks take about 1hr to format & about ½ an hr to copy 250 MB of data to the disc.
6). The Access speed of an Optical disk is low.

DVD (Digital Video Discs).

A DVD looks like a CD-ROM. However, a DVD can store much more information.

For example:

A single-sided DVD can hold 4.7 GB of information (a 133 minutes of full-motion video), while a double-sided DVD can hold 17GB of information (the equivalent of 8 hrs of studio quality video); enabling most movies to be stored on a single disc.
This amount of storage gives software programmers flexibility when it comes to designing programs. They are able to store all the high-quality graphic images, digital sound & tools they want in a single DVD.

Currently, DVDs are used primarily for movies. The DVD videos offer superior pictures & sound, the ability to play audio CDs in a DVD player, and pictures that are sharp & clear than VHS videotapes.

To use a DVD, your computer should have a DVD-ROM. To read the DVD-ROM, a **DVD-ROM drive** is required.

In order to enjoy all the functionality of a DVD, the computer must have a **Motion Picture Expert Graph** (**MPEG**) **decoder card** or **MPEG software**. This enables the user to view full screen video or video clips from a DVD video disc.

DVD drives are reasonably/ fairly priced.
DVD drives can read all other ROM formats - audio CDs, CD-ROMs, CD-R, CD-RW & DVD-ROM discs.

The current DVDs are not recordable, i.e. they don't have the ability to record information.

HANDLING PRECAUTIONS FOR MAGNETIC MEDIA.

(i). Should be stored in optimum temperature ranges, e.g. $10^{o}C - 52^{o}C$ for diskettes.
(ii). Should be protected in their cases when not in use in order to safeguard their recording surfaces against environmental influences such as dust, touch, direct sunlight, radiations, etc.
(iii). When loading/ mounting the media into its reading/writing unit, care should be taken to avoid brushing the recording surfaces against the mechanical components of the drive.
(iv). Should never be brought near moving or magnetic bodies. Such bodies might cause the demagnetization of the recording surfaces (i.e., remove the magnetic property from the surfaces) making recording in terms of magnetism impossible.
(v). Put on the power before mounting the media and off after removing the media from the drive. This is because the fluctuation in power might also cause de-magnetization.

Physical storage considerations.

Recording density – The no. of useful storage cells per unit of length or area.

For example,
- The no. of characters per inch on a magnetic tape or punched card.
- The no. of bits in a single linear track measured per unit of length of the recording medium.

Volume - A term used for any individual physical storage medium that can be written to or read from. E.g., a fixed hard disk, floppy disk, CD-ROM, a disk cartridge or tape cartridge.

Formatting - Before a diskette can be used, it must be formatted. This prepares the disk so that the drive can use it.

Initialization - Before a disk is recorded, it has to be initialized, i.e., writing zeros to every byte on every track. This eliminates all trace of any existing data.

Fragmentation - When data is written on a newly formatted disk, it is usually written to unused contagious sectors. If data is erased, then the deleted sectors may leave spaces among used sectors. Overtime, after many inserts and deletes, these free sectors may be scattered across the disk. In such a phenomenon, the disk is said to be fragmented.

Exercise (a).

1. **(a).** What is a Disk?
(b). Explain in detail the uses of a disk in a computer system.
(c). State the two basic types of magnetic disks.
(d). Give THREE differences between the two types of magnetic disks identified in 1(c).
(e). Give 3 reasons why magnetic disks have become the most commonly used medium for online secondary storage in microcomputer systems.
2. **(a).** What is a Disk drive?
(b). State FOUR drives of a computer.
3. **(a).** What is a hard disk and what is it meant for?
(b). What are the components of a hard disk.
4. The disk pack of a hard disk has 6 disk plates.
(a). Calculate the number of surfaces that can be used for recording data. Explain your answer.
(b). Apart from the number of recording surfaces, identify TWO other features that can be used to determine the storage capacity of the hard disk.
5. **(a).**What is a Floppy disk?
(b). How many types of floppy disks are there in terms of size? Name them and state their features.
(c). Draw a well-labeled diagram of a 3.5-inch floppy disk showing its parts.

(d). How does a Floppy disk differ from a Hard disk?
(e). State FOUR precautions that should be taken when handling diskettes.

6. Distinguish the following:
(a). Magnetic tape unit and Magnetic tape.
(b). Optical disk drive and Optical disk.

7. What is meant by:
(a). An even parity check?
(b). An odd parity check?

8. Explain why the use of blocks of records can enable data to be stored more efficiently on magnetic tapes.

9. Define '*Transfer time'* and '*Transfer rate'* with regard to tapes.

10. Give 3 advantages of using magnetic tapes as secondary storage devices in microcomputer systems.

11. Give 5 similarities & 5 differences between magnetic tapes and Magnetic disks.

12. Explain the meaning of *Serial Access* and *Direct Access*. Give examples of backing storage devices that uses each of these methods of access.

13. List 3 advantages of each of the following types of secondary storage media.
(i). Magnetic Tape.
(ii). Magnetic Disk.
(iii). Optical Disk.

14. **(a).** Name the two types of Optical disks.
(b). Clearly differentiate between the TWO types of Compact Disks (CD-ROMs).
(c). List 3 reasons why Optical discs (CD-ROMs) are not mostly used in microcomputer systems as storage devices.

Exercise (b).

1. **(a).** Explain the term "Backing store". Give examples.
(b). State 3 reasons why do most computers require backing store?
(c). Name two different types of backing storage media and compare the accessibility of data from each of these types.
(d). Draw a diagram to show the construction of ONE backing storage device.

2. A floppy disk drive is an auxiliary storage drive:
(a). With which type of computer would you normally associate this device?
(b). Why does this type of computer commonly have disk drives as well as Main memory?
(c). If one character is stored in an 8-bit byte, and a floppy disk is said to store 360 KB. Calculate the precise number of characters that could be stored in the disk. Explain your answer.
(d). Compare the two types of diskettes used in terms of size, capacity and whether they are low or high density

3. Define the following terms as used in Magnetic disks:
(i). Access time.
(ii). Seek time.
(iii). Rotational delay.
(iv). Data transfer time.

4. **(a).** List THREE examples of Optical storage devices.

(b). Give THREE reasons why Optical disks are better storage devices compared to floppy disks.

5. Write short notes on the following:
(i). Diskettes.
(ii). Hard disks.
(iii). Magnetic tapes.
(iv). Optical disks.

6. **(a).** Explain the term "Access time" and how it can be calculated.
(b). Draw a labeled diagram of Magnetic tape deck/unit.

7. Explain the following terms with regard to magnetic tape systems:
(i). Load-Point marker.
(ii). Inter-Block Gap.
(iii). Header label.
(iv). Block.
(v). Recording density.

8. What is the importance of Inter-Block Gaps in a magnetic tape?

9. Explain the precautions of handling magnetic media.

Exercise (c).

1. "In future computer diskettes will be obsolete as every computer will rely on Optical disks". State whether or not you agree with this claim and give TWO clear reasons to support your answer.

2. Assuming that a computer DVD has a storage space of 4GB and a normal movie (video) file takes 700MB of storage space. How many movies can be stored in a single DVD storage device? (Give your answer to the nearest whole number).

3. How many optical disks of 720MB storage capacity are needed to store 20GB storage of hard disk data? (Give your answer to the nearest whole number).

OUTPUT DEVICES

When the computer processes the data (or after the computer finds the solution to the problem), it displays the results (or communicates the solution to whoever posed the question) by use of an **Output device**.

The term **Output** is used to describe all that comes out, from the computer memory, or from the processing stage of a data processing system to the external environment.
Output therefore, involves receiving information (processed data) from the computer through a suitable device for external use.

An output device provides the user with the results from the computer.

FUNCTIONS OF OUTPUT UNITS.

1. Transmit the intermediate results & final results to the users.
2. Convey messages, e.g. error messages, to the operators.
3. Provide immediate response to queries/ questions.
4. They are used when writing onto the secondary storage media.
5. Accept the results produced by the computer (which are in coded form & hence cannot be easily understood) & convert these coded results to human readable form.

The output produced by computers can be put into 2 broad categories: -

(a). **Human-readable output**, which serves the informational needs of people. This is a form of output that is readily understandable by human beings, e.g., printed or drawn output.

(b). **Machine-readable output**, which is required/used for subsequent input to the computer. In this case, the output may be temporarily stored on machine-readable media.

For example,

In the production of a payroll for a company, a *payroll* report is produced listing the amount each employee must be paid. This report can then be used by the person responsible for issuing cheques.

At the same time, an updated employee file is produced, say, on a tape. The tape will be used as input to the computer for the next payroll run.

The quality, validity and usefulness of the output is influenced by the output facility used. The following factors/ considerations determine the choice of output equipment and media.

(i). Suitability of the application.
(ii). The speed at which the output is required.
(iii). Whether a printed version is required.
(iv). The volume of the data.
(v). Cost of the method chosen as compared with the benefits to be derived.

DIVISIONS OF OUTPUT.

Output can further be classified as: -

1. Hardcopy output.
2. Softcopy output.

SOFTCOPY OUTPUT.

This is where the end results are displayed on a screen. The user can see the results, but cannot touch them.

The output lasts for a short-time only, i.e., it is available only as long as it appears on the screen.

Examples of Softcopy Output devices.

- Visual Display Units (VDU) / Monitor.
- Audio Response Units.
- Speakers.

HARDCOPY OUTPUT.

Hardcopy implies that the output is permanent, i.e. it can be retained for an indefinite period.

The user can see & touch the results.

Hardcopy is desirable if the information or the results of the computer working is to be maintained for future reference/ use.

Examples of Hardcopy Output devices.

- Printers.
- Graph Plotters.
- Microforms.

Exercise (a).

1. **(i).** What is the difference between "Hardcopy" and "Softcopy"?
(ii). Name TWO output devices which produce temporary output.
(iii). Name THREE output devices which produce permanent output.
2. What are the factors, which determine the choice of output media and device?

Exercise (b).

1. List FIVE different types of computer Output devices.

VISUAL DISPLAY UNIT (VDU)/ MONITOR.

Visual display unit (or a Monitor) is a television-like screen, which displays the data that is being typed at a Keyboard. It also displays the information that has been processed by the computer in a human-sensible form.

In many cases, an ordinary television set can serve as the display unit.

The display is meant to provide a means of visually checking whether the information that has been entered is correct.

The output displayed on a monitor screen is called a **Softcopy output**.

Classes of Monitors.

