INFUSION NOTES

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RAJASTHAN

COMPUTER INSTRUCTOR

(RAJASTHAN STAFF SELECTION BOARD (RSSB))

(ENGLISH MEDIUM)

राजस्थान कर्मचारी चयन बोर्ड

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PART – 3

COMPUTER STUDY (PART - 1)

Preface

*Dear Readers, The presented notes "**Rajasthan Computer Instructor (English Medium)**" have been prepared by a dedicated team of teachers and colleagues, each proficient in their respective subjects. These notes aim to provide comprehensive support to readers appearing for the "**Rajasthan Computer Instructor Recruitment Examination**" conducted by the Rajasthan Staff Selection Board.*

Despite careful efforts, there may still be some errors or shortcomings in the notes. Therefore, valuable suggestions from you, the respected readers, are warmly welcomed.

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Chapter – 1

Fundamentals Of computer

Overview:

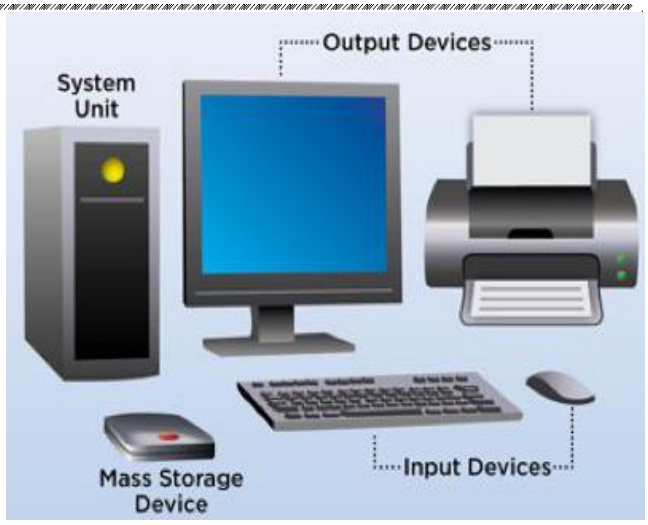
Introduction of a Computer system

A computer is an electronic device that accepts information (Data), processes it according to specific instructions, and provides the results as new information.

We describe our definition of computer by its working way facts

A computer system is made up of both hardware and software components. At a fundamental level, computers operate through these four function which are –

I. **Input**: The transfer of information into the system (example- through a keyboard).
II. **Output**: The presentation of information to the user (example- on a screen).
III. **Processing**: The retrieval or manipulation of information into a new form (example- results from a search engine).
IV. **Storage**: The storing or preservation of information for later use (example - files stored on a hard drive).



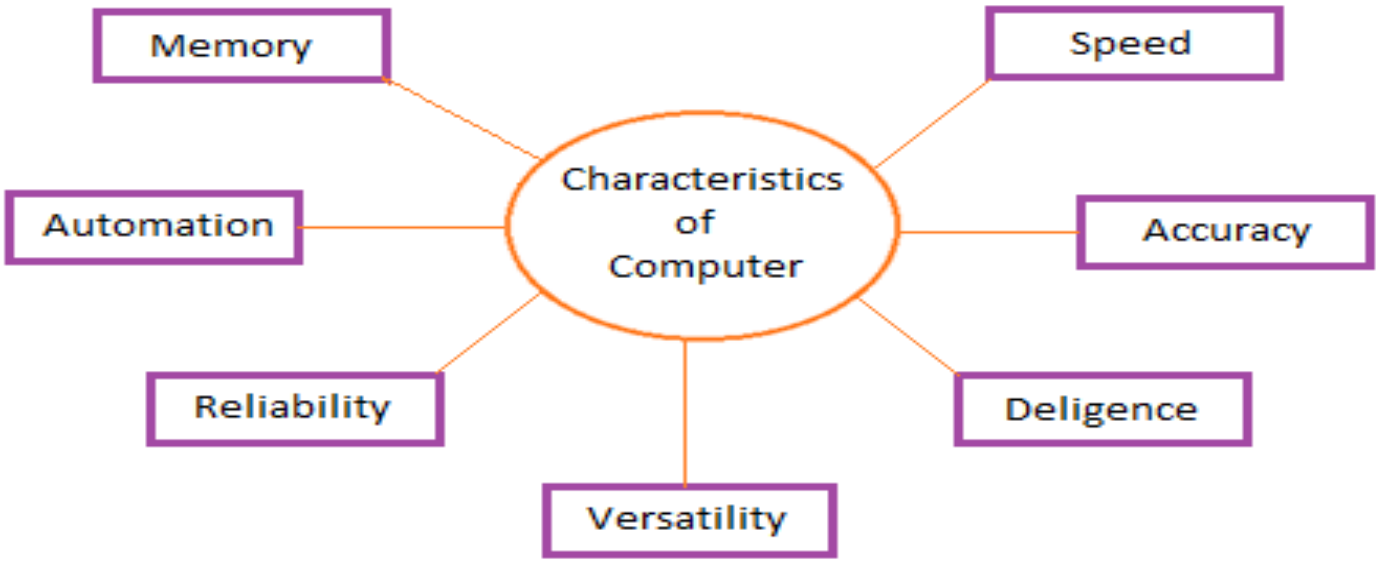
Characteristics of computer system: –

1. Speed of Computer

We know computer can work very fast. It takes only few seconds for calculations that we take hours to complete. It can perform millions of instructions and even more per second. Therefore, we determine the speed of computer in terms of microsecond (10-6 part of a second).

2. Accuracy of computer: –

Computers not only provide incredible speed, instead, they are also capable of consistently working with accuracy. The degree of accuracy in computers is very high. It can perform calculations at almost 100% accuracy. Errors may occur in a computer system, but only because of wrong human input or inaccurate data.



3. Diligence of computer: –

A computer is never tired. It is free from tiredness, lack of concentration, fatigue, etc. It can work for hours without creating any error. If millions of calculations are to be performed, a computer will perform every calculation with the same accuracy. Due to this capability it overpowers human being in routine type of work.

4. Versatility of computer: –

Versatility means that the computer has the ability to perform completely different kinds of works with the same accuracy and efficiency at the same time. It is not just a calculating machine anymore. Computers are very versatile. The same computer can be used for various applications. For instance, you -

a. Can use a Personal Computer (PC) to prepare a latter, prepare the balance sheet of a company.
b. Store a database of employees, produce a professional-looking advertisement, send or receive fax messages.
c. For a computer to perform a new job, all it needs is a program. (A program is a set of instructions.
d. That enables a computer to do a particular task.) Thus, if you want a computer to do perform a new task.
e. All you need to write a new program for that task.

5. Power of Remembering: –

Computer has the power of storing any amount of information or data. Any information can be stored and recalled as long as you require it, for any numbers of years. It depends entirely upon you how much data you want to store in a computer and when to lose or retrieve these data.

6. No IQ / Dumb machine: –

Computer is a dumb machine and it cannot do any work without instruction from the user.

It performs the instructions at tremendous speed and with accuracy. It follow all the instruction which you want to be perform. So a computer cannot take its own decision as we can.

7. No Feeling/ It has No Emotions: –

It does not have feelings or emotion, taste, knowledge and experience. Thus it does not get tired even after long hours of work.

8. Storage of computer: –

The Computer system has an in-built memory where it can store a large amount of data.

You can also store data in secondary storage devices such as floppies, pen drives, CD, DVD etc. which can be kept outside your computer and can be carried to other computers.

About the history of computer -

The first use of the word "computer" was recorded in 1613, referring to a person who carried out calculations, or computations, and the word continued to be used in that sense until the middle of the 20th century.

History of Computers

The history of computers spans thousands of years and has evolved from simple manual devices to the complex machines we use today. Here's a brief timeline and overview of the major milestones in the development of computers:

1. Early Computing Devices (Before 1800)

- **Abacus (3000 BC)**: The first known computing device, used by ancient civilizations like the Sumerians and Egyptians for basic arithmetic operations. It consists of beads sliding on rods or wires.
- **Antikythera Mechanism (100 BC)**: A complex analog computer from ancient Greece, used to predict astronomical positions and eclipses.
- **Napier's bones (1617)**: Invented by John Napier, these were tools for performing multiplication and division using a set of rods.

2. Mechanical Era (17th to 19th Century)

- **Blaise Pascal's Pascaline (1642)**: A mechanical device for adding and subtracting numbers, regarded as the first mechanical calculator.
- **Gottfried Wilhelm Leibniz's Step Reckoner (1673)**: A machine that could perform addition, subtraction, multiplication, and division.
- **Charles Babbage (1837)**: Often referred to as the "father of the computer," Babbage conceptualized the **Analytical Engine**, the first design for a mechanical computer. Though it was never completed, it had all the basic components of modern computers—input, output, memory, and a processing unit.
- **Ada Lovelace (1843)**: A mathematician who is considered the first computer programmer. She wrote an algorithm for the Analytical Engine, making her the first person to recognize the machine's potential to be programmed.

3. Electromechanical Era (Early 20th Century)

- **Herman Hollerith's Tabulating Machine (1890)**: Hollerith invented a punch card-based system to tabulate census data. This machine helped expedite the U.S. Census process, laying the foundation for IBM's future development.

- ***Konrad Zuse's Z3 (1941)***: *A German engineer who built the world's first programmable digital computer, the Z3. It was capable of performing complex calculations, though it was never fully operational.*

4. The Birth of Electronic Computers (1940s-1950s)

- ***Colossus (1943)***: *Developed by Tommy Flowers, this was a British machine used during World War II for code-breaking, particularly the German Lorenz cipher.*
- ***ENIAC (1945)***: *The **Electronic Numerical Integrator and Computer** was the first fully functional electronic general-purpose computer, capable of performing a variety of calculations at unprecedented speeds. It was developed by John W. Mauchly and J. Presper Eckert.*
- ***UNIVAC I (1951)***: *The first commercially produced computer, designed by Mauchly and Eckert. It was used for business and government applications, including predicting the outcome of the 1952 U.S. presidential election.*

5. The Transistor Era (1950s-1960s)

- ***Transistor (1947)***: *Invented by John Bardeen, Walter Brattain, and William Shockley at Bell Labs, the transistor replaced vacuum tubes, making computers smaller, faster, more reliable, and energy-efficient.*
- ***IBM 7090 (1959)***: *IBM introduced the IBM 7090, one of the first transistorized computers, making them smaller and more affordable for businesses and universities.*
- ***Mainframe Computers***: *Large, powerful computers capable of handling extensive data processing tasks, used in businesses and government sectors.*