(a). Cathode Ray Tubes (**CRT**) – found in most desktop microcomputers.
(b). Liquid Crystal Displays (**LCD**) – used by Laptops and Notebooks.

- The resolution of a CRT is adjustable, while that of an LCD is often set.
- The CRT can display an almost unlimited no. of colours, but the LCD can display a limited no. of colours.
- LCD's are backlit by a series of light bulbs. Notebooks use only 1 light bulb in order to conserve power, but desktop LCD's can use up to 4 bulbs.

  These bulbs can be replaced by the user. They also have a life span. Therefore, after sometime, you will notice that the screen starts becoming dimmer. Take the LCD to the vendor for a bulb.

Advantages of LCD over CRT.

1. The screen of a LCD is much thinner & smaller than of CRT.
LCD screens come in 14 or 15-inch sizes. A 15" LCD has a 15" viewable screen; a size that is only slightly smaller than a 17" CRT.
2. LCD's have no flicker.
3. They consume low power than the CRT.

The performance of a computer Monitor depends on 3 factors: -

(a). ***Size of the screen.***
(b). ***The number of colours it can display.***

- ❖ **Monochrome monitors -** display only 1 type of colour (*Black* for Background & *White* for Foreground).
- ❖ **Colour monitors** - display a variety of colours.
  Examples; Enhanced Graphics Adapter (EGA), Video Graphics Adapter (VGA), Super Video Graphics Adapter (SVGA).

  The higher the no. of colours displayed, the more realistic the images.

(c). ***The Screen resolution*** (or ***sharpness of the image***), which is determined by the no. of pixels.

The Viewing angle - the picture appears clear when viewed straight on or a certain amount of degrees off the center; but when you are too far over to the side, the picture grows too dim to see.

A VDU can be used to display lines of text as well as *graphics* (images, pictures & drawings).

When used for output of text, a typical display unit is made of 24 lines; each line consisting of between 40 – 80 characters.

When used for output of Graphics, the screen is considered to be composed of a no. of dots arranged in rows & columns.

•••••••••
•••••••••

Each dot is called a ***Picture element*** (or ***Pixel***).
A **Pixel** is a screen dot & is a direct mapping of the information (e.g. character) in the Video RAM contained in the monitor's Adapter card.

To display an image on the screen, the selected pixels are brightened or darkened.

The term **Resolution** is used to describe the no. of pixels per unit area of the screen. E.g., the no. of pixels per cm^2.

If there are few pixels per unit area, the display is said to be of a ***Low-resolution***. If there are many pixels unit area, we talk of ***High-resolution*** display.
The higher the screen resolution, the finer & the higher the no. of different images that can be displayed.

Note. Specific applications require certain resolutions to be able to run, e.g., *Microsoft Windows*.

MORE ABOUT MONITORS & DISPLAY ADAPTERS.

Monitors do not have a direct impact on the performance, but have a significant impact on the use of a PC. A bad quality monitor can hinder the use of an otherwise high-tech PC.

Display – Presentation of information such as by projection on a screen, an Audio message, a computer print-out, etc.

Display Adapter Card (also called Video Card or Graphics Card).

The real brain of a display operation is the **Video Card.** It is inserted into the slot on your computer's motherboard as an expansion card. It then speaks to the monitor about what the computer is asking it to do.

The Video card determines how fast graphics display, how many colours can be used, etc.

For a Monitor to work to its best, it must be fitted with a Video card capable of bringing out the best in it.

The Video Card receives image data from the Processor in form of digital information & stores it in video RAM. The digital information is then converted into analogue display signal, which is fed to the monitor.

How a Monitor Works.

The inner surface of the screen is coated with a **Phosphorus** material that emits/ produces light when struck by an electron beam. Whenever the electrons hit the phosphor, it glows, producing images.

When the Monitor is plugged into the Video card, it gets a **scan frequency** (or a signal) giving the timing of the screen redraws.
The electron beam must cross the screen in synchronization with the scan signal of the Video card. The beam starts at the top left of the screen, crossing to the right. As it does this, it excites the phosphor dots. On reaching the right side of the screen, it returns to the left side in order to refresh the line of pixels underneath the first one. It continues this process down the screen, returning to the top to do it over again when it has finished the entire screen.

During the process, the beam excites those phosphor dots, which the video card tells it to. Therefore, the card gives instructions to the electron gun to excite some pixels; hence, forming pictures.

On a Colour monitor, each pixel contains 3 separate dots, one for each of the primary colours of light; *Red, Yellow,* & *Blue*. Combining these colours together produces the range of colours that we all know.

Screen burnout.

This is a term used to describe the damage caused to the inner surface of the screen display.

Inside the Monitor, an electron beam is aimed at a ***Phosphor***-coated screen. If a screen display is static, the electron beam continually strikes the same place on the screen surface, and eventually burns a hole in (or wears away) the Phosphorus coating. This might take several days or weeks to occur.

Note. Damage to the screen cannot be repaired. The damage is visible by turning & inspecting the screen surface closely. If an image can be seen, then the screen has suffered damage (i.e. it has burned out).

Factors that determine how severe the screen burnout is.

(i). Type of Phosphorus coating used on the screen's inner surface.
(ii). Length of time the screen image remains constant.
(iii). The brightness & contrast of the screen.

How to avoid screen burnout.

Screen burnout can be avoided by applying the following common sense principles: -

1. Switch the Monitor off, if you wish to be away over long periods.
2. Turn down the screen brightness, if leaving the machine unattended.
3. Using a "***Screen Saver***" program.

Types of Monitors (Displays or video Adapters).

(1). Colour Graphics Adapter (CGA) display.

This was the original type of Monitor, but now it is obsolete.

It supported colour, but could only display a limited no. of colours. Usually, it supported 4 colours at a time.

It also ran at a low graphics resolution of 640 x 200 pixels.

(2). Enhanced Graphics Adapter (EGA) display.

It is a low-grade adapter. It was developed to improve the capabilities of CGA.

An **EGA display** works with a 9-pin connector and an *EGA video card*.

They have a resolution of 640 x 350 pixels, which is better than that of CGA monitors.

They also offer two brightness levels for each primary colour dot, thus, displaying a wider range of colours. EGA screens can show 16 different colours.

(3). Video Graphics Adapter (VGA) display.

It was introduced by IBM in 1987 for use on earlier IBM PS/2 systems. The VGA Video card contains all the circuitry needed to produce VGA graphics, and like all expansion cards, it plunges into a slot on the motherboard via an 8-bit interface.

VGA is able to display photographic quality images on a PC, i.e. it offers clean images at higher resolutions. It is able to build an image that is 640 x 480 pixels in size.

With a VGA, a PC has to deal with 640 x 480 x 3 bits every time a picture changes.

The standard VGA can produce about 256 colours at a time from a palette of 262,144 colours.

The VGA can also be used in Monochromes. It is able to translate colour graphics into graphics using 64 different shades of grey. This, in effect, simulates colour on a monochrome monitor.

VGA video card requires a VGA monitor, or a monitor capable of accepting the analog output of a VGA card.

(4). Super Video Graphics Adapter (SVGA) display.

SVGA is much more advanced than VGA.
In most cases, one SVGA card can produce millions of colours at a choice of resolutions. It is able to show 256 colours at a resolution of 1024 x 768 pixels.
SVGA is able to support 1024 x 768 x 3 bits potentially changing 50 times per second.

Note. EGA, & VGA monitors are not interchangeable. A VGA monitor won't even plug into a CGA or EGA card. A SVGA monitor is not supposed to work with a standard VGA card.

Advantages of VDU/ Monitors.

(i). The speed of output is fast – a Monitor displays the output almost instantly/ immediately.
(ii). It displays the information enabling the operator to visually verify/confirm if the data is correct.
(iii). Enables the operator to monitor his/her performance & improve productivity.
(iv). Used when saving the information to a secondary storage media.
(v). Minimizes paper work, hence reducing the cost incurred on stationery.
(vi). Hardware costs are minimal since no extra equipments are needed as long as the VDU is available. The screen is cheap, if bought as individual device.

Disadvantages of VDU.

(i). Produces softcopy output, i.e., the output is temporary & can get lost when the power is switched off.
(ii). It is impossible to produce multiple copies.
(iii). It causes fatigue to the user's eyes, especially when stared at for a long duration.
(iv). Can lure computer operators into not keeping hardcopy records.
(v). Screen might not allow the viewing of the full area of data.

Factors to consider when selecting/ buying a Monitor: -

1. **Compatibility with the adapter card:** The monitor must be capable of displaying the pictures that the display adapter card can generate. Otherwise, the display will be unstable.
   The Video card must be compatible with your computer's bus.
2. **Memory:** You should have at least 2 MB of Video memory, but if you have a larger monitor, start with 4 MB of memory. Look for a video card that has room for expansion in the future in case you have to buy a larger monitor.
3. **Monitor size:** This is the distance diagonally across the face of the monitor. The larger the monitor size, the more the viewable picture area.
4. **Resolution and Refresh Rate:** Both features depend on each other. They work hand-in-hand to produce a clean image.

   Refresh Rate (sometimes referred to as **Scan Rate**) is the no. of times per minute that a computer screen image is renewed (or the rate at which each pixel on a screen is re-drawn). The Refresh Rate is measured in **Hertz** (**Hz**).

   Make sure you know the refresh rate of your monitor. The recommended refresh rate is 60 Hz & above. The higher the refresh rates, the better.
   A low refresh rate results in an image that flickers (shines unsteadily), resulting in eye-strain.

   The standard for flicker-free images is 85 Hz. To detect flicker, look slightly above or to the side of the monitor. Sometimes, it helps to be in a darker room.

   Your Video card plays an important role in all this. If your card cannot provide support for the resolutions and refresh rates of the monitor, the picture will look degraded. When pairing a video card with a monitor, at least make sure that it is capable of delivering a 72 Hz refresh rate at any resolution supported by that monitor.

   Note. In order to stop images fading on the screen, they must be **refreshed** (sent to the screen) at least 50 times per second. Each pixel on the screen has 3 bits of information (corresponding to Red, Green, & Blue) attached to it, and all of them have to be redrawn at high speed.

The higher the resolution, therefore, the more strain is placed on the performance of the monitor's Adapter card.

VOICE OUTPUT DEVICES (Audio Response Units -ARU).

An ARU converts data/ information from the computer memory (which is in electronic form) through various specialized additional circuitry into waveforms/ sound for the receiver to hear.

The sound can be spoken language, musical notes or beeps. This output is obviously **Softcopy**.

Voice output is useful where reading is not necessary or is impossible and where fast output is required.

For example, Voice output is used:

- As a learning aid.
- In emergency situations for messages.
- In answering services, e.g. Post office talking clock.

When an ARU is used to produce speech, it is called a **Speech Synthesizer**.

A Speech synthesizer is a useful form of output especially when communication with a computer is made using telephone lines. A user dials the computer & makes an inquiry. The computer output is passed through the Speech synthesizer, which is located near the computer. The output is converted to a spoken reply, which is sent to the user over the telephone line.

Speech synthesizers are being included in many consumer products. For example,

- A *Bathroom scale* with a synthesizer can tell a person his weight, and whether he has gained or lost weight.
- In *Cameras,* they can tell you if your film or exposure is set wrongly.
- A *washing machine* with a synthesizer can tell you if and when to add more detergent, or the fabric conditioner.

Advantages of Voice Output.

(i). It is very fast, making it useful in emergency situations to relay messages.
(ii). Can be used for distant communication, especially if done over Telephone lines.
(iii). Useful where reading is impossible - can be used by visually disabled people.
(iv). Errors are easily corrected. For example, when used in a washing machine, it can tell you if and when to add more detergent, or the fabric conditioner.

Disadvantages/ Limitations of Voice Output.

(i). The output is not permanent.
(ii). It may be boring, especially for prolonged output.
(iii). Cannot be used by people with hearing problems.
(iv). If the message is conveyed through beeps, it may be hard to understand.

PRINTERS.

A Printer is an output device that facilitates the transfer of information from a computer to a paper. It is used when a permanent record of the output may be needed on paper.

Printed output is usually referred to as **Hardcopy output,** which means that the document can be kept indefinitely for future reference or use. The printed output can be distributed conveniently to reach the recipients of such information/results.

CLASSIFICATION OF PRINTERS.

Printers are basically classified in 3 ways: -

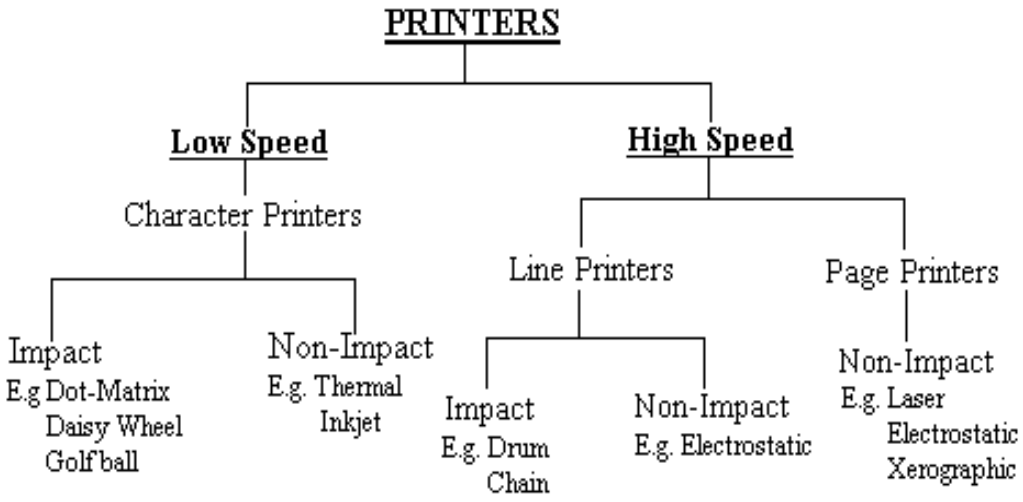
(1). In terms of Print speed.
- Low-speed.
- High-speed.

(2). According to the amount of text it can print per given period of time.

- Character Printers.
- Line Printers.
- Page Printers.

(3). The method used to produce the characters on the stationery/ paper.

- Impact Printers.
- Non-impact Printers.



CHARACTER (SERIAL) PRINTERS.

® **Character printers** are usually low-speed printers that print 1 character at a time.
® Are comparatively slow & less costly than Line or Page printers.
® Have printing speeds that vary from 10 to over 200 characters per second (cps).
® They usually use the *Daisy wheel* or *Dot-matrix* printing mechanism.

LINE PRINTERS.

® They usually print one whole line at a time.
® Are more expensive than the Character printers, but less costly compared to the Page printers.

PAGE PRINTERS.

® Print 1 whole page at a time.
® Are faster & relatively more expensive than both Line printers & Character printers.
® Page printers are Non-impact printers, i.e. there printing operation is silent.
® They provide high quality outputs.
E.g. **Laser** printer.

BASIC METHODS OF PRODUCING PRINT.

(a). Impact or Non-impact printing.

Impact printers.

An Impact printer works like a typewriter where a piece of metal or plastic with a raised letter strikes an inked ribbon against a sheet of paper, leaving an image of the letter on the paper.
Each character print is provided by an appropriate character symbol on the print head element.
The inked ribbon lies between the printing head element & the paper, so that the ribbon ink can be used to pass the character images on the print-head element onto the stationery during the print head hit impact.

Note. Impact printers can further be classified as *Character* or *Line printers*.

Non-impact printers.

In Non-impact printers, the print-head element does not come into contact with the stationery/ paper.
They use *Thermal*, *Chemical*, or *Electrostatic* principles to produce the characters on the paper.

They need special papers.

Comparison between Impact & Non-impact printers.

Impact Printers	Non-impact Printers
1. Use Inked ribbon.	**1.** Use thermal or electrostatic principles.
2. Slow.	**2.** Faster.
3. Able to produce multiple copies by use of carbon papers.	**3.** Almost impossible to produce multiple copies.
4. Cheaper.	**4.** Costly due to the technology involved.
5. They are noisy because the character to be printed is pressed against an inked ribbon onto to the paper by a print-head element.	**5.** Printing operation is silent because there is no print-head element hitting against the stationery.

(b). Dot-matrix or shaped-character printing.

Dot-matrix printers produce each character by printing the appropriate dot combination.

Shaped character printers produce each character by use of the whole character symbol just like as in an ordinary typewriter.

PRINT SPEEDS.

The speed of a printer is expressed in *Characters per second* (*cps*), *Lines per minute* (*lpm*), or *Pages per minute* (*ppm*).

There are basically 2 types of printers: -

- ❖ Low-speed printers.
- ❖ High-speed printers.

Each type is then classified further based on the technology used for producing the output & the amount of text it can print per given period of time.

1. LOW-SPEED PRINTERS.

They usually print between 10 cps to approx. 300 lpm.

Note. All *Character printers* can be classified as low-speed printers.

The different types of low-speed printers are: -

- Dot-matrix.
- Daisy wheel.
- Golf ball.
- Thermal printers.
- Inkjet printers.

2. HIGH-SPEED PRINTERS.

Are able to print between 300 to approx. 3,000 lines per minute.

High-speed printers are broadly classified into: -

(i). Line printers.
(ii). Page printers.

LINE PRINTERS.

Note. Line printers have a high speed as compared to the Character printers. For example, if a line of 80 characters is to be printed, the character printer need to strike against the stationery through the inked ribbon 80 times before all the character images forming the line are passed

on the stationery. A Line printer only strikes once for the whole line of 80 characters to be printed onto the stationery through the inked ribbon.

There are 3 types of Line printers: -

- Drum printers.
- Chain printers.
- Electrostatic printers.

Advantages of using Printers.

(i). Produces a permanent output that can be maintained for future reference.
(ii). The information can be conveniently distributed to reach the recipients of such information or results.
(iii). The advanced models of printers with colour capabilities can produce styled prints.

Disadvantages of using Printers.

(i). Very expensive, if bought as an individual device.
(ii). Some Printers are Noisy.
(iii). Not possible to produce multiple copies, especially the Impact printers.
(iv). Their speed of output (i.e., the printing) is slow.

Factors to consider when selecting a Printer.

The following factors are to be taken into consideration while selecting a printer.

1. **The Cost involved.**
   This will include the printer's initial price, the costs of maintenance & the cost of consumable items, e.g. printing papers, ribbons/cartridges, etc.
2. **Volume of printing expected.**
   This will help in selecting a printer in terms of *print speeds*.
3. **The nature of the reports to be generated & their recipients.**
   The printing quality, such as the capability to print graphics & colour printing should be considered with respect to the needs of the recipients.
4. **The capability for the selected printer**.
   These include multiple copy production, print styles, page width, etc.
5. **Compatibility with other computers.**
   This will involve the interface with the computer system being used and/or make of particular computer.
6. Environment in which the Printer will operate.
7. Reliability of the Printer.
8. Application it is required for & also the available application software packages.
9. Stationery (type of paper) used by the printer.
10. Documentation.

Printer driver - A program that controls how your computer and printer interact.

Tip. You might get bad work when you send graphics to a non-graphic printer or when you use a wrong driver.

Question. Explain how the factors identified in this chapter could influence the choice of printer to be used on a computer system.

Comparison between a Screen and a Printer.

Screen	Printer
1. Produces a softcopy (displayed) output.	**1.** Produces a hardcopy (printed) output.
2. Output is temporary, i.e. the display gets	**2.** Output is permanent, i.e. can be maintained

lost when the power is switched off.	for future references.
3. Cheaper, if bought as individual device.	**3.** More costly.
4. Output is silent, since there are no mechanically moving parts for the display to appear on the screen.	**4.** Output is noisy. Impact printers have printing head elements that hits against the paper in order to transfer the character images onto the stationery. Non-impact printers are considerably silent.
5. Impossible to produce multiple copies.	**5.** Using Impact printers, it is possible to produce multiple copies.
6. Output is fast.	**6.** Speed of output (printing) is comparatively slow.
7. Print quality is high.	**7.** Some printer's quality is low while others produce better quality prints.
8. May cause fatigue to the user's eyes especially when stared at for a long duration.	**8.** The printed information is more convincing to the recipients (humans).
9. Have different print styles, e.g., Italics and colour displays are possible.	**9.** Styled prints are only possible with advanced models with the colour capabilities.

GRAPH PLOTTERS.

These are output devices that produce graphics, such as diagrams, maps, images, statistical charts etc, on paper.

Plotters use pens of different types, varying thickness & different colours, in order to plot. The pens are usually under the direct or indirect influence of electronic pulses output by the computer.

Plotters are described/ named depending on the type of the base onto which the stationery is placed for the graphical output to be produced onto the paper.

The 2 commonly available Graph plotters are: -

(i). The Drum plotter.

(ii). The Flatbed plotter.

Characteristics of Graph Plotters.