6. The Integrated Circuit and Microprocessor Era (1970s-1980s)

- ***Integrated Circuit (IC) (1958)***: *Invented by Jack Kilby and Robert Noyce, ICs allowed multiple electronic components to be placed on a single chip, making computers more compact and affordable.*
- ***Microprocessor (1971)***: *Intel introduced the **Intel 4004**, the first commercially available microprocessor, a single chip capable of performing basic computing functions.*
- ***Personal Computers (PCs)***: *With the advent of microprocessors, personal computers became feasible. Companies like **Apple (Apple I, 1976)**, **IBM (IBM PC, 1981)**, and **Compaq** introduced personal computers to the market for individual and business use.*

7. The Internet and Networking Era (1990s-2000s)

- ***World Wide Web (1990)***: *Tim Berners-Lee invented the **World Wide Web** (WWW), a system that allows documents to be linked and accessed over the Internet using hyperlinks, giving rise to modern web browsing.*
- ***Rise of the Internet (1990s)***: *The development of browsers like **Netscape Navigator** and **Internet Explorer**, along with widespread Internet access, made online communication, shopping, and research commonplace.*
- ***Commercialization of the Web (1994)***: ***Amazon (1994)** and **eBay (1995)** were some of the first companies to capitalize on e-commerce, offering online shopping and auctions, respectively.*

8. The Mobile and Cloud Computing Era (2010s-Present)

- ***Smartphones and Tablets (2000s)***: *Mobile devices like the **iPhone (2007)** and **iPad (2010)** revolutionized how we interact with computers, introducing touchscreens, apps, and mobile computing.*
- ***Cloud Computing (2000s)***: *With companies like **Amazon Web Services (AWS)** and **Google Cloud** leading the charge, cloud computing has allowed for scalable, internet-based services such as data storage, software hosting, and computing power, reducing the need for powerful personal computers.*
- ***Artificial Intelligence (AI) and Machine Learning (2010s)***: *AI and ML have transformed many industries, with applications ranging from voice assistants like **Siri** and **Alexa** to self-driving cars and automated decision-making systems.*
- ***Quantum Computing (Emerging Technology)***: *Quantum computing, still in the research phase, promises to revolutionize computing power by using quantum bits (qubits) instead of traditional binary bits, enabling unimaginable computational speeds and solving problems that were previously unsolvable.*

Computer generations

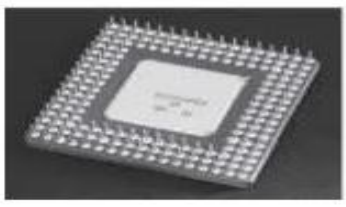
Basic Terms

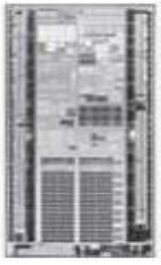
A. **Vacuum tube** – An electronic device that controls the flow of electrons in a vacuum. It used as a switch, amplifier, or display screen in many older model radios, televisions, computers, etc.

B. **Transistor** – An electronic component that can be used as an amplifier or as a switch. It is used to control the flow of electricity in radios, televisions, computers, etc.

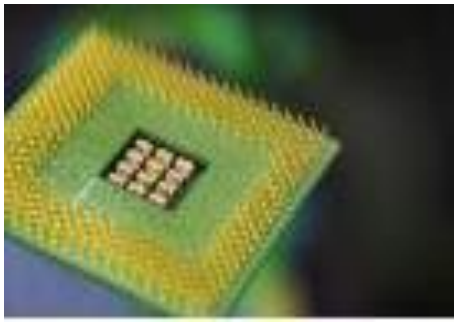
C. **Integrated circuit (IC)** – A small electronic circuit printed on a chip (usually made of silicon) that contains many its own circuit elements (e.g. transistors, diodes, resistors, etc.).

D. **Microprocessor** – an electronic component held on an integrated circuit that contains a computer's central processing unit (CPU) and other associated circuits.





E. **CPU (central processing unit)** – It is often referred to as the brain or engine of a computer where most of the processing and operations take place (CPU is part of a microprocessor).



F. **Magnetic drum** – A cylinder coated with magnetic material, on which data and programs can be stored.

G. **Magnetic core** – uses arrays of small rings of magnetized material called cores to store information.

Classification of generations of computers

The evolution of computer technology is often divided into five generations.

I. First generation (1940s-1950s)

- Main electronic component – vacuum tube
- Main memory – magnetic drums and magnetic tapes
- Programming language – machine language
- Power – consume a lot of electricity and generate a lot of heat.
- Speed and size – very slow and very large in size (often taking up entire room).
- Input/output devices – punched cards and paper tape.
- Examples – ENIAC, UNIVACI, IBM 650, IBM 701, etc.
- Quantity – there were about 100 different vacuum tube computers produced between 1942 and1963.

2. Second Generation

- The main characteristics of second generation of computers (1950s-1960s)
- Main electronic component – transistor
- Memory – magnetic core and magnetic tape / disk
- Programming language – assembly language
- Power and size – low power consumption, generated less heat, and smaller in size (in comparison with the first generation computers).
- Speed – improvement of speed and reliability (in comparison with the first generation computers).
- Input/output devices – punched cards and magnetic tape.
- Examples – IBM 1401, IBM 7090 and 7094, UNIVAC 1107, etc.

3. Third generation (1960s-1970s)

- Main electronic component – integrated circuits (ICs)
- Memory – large magnetic core, magnetic tape / disk
- Programming language – high level language (FORTRAN, BASIC, Pascal, COBOL, C, etc.)
- Size – smaller, cheaper, and more efficient than second generation computers (they were called minicomputers).
- Speed – improvement of speed and reliability (in comparison with the second generation computers).
- Input / output devices – magnetic tape, keyboard, monitor, printer, etc.
- Examples – IBM 360, IBM 370, PDP-11, UNIVAC 1108, etc.

4. Fourth Generation

- The main characteristics of fourth generation of computers (1970s-present)
- Main electronic component – very large-scale integration (VLSI) and microprocessor.
- VLSI– thousands of transistors on a single microchip.
- Memory – semiconductor memory (such as RAM, ROM, etc.)
- RAM (random-access memory) – a type of data storage (memory element) used in computers that temporary stores of programs and data (volatile: its contents are lost when the computer is turned off).
- ROM (read-only memory) – a type of data storage used in computers that permanently stores data and programs (non-volatile: its contents are retained even when the computer is turned off).
- Programming language – high level language (Python, C#, Java, JavaScript, Rust, Kotlin, etc.).
- A mix of both third- and fourth-generation languages
- Size – smaller, cheaper and more efficient than third generation computers.
- Speed – improvement of speed, accuracy, and reliability (in comparison with the third generation computers).
- Input / output devices – keyboard, pointing devices, optical scanning, monitor, printer, etc.
- Network – a group of two or more computer systems linked together.
- Examples – IBM PC, STAR 1000, APPLE II, Apple Macintosh, etc.

5. Fifth Generation

- The main characteristics of fifth generation of computers (the present and the future)
- Main electronic component: based on artificial intelligence, uses the Ultra Large-Scale Integration (ULSI) technology and parallel processing method.
- ULSI – millions of transistors on a single microchip
- Parallel processing method – use two or more microprocessors to run tasks simultaneously.
- Language – understand natural language (human language).
- Power – consume less power and generate less heat.
- Speed – remarkable improvement of speed, accuracy and reliability (in comparison with the fourth generation computers).
- Size – portable and small in size, and have a huge storage capacity.
- Input / output device – keyboard, monitor, mouse, trackpad (or touchpad), touchscreen, pen, speech input (recognise voice / speech), light scanner, printer, etc.

I. Example – desktops, laptops, tablets, smartphones, etc.

	Wired Mouse	Wireless Mouse	Bluetooth Mouse
Advantages	I. Better accuracy II. Low-latency III. More affordable IV. No batteries required	I. Extended range from computer. II. Not restrained by cord length unrestricted movement. III. Doesn't require mouse pad	I. Extended range from computer II. Not restrained by cord length III. Unrestricted movement IV. Doesn't require mouse pad
Disadvantages	I. Less freedom of movement II. Constrained to length of cord III. Less convenient	I. Requires batteries to operate II. Lower accuracy (may be negligible for non-gamer users) III. More expensive than wired models	I. Requires batteries to operate II. Lower accuracy (may be negligible for non-gamer users) III. More expensive than wired models IV. May require purchase of USB Bluetooth receiver if your machine does not have Bluetooth functionality

2. Trackball- (Pointing device)

A trackball is a computer cursor control device used in many notebook and laptop computers. The trackball is usually located in front of the keyboard toward the user. Essentially, the trackball is an upside-down mouse that rotates in place within a socket. The user rolls the ball to direct the cursor to the desired place on the screen and can click one of two buttons (identical to mouse buttons) near the trackball to select desktop objects or position the cursor for text entry.

Advantages of using a trackball -:

Less work surface is required for trackball to function. As its stationary, the trackball allows continuous and fast scrolling and does not require repositioning. Precision control is more the case of the trackball. Ergonomic advantages are more pronounced trackballs. Unlike other input devices, trackballs require only minimal cleaning

Disadvantages of using a trackball -:

a) Compared to mouse, trackballs are physically larger.

b) As they are little more expensive, the selection is not as broad as other input devices.

3. Keyboard

A keyboard is for putting information including letters, words and numbers into your computer. You press the individual buttons on the keyboard when you type. The number keys across the top of the keyboard are also found on the right of the keyboard. The letter keys are in the centre of the keyboard. The symbol keys to the right of the letters include symbols such as the question mark and full stop. The keys that surround the letters, numbers and symbol keys on the left, right and bottom of the keyboard help you to choose where and how you type.

Using the keys-

a) When you open a document or click in a box to type, you will see a vertical flashing line. This is called cursor, it shows you where you are about to start typing on a page or screen.
b) Pressing the 'shift' key allows you to type capital letters and the symbols at the top of the keys.
c) The 'shift' keys are on the left and right of the keyboard, with the arrow pointing upwards.
d) For capital letters, hold down the 'shift' key and hold and type the letter.
e) For symbols at the top of a number key, press down the symbol key and then type the symbol. You can use the 'shift' key to type any symbol at the top of a key.
f) The 'caps lock' key allows you to write in capital letters. To turn it on, press it once and type. To turn it off, press it again.

Putting in spaces, moving your cursor and deleting text-

a) The 'space bar' puts a space between words. Press it once to put in a space.
b) The 'tab' key puts a bigger space between words. Press it once to put in a space.
c) The 'enter' key moves your cursor down a line.
d) The 'arrow' keys allow you to move your cursor in all directions on the page or screen - up, down, left and right.
e) To delete your typing you need to put your cursor to the right of a word. Press the 'backspace' button to delete your word. The cursor will move to the left and delete as it goes.

Type of Keyboard-

1. Qwerty Keyboards
2. Wired Keyboards
3. Ergonomic Keyboards
4. Wireless Keyboards
5. USB Keyboards
6. Bluetooth Keyboards

Function of Keys of Keyboard

A. Alphabet Keys (A to Z)-

a) A keyboard has 26 alphabet keys from A to Z.
b) These keys help in typing the data in the form of alphabets from A – Z.
c) **Uses:** - Generally, used for typing words, sentences, etc.

B. Numeric Keys-

a) These keys are used for typing the numbers.
b) They are marked with the digits from 0 to 9.
c) You can see it above the set of alphabet keys on a keyboard.
d) And you can also use the numeric keypad placed on the right side of the keyboard to type numbers.
e) Uses: Generally, used for typing numbers in the calculator, filling forms, and searching online, etc.

C. Functional Keys (F1-F12)-

a) The function keys are used for special functions.
b) They are marked from F1-F12. They are placed on top of the keyboard above the set of numerical keys.
c) **Uses:** -

- F1 – Opens the Help screen for almost every program.
- F2 – Allows you to rename a selected file or folder.
- F3 – Opens a search feature for an application that is active at the moment.
- F4 – Alt + F4 closes the active window.
- F5 – Allows you to refresh or reload the page or document window.
- F6 – Moves the cursor to the address bar in most Internet browsers.
- F7 – Used to spell check and grammar check a document in Microsoft Apps (example -Word).
- F8 – Used to access the boot menu in Windows when turning on the computer.
- F9 – Refreshes a document in Microsoft Word and sends and receives emails in Outlook.
- F10 – Activates the menu bar of an open application. Shift + F10 is the same as right clicking.
- F11 – Enters and exits full screen mode in Internet browsers.
- F12 – Opens the Save As dialog box in Microsoft Word.

D. Cursor Control keys-

a) The cursor is a blinking symbol that appears on the screen.

b) The cursor controls keys are used to move the cursor in any one of the four directions such as up, down, left, or right.

c) The arrow marks on the keys indicate the direction in which the cursor will move when the specific cursor keys are pressed.

d) Uses: Generally, used in moving the cursor in up, down, left, right direction and in playing games to move the character in different direction mention in the game by game developers.

E. Enter Key-

- This key is used to send the request to the CPU, once the task is completed.
- Enter key is also used to move the cursor to the beginning of the next line.
- Uses: Generally, used in software like MSOffice, notepad, to move the cursor to the beginning of the next line and in software many software used for executing the processes.

F. Spacebar Key on keyboard-

Physically, this is the longest key on the keyboard. It is used to insert blank spaces between two words or letters or numbers or symbols.

Uses: As you see above it is generally used to insert blank spaces between two words or letters or symbols or numbers in software like a notepad, MSOffice, etc.

G. Backspace Key-

a) This key is used to remove one character at a time to the left of its current position of the cursor.

b) Uses: It is also broadly used, in software like notepad, MS office, etc.

H. Delete Key-

a) Del or delete key is used to erase the typed contents on the right side of its current position of the cursor.

b) Uses: It is also broadly used, in software like notepad, MS office, etc. to erase the typed contents on the right side of its current position of the cursor.

I. Shift Key-

a) There are two shit keys on a keyboard-one on the left side and one on the right side. And it's the second-largest key on the keyboard.

b) This key is used in combination with other keys.

c) Uses: Some keys, like numeric keys have special symbols printed on their upper portion. The shift key is used to print these symbols.

d) And you can also type alphabet keys in lower-upper upper-lower when you pressed the shift key while typing text from alphabet keys.

e) And you can also use the num pad on the right side of the keyboard as cursor keys while pressing shift keys simultaneously.

J. Caps Lock Key-

a) This key is used to type the alphabets either in capital letters or in small letters.

b) Uses: When the caps lock key is pressed on all the letters which we type will appear in upper case.

c) When the caps lock is pressed off, all the letters we type will appear in lower case.

K. Escape Key-

a) Esc is the short form of Escape key. It is situated in top-left corner of the keyboard.

b) Uses: It allows the user to abort, cancel, or close an operation in many software on a computer.

L. Symbol keys-

a) Symbol keys are situated in many areas on the keyboard. These are used to type symbols like. ', {,], <, and? etc.

b) Uses: Used in software like MSWord, notepad etc. to type symbols.

M. Tab key-

a) Tab key is only one in the left side of the keyboard.

b) Uses: Generally, used for switching between menu in the different type of software. And also used to perform the task of 4 times of spacebar key easily.

N. Ctrl and Alt Keys-

These keys are used with other keys to perform different types of tasks on the computer. And it makes some tasks shortcuts to perform these tasks easily.

Example -

Ctrl + shift + esc = open task manager

Ctrl + A = Selects all

5. Joy Stick- (Pointing device)

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions. The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games. It is useful for playing computer and video games. It is very easy to use by beginners. It is very fast interface. It is easier to navigate. The control is in 3D (three dimensions).They provide fast interactions as required in most games and hence used in games such as racing or flying styles etc.

Disadvantages of Joystick-

I. It is difficult to control the ON screen pointer compare to mouse. Some people find it more difficult to control than mouse.
II. Movement indirect in plane different from the screen.
III. They are not robust and can break if too much force is applied on them.
IV. It requires lifting of hand from keyboard keys and requires different hand movements.
V. The prolonged use of joystick can cause fatigue in the arms.

6. Light pen-

A light pen is a computer input device in the form of a light-sensitive wand used in conjunction with a computer's cathode-ray tube (CRT) display. It allows the user to point to displayed objects or draw on the screen in a similar way to a touchscreen but with greater positional accuracy.

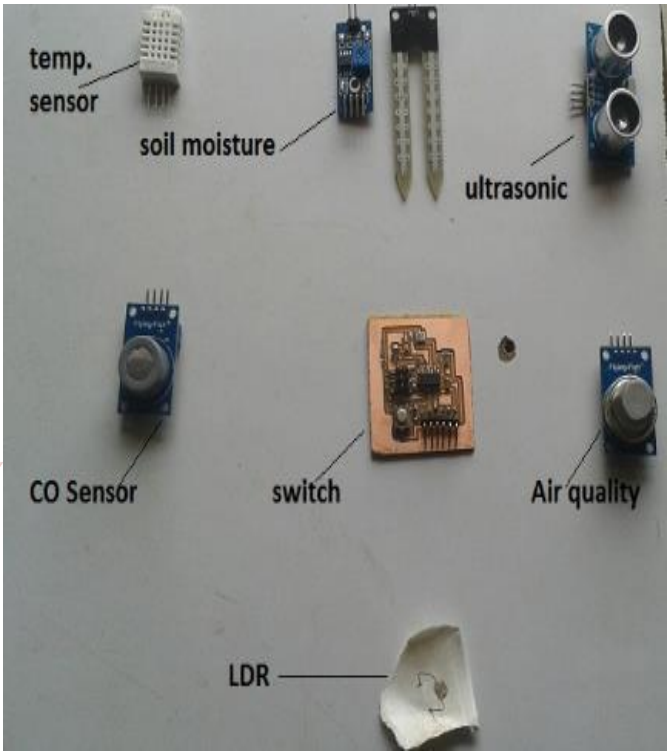
Working of Light Pen

a) The pen contains a photocell in a small tube.
b) When the pen is moved on the screen, light from the screen at the location of pen causes the photocell to respond.
c) The electric response is transmitted to the computer that can identify the position on screen at which the light pen is pointing.

Light Pen

7. Sensor Device-

I. Sensor Device is a type of input device which do some processing and generates output.
II. The other meaning of sensor device is that it is a type of device which convert signals from one source of energy to the electrical domain.
III. One of the sensor examples is a Light Dependent Resistor (LDR).



8. Touch screen- (Pointing device)

A touch screen is a computer display screen that is also an input device. The screens are sensitive to pressure; a user interacts with the computer by touching pictures or words on the screen. Since touchscreen devices accept input directly through the screen, they do not require external input devices, such as mice and keyboards. This makes touchscreens ideal for computer kiosks, as well as portable devices, such as tablets and smartphones. While a touchscreen may look like an ordinary display, the screen includes several extra layers that detect input. Many touchscreen applications also allow you zoom in and out by spreading two fingers apart or pinching them together.

Output devices-

Output device receives information from the CPU and presents it to the user in the desired from. The processed data, stored in the memory of the computer is sent to the output unit, which then converts it into a form that can be understood by the user. The output is usually produced in one of the two ways – on the display device, or on paper (hard copy).Output devices return processed data that is information, back to the user. An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) which converts the electronically generated information into human-readable form. An output device is used to send data out of the system. The user sees the result after processing of data by the computer through output devices

Types of Output Devices –

These can be categorised into three types based on the output produced by the computer these are -

1. Soft copy
2. Hard copy
3. Sound output

I. Soft copy output device

The output on the screen is called a soft copy. The soft copy output can be provided on the following devices.

I. Monitor (Visual display units (VDUs))

Visual display units (VDUs) are television-like screens that provide the user-interface in the form of display of text, numbers and images. The VDUs may be monochrome or colour. The support of monochrome or colour and clarity of display depend on the type of video monitor and the video adapter installed in the microcomputer. The video display terminal (VDT) consists of a monitor or CRT and a keyboard. The CRT serves as an output device and the keyboard as an input device. Thus VDT is an input/output device. If the terminal is provided with some memory and certain processing capability, it becomes a smart or intelligent terminal. A terminal without processing power is called a dumb terminal.

Types of Monitor

A. Cathode-Ray Tube (CRT) Monitor

The CRT display is made up of pixels generated by phosphorescent dots. The sharpness and clarity of the image depends upon the number and size of the pixels. Cathode-ray tubes work like vacuum tubes which produce images in the form of video signals. The front surface of the screen is called face plate, which is made up of fiber optics and displays images. There are three electron beams red, green and blue that beats the screen. So the colors which you see on the screen are the blends of these three beams. Early TVs are an example of CRT display. The disadvantage of CRT displays is that they were large in size and need high power.

A. Flat-Panel Display Monitor-

These days flat-panel display technology is consolidate. They have reduced volume, weight and power requirement in comparison to the CRT. They use liquid crystals or plasma to produce output. Light passes through the liquid crystals to generate pixels. Calculators, video games, monitors, laptops and graphics display, all are current uses of flat-panel displays that can be hanged on walls or wear on your wrists.

B. LCD Monitor (Liquid-Crystal Device)

The LCD Monitor is a flat panel screen that is smart in size and light weight. It consists of liquid crystal technology which is used in the display of laptops, tablets, smart phones, etc. the LCD screen forms two layers of polarized glass. Old LCDs had passive-matrix screens, while modern LCDs use active-matrix technology.

C. LED Monitor (Light-Emitting Diodes)-

The LED Monitor is an upgrade and improved version of LCD monitor. They are also flat-panel display and uses liquid crystal technology having multiple LED panels. The main difference between LCD and LED is the source of light to backlight the display.

Modern LED displays produce more brilliance and greater light intensity but also consume less power.