- They are large in size.
- They use Ammonia papers.
- They use special ink.
- Have a wide carrying capacity.

Uses/ applications of Graph Plotters.

Graph Plotters are used: -

- In Computer Aided Design (CAD) – are mainly used for printing large architectural or engineering drawings. In this case, the computer is used to form the graphical design & the Plotter produces the output.
- In Weather forecasting for drawing **Isobars** on weather maps.
- In Statistical work for producing graphs or complicated mathematical formulas.
- In **Cartography** to produce contour maps.
- In Craft & Textile industry for drawing designs.

Advantages of Graph Plotters.

(i). Can produce information in an easily understandable form.
(ii). Their presentation is quick & reliable.
(iii). They produce large graphical designs of high quality, which are easy to read & use.

(iv). A Plotter can be used to print even on A1 sized papers, while the largest paper size that can be used with a normal printer is A3.

Disadvantages of Graph Plotters.

(i). They require Graphic software, which is usually very expensive.
(ii). Graph plotters operate at low speeds, hence are normally connected in an *Off-line mode* to avoid wasting the computer time.

COMPUTER OUTPUT ON MICROFORM (COM).

This is the process of transforming digital data produced by the computer into human-readable form & recording it in reduced physical size into a photographic film.

This method of output provides photographed type of computer output stored as microscopic filmed images into the microform.

Microforms are photographically reduced documents on films (magnetic media).

There are 2 forms/ classes of the Microform: -

(i). The **Microfilm**, which is a film reel of 16mm.
(ii). The **Microfiche** - a rectangular shaped sheet of film, measuring about 10 x 15 mm. A typical microfiche can hold the equivalent of 300 pages of printed paper.

Both the Microfilm & Microfiche are small.

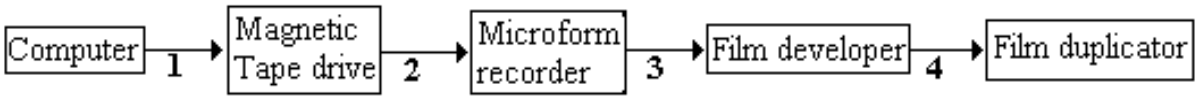
Differences between Microfilms and Microfiche.

Microfilm	Microfiche
1. Microfilm is a photograph film.	**1.** Microfiche is a normal paper.
2. Can store about 3,000 pages of A4 sized paper.	**2.** Can store about 98 pages of A4 sized paper.
3. Displays real images in reduced form.	**3.** Displays sketches.
4. Cheap.	**4.** Expensive.
5. Has a long life span.	**5.** Has a short life span.
6. Requires special devices for viewing.	**6.** Can be viewed by naked eyes.

Advantages of Microfilms over Microfiches.

(i). Microfilms last longer than Microfiches.
(ii). Microfilms display real images, making it easy to read & understand.
(iii). Microfilms are cheaper compared to fiches.
(iv). Microfilms require special devices for viewing while Microfiches do not.

Illustration of the COM process.



1. The computer displays the results onto the screen.
2. The contents are then photographed onto the microform (an online operation).
Alternatively, the computer can write the output into a storage medium, e.g. Magnetic tape.
3. The data on the tape is then read by transcriber machine called the **Microform recorder** & displays them on a screen connected to the machine.
4. The contents being displayed on the screen are then photographed by a high-speed camera using microfilm onto the microform.
Since the transcriber machine is not under direct influence of the computer, the operation is Off-line.
5. The film is then developed.
6. If necessary, duplicates are made using the **Film duplicator**.

In some systems, a separate device is needed for each of these stages. In others, the tape drive is not needed, instead the computer sends the output directly to the *Microfilm recorder*.
Also, some recorders are capable of processing the film, so a separate film developer is not needed.

In order to view a film, a **Microfilm viewing station** is used. This magnifies the images on the film so they can be easily read.
The station usually has a Printer connected to it to produce hardcopy, if required.

Applications of COM.

Microfilm output is conveniently suited to applications/ areas where: -

- There is bulky storage of information.
- The volume of output is high, say, 100,000 pages per month.
- The data must be stored for long periods and use or update is not frequently necessary; as in case of old copies of customer's files in banks, or back copies of newspapers. Such data is usually referred to as **Archival data**.
- In Postal services, where the cost of mailing a microfiche is considerably less than mailing the equivalent bulky report.

Examples of areas where the COM is used in:

- Libraries for books, catalogues, references, etc.
- Government authorities - to retain/ keep Town plans, maps, statistics, etc.
- Banks, Insurance companies, etc to store personnel or customers records.
- National Registration Board for security purposes.
- Registration of Motor vehicles, i.e., for Logbook and details of the vehicle.
- Immigration department – issuing of passports (originals and passports).
- National **Archives**.
- Thomas de la Rue – concerned with printing of money (both original & copies).

Advantages of using the COM.

(i). Saves on stationery and space.
(ii). Capable of producing many copies.
(iii). A very fast form of output -usually faster than printing.
Using the COM, the equivalent of 30,000 – 40,000 lines of output can be produced per minute (which is 20 times faster than the fastest Impact Line printer).
(iv). Not bulky, hence conveniently transportable.
(v). The microform contents are not easily read using naked eyes, hence guaranteeing the security of the reports.
(vi). It lasts longer as compared to paper medium output.
(vii). Compared to paper, the film costs are low. However, the initial cost is high, because the necessary equipment is expensive.

Disadvantages of Microforms.

(i). They are expensive.
(ii). Cause eye-strain if an attempt is made to read microform contents.
(iii). Requires special equipment for viewing the contents of the microform & for producing full-sized copies.
(iv). The contents in a microform are not easy to update.
(v). They are less convenient.

Exercise (a).

1. **(i).** Name FOUR types of Monitor cards or Adapters.
(ii). What is meant by the term "**Resolution"** as applied to a graphics display?

(iii). Why would one wish to use a high resolution rather than a low-resolution display?

2. Computer output is normally made through Screen or Printer. Compare Screen and Printer as output devices.

3. With reasons, briefly describe the most appropriate type of printer or output device for the output of:
(i). Customer invoices on multiparty stationary.
(ii). Letters to customers.
(iii). Detailed engineering designs.

4. **(a).** Name some everyday appliances/ devices in which an Audio response unit would be useful.
(b). Identify 4 Limitations of the Speech Recognition devices found today.

5. Give THREE Factors used to classify Printers. Describe the various types of Printers in each class.

6. **(a).** Name THREE different principles which are used for producing printed output.
(b). Clearly differentiate between Impact and Non-impact printers.
(c). Give two examples of the commonly used Non-impact printers.

7. Give one device, which can perform both input and output functions in a computer.

8. Write short notes on the following:
(i). Dot-matrix printer.
(ii). Daisy wheel printer.
(iii). Golf-ball printer.
(iv). Drum printer.
(v). Chain Printer.
(vi). Laser printer.

9. **(a).** A printer, which is connected to your computer prints garbage when required to print. What could be THREE probable reasons for not printing properly?
(b). Why is it not possible to print a Graphic on a Daisy Wheel printer?

10. **(a).** What is a Plotter?
(b). What advantages does a Plotter have over normal Printer machines?

11. **(a).** Describe the process of producing Computer Output on Microform (COM).
(b). Give the advantages of Computer Output on Microform offer printed output.

12. State TWO advantages and TWO disadvantages of using each of the following devices for output.
(i). VDU (monitor/ screen).
(ii). COM.
(iii). Voice Output.
(iv). Printer.

Exercise (b).

1. Explain briefly how the following devices work.
(a). Voice (Speech) synthesizer.
(b). Computer Output on Microfilm (COM).

2. **(a).** Define a Printer.
(b). With the aid of a diagram, show how Printers are classified.

3. Compare and contrast:
(i). Impact and Non-Impact printers.
(ii). Inkjet and Thermal or Electrostatic Printers.

4. **(a).** Why do you think a Desktop Laser printer is a popular choice of printer to use with a Workstation?
√ High volume of output – a high-speed Laser printer will print 146 pages per minute.
√ Output quality is very high (400 – 1200 dpi) – it can produce both text & diagrams or pictures of high quality and therefore can be used to produce manuals and small publications.

(b). What printers are suitable for producing business letters?
(c). What factors should you consider when selecting or purchasing a Printer?

5. Describe in brief the difference between:
(a). A Flatbed plotter and a Drum plotter.
(b). Microfilm and Microfiche.

Exercise (c).

1. **(a).** What are the essential differences among Character, Line and Page printers?
(b). Give a typical example of each.
2. Describe the factors to be considered while selecting a printer.
3. Write short notes on the following: -
(i). VDU.
(ii). Graph Plotters.
(iii). Voice Output.
4. **(a).** What is a Computer Output on Microform (COM)?
(b). Explain the working of COM system.
(c). Give the advantages and disadvantages of COM.
5. Explain the Printer under the following headings: -
(i). Character prints per given time.
(ii). Print provision, i.e. the way they provide the prints onto the stationery.
(iii). Print speed.
Give an account of the operational characteristics.

SYSTEMS INTERCONNECTION

THE MOTHERBOARD (also called **System Board** or **Circuit board)**.

Computers, like all electronic circuit devices are made of printed **Circuit boards** (electronic boards on which copper wires have been printed to form circuit paths).

The Motherboard is the main part (large circuit board) of your computer that every thing else plugs into.
It is usually a sheet of olive green or brown fiberglass with several thin gold lines on it and chips sticking off it.

By itself, the Motherboard is just an empty plate. It's the hardware that sits on it that does the work. On it, we have the CPU, SIMM sockets, BIOS and slots.

The Motherboard provides a convenient method of inter-board connection. It is where all electronic components such as the Microprocessor, Memory chips, Interface chips, and Bus connections are assembled.

The motherboard also contains a no. of expansion slots in which Interface cards are slotted (plugged in).

The little gold lines are called **Buses** and act as roadways of information between all these features. The buses enable the parts to communicate and perform the functions of your computer.

INPUT/OUTPUT (I/O) PORTS.

A **Port** is a connection or socket used to connect a device, such as a Printer, Monitor, Mouse, Scanner, etc to your computer.

I/O Ports are the sockets found at the back of your computer where you can connect external computer devices to the interface cards inside the computer. They allow access in & out of the computer for cables.

There are several types of external ports: -

1. Parallel (LPT) ports.

2. Serial (Com) ports.
3. USB ports.
4. SCSI ports.

PARALLEL PORTS.