D. Plasma Monitor

The plasma monitor is also a flat panel display, which uses plasma display technology. It contains small tiny cells between two glass panels. These cells are mixture of noble gasses and a small amount of mercury. When electromotive force is applied, the gas turns into a plasma and releases ultraviolet light that creates images on the screen. Plasma monitors offer a unique and excellent viewing experience.

2. Printer and scanner

Hard copy output devices

Hard copies are tangible computer outputs. Printer and plotter are used to get a hard copy output.

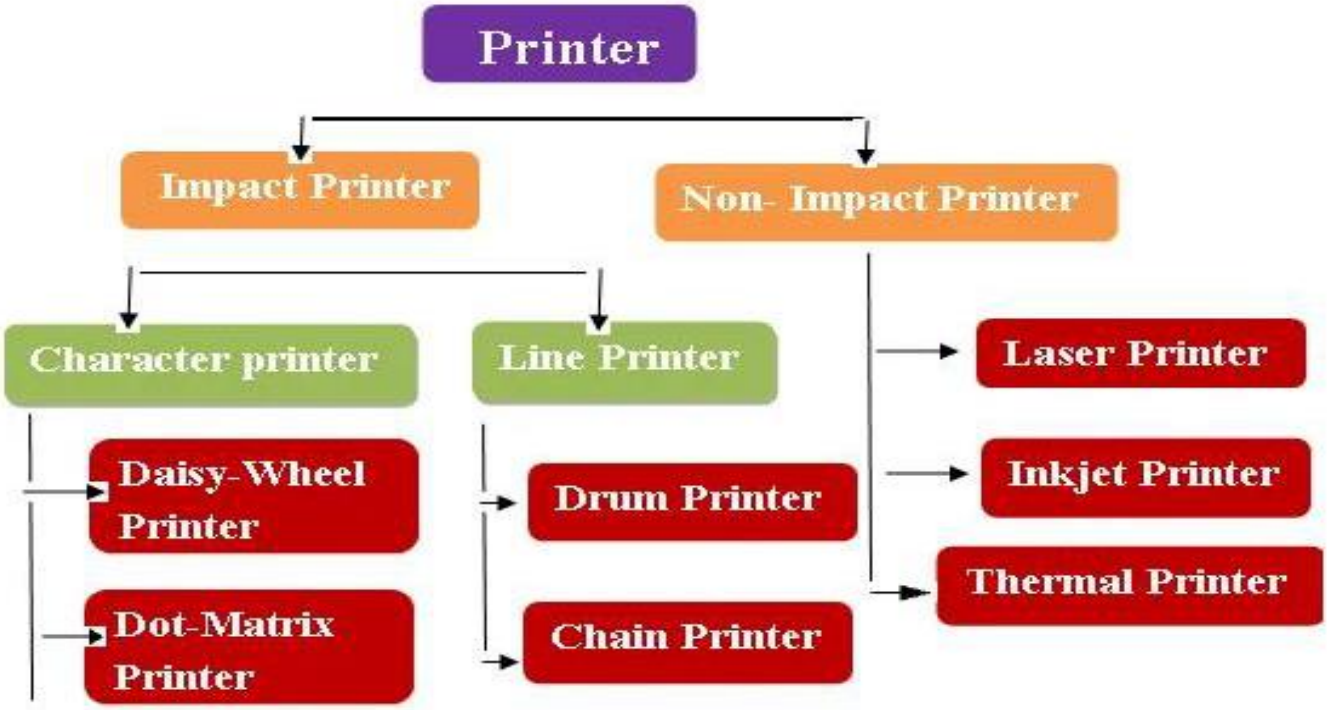
A. Printer

I. This is used to produce a hard copy output. There are different kinds of printing technology.

II. Two factors that determine the quality of a printer are its resolution and speed. Resolution is measured in terms of DPI.

III. Speed is measured in terms of number of characters printed in a unit of time and is represented as characters per second (CPS), lines per minute (LPM), or pages per minute (PPM).

IV. Based on the technology used, they can be classified as impact or non-impact printers.



1. **Impact printers**
2. **Non-Impact printers**

I. Impact printers

a) An impact printer is a type of printer that operates by striking a metal or plastic head against an ink ribbon.

b) The ink ribbon is pressed against the paper, marking the page with the appropriate character, dot, line, or symbol.
c) Common examples of impact printers include dot matrix, daisy-wheel printers, and ball printers.

Type of Impact printers

Impact printers are of two Types:

I. Character Printer
2. Line Printer

I. CHARACTER PRINTER-

A Character printer prints a single character at a time. They are low speed printers. Their printing speed lies in the range of 10-600 character / second.

Types of Character printers

Character printers are generally of two types:-

I. Dot Matrix Printer
2. Daisy wheel Printer

I. Dot matrix printer-

- These printers print each character as a pattern of dots. The print head is made up of a matrix of tiny needles, typically 9 rows with 7 columns (9 *7 matrix needles).
- These shapes of each character are formed in the form of tiny dots. The printing quality of a dot matrix printer is inferior to a daisy wheel printer. But the printing speed of a Dot Matrix Printer is range from 40 to 600 characters per second. Dot Matrix Printers are less expensive than daisy – wheel printer. The main advantage of dot matrix printer over latter – quality printer is that dot – matrix printer can print characters in different shape, size and fonts. It has ability to print charts and graphics.

Advantages -

I. Dot matrix printer uses continuous paper rather than requiring individual sheet.
II. Dot matrix printer is fast and cheap.
III. Dot matrix printer can print charts and graphics.

Disadvantages -

I. Dot matrix printers are noisy.
II. Dot matrix printers do not produce high quality.

2. DAISY-WHEEL PRINTERS-

Also known as Letter Quality Printer. These printers use a print wheel font, which is termed as daisy wheel. Each petal or hammer of Daisy-Wheel has a character raised on it. A motor spins the wheel at a rapid rate. When the desired character spins to the correct position, a print hammer strikes it to produce the output. The speed of these Daisy-Wheel Printers normally ranged between 10-75 characters per second. The noise levels of these printers are high. These printers are most commonly used in electronic typewriter.

Advantages of a Daisy-Wheel Printer

I. Can print letter quality characters.
II. Gives fine quality output.

Disadvantages of a Daisy-Wheel Printer

I. Printing speed is very slow
II. Noisy
III. Cannot print Graphics
IV. They are very costly.

2. LINE PRINTERS

I. Line printers are impact printers used with mini and mainframe computers. For producing large volume outputs.

II. These printers print one line of the text at a time that is why known as line printer. Its printing speed lies in the range of 300-3000 lines per minute (LPM).

III. Actually line printer prints only one character at a time but because of its printing speed, observer observes that it prints a whole line a time.

Types of Line Printers

Line Printers are of two types

I. Drum Printer
II. Chain Printer

1. DRUM PRINTER

I. The drum printer consists of a cylindrical drum. Asset of characters are embossed on its surface t print.
II. A set of print hammers is associated with each character.
III. As the drum rotates, the hammer wait for desired character and is activated when character appear in front of hammer.
IV. The hammer is placed behind the paper.
V. There hammers strike the paper along with ribbon (ribbon is placed between hammer and drum) against the embossed character on the surface one revolution of drum is needed to print a line.
VI. As the line is printed the paper moves upward to print next line.

2. CHAIN PRINTER

A chain containing characters is used for printing. The chain knows as print chain rotates very rapidly. With each link of the chain is character font. Magnetically driven hammers are there in each print position and all the characters which are to be printed are received by the printer through processor. When the desired character comes in the print position the hammers strike the ribbon and paper against the character thus it prints one line at a time. It is very noisy and its speed ranges from 400-24000 line per minute (LPM).

2. NON -IMPACT PRINTER

I. These printer uses ink and special electrical machines for producing outputs.
II. Non – impact printers are all those printers whose printing heads do not touch paper.
III. A non-impact printer forms characters and image on a piece of paper without actually striking the paper.

Types of Non -Impact Printers

I. Laser printer
II. Inkjet printer
III. Thermal printer

1) LASER PRINTERS

They print one page at a time thus laser printer is also referred as Page Printer. A laser printer uses electronics, lasers, xerography and other techniques, which is called electro photographic technique. A laser beam is directed across the surface of a light or photosensitive drum. An image is produced, with the use of raster scan principal, in the form of tiny dots. The laser exposed areas attract toner (or ink power). There after the drum transfers the toner to the paper. The paper then moves to a fusing station where the toner is permanently fused on the paper with heat or pressure. After this the drum is discharged and cleaned and ready for processing the next page.

Advantages of Laser Printers

A. Very high speed
B. Low noise level
C. Low maintenance requirement.
D. Very high quality output on ordinary paper.
E. Good graphics quality (300 dpi to 1200 dpi) and excellent graphics capabilities.
F. Supports many fonts and different character size.
G. Color printing possible

MS Power point

Components of PowerPoint

Various components of MS-PowerPoint 2007 window are described below

I. **Title Bar-** It contains the name of currently opened file followed by software name.

II. **Ribbon** -It is same as Word and Excel, just few tabs are different like Animations, Slide Show, etc.

III. **Slide** -It appears in the centre of the window. You can create your presentation by adding content to the slides.

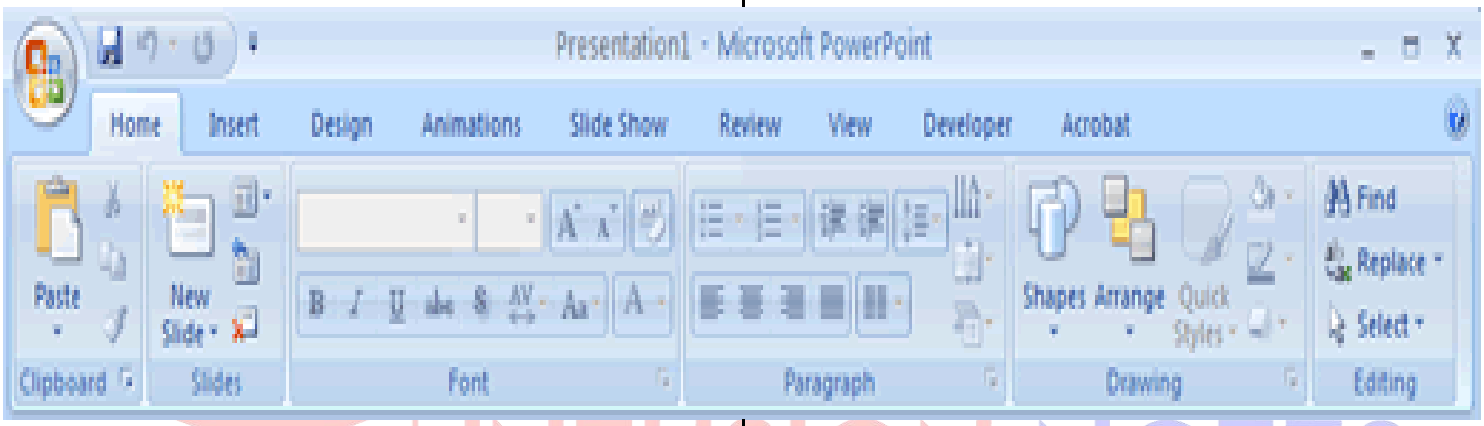
IV. **Slide Pane** -This area of PowerPoint window displays all the slides that are added in the presentation.

V. **Slides View Tab** -This tab displays a thumbnail view of all the slides.

VI. **Outline View Tab** -This tab displays the text contained in the presentation in an outline format.

VII. **Notes Section** -This can be used for creating notes.

VIII. **Status Bar-** It displays the number of the slide that is currently being displayed.



Home Tab :-

Slide Group

- **New Slide :-** Using the New Slide option, you can insert a new slide into your presentation.
- **Layout :-** You can change the layout of your slide by using the Layout option.
  Example: Title Slide, Title and Content, Section Header, Two Content, Comparison, Title Only, Blank, Content with Caption, Picture with Caption.
- **Delete :-** We can delete the selected slide by using the Delete option.
- **Reset :-** By using the Reset option, we can restore our slide to its previous state.

Font Group :- same as ms word

Paragraph Group:- same as ms word

Drawing Group

A. **Shapes :-** Using the Shape option, you can insert any type of shape into your presentation.

B. **Arrange :-** You also get many options under the Arrange option, which are as follows:

C. **Bring to Front:** If you have an image or shape in your presentation and you want to bring an image or shape on top of another image or shape, you can use this option.

D. **Send to Back:** If you have an image or shape in your presentation and you want to bring one image or shape below another image or shape, you can use this option.

E. **Bring Forward:** If there are many images and shapes in your presentation, and they are on top of each other, and you want to bring them up one by one, you can use this option.

F. **Send Backward:** If there are many images and shapes in your presentation, and they are on top of each other, and you want to bring them down one by one, you can use this option.

G. **Group:** Using this option, you can create a group by joining two or more images or shapes.

H. **Ungroup:** Using this option, you can break the grouped images or shapes, that is, you can ungroup them.

I. **Regroup:** Using this option, you can make the ungrouped group back into a group.

J. **Align:** Using this option, you can align your image or shape to the left, right, center, top, middle, etc.

K. **Rotate:** Using this option, you can rotate your image or shape, such as Rotate Right 90°, Rotate Left 90°, Flip Vertical, Flip Horizontal.

L. **Selection Pane:** Using this option, you can show or hide your images or shapes.

Quick Style:

Using the Quick Style option, you can apply different types of styles to your shape.

A. **Shape Fill :-** Using the Shape Fill option, you can fill any shape with the desired color.

B. **Shape Outline :-** Using the Shape Outline option, you can fill the outline (border) of your shape with color, and you can also increase or decrease the size of the outline (border).

C. **Shape Effect :-** Using the Shape Effect option, you can add any effect you want to your shape, such as Preset, Shadow, Reflection, Glow, etc.

Editing Group

A. **Find :-** Using the Find option, you can search for any text in your presentation.

B. **Replace :-** Using the Replace option, you can replace any word in your presentation with another word.

C. **Select :-** The Select option contains the following:

D. **Select All :-** Using this option, you can select everything on your document page at once.

E. **Select Object :-** Using this option, you can select objects, i.e., images and shapes on your document page.

F. **Selection Pane :-** Using this option, you can show or hide your images or shapes.

Insert tab

Text Group

A. **Text Box :-** Using the Text Box option, you can draw a text box on your page.

B. **Header & Footer :-** If you want something written on the top and bottom of your printed page, then you can add a Header for the top and a Footer for the bottom.

C. **Word Art :-** You can write stylish text by using the WordArt option.

D. **Date & Time :-** By using the Date & Time option, you can insert the current date and time into your document.

E. **Slide Number :-** You can insert the Slide Number in your document by using the Slide Number option.

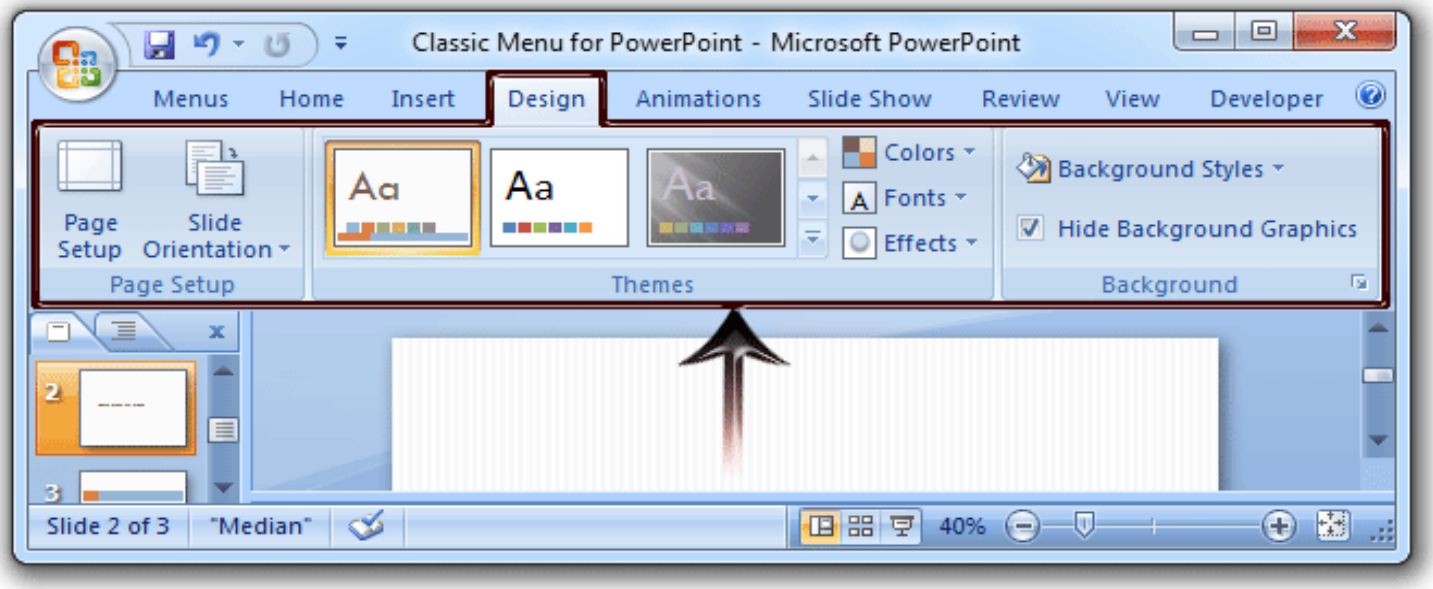
F. **Object :-** Using the Object option, you can insert files from other software into your PowerPoint presentation, such as Excel, MS Paint, or MS Word.

Media Group

A. **Movie :-** You can insert a Video in your presentation using the Video option.

B. **Sound :-** You can insert Audio in your presentation using the Audio option.

Design



Page Setup Group

A. **Page Setup :-** *Use this option to set the size of the slide.*

B. **Slide Orientation :-** *This option is used to set the orientation of the slide, which is by default Landscape.*

Themes Group

A. **Themes :-** *Through this option, we can change the color, text effects, font, etc. of the diagram made in the slide simultaneously.*

B. **Color :-** *This option allows us to change only the color of the color diagram created in the slide.*

C. **Font :-** *Through this option, we can change the language of the text in the color diagram created in the slide.*

D. **Effect :-** *This option allows us to soften or harden the color of the color diagram created in the slide.*

Background Group

A. **Background Style:** *Through this option, we can apply different types of styles to the background of the slide.*

B. **Hide Background Graphics:** *Through this option, we can hide the design of the themes applied to the slide.*

Animations

Preview Group

Preview

Using the Preview option, we can see the preview of the animation we have applied to the slide.

Animation Group

- **Animate :-** *This option is used to apply animation to an object in the slide.*
- **Custom Animation :-** *Using the Animation option, we can add animation to Text, Image, or Shape.*

Custom Animation Effects include four types:

A. **Entrance :-** It means "entry", so you can show the entry of any object in the slide.

B. **Emphasis :-** It means "emphasis". You can use it when there is an object on the slide and you want to highlight it for the audience.

C. **Exit :-** It means "exit". You can use this to make any object exit the slide.

D. **Motion Paths :-** With this option, you can give motion to any object on the slide. For example, if you create a circle, the object will move in the same circular path.

Transition of this Slide Group

A. **Transition Effect :-** With the help of this option, we can apply different types of transition effects to the slide.

B. **Transition Sound :-** With this option, we can add sound to the transition effect in the slide, such as bomb, drum, breeze, click, etc.

C. **Transition Speed :-** With this option, we can adjust the speed of the transition effect in the slide. It can be set to three types: Slow, Medium, or Fast.

D. **Apply to All :-** With this option, we can apply the transition effect to all the slides simultaneously.

Advance Slide

A. **On Mouse Click :-** With this option, we can make the slide show by clicking the mouse.

B. **Automatically After :-** With this option, we can set the slide to show automatically, and we can also set a timing for it.

Slide Show Tab

Start Slide Show Group

A. **From Beginning :-** Through this option, you can start the presentation from the first slide.

B. **From Current Slide :-** With this option, you can present the presentation starting from the current slide.

C. **Custom Slide Show :-** Using the Custom Slide Show option, you can play only the slide show that you want to present.

Set Up Group

A. **Set Up Slide Show :-** Using the Set Up Slide Show option, you can configure advanced settings for your slide show, such as looping continuously, manually advancing slides, etc.

B. **Hide Slide :-** You can hide a slide by using the Hide Slide option.

C. **Record Narration :-** By checking the Record Narration option, you can record a narration during the slide show.

D. **Rehearse Timings :-** Using the Rehearse Timings option, you can set the timing for each slide in the slide show, ensuring the presentation is completed in the specified time.

E. **Use Rehearsed Timing :-** If you want to use the rehearsed timings, check this option. If you do not want to use them, uncheck it.

Monitor Group

Resolution

With this option, the resolution of the presentation is reduced or increased. Because the presentation is shown on the small screen and with the help of the projector, it is also shown on the big screen. The higher the resolution of the presentation can increase the quality of Slide.