The standard PC parallel port was originally designed for sending information to Printers or Scanners. That is the reason why they are sometimes referred to as **Line Printer Terminal** (**LPT**) **ports**.

They are D-shaped with *holes* for 25 pins.

It is used mainly to connect Printers, Scanners, and sometimes external Hard drives, CD-ROM drives, Tape devices & Network adapters to your computer.

Parallel ports transmit data using an 8–bit parallel interface & are therefore, used for devices that accept information 8 bits at a time. They transmit data byte-by-byte. They are usually faster than Serial ports.

Note. The SCSI Port is an example of a parallel port.

SERIAL PORTS.

They are sometimes referred to as **Communication** (**COM**) **ports**.

Are also D-shaped with 9 or 25 *pins*.

They are used primarily to connect devices such as serial Mice, external Modems, and sometimes Printers to the System unit. They can also be used for computer-to-computer connection.

The Serial port has 2 data lines, one for data in & the other for data out.

Transmission rates of Serial ports are slower than those of Parallel ports. This is because, Serial ports transmit data bit-by-bit. Therefore, they are used for devices that accept information 1 bit at a time (or for devices that are a bit slow).

UNIVERSAL SERIAL BUS (USB) PORTS.

Many new PCs come with USB ports. USB ports support a wide range of desktop peripherals, e.g., Keyboards, digital Cameras, etc.

USB combines the best features of SCSI architecture with an advanced Plug-and-play standard. It replaces the traditional Serial & Parallel ports with a single port that is extensible through the use of hubs and devices daisy-chained in a tree arrangement.

USB was designed to deliver a data transfer rate of up-to 12Mbits/sec to & from the PC. It also supports low-speed mode of 1.5Mbit/sec for devices like Keyboards, Mice and Joysticks.

USB is "user-friendly

Advantages of USB ports over Serial & Parallel ports.

(i). Devices are powered by the bus – there is no need for external power adapters. USB allows unpowered devices to draw up to 500 mA over the connector cable.
(ii). Can support a max. of 127 daisy-chained devices, because of its high bit addressing system.

SCSI (Small Computer Systems Interface) PORTS.

Pronounced as ***Scuzzy***.

SCSI is a device interface used by PCs, Apple Macintosh computers and many UNIX systems.

Small Computer System Interface (**SCSI**) **card** is used for attaching to peripheral devices that require high speed data transfers between the device and memory.
The SCSI cards provide parallel high-speed data transfer in the range of 10 MB/s to the memory.

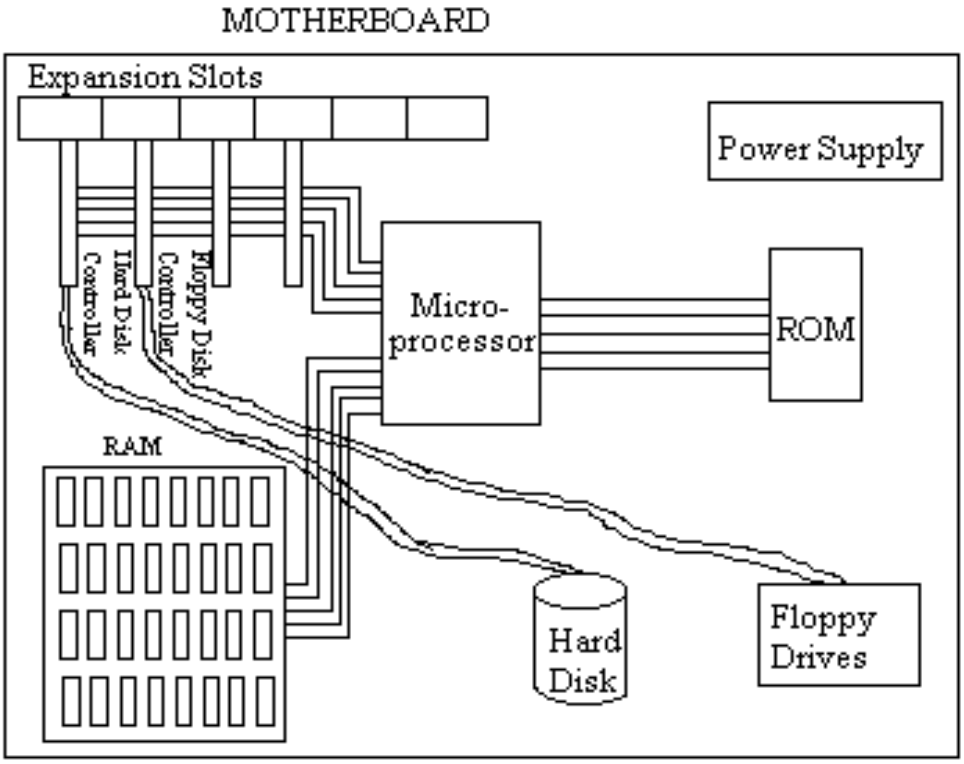
It connects peripherals to your computer via standard hardware interface, which uses standard SCSI commands.

COMPONENTS ASSEMBLY.

The basic Microcomputer system consists of the *Motherboard*, the *Power Supply unit*, *Hard disk & Floppy disk drives*, *I/O interface cards*, *Disk controller card*, *Video card*, optional *CD-ROM drive*, *Sound* and *Network interface cards*.

All these components are housed in a cabinet (or *Chassis*). The cabinet has rear connectors for peripheral devices through the motherboard or interface cards.

The Interface cards are usually plugged into the microcomputer's card slots with power-supply voltages and bus signals distributed to the card slots.
Cables then go from connectors on the interface cards to the peripheral devices.



Complete Assembly of Systems Unit Electronics

SELECTING A COMPUTER SYSTEM.

When planning to acquire computer equipments, the individual or organization should carefully weigh the merits and demerits of the methods used to finance the equipment

The requirements analysis for selecting a computer system should cover the following:

1. Identify all requirements of the user.
2. Evaluate hardware requirements that will meet the user's needs.
3. Evaluate software requirements that will meet the user's needs.

FACTORS TO CONSIDER WHEN SELECTING A COMPUTER SYSTEM.

The various factors to be considered in selecting a computer system are categorized as follows;

(1). Economic factors.

- Cost comparisons.
- Acquisition methods.
- Return on investment.

(2). Hardware factors.

- Hardware performance, reliability, capacity, and price.
- Firmness of delivery date.
- Accessibility of back-up facilities.
- Presence or absence of modularity.
- Effective life of the proposed hardware.
- Compatibility with existing systems..

(3). Software factors.

- Software performance and price.
- Firmness of delivery date on the proposed software.
- Availability of useful and well-documented packaged programs.
- Ease of use and modification.

(4). Service factors.

- Maintenance terms and quality.
- Training facilities offered and the quality of training provided.
- Programming and conversion assistance offered.
- Facilities provided by the manufacturer for checking new programs.

(5). Reputation of a manufacturer.

- Financial stability.
- Clean record of keeping promises.

HARDWARE FACTORS.

Some factors considered when selecting a computer hardware are:

(a). Processor Speed.

Every computer has a clock that drives its operation. The **Processor speed** is the speed at which the system Clock synchronizes the operations of the CPU & can be measured in **Hertz** or **Megahertz** (1MHz = 1 million cycles per second).

The processing power of a computer depends on its *Processor speed* & *the amount of data it can handle at the same time*.

(b). Memory capacity (amount of Main memory –RAM).

All computers have some amount of **Random Access Memory** (**RAM**). RAM is a section of the Main memory, which is used for holding data & instructions required immediately by CPU to perform a task.

(c). Warranty (Service contract/ assurance/ guarantee).

A **Warranty** is an agreement between the buyer and the seller that spells out terms and conditions of, after selling a product in case of failure or malfunction.

A Warranty is usually the duration in which your computer is supposed to work without any problem.

A good warranty should cover the following points:

1. Scope of cover, such as 6 months, 1 year, etc.
2. Callout response and liability agreement. .
3. Preventive maintenance.

(d). Cost of the system.

The cost of a computer system depends on:

1. Its Processing capability.
2. Its Size.

   The cost of a computer is directly related to the size. Portable computers are more expensive than their desktop equivalents, because of the superior technology involved to manufacture smaller components without losing performance abilities.
3. Whether it is branded or a clone. Branded computers are more expensive that their equivalent clones. This is because of their reliability and good after sale services.

(e). Upgradeability of the computer.

The type of the computer purchased should be upgradeable, i.e., it should allow upgrading of the Processor & the Hard disk to make it suit your needs. The RAM memory can also be upgraded/ increased by simply adding new memory modules into the memory slots on your Motherboard.

(f). Compatibility of the system.

The hardware facilities of the computer should relate well with the different kind of devices available. It must also support Plug-and-Play facilities.
This ensures that the computer system operates in a systematic, reliable, & efficient manner as required by the user.

(g). Portability.

The size of the computer should be small so as to enhance portability. In other words, it should be sufficiently light & hence easily transportable.

(h). User needs.

The computer hardware selected should be able to accommodate the user programs as well as any other device which might be added; both hardware and software.

User needs also determine the type of data that will be processed. Therefore, the type of hardware chosen should be the most appropriate to satisfy the needs. For example, in a Supermarket, a special device called a *Point of Sale* (*POS*) *Terminal* is most suitable to record transactions.

(ix). Popularity of the computer manufacturer.

The computer must be from a well-known manufacturer. This can only be detected by use of the brand names such as Compaq, Dell, IBM, and Hp.

(x). Availability of hardware spare parts.

The computer spare parts, i.e., Input and output devices, should be readily available.

(xi). Monitor.

Depending on preference, your choice for a monitor may depend on Size, resolution, and the technology used to make it.
Currently, Flat panel displays have become a new market standard quickly replacing the Cathode Ray Tube (CRT).

(xii). Multimedia capability.

Multimedia is the combination of video, audio, text, and images to provide an interactive, creative, and effective way of producing and communicating information.

A multimedia system should have *Speakers*, *CD/DVD drive*, *Sound card,* and a *SVGA monitor*. It should also have software that supports multimedia capability.

SOFTWARE FACTORS.

The following factors should be considered when selecting software:

(a). Authenticity of the software.

The term **Authenticity** refers to genuineness, validity or legitimacy of an item.

When acquiring software from the vendor, make sure it is the original copy that is accompanied by the license and certificate of authenticity of the developer.
You should only use software of the major Software houses.

(b). Documentation of the programs.

Documentation refers to the manuals prepared by the developer having details on how to install, use and maintain the software.

These include; Installation guide, Maintenance guide, User guide, a Reference manual, etc.