Change the pen to a pointer during a show	Ctrl + A
Hide the pointer or pen during a show	Ctrl + H
Move to the next hyperlink during a show	Tab
Make the screen go black during a show	B
Make the screen go white during a show	W
Stop or restart an automatic show	S
Return to the first slide during show	1 + Enter
Group Items (with items selected)	Ctrl + G
Ungroup	Ctrl + Shift + G
During presentation, Go to slide number	Slide number + Enter
Copy formatting of selected shape	Ctrl + Shift + C
Paste formatting only to another shape	Ctrl + Shift + V
Insert hyperlink	Ctrl + K
Stop the show. Press S again to restart the show	S
End the slide show	Esc
Select to the end of a word	Ctrl + Shift + Right arrow
Select to the beginning of a word	Ctrl + Shift + Left arrow
Select all objects	Ctrl + A (on Slides tab)
Select all slides	Ctrl + A (in Slide Sorter view)
Select all text	Ctrl + A (on the Outline tab)
Delete one word to the left	Ctrl + Backspace
Delete one word to the right	Ctrl + Delete
Cut selected object or text	Ctrl + X
Copy selected object or text	Ctrl + C
Paste cut or copied object or text	Ctrl + V
Undo	Ctrl + Z
Redo	Ctrl + Y
Open Find dialog box	Ctrl + F
Cancel	Esc
Move to File tab ribbon	Alt + F, use letters to navigate
Move to Home tab ribbon	Alt + H, use letters to navigate
Move to Insert tab ribbon	Alt + N, use letters to navigate
Move to Design tab ribbon	Alt + G, use letters to navigate
Move to Transitions tab ribbon	Alt + K, use letters to navigate
Move to Animations tab ribbon	Alt + A, use letters to navigate
Move to Slide Show tab ribbon	Alt + S, use letters to navigate
Move to Review tab ribbon	Alt + R, use letters to navigate
Move to View tab ribbon	Alt + W, use letters to navigate
On the ribbon, to move between commands	Tab or Shift-tab
To move between groups on a ribbon	Ctrl + Right Arrow or Ctrl + Left Arrow
Activate a selected command on the ribbon	Spacebar or Enter key
Open a gallery on the ribbon	Spacebar or Enter key
Finish with a control on the ribbon and move back to the document	Enter key
Expand or collapse the ribbon	Ctrl + F1
Help	F1
Edit in selected placeholder	F2

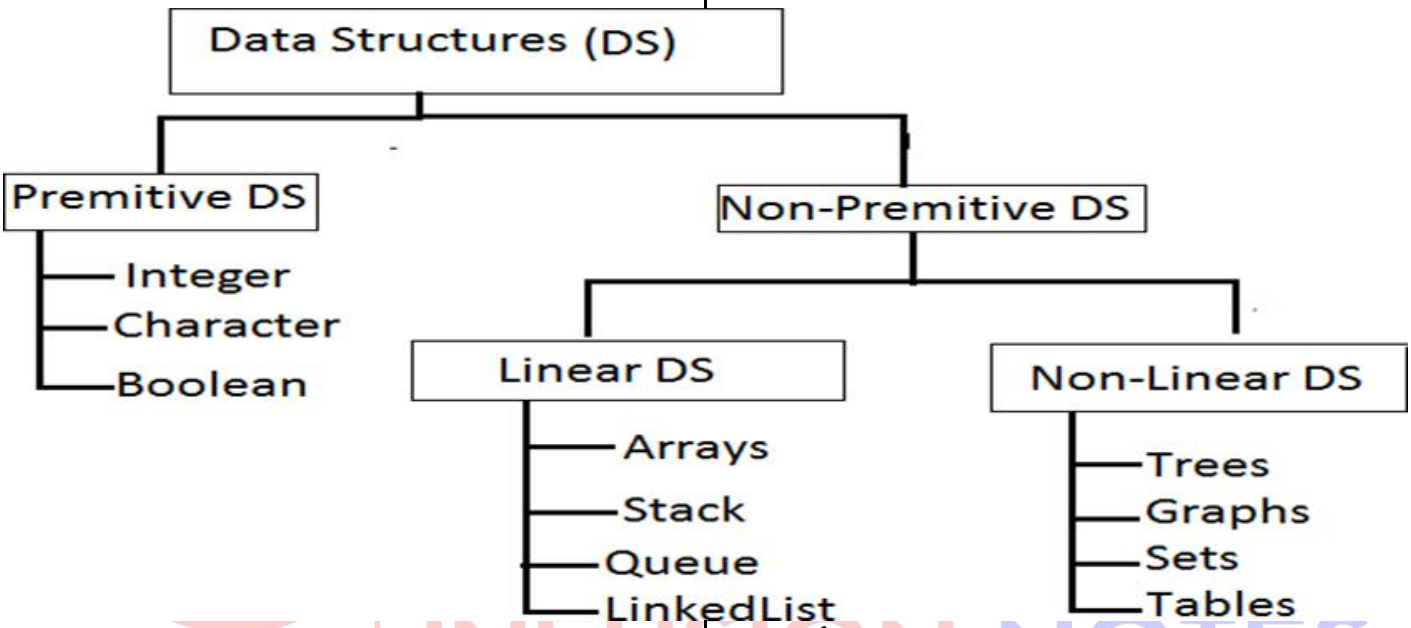
Chapter – 3

DATA STRUCTURES AND ALGORITHMS (DSA)

Definition of Data Structure

A **data structure** is a specialized format for organizing, processing, storing, and retrieving data in a computer system. It is a way of arranging data in memory to perform operations like searching, inserting, updating, deleting, and accessing efficiently.

Data structures provide a way to manage large amounts of data, such as databases or big datasets, in a way that makes it easier to perform operations on the data efficiently. They can be classified into two categories: **linear** and **nonlinear**.



Key Characteristics of Data Structures:

1. **Organization**: Data structures determine how data is organized in memory or on disk.
2. **Efficiency**: Data structures help in performing operations such as searching, sorting, inserting, and deleting efficiently.
3. **Relationship**: Data structures define relationships between individual data elements, making it easier to retrieve related information.
4. **Manipulation**: Data structures provide methods for manipulating and processing the data efficiently.

Types of Data Structures:

1. **Primitive Data Structures**: These are the basic data types provided by programming languages, such as:
   - **Integer**
   - **Character**
   - **Float**
   - **Boolean**
2. **Non-Primitive Data Structures**: These structures are more complex and are made up of multiple primitive data types. Some examples are:
   - **Arrays**
   - **Linked Lists**
   - **Stacks**
   - **Queues**
   - **Trees**
   - **Graphs**

Examples of Data Structures:

1. **Array**: A collection of elements, all of the same type, stored in contiguous memory locations. Arrays allow random access to elements using indices.
2. **Linked List**: A linear collection of data elements, where each element (called a node) points to the next one. Linked lists do not require contiguous memory, and elements can be dynamically added or removed.
3. **Stack**: A linear data structure that follows the **LIFO (Last In, First Out)** principle, where elements are added and removed from the top of the stack.
4. **Queue**: A linear data structure that follows the **FIFO (First In, First Out)** principle, where elements are added at the rear and removed from the front.

5. **Tree**: A hierarchical data structure consisting of nodes, with each node containing a value and pointers to its children. Trees are used to represent hierarchical relationships, such as organizational structures or file systems.

6. **Graph**: A collection of nodes (vertices) connected by edges. Graphs can represent complex relationships, like social networks or network routing.

Why Use Data Structures?

- **Optimization**: Different data structures provide optimized solutions for different types of operations, such as quick lookups, efficient insertions, or deletions.
- **Scalability**: They allow the handling of large amounts of data efficiently.
- **Data Integrity**: Organizing data in a structured manner ensures consistency, making it easier to update or manipulate.

Importance of Data Structures in Computer Science:

- **Efficiency**: Choosing the right data structure leads to efficient algorithms and faster processing.
- **Memory Management**: Some data structures, such as linked lists, allow dynamic memory allocation, leading to efficient use of available memory.
- **Problem Solving**: Data structures are essential for solving complex problems, such as graph traversal, shortest path finding, and sorting.

In summary, data structures are foundational for computer science and programming. They enable efficient management and manipulation of data, leading to better performance and optimized solutions.

Difference Between Linear and Nonlinear Data Structures

Linear Data Structures and **Nonlinear Data Structures** are two fundamental categories of data structures, and they differ in how elements are arranged and accessed. Let's break down the differences between them:

Type of data structures

1. Linear Data Structures

In linear data structures, elements are stored in a sequential order, meaning each element is connected to the next in a single sequence or list. This allows for straightforward traversal from the first element to the last. These structures follow the **FIFO (First In, First Out)** or **LIFO (Last In, First Out)** principle based on the type of linear structure.

Examples of Linear Data Structures:

- **Arrays**
- **Linked Lists**
- **Stacks**
- **Queues**

Characteristics of Linear Data Structures:

- **Elements are arranged sequentially**: In linear structures, the data elements are stored one after the other.
- **Single level of traversal**: You can traverse the data structure in a single linear pass, from the first to the last element.
- **Access is generally simpler**: Since elements are ordered, you can access elements sequentially.
- **Memory allocation**: Arrays, for example, use contiguous memory for storing elements.

Operations:

- Insertion, deletion, and traversal occur in a linear manner.
- Operations on these structures are performed sequentially or from one end to another.

Memory:

- Memory usage is generally fixed (for arrays) or dynamic (for linked lists).

Time Complexity:

- **Accessing**: O(1) for arrays, O(n) for linked lists.
- **Insertion and Deletion**: O(1) for stacks/queues at the end, but O(n) for insertion/deletion at other positions in an array.

2. Nonlinear Data Structures

In nonlinear data structures, elements are not arranged in a sequential or linear manner. Instead, they are organized in a hierarchical or graph-like structure where each element can have multiple relationships with other elements.

Examples of Nonlinear Data Structures:

- **Trees** (e.g., Binary Tree, AVL Tree, Heap)
- **Graphs** (e.g., Directed Graph, Undirected Graph)

Characteristics of Nonlinear Data Structures:

- **Elements are connected in a hierarchical or graph-like manner**: In trees, elements (nodes) are arranged in a hierarchy with a root node, and in graphs, elements are connected by edges in a complex network.
- **Multiple paths or branches**: A single node can be connected to multiple other nodes, creating complex relationships.
- **Multiple levels of traversal**: In trees, you traverse at multiple levels (e.g., pre-order, in-order, post-order). In graphs, traversal can follow edges, forming cycles or paths.

Operations:

- **Insertion, Deletion, and Search**: Operations in trees and graphs can be performed at different levels or based on relationships, making the operations more complex compared to linear structures.

Memory:

- Memory usage is generally more flexible and can be dynamic, with no strict ordering of elements. In graphs, adjacency lists or matrices are used to store relationships.

Time Complexity:

- **Accessing**: Can be more complex; for example, searching in a tree is O(log n) for balanced trees, but can be O(n) for unbalanced trees.
- **Traversal**: Graph traversal algorithms like BFS or DFS take O(V + E), where V is the number of vertices and E is the number of edges.

Key Differences between Linear and Nonlinear Data Structures

Feature	Linear Data Structures	Nonlinear Data Structures
Element Arrangement	Elements are arranged in a sequential order.	Elements are arranged in a hierarchical or graph-like structure.
Traversal	Single-level traversal (one element after another).	Multiple-level traversal (through branches or paths).
Relationships Between Elements	Each element has a relationship with only one next element (except in doubly linked lists).	Elements can have multiple relationships with other elements.
Memory Allocation	Fixed or sequential memory allocation (e.g., arrays) or dynamic (e.g., linked lists).	Dynamic memory allocation; elements are not contiguous.
Examples	Arrays, Linked Lists, Stacks, Queues.	Trees (Binary, AVL, etc.), Graphs (Directed, Undirected).
Efficiency	Faster for accessing sequential elements (e.g., arrays).	More efficient for hierarchical or complex relationships (e.g., search in trees, traversal in graphs).
Complexity of Operations	Simpler operations (sequential).	More complex operations (multiple levels of traversal).
Time Complexity	O(1) for access, O(n) for insertion/deletion (in arrays).	Varies, for example, O(log n) for balanced trees, O(V + E) for graph traversal.
Use Cases	Suitable for applications where data needs to be stored in a sequence (e.g., data processing, queues).	Suitable for applications requiring hierarchical relationships or complex networks (e.g., file systems, social networks).

- **O(n) – Linear space**: The algorithm uses memory that scales linearly with the size of the input. For example, storing an array of size nn.

Example of Space Complexity:

- A recursive algorithm may have space complexity O(n)O(n) because of the memory required to store function call stacks.

Big O Notation

Big O notation is used to express the upper bound of the runtime or space usage of an algorithm. It describes the worst-case scenario for an algorithm's growth rate. It's crucial because it allows us to compare different algorithms regardless of the specific details of hardware, input values, or other factors.

Examples of Common Algorithms and Their Complexities:

1. **Binary Search:**
   - Time Complexity: **O(log n)** (since it divides the input in half at each step)
   - Space Complexity: **O(1)** (since it doesn't require extra space beyond a few variables)
2. **Bubble Sort:**
   - Time Complexity: **O(n²)** (due to nested loops that compare and swap adjacent elements)
   - Space Complexity: **O(1)** (in-place sorting)
3. **Merge Sort:**
   - Time Complexity: **O(n log n)** (since it divides the input in half and merges the results)
   - Space Complexity: **O(n)** (due to the additional space required for merging)
4. **Quick Sort:**
   - Time Complexity: **O(n log n)** on average, but **O(n²)** in the worst case (due to bad pivot selections)
   - Space Complexity: **O(log n)** (due to recursion stack in the best case)

Best, Worst, and Average Cases:

- **Best Case**: Describes the minimum time or space an algorithm will take.
- **Worst Case**: Describes the maximum time or space an algorithm will take.
- **Average Case**: Describes the expected time or space usage, averaged over many inputs.

Why Algorithmic Complexity Matters:

Understanding algorithmic complexity is critical for optimizing code, especially for large datasets. For example:

- **Scalability**: Efficient algorithms scale well with increasing input sizes. Algorithms with **O(n)** or **O(log n)** complexity are often preferred over **O(n²)** or **O(2ⁿ)** for large data.
- **Performance**: Minimizing the time complexity and space complexity leads to faster execution and lower resource consumption, which is crucial in real-world applications like web servers, databases, and scientific simulations.

In summary, **algorithmic complexity** is essential for evaluating the performance of algorithms, and understanding it helps in selecting the right approach for solving a problem efficiently.

Operations on the Data Structures:-

Following operations can be performed on the data structures:

1. Traversing
2. Searching
3. Inserting
4. Deleting
5. Sorting
6. Merging

- **Traversing –** It is used to access each data item exactly once so that it can be processed.
- **Searching –** It is used to find out the location of the data item if it exists in the given collection of data items.
- **Inserting –** It is used to add a new data item in the given collection of data items.
- **Deleting –** It is used to delete an existing data item from the given collection of data items.
- **Sorting –** It is used to arrange the data items in some order i.e. in ascending or descending order in case of numerical data and in dictionary order in case of alphanumeric data.
- **Merging –** It is used to combine the data items of two sorted files into single file in the sorted form.

Abstract Data Types

1. Abstract Data type (ADT) is a type (or class) for objects whose behaviour is defined by a set of value and a set of operations.
2. The definition of ADT only mentions what operations are to be performed but not how these operations will be implemented. It does not specify how data will be organized in memory and what algorithms will be used for implementing the operations. It is called "abstract" because it gives an implementation-independent view. The process of providing only the essentials and hiding the details is known as abstraction.
3. The user of data type does not need to know how that data type is implemented
4. Now we'll define three ADTs namely List ADT, Stack ADT, Queue ADT.

1. List ADT

- The data is generally stored in key sequence in a list which has a head structure consisting of count, pointers and address of compare function needed to compare the data in the list.
- The data node contains the pointer to a data structure and a self-referential pointer which points to the next node in the list.

The List ADT Functions is given below:

A list contains elements of the same type arranged in sequential order and following operations can be performed on the list.

- get() – Return an element from the list at any given position.
- insert() – Insert an element at any position of the list.
- remove() – Remove the first occurrence of any element from a non-empty list.
- removeAt() – Remove the element at a specified location from a non-empty list.
- replace() – Replace an element at any position by another element.
- size() – Return the number of elements in the list.
- isEmpty() – Return true if the list is empty, otherwise return false.
- isFull() – Return true if the list is full, otherwise return false.
- Stack ADT

2. In Stack

- ADT Implementation instead of data being stored in each node, the pointer to data is stored.
- The program allocates memory for the data and address is passed to the stack ADT.
- The head node and the data nodes are encapsulated in the ADT. The calling function can only see the pointer to the stack.
- The stack head structure also contains a pointer to top and count of number of entries currently in stack.
- A Stack contains elements of the same type arranged in sequential order. All operations take place at a single end that is top of the stack and following operations can be performed:
- push() – Insert an element at one end of the stack called top.
- pop() – Remove and return the element at the top of the stack, if it is not empty.
- peek() – Return the element at the top of the stack without removing it, if the stack is not empty.
- size() – Return the number of elements in the stack.
- isEmpty() – Return true if the stack is empty, otherwise return false.
- isFull() – Return true if the stack is full, otherwise return false.

3. Queue ADT

- The queue abstract data type (ADT) follows the basic design of the stack abstract data type.
- Each node contains a void pointer to the data and the link pointer to the next element in the queue. The program's responsibility is to allocate memory for storing the data.
- A Queue contains elements of the same type arranged in sequential order. Operations take place at both ends, insertion is done at the end and deletion is done at the front. Following operations can be performed:
- enqueuer () – Insert an element at the end of the queue.
- Dequeuer () – Remove and return the first element of the queue, if the queue is not empty.
- Peek () – Return the element of the queue without removing it, if the queue is not empty.
- Size () – Return the number of elements in the queue.

- *isEmpty() – Return true if the queue is empty, otherwise return false.*
- *isFull() – Return true if the queue is full, otherwise return false.*

Arrays

An array is a basic data structure used to store a fixed-size collection of elements of the same type. These elements are arranged in contiguous memory locations, allowing each element to be indexed or accessed directly using an integer index.

Characteristics of Arrays in Data Structures

1. ***Fixed Size:*** *Once an array is declared, its size cannot be changed. You need to know the number of elements you will store in the array beforehand.*
2. ***Homogeneous Elements:*** *All elements in an array must be of the same data type, such as all integers, all floats, or all characters.*
3. ***Indexed by Integers:*** *Each element in an array is assigned a unique integer called an index, which identifies its position within the array. Indexing usually starts at 0.*
4. ***Efficient Access:*** *Because of the way arrays are stored in memory (contiguously), accessing any element by its index is very efficient. This direct access using the index is often referred to as "random access."*

Uses of Array in Data Structure

Arrays in data structures are used across various domains for efficient data management and manipulation:

1. ***Data Storage:*** *Arrays provide a compact way of storing elements of the same type. They are commonly used for storing data like user records, inventory details, and other sequential data.*
2. ***Implementation of Matrices:*** *In mathematical and scientific computations, two-dimensional arrays are used to represent matrices which are crucial in operations such as transformations in graphics, solving systems of linear equations, and statistical analyses.*
3. ***Handling Buffer Data:*** *Arrays are used in programming to manage buffer storages, which are essential for the temporary storage of data during the transfer between two places in a system, such as reading files or handling I/O streams.*
4. ***Lookup Tables and Reverse Lookups:*** *Arrays can be used to create fast access lookup tables, allowing for efficient data retrieval. They are especially useful in applications where frequent retrieval of information based on a key is required.*
5. ***Implementation of Other Data Structures:*** *Arrays serve as the underlying data structure for more complex structures like heaps, stacks, queues, and graphs, used in more complicated algorithms.*
6. ***Sorting and Searching Algorithms:*** *Arrays in DSA are used to implement various sorting algorithms, such as quicksort, merge sort, and heapsort, due to their ease of element manipulation and access.*
7. ***Memory Management:*** *In lower-level programming, arrays play a crucial role in memory management schemes, helping manage resources effectively in a compact format.*
8. ***Image Representation:*** *In computer graphics, images are stored as arrays of pixels where each pixel represents a color. Manipulations and effects applied to images are often performed via operations on these arrays.*
9. ***Handling Static Datasets:*** *Arrays are ideal for applications where the data size is known and does not change over time, allowing for efficient access and manipulation.*
10. ***Game Development:*** *Arrays are used extensively in game development for storing game states, grid layouts for board games, sprite information in animations, and much more.*

In this "Arrays in Data structures" tutorial, you have seen the basics of array implementation, now you will perform operations on arrays.

Operations Can You Perform on an Array-

- *Traversal*
- *Insertion*
- *Deletion*
- *Searching*
- *Sorting*

There are two types of array in Data Structures, which are:

1. ***Single-dimensional array:*** *It is a collection of elements of the same data type that are stored in a contiguous block of memory.*

- Once the resource becomes available, the process is moved back to the **Ready** state.

4. Termination:

- Once the process completes its task or is terminated by the OS or another process, it enters the **Terminated** state.
- The OS frees any allocated resources and deletes the PCB.

Thread

I. A thread, sometimes called a lightweight process (LWP), is a basic unit of CPU utilization; it comprises a thread ID, a program counter, a register set, and a stack.
II. It shares with other threads belonging to the same process its code section, data section, and other operating-system resources, such as open files and signals.
III. A traditional (or heavyweight) process has a single thread of control.
IV. If the process has multiple threads of control, it can do more than one task at a time.

What is Multithreading?

I. Multithreading is the ability of the program to manage and execute multiple requests at the same time.
II. Multiple threads are created in the single process.
III. In the above example, if there is no multi-threading, we cannot create multiple threads to run multiple instances of notepad application. There will be only one notepad thread working.
IV. This is a high-level understanding of the process and thread. Let's get into the detail to see how the Operating System manages process and thread, internally.