This documentation enables the user to work with the software with minimum guidance.

(c). User needs (requirements) of the software.

The needs of the user determine the type of operating system and application programs that should be purchased..

(d). Reliability and security.

People are more comfortable with software that offers good security to confidential and private information.

(e). User friendliness of the software.

The software purchased is expected to be "*User-friendly*". **User-friendliness** is a measure of how easily the user can be able to operate the computer.

Features/characteristics of User-friendly software.

- ❖ It should be easy to learn & use and also suit people with little or no computing knowledge.
- ❖ The programs should enable the end-user to perform many of the routine functions & operations such as, manage computer files, diagnose & repair computer problems that enable the computer to run more smoothly & efficiently.
- ❖ The software should be self-contained, so that the user is not forced into accessing manuals.
- ❖ The amount of effort & the information required for the user to get the software complete required tasks should be minimal.
- ❖ The user should be made to feel in control of what is going on.
- ❖ The software should behave in a logical & consistent manner, enabling the user to reason about what is going on and apply what has been learned.

(f). Cost of the Software.

The software purchased should be relatively cheap, and should be able to meet one's needs.

Note. One cannot just buy a program because it is cheap. There are many other factors that may force a person to buy far much more expensive software even with cheaper alternatives available.

In case the off-the-shelf software does not fit the needs of the users, it would be advisable to develop in-house software, even though they may be a bit more expensive.

(g). Compatibility and System requirements of the software.

Software compatibility refers to the ability of the computer to run depending on the system setup (configuration).

Different programs will be loaded to different types of hardware. For example, some software may only run on a computer that has 32MB or RAM and above. Any computer, whose configuration is lower than this, is said to be incompatible.

Therefore, the programs selected should relate (fit) well with/within the existing computer resources, e.g., hardware facilities and ensure that the computer system operates in a systematic, reliable & efficient manner as intended by the user.

Some software are not compatible (well suited), e.g. Apple Programs. Otherwise, it is important that one reads the installation guide and system requirements that comes with the software in order to avoid disappointment.

(h). Portability of the software.

Portability refers to whether a program can be copied or installed in more than one computer.

The software should be **Portable,** i.e. it should also be able to run on several different types of computers with very little or no modification (without re-writing the code).

Note. Although, most software in the market today are portable, some developers produce software which can be installed on one machine only. This means that, if one has, say 20 computers, he/she should buy a license for each.

(ix). Standards of the software.

The software should be standardized, i.e. the version of the program should not be too low or too high.

(x). Popularity of the software.

Before buying particular software, its current users should be interviewed to find out whether the software is successful and famous in the market.

Exercise (a).

1. Identify and describe 8 hardware and 8 software factors that can be considered when selecting a computer.
2. State and discuss four factors one would consider when purchasing computer software.
3. What hardware issues would one consider when buying a computer?

ACQUISITION (PROCUREMENT) OF A COMPUTER.

Introduction.

Introducing a computer into the business is an act that should be considered with great concern, because it involves capital expenditure, and as such, it should only be done if it is necessary and its acquisition should be in a cost-effective manner.

Before acquiring the computer and its related facilities, one should investigate the effects of introducing the computer into the organization. This is to ensure that adequate returns are expected from such an investment.

Computer costs.

The cost of introducing a computer into the organization depends on Size, Nature & the application requirements of the affected organization.

Small & simple organizations may require less sophisticated computer installations. Big & complex business organizations may require complex configuration and sophisticated related facilities.

The costs for installing a computer system may be classified as;

1. Initial costs.
2. Recurrent costs.

Initial costs.

This is the initial capital expenditure onto the computer facilities when they are being acquired.

These costs depend on the Type, Nature and the Model of the facilities to be acquired.
The costs are influenced by the method used to acquire the computer and its related facilities.

The organization should consider ways or plans of acquiring the following facilities:

Facility	Examples
Hardware	C.P.U and Peripherals
Software	System and Application programs
Storage Media	Tapes, Disks, Cassettes, etc.
Training	Managers, Analysts, Programmers, Operators, etc.
Computer room	Construction, Environmental conditions, Equipments, etc.
Others	Feasibility study, Programming, Changeover costs, etc.

Recurrent costs.

Once the computer facilities have been acquired and the system becomes operational, the operating costs for the computer system have to be met by the organization.

Examples of such costs are:

(i). Depreciation costs – the charges on depreciating machines & other equipments, e.g., Air conditioning facilities.
(ii). Wages of staff, e.g., Analysts, Programmers, Operators, etc.
(iii). Administration expenses, e.g., Telephone bills, Insurance cover, consumable costs, etc.
(iv). Other general expenses, e.g. conducting seminars, on-job training for staff, etc.

OPERATING SYSTEMS

Definition.

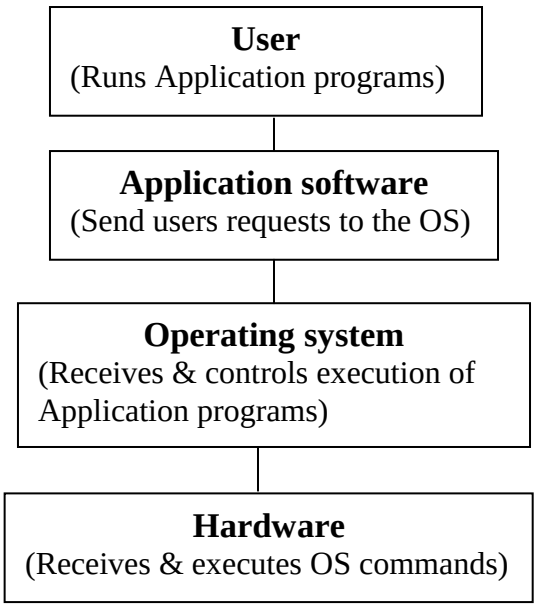
- An **Operating system** is a set of programs that is used to manage the basic hardware resources of a computer.
- This is the main program that controls the execution of user applications, and enables the user to access the hardware & software resources of the computer.

When the computer is switched on, the OS programs run & check to ensure that all parts of the computer are functioning properly.

Operating system's platform.

In a data processing environment, the user sees a computer as a group of application programs that enable him/her to accomplish specific tasks.
However, application programs do not use the hardware devices directly. They send messages through the operating system which has the capability to give instructions to the hardware to perform a particular task.

The user communicates his/her intentions to the OS through the use of a special instruction set known as **Commands**.



As in this diagram, the OS is a layer of software on top of the bare hardware, and is used to manage all parts of computer hardware & also act as an interface between the user & the computer.

The OS monitors & controls computer operations so that the user can do useful work on the computer, and it also enables Application programs use the hardware in a proper, orderly and efficient way.

An OS consists of a special program called a **Supervisor (Kernel/ Executive)**, which is stored in ROM of the Main Memory. The Supervisor/Kernel contains the most necessary commands and procedures & controls the running of all other programs, each performing a particular service.

NB. The programs that make up the Operating system are too large to fit in main memory at one time. These programs are usually installed on a direct access backing storage device, such as the hard disk.
When the Supervisor needs a particular program, it is read from the disk & loaded into the RAM memory, where it can be executed.

Reasons why an Operating system is needed in a computer (why operating systems were developed).

i). Modern computer systems are so complex & fast such that they need internal control.

ii). To ensure that the full system software facilities are readily available.

iii). Due to the complexity of systems, jobs need to be controlled in what they are allowed to do for security.

iv). To increase the **throughput**, i.e., to increase the amount of data that can be processed through the system in a given period of time.

v). Improve communication between the user & the computer.

vi). To make complex tasks very simple for the user to carry out.

vii). It helps the computer to correct any problem that might occur.

When an error occurs that can cause the computer to stop functioning, a diagnostic message is displayed. The meaning of the message is then checked in the computer operations manual.

viii). Reduces job setup time.

When one job is running, other programs can be read onto the job queue. The Input/Output devices can also be made ready without delay.

ix). Most computers allow many programs to be run & also many users to use the system at the same time.

Devices/resources under the control of an Operating System.

A computer is composed of a set of software-controlled resources that enable movement, storage and processing of data & information.

As a resource manager, the OS manages the following basic resources/ devices: -

1. Processor.
2. Main memory (RAM).
3. Secondary storage devices.
4. Input/Output devices and their Ports.
5. Communication devices and their Ports.
6. Files.

FUNCTIONS OF AN OPERATING SYSTEM.

The OS creates a working environment in which the user can run programs. The general functions of the operating system are:

1. **Processor management.**

   The processor is a scarce resource. It executes tasks called *processes*.

A *Multi-tasking* computer system can run several applications simultaneously. At times, several tasks may require processing, hence creating competition. However, the CPU can only execute one program at any one time.

Therefore, access to the CPU must be carefully controlled & monitored. The OS must decide, which program will be allowed into the system, and for how long.

To do this, the OS arranges the tasks according to priority and has the ability to stop a particular task to allow the processor to service another task.

2. Memory allocation & loading of programs.

- Programs must be loaded into memory before they can be executed, and moved out of memory when they are no longer required. Therefore, before processing starts, the OS ensures that the programs are transferred into the available memory location in the Main memory from the backing store, e.g. a disk.
- At any one given time, a number of tasks may require the memory so that they can be accessed & processed by the computer. The computer memory is a scarce resource, and therefore, the OS must determine which task will remain in memory awaiting for execution and which one will be sent back to secondary storage to wait.
- The OS keeps track of what parts of memory are in use and by which program, and what parts are free.
- The OS also handles the data files used by the programs that are being executed by the CPU.
- In addition, the OS ensures that storage space is provided for data generated by programs & during data transfer operations such as, disk copying or printing.

3. Input/Output devices & ports management.

- Every computer has many Input & Output (I/O) devices. The OS controls the input from & output to the various devices. It also tries to monitor the state of each I/O device and signals any faults detected.
- During the course of their execution, programs will request the use of an Input or Output device. In a multi-user system, conflicts are likely to occur when one program requests a device that is being used by another program. Therefore, the OS will control allocation of I/O devices and attempt to resolve any conflicts that arise.
- Because most input/output devices are slower than the processor, the OS has to control the flow of data from the time of input to the time the user receives it as information. It ensures that the right data reaches the processor at the right time.
- The OS also defines the various input/output ports found on the computer, e.g., *printer port*.

4. Management of secondary storage devices.

The OS manages the storage & retrieval of data on secondary storage devices. It also utilizes the free space on hard disks to enhance the performance of the computer by temporarily holding tasks on it that were in RAM ready for processing but have to wait for sometime.