The OS supports the threads that can provided in following two levels:

User-Level Threads

I. User-level threads implement in user-level libraries, rather than via systems calls, so thread switching does not need to call operating system and to cause interrupt to the kernel.
II. In fact, the kernel knows nothing about user-level threads and manages them as if they were single-threaded processes.

Advantages:

I. User-level threads do not require modification to operating systems.
II. Simple Representation: Each thread is represented simply by a PC, registers, stack and a small control block, all stored in the user process address space.
III. Simple Management: This simply means that creating a thread, switching between threads and synchronization between threads can all be done without intervention of the kernel.
IV. Fast and Efficient: Thread switching is not much more expensive than a procedure call.

Disadvantages:

I. There is a lack of coordination between threads and operating system kernel.
II. User-level threads require non-blocking systems call i.e., a multithreaded kernel.

Kernel-Level Threads

I. In this method, the kernel knows about and manages the threads.
II. Instead of thread table in each process, the kernel has a thread table that keeps track of all threads in the system.
III. Operating Systems kernel provides system call to create and manage threads.

Advantages:

- Because kernel has full knowledge of all threads, Scheduler may decide to give more time to a process having large number of threads than process having small number of threads.
- Kernel-level threads are especially good for applications that frequently block.

Disadvantages:

I. The kernel-level threads are slow and inefficient.
II. For instance, threads operations are hundreds of times slower than that of user-level threads.
III. Since kernel must manage and schedule threads as well as processes.
IV. It require a full thread control block (TCB) for each thread to maintain information about threads.
V. As a result there is significant overhead and increased in kernel complexity.

Difference between Process and Thread

I. The thread is also called a lightweight process. It requires fewer resources as compared to the process to run.

II. One single process can consist of multiple threads.
III. Every process requires its own address space to run on a processor. Whereas threads within a single process share the single address space. So threads are easier to create than process.
IV. Threads read and write at the same place. It is good and easy for communication between multiple threads in the single process.
V. The data communications between multiple processes are difficult and it is carried out by IPC (inter-process communication).
VI. Context switching overhead is less in the thread as compare to process. So threads decrease overall execution time and the cost of the communication.
VII. Threads are useful to execute lightweight tasks whereas processes are responsible for running heavyweight tasks.

What is Inter Process Communication?

I. Inter Process Communication (IPC) is a capability supported by operating system that allows one process to communicate with another process.
II. The processes can be running on the same computer or on different computers connected through a network.
III. Inter Process Communication (IPC) enables one application to control another application, and for several application to share the same data without interfering with one another.

Synchronization

I. Synchronization is a necessary part of interprocess communication processes.
II. It is provided by the interprocess control mechanism.
III. Some of the methods to provide synchronization are as follows –

A. Semaphore

I. A semaphore is a variable that controls the access to a common resource by multiple processes.
II. The two types of semaphores are binary semaphores and counting semaphores.

B. Mutual Exclusion

I. Mutual exclusion requires that only one process thread can enter the critical section at a time.
II. This is useful for synchronization and also prevents race conditions.

C. Barrier

I. A barrier does not allow individual processes to proceed until all the processes reach it.
II. Many parallel languages and collective routines impose barriers.

D. Spinlock

I. This is a type of lock. The processes trying to acquire this lock wait in a loop while checking if the lock is available or not.
II. This is known as busy waiting because the process is not doing any useful operation even though it is active.

Approaches of Interprocess Communication

The different approaches to implement interprocess communication are given as follows –

A. Pipe

I. A pipe is a data channel that is unidirectional.
II. Two pipes can be used to create a two-way data channel between two processes. This uses standard input and output methods.
III. Pipes are used in all POSIX systems as well as Windows operating systems.

B. Socket

I. The socket is the endpoint for sending or receiving data in a network.
II. This is true for data sent between processes on the same computer or data sent between different computers on the same network.
III. Most of the operating systems use sockets for interprocess communication.

C. File

I. A file is a data record that may be stored on a disk or acquired on demand by a file server.
II. Multiple processes can access a file as required. All operating systems use files for data storage.

D. Signal

I. Signals are useful in interprocess communication in a limited way.
II. They are system messages that are sent from one process to another.
III. Normally, signals are not used to transfer data but are used for remote commands between processes.

E. Shared Memory

I. Shared memory is the memory that can be simultaneously accessed by multiple processes.

INFUSION NOTES
WHEN ONLY THE BEST WILL DO

Dear Aspirants, here are the our results in differents exams (Proof Video Link)

RAS PRE. 2021 - https://shorturl.at/qBJ18 (74 प्रश्न , 150 में से)

RAS Pre 2023 - https://shorturl.at/tGHRT (96 प्रश्न , 150 में से)

UP Police Constable 2024 - http://surl.li/rbfyn (98 प्रश्न , 150 में से)

Rajasthan CET Gradu. Level - https://youtu.be/gPqDNlc6URO

Rajasthan CET 12th Level - https://youtu.be/oCa-CoTFu4A

RPSC EO / RO - https://youtu.be/b9PKjl4nSxE

VDO PRE. - https://www.youtube.com/watch?v=gXdAk856W18&t=202s

Patwari - https://www.youtube.com/watch?v=X6mKGdtXyu4&t=2s

PTI 3rd grade - https://www.youtube.com/watch?v=iA_MemKKgEk&t=5s

SSC GD - 2021 - https://youtu.be/2gzzfJyt6vI

EXAM (परीक्षा)	DATE	हमारे नोट्स में से आये हुए प्रश्नों की संख्या
MPPSC Prelims 2023	17 दिसम्बर	63 प्रश्न (100 में से)
RAS PRE. 2021	27 अक्तूबर	74 प्रश्न आये
RAS Mains 2021	October 2021	52% प्रश्न आये

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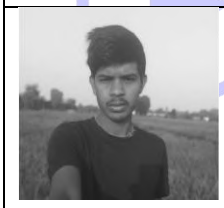
RAS Pre. 2023	01 अक्टूबर 2023	96 प्रश्न (150 मेंसे)
SSC GD 2021	16 नवम्बर	68 (100 में से)
SSC GD 2021	08 दिसम्बर	67 (100 में से)
RPSC EO/RO	14 मई (1st Shift)	95 (120 में से)
राजस्थान S.I. 2021	14 सितम्बर	119 (200 में से)
राजस्थान S.I. 2021	15 सितम्बर	126 (200 में से)
RAJASTHAN PATWARI 2021	23 अक्तूबर (1st शिफ्ट)	79 (150 में से)
RAJASTHAN PATWARI 2021	23 अक्तूबर (2nd शिफ्ट)	103 (150 में से)
RAJASTHAN PATWARI 2021	24 अक्तूबर (2nd शिफ्ट)	91 (150 में से)
RAJASTHAN VDO 2021	27 दिसंबर (1st शिफ्ट)	59 (100 में से)
RAJASTHAN VDO 2021	27 दिसंबर (2nd शिफ्ट)	61 (100 में से)
RAJASTHAN VDO 2021	28 दिसंबर (2nd शिफ्ट)	57 (100 में से)
U.P. SI 2021	14 नवम्बर 2021 1st शिफ्ट	91 (160 में से)
U.P. SI 2021	21नवम्बर2021 (1st शिफ्ट)	89 (160 में से)
Raj. CET Graduation level	07 January 2023 (1st शिफ्ट)	96 (150 में से)
Raj. CET 12th level	04 February 2023 (1st शिफ्ट)	98 (150 में से)
UP Police Constable	17 February 2024 (1st शिफ्ट)	98 (150 में से)

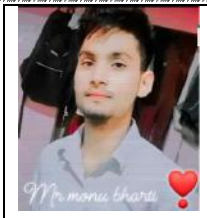
& Many More Exams like UPSC, SSC, Bank Etc.

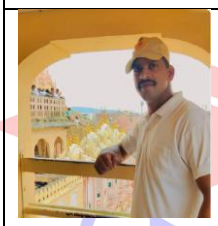
INFUSION NOTES
WHEN ONLY THE BEST WILL DO

Our Selected Students

Approx. 563+ students selected in different exams. Some of them are given below -

Photo	Name	Exam	Roll no.	City
	**Mohan Sharma S/O Kallu Ram**	Railway Group - d	114195120370022	PratapNagar Jaipur
	**Mahaveer singh**	Reet Level- 1	1233893	Sardarpura Jodhpur
	**Sonu Kumar Prajapati S/O Hammer shing prajapati**	SSC CHSL tier-1	2006018079	Teh.- Biramganj, Dis.- Raisen, MP
N.A	**Mahender Singh**	EO RO (81 Marks)	N.A.	teh nohar , dist Hanumangarh
	**Lal singh**	EO RO (88 Marks)	13373780	Hanumangarh
N.A	**Mangilal Siyag**	SSC MTS	N.A.	ramsar, bikaner

	**MONU S/O KAMTA PRASAD**	SSC MTS	3009078841	kaushambi (UP)
	**Mukesh ji**	RAS Pre	1562775	newai tonk
	**Govind Singh S/O Sajjan Singh**	RAS	1698443	UDAIPUR
	**Govinda Jangir**	RAS	1231450	Hanumangarh
N.A	**Rohit sharma s/o shree Radhe Shyam sharma**	RAS	N.A.	Churu
	**DEEPAK SINGH**	RAS	N.A.	Sirsi Road , Panchyawala
N.A	**LUCKY SALIWAL s/o GOPALLAL SALIWAL**	RAS	N.A.	AKLERA , JHALAWAR
N.A	**Ramchandra Pediwal**	RAS	N.A.	diegana , Nagaur

	**Monika jangir**	RAS	N.A.	jhunjhunu
	**Mahaveer**	RAS	1616428	village-gudaram singh, teshil-sojat
N.A	**OM PARKSH**	RAS	N.A.	Teshil-mundwa Dis- Nagaur
N.A	**Sikha Yadav**	High court LDC	N.A.	Dis- Bundi
	**Bhanu Pratap Patel s/o bansi lal patel**	Rac batalian	729141135	Dis.- Bhilwara
N.A	**mukesh kumar bairwa s/o ram avtar**	3rd grade reet level 1	1266657	JHUNJHUNU
N.A	**Rinku**	EO/RO (105 Marks)	N.A.	District: Baran
N.A.	**Rupnarayan Gurjar**	EO/RO (103 Marks)	N.A.	sojat road pali
	**Govind**	SSB	4612039613	jhalawad

	**Jagdish Jogi**	EO/RO (84 Marks)	N.A.	tehsil bhinmal, jhalore.
	**Vidhya dadhich**	RAS Pre.	1158256	kota
	**Sanjay**	Haryana PCS	96379 	Jind (Haryana)

And many others.....