5. Management of communication devices & ports.

Communication refers to how the various devices and programs in & out of the computer system send & receive messages from one another and from the processor.

The OS controls the communication process between the various tasks & the computer. To achieve external communication, an external device is usually connected to a communication port using cables or wireless communication media.

6. File management.

The OS is concerned with the logical organization of the information (the **File System)** and provides a means through which files can be sorted, retrieved & shared.

It also provides a means of protecting data files & programs against unauthorized access and corruption.

7. Job scheduling.

The OS arranges & loads programs in order to provide a continuous sequence of processing & also provide the appropriate responses to events.

The processor can handle only one task at a time. Therefore, in a situation where more than one application program is occupying the main storage, the OS has to determine which task will be processed first and ensures that the one that is currently being processed is closely monitored to avoid wasting time in the processor.

The jobs are allocated priorities so as to ensure that there is continuous processing until all the jobs within the memory are executed. This ensures that the CPU does not remain idle at any given instance.

Some of the job scheduling functions include:

- Controlling the loading & running of programs.
- Communicating directly with users and/or the operator.
- Dealing with user commands to organize files and run programs.

NB: A **Job** is a group of tasks taken as a unit of work for a computer, e.g., one or more computer programs, files, & instructions, to the operating system.

8. Job sequencing.

The OS keeps a list of jobs/tasks currently being run and monitors them as they move in & out of the processor. It also arranges them in a particular order to make it easy for the processor to execute them and to know how & when to fetch instructions & data for each task.

9. Resource control and allocation.

The OS controls the selection & operation of hardware devices used for input, output and storage.

The OS determines which task uses a particular resource and at what time. To do this, it gives each resource a unique identification number called an ***Interrupt number*** so that, when two tasks request to use a resource at the same time, the one with higher priority interrupt is granted control.
This prevents an undesirable situation called ***deadlock*** that occurs when a particular task holds a needed resource & refuses to release it for use by other tasks.

10. Error reporting & correction routines.

The OS has many ways of reporting to the user of any errors that occur during program execution. It does this by monitoring the status of the computer system & performing error checks on both hardware and software.

When the user makes an error, the OS through the Kernel determines the cause of the error, and prints diagnostic messages on the screen suggesting appropriate routines of how the error can be corrected.
In case of a fatal error that cannot be corrected, the program will be suspended permanently. E.g., the user program will prematurely terminate when it encounters an illegal operation, such as, dividing a no. by 0 or if it attempts to read a data file that had not been opened.

11. Interrupt handling.

An **Interrupt** is a break from the normal sequential processing of instructions in a program.

Each hardware device communicates to the processor using a special number called the *Interrupt Request number* (*IRQ*). Therefore, when an interrupt occurs, control is passed to the Kernel, which determines the cause of the interrupt. The processor stops executing the current program to wait for the corrective response of the user. Control is returned to the program that was interrupted once corrective action has been taken.

Some causes of Interrupt.

i). *An Interrupt caused by Power failure.*

The Kernel saves vital information using the dying power supply so that it can be restarted when power is returned.

ii). *Arithmetic or logic errors.*

When the ALU detects that an error has occurred, (e.g., the output may be requested to a non-existent device) it generates a signal that causes an interrupt. Control is transferred to the Kernel, which indicates the appropriate error correction routines.

iii). *Hardware malfunction*, e.g. parity errors.

The I/O control for each device & its associated hardware normally takes care of parity checking. If a parity error is detected, the Kernel is notified by an interrupt.

Device driver - a software that the OS uses to control a specific piece of hardware.

12. Interfaces the user to the system's hardware.

The OS provides quick means of communication between the computer user & its programs.

The user requests the services of the OS by use of commands & the OS communicates the messages regarding the processing to the user through, either the screen or printer. Thus, a form of 'conversation' is established between the OS & the computer user.

13. Logging & accounting.

The OS keeps records (internal logs) on how the computer's resources, e.g., CPU time, memory usage, & the peripherals are being used. It also keeps a complete record of all that happens during processing (usually in the form of a printed log).

14. The OS protects hardware, software & data from improper use. They ensure that application programs use the hardware in an efficient way.

Examples of operating systems:

- DOS (Disk Operating System).
- Windows operating system.
- MacOS (Macintosh).
- Unix.
- Linux.

Characteristics of an operating system.

An OS should have the following characteristics:

a). Reliable.

The OS should be at least as reliable as the hardware on which it runs. If a software or hardware error occurs, the system should be able to detect the error and either try to correct the problem or try to minimize the damage to the users of the system from the error.

b). Protected.

A user doesn't want other users to interfere with him. Therefore, the system should protect users from being affected both by errors of other users and by malicious attempts at tampering.

c). Efficient.

The OS is usually a complex program that uses a large part of the hardware resources for its own functions. The resources consumed by the OS are not available for users.
Therefore, the system itself should be very efficient, & should manage user's resources to minimize their idle time.

d). Convenient.

Systems should be designed keeping users in mind.

Therefore, an OS should be flexible & convenient to use. In addition, in order to allow the sharing of resources, the OS must be in complete control of the allocation of the computer resources.

e). Predictable.

User demands on the system are generally unpredictable. At the same time, users prefer to get service that does not vary widely over extended periods of time. An estimate as to when the user will get his input should be given.

Revision Questions

1. Name two major reasons why it became necessary to use an Operating system.
2. (a). Identify FOUR resources that the Operating system should manage.
(b). What function should the Operating system perform to manage each of the resources above?
3. List and explain any five general functions of an operating system.
4. What is meant by the term Job in computer studies?
5. Name four examples of operating systems.

CLASSIFICATION OF OPERATING SYSTEMS.

The OS determines determine the type of processing that a computer system is able to perform, since it controls the allocation & use of the computer resources.

Operating systems can be classified according to:

1. Number of tasks that the system can perform concurrently.
- Single-tasking (program) operating system.
- Multi-tasking operating system.

2. Number of users the system can support at the same time.
- Single-user operating systems.
- Multi-user operating systems.

3. Human Computer interface (i.e., how the user & the computer interact).
- Command line.
- Menu driven interface.
- Graphical user interface (GUI).

Classification according to tasks handled concurrently.

Single-tasking OS.

Single-tasking OS allows only one user-program in the main memory to be processed at a particular time.

This means that, the user can only run one interactive program at a time. The user must then exit from the program before loading & running another program.

Example of a single user OS;

– MS-DOS.

Multi-tasking (Multiprogramming) OS.

A *Multi-tasking OS* allows a single CPU to execute/process more than one program, all of which are in memory, at the same time.

Each program is allocated a **time-slice**. In this case, the programs take turns at short intervals of processing time. The CPU switches its attention between programs as it receives requests for processing, executing statements from one program, and then from another.

The programs to be run are loaded into the memory and the CPU begins execution of the first one. When the request is satisfied, the second program is brought into memory and execution starts on the second program, and so on.

Note. In multi-programming, the computer is able to work on several programs at the same time. It works on the programs on sequence, one after the other, and that at any given instant it executes instructions from one program only. However, the computer works so quickly that it appears to be executing the programs simultaneously.

Classification according to number of users.

Single-user OS.

A *single-user OS* is designed to be used by only one person. It allow only one user/person to operate the machine at a time in an interactive, conversational mode, and runs only one user program at a time, e.g. MS-DOS.

Multi-user (or multi access) OS.

A *multi-user OS* allows more than one user (many people) to interactively use/access the computer at the same time.

Examples;

- UNIX,
- Novell Netware,
- Ms-Windows 2000,
- Ms-Windows NT,
- Linux, etc

Classification according to Human Computer Interface (HCI).

The term *Human Computer Interface* (**HCI**) refers to the method of interaction between the computer & the user, and determines how easily the user can operate the computer.

The HCI enables communication to & from between the user and the computer.

User-friendliness.

HCI is expected to be "*user-friendly*", i.e., it should be one that the end-user finds helpful, and easy to learn & use.

Features/characteristics of a user-friendly HCI.

i). It should be relatively easy for the user to try to start using the system.

ii). The system should be self-contained, so that the user is not forced into accessing manuals.

iii). The amount of effort & the information required for the user to get the system complete required tasks should be minimal.

iv). The system should be robust & reliable, i.e., the user should be protected from unexpected system actions, including system failures.

v). The system should be able to adjust to different levels of expertise between users & also as users grow in competence.

vi). The user should be made to feel in control of what is going on.

vii). The system should behave in a logical & consistent manner, enabling the user to reason about what is going on and apply what has been learned.

Types of User interfaces.

There are different types of Human Computer Interfaces: -

1. Command driven interface.
2. Menu driven interface.
3. Graphical User Interface (GUI).

Command driven interface.

This is an interaction between the user & the computer that requires the use of commands

The user types a command at the prompt found on a command line. The computer then reads instructions from the command line and executes them.

Example;

To copy a file called **Fruits.Dat** from *Hard disk C* to *Floppy disk A* using MS-DOS; type

C:\ >**COPY Fruits.Dat A:** (press the **Enter key** for the command to be executed).

Commands enable the user to quickly instruct the computer what to do.

Command-driven software is more flexible, but it is more difficult to learn. The user must know what commands are available, what they do & how they should be typed. For this reason, commands are most popular with experienced technical persons, such as computer Operators, Programmers or in situations where the end-user continually works with the same program and has therefore mastered the commands.

To make commands more user-friendly, the following points need to be observed: -

1. The command words used should be descriptive VERBS that clearly convey the intended action, e.g., PRINT, COPY, RENAME, DELETE, etc.
2. Unique abbreviations should be provided for more experienced users, e.g., PRI, COP, REN, DEL, CHKDSK, etc.
3. Multiple items on a single command line should ALWAYS be separated by blank s**paces**.
   E.g., PRINT can be used in the following ways: -
   - PRINT Report1 – prints the named document on the default printer.
   - PRINT Report1 Report2 Report3 – prints the three documents on the default printer.

Examples of Command line interfaces:

– MS-DOS,
– Early versions of PC-DOS, OS/2, and UNIX.

Disadvantages of using command driven interfaces

- They are more difficult to learn.
- The user must know the command to type.
- It is less user-friendly.
- It is not easy to use, i.e., one is required to master the command format/syntax.

Menu driven interface.

This type of interface provides the user with a list of program commands displayed on the screen to choose from & a simple means of selecting between them.

To activate a choice in the menu, one can use the Enter key, or move the cursor until it is positioned at the desired choice & then press the activation key so that the system can start acting upon the information given.

This interface is suitable for beginners and infrequent users who may have difficulties in remembering commands.

There are 2 types of menus: -

(a) **Pull-down menus** – are special types of menu used mostly in Windows.
(b) **Pop-up menus & Pop-down menus**. These menus are made to appear above or below an item on the screen in order to elicit/obtain a choice from a user.

Later versions of DOS have a menu driven interface called the *DOS Shell* or *DOS Editor*.

Advantages of Menu driven interfaces

- Menus provide many options to select from.
- The user is presented with a choice and therefore, does not need to master any commands.
- They are easier to use.

Graphical User Interface (GUI).

This is an interaction between the user & computer that involves issuing of commands to the computer by activating certain small graphic images displayed on the screen called **Icons**.

To issue a command, the icons can be selected using a pointing device like a Mouse.

GUI is mostly found on Workstations or PCs fitted with graphic adapters able to support high-resolution graphics.

Examples of GUI based OS;

- Presentation manager of OS/2,
- Ms-Windows,
- Linux,
- Apple Macintosh.

Features of a graphical user interface. (2 marks)

- Programs are represented graphically by use of Icons.
- Commands are selected and issued using pointing devices, e.g., Mouse, trackball.
- There is use of pull-down menus.
- Programs open by displaying windows.

Advantages of using GUI based OS

- They are user friendly.
- Easy to learn & use.

Revision Questions

1. What criteria are used to classify types of operating systems?
2. (a) Differentiate between multi-user and multitasking operating systems.
(b) State any computer software that can be classified as a Multi-user operating system.
3. Name three types of user interfaces employed by different commercial Operating systems.
4. (a) Differentiate between command-line interface and graphical user interface operating systems based on the way commands are entered.
(b) State two main advantages of GUI interfaces.

Factors to consider when choosing an operating system.

The following factors should be considered when choosing an operating system for a computer;

1. Hardware configuration of the computer, e.g., RAM memory size, hard disk capacity, type of processor, etc.

2. Basic design of the computer, - i.e., is it an IBM or IBM compatible, or an Apple computer?
3. Hardware compatibility.
4. User needs (requirements), i.e., the applications intended for the computer.
5. User friendliness or Human computer interface, i.e., is it Command line based, Menu-driven or a Graphical user interface?
6. Availability in the market, e.g. Microsoft Windows based OS are very common.
7. Portability.
8. Cost – how expensive the OS is.
9. Reliability, i.e., can it run without *crashing* or *hanging* (stop responding to commands).
10. The method of communication with the computer, e.g. the number of peripherals.
11. The method of operating the computer.

WINDOWS OPERATING SYSTEMS.

Windows operating system was developed as a **Graphical User Interface** (**GUI**) for PCs running on MS-DOS.

It provides a friendly interface that allows the users to enter commands by pointing and clicking at objects that appear on the screen using a pointing device, e.g., a Mouse or a trackball. These graphical capabilities make a program easier to use.

Microsoft Windows takes its name from the on-screen "*Window*" that it uses to display information.

- A **Window** is a rectangular portion/ area of the screen that Windows sets aside for a specific task.
- A **Window** is a rectangular area on a display screen in which text and graphical images may be displayed.

Examples of Windows operating systems:

– Microsoft Windows 95, 98, 2000 Professional, 2003, NT, Millennium (Me), XP, and Vista.
– Linux,
– UNIX,
– MacOS.
– OS/2.

Common features of Windows operating systems:-

1). They all have similar user-interfaces. For example;
- *Windows*.
- *Pointing device* – a device such as a mouse or trackball, that enables the user to select objects on the display screen.
- *Pointer* – a symbol (arrow) that appears on the display screen, and can be used to select objects & commands.
- *Icons* – small graphical pictures that represent commands, files, or applications. By moving the pointer to the icon and pressing a mouse button, one can execute a command or convert the icon into a window.
- *Buttons* – items used to initiate a process in an application.
- *Menus* – they provide choices that let the user execute commands by selecting them.
- *Desktop* – this is the area on the display screen where icons are grouped.

2). It is *user-friendly*. Windows is menu driven, hence easy to operate, because the options used in particular applications are usually displayed on the screen in form of **Icons**.

3). All Windows operating system support multiple users & have the ability to *Multi-task*, i.e., they allow one to run more than one program at the same time, each in its own window.

4). It is easy to exchange information between Windows applications, i.e., it is easy to transfer or copy information from one program to another.

5). All Windows applications share a common set of commands. For example, *Open, Save, Print,* etc & therefore, you don't need to learn a different set of commands for each application.

6). Ability to handle long file names, e.g., Windows 95 and later versions accept file names of up to 255 characters including spaces.

7). Most Windows operating systems have *Plug and play* (*PnP*) features. They automatically accept a new hardware once it is connected to the computer.

Advantages of Windows Operating Systems.

i). It is easy to open programs, find documents, and switch between programs.

ii). Windows provide facilities such as the *Windows Explorer*, which enable one to browse through & manage you files, folders, and drives easily.

iii). Windows can support long file names, making it easier to find and organize files.

iv). Windows has improved Video, CD & sound capabilities, and can fully support MS-DOS-based games.

v). Windows makes it easier to install new hardware devices onto the system. It is able to recognize and sets up a certain Plug-and-Play hardware whose card has been inserted in the computer automatically.

vi). Windows allows true *Multitasking*, i.e. it allows the user to run more than one (several) program at the same time, each in its own window.

vii). Windows is *user-friendly*, i.e., it is menu driven, hence easy to operate, because the options used in particular programs are usually displayed on the screen in form **icons**.

viii). Windows supports a wide choice of networks & transmission protocols. It also has facilities for sharing files & devices.

ix). Windows has facilities that allow people to work with all types of electronic communications, e.g., it allows people to send text messages, transfer files, and also hold digital live face-to-face conversations with family friends & business associates around the world.

x). Windows includes **My Briefcase,** a file synchronization tool & a utility for transferring files over a direct cable link or dial-up networking.

xi). All Windows applications share a common set of commands. E.g., *Open*, *Save*, *Print*, etc & therefore, there is no need to learn a different set of commands for each application.

xii). Windows allows movement of text or items from one program to another. i.e., it is easy to exchange information between Windows applications.

xiii). Windows has facilities that enable the computer to save power resources by putting the computer on standby or hibernation.

xiv). Windows includes a Help system that makes your computer easier to use. It helps you find answers to your questions easily, or get up-to date technical support from the WWW.

Differences between Ms-Windows & Disk Operating System.

Ms-Windows	MS-DOS
1. There are icons	**1.** No Icons
2. Uses both the Mouse & Keyboard as Input devices.	**2.** Only the Keyboard is used as Input device.
3. There is use of Menus.	**3.** It is command-based.

4. User-friendly.	**4.** Not user-friendly.
5. Windows fully supports networking.	**5.** DOS cannot support networking.
6. Requires a computer with high memory size.	**6.** Uses less memory compared to Windows.
7. Windows can support DOS, i.e. it is possible to run DOS-based programs in Windows.	**7.** DOS cannot support Windows, i.e. it is not possible to run Window-based programs in MS-DOS.
8. Uses Multi-coloured screen.	**8.** Uses monochrome (1 coloured) screen.
9. It is a Multi-user OS.	**9.** It is a single-user OS.
10. It is a multi-tasking OS, i.e. can support more than 1 program at a time.	**10.** It is a single-tasking OS, i.e. can only support one program at a time.
11. Comes in different versions.	**11.** MS-DOS is an operating system by itself.
12. Uses *folders* for storage of files.	**12.** Uses *Directories* to organize files.

Review Questions

1. Give FOUR advantages of which Windows based Operating system software has over Disk Operating System software.
2. (a). List Four types of Windows versions.
(b). Why is Windows termed as a friendly Operating system?
List four key features of the Windows Operating environment.

WINDOWS OPERATING SYSTEMS.

Windows operating system was developed as a **Graphical User Interface** (**GUI**) for PCs running on MS-DOS.

It provides a friendly interface that allows the users to enter commands by pointing and clicking at objects that appear on the screen using a pointing device, e.g., a Mouse or a trackball. These graphical capabilities make a program easier to use.

Microsoft Windows takes its name from the on-screen "*Window*" that it uses to display information.

- A **Window** is a rectangular portion/ area of the screen that Windows sets aside for a specific task.
- A **Window** is a rectangular area on a display screen in which text and graphical images may be displayed.

Examples of Windows operating systems:

– Microsoft Windows 95, 98, 2000 Professional, 2003, NT, Millennium (Me), XP, and Vista.
– Linux,
– UNIX,
– MacOS.
– OS/2.

Common features of Windows operating systems:-

1). They all have similar user-interfaces. For example;
- *Windows*.
- *Pointing device* – a device such as a mouse or trackball, that enables the user to select objects on the display screen.
- *Pointer* – a symbol (arrow) that appears on the display screen, and can be used to select objects & commands.
- *Icons* – small graphical pictures that represent commands, files, or applications. By moving the pointer to the icon and pressing a mouse button, one can execute a command or convert the icon into a window.
- *Buttons* – items used to initiate a process in an application.
- *Menus* – they provide choices that let the user execute commands by selecting them.

- *Desktop* – this is the area on the display screen where icons are grouped.

2). It is *user-friendly*. Windows is menu driven, hence easy to operate, because the options used in particular applications are usually displayed on the screen in form of **Icons**.

3). All Windows operating system support multiple users & have the ability to *Multi-task*, i.e., they allow one to run more than one program at the same time, each in its own window.

4). It is easy to exchange information between Windows applications, i.e., it is easy to transfer or copy information from one program to another.

5). All Windows applications share a common set of commands. For example, *Open*, *Save*, *Print*, etc & therefore, you don't need to learn a different set of commands for each application.

6). Ability to handle long file names, e.g., Windows 95 and later versions accept file names of up to 255 characters including spaces.

7). Most Windows operating systems have *Plug and play* (*PnP*) features. They automatically accept a new hardware once it is connected to the computer.

Advantages of Windows Operating Systems.

i). It is easy to open programs, find documents, and switch between programs.

ii). Windows provide facilities such as the *Windows Explorer*, which enable one to browse through & manage you files, folders, and drives easily.

iii). Windows can support long file names, making it easier to find and organize files.

iv). Windows has improved Video, CD & sound capabilities, and can fully support MS-DOS-based games.

v). Windows makes it easier to install new hardware devices onto the system. It is able to recognize and sets up a certain Plug-and-Play hardware whose card has been inserted in the computer automatically.

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