MODULE-1
INTODUCTION TO COMPUTER HARDWARE AND SOFTWARE, OVERVIEW OF C

Computers are such an integral part of our everyday life now most people take them and what they have added to life totally for granted.

The history of the computer goes back several decades however and there are five definable generations of computers.

Each generation is defined by a significant technological development that changes fundamentally how computers operate – leading to more compact, less expensive, but more powerful, efficient and robust machines.

1940 – 1956: First Generation – Vacuum Tubes

These early computers used vacuum tubes as circuitry and magnetic drums for memory. As a result they were enormous, literally taking up entire rooms and costing a fortune to run. These were inefficient materials which generated a lot of heat, sucked huge electricity and subsequently generated a lot of heat which caused ongoing breakdowns.

These first generation computers relied on 'machine language' (which is the most basic programming language that can be understood by computers). These computers were limited to solving one problem at a time. Input was based on punched cards and paper tape. Output came out on print-outs. The two notable machines of this era were the UNIVAC and ENIAC machines – the UNIVAC is the first every commercial computer which was purchased in 1951 by a business – the US Census Bureau.

1956 – 1963: Second Generation – Transistors

The replacement of vacuum tubes by transistors saw the advent of the second generation of computing. Although first invented in 1947, transistors weren't used significantly in computers until the end of the 1950s. They were a big improvement over the vacuum tube, despite still subjecting computers to damaging levels of heat. However they were hugely superior to the vacuum tubes, making computers smaller, faster, cheaper and less heavy on electricity use. They still relied on punched card for input/printouts.

The language evolved from cryptic binary language to symbolic ('assembly') languages. This meant programmers could create instructions in words. About the same time high level programming languages were being developed (early versions of COBOL and FORTRAN). Transistor-driven machines were the first computers to store instructions into their memories – moving from magnetic drum to magnetic core 'technology'. The early versions of these machines were developed for the atomic energy industry.

1964 – 1971: Third Generation – Integrated Circuits

By this phase, transistors were now being miniaturised and put on silicon chips (called semiconductors). This led to a massive increase in speed and efficiency of these machines. These were the first computers where users interacted using keyboards and monitors which interfaced with an operating system, a significant leap up from the punch cards and printouts. This enabled these machines to run several applications at once using a central program which functioned to monitor memory.

As a result of these advances which again made machines cheaper and smaller, a new mass market of users emerged during the '60s.This generation of computers also had an operating system which is a special program meant to control the resources of the computer. By virtue of feature known as time sharing, the computer could run programs invoked by multiple users. The existing programming languages were supplemented by BASIC, C, C++ and Java.

1972 – 2010: Fourth Generation – Microprocessors

This revolution can be summed in one word: Intel. The chip-maker developed the Intel 4004 chip in 1971, which positioned all computer components (CPU, memory, input/output controls) onto a single chip. What filled a room in the 1940s now fit in the palm of the hand. The Intel chip housed thousands of integrated circuits. The year 1981 saw the first ever computer (IBM) specifically designed for home use and 1984 saw the MacIntosh introduced by Apple. Microprocessors even moved beyond the realm of computers and into an increasing number of everyday products.

The increased power of these small computers meant they could be linked, creating networks. Which ultimately led to the development, birth and rapid evolution of the Internet. Other major advances during this period have been the Graphical user interface (GUI), the mouse and more recently the astounding advances in lap-top capability and hand-held devices.

2010- : Fifth Generation – Artificial Intelligence

Computer devices with artificial intelligence are still in development, but some of these technologies are beginning to emerge and be used such as voice recognition.

AI is a reality made possible by using parallel processing and superconductors. Leaning to the future, computers will be radically transformed again by quantum computation, molecular and nano technology.

The essence of fifth generation will be using these technologies to ultimately create machines which can process and respond to natural language, and have capability to learn and organise themselves.

Computer Types:-

Super Computer:-

These are huge machines having most powerful and fast processors. A super computer has multiple CPUs for parallel data processing. Speed is measured in terms of flops(floating point operations per second)

super computers are too powerful to be used for transaction processing. They are mainly used in the areas like weather forecasting, analysis of geological data, nuclear simulation and space exploration. They are also used to solve complex scientific problems. Super computers have enormous storage and use huge amounts of power and generate a lot of heat. because of the exorbitant cost, they are mainly used by government agencies

Main frames:-

Mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports many simultaneous execution of programs.

Mainframes are used to handle data and application related to the organisation as a whole.

Today, main frames are employed to handle online transactions, the capability to handle large amount of data makes the main frame suitable for use in government, banks and financial institutions and large corporations.

Minicomputers:-

Computer that is smaller, less expensive, and less powerful than a mainframe or supercomputer but more expensive and more powerful than a personal computer. Minicomputers are used for scientific and engineering computations, business-transaction processing, file handling, and database management, and are often now referred to as small or midsize servers.

Microcomputers:-

An electronic device with a microprocessor as its central processing unit (CPU). *Microcomputer* was formerly a commonly used term for personal computer, particularly any of a class of small digital computer whose CPU is contained on a single integrated semiconductor chip. Thus, a microcomputer uses a single microprocessor forits CPU, which performs all logic and arithmetic operations. The system also contains a numberof associated semiconductor chips that serve as the main memory for storing program instructions and data and as interfaces for exchanging data of this sort with peripheral equipment—namely, input/output devices (e.g., keyboard, video display, and printer)

and auxiliary storage units. Smaller microcomputers first marketed in the 1970s contain a single chip on which all CPU, memory, and interface circuits are integrated.

They are mainly used for engineering and scientific applications and for software development along with word processing, desktop publishing, internet browsing and can also handle audio, video and image files

Smartphones and Embedded Computers:-

Smartphones are a class of mobile phones and of multi-purpose mobile computing devices. They are distinguished from feature phones by their stronger hardware capabilities and extensive mobile operating systems, which facilitate wider software, internet (including web browsing over mobile broadband), and multimedia functionality (including music, video, cameras and gaming), alongside core phone functions such asvoice calls and text messaging. Smartphones typically contain a number ofmetal-oxide-semiconductor (MOS) integrated circuit (IC) chips, include various sensors that can be leveraged by their software,and support wireless communications protocols (such as Bluetooth. Wi-Fi or satellite navigation) .

Embedded computers are everywhere. They are in phones, microwaves, airplanes,automobiles, calculators… The list goes on and on. An embedded computer, which is an integral component of most embedded system, is a combination of hardware and software thatis designated to perform a highly specific function. Because the software in embeddedcomputers is designed to only execute certain tasks, the computer's software in one device canbe totally distinct from that of another. The hardware of an embedded computer is also specially designed to withstand stresses in its intended environment.

BITS, BYTES AND WORDS

Bit is short for 'binary digit.' It's a single digit in a binary number, and it can be either 1 or 0.

A byte is 8 bits. That's the definition. With 8 bits you can store any number between 0 and 255, since there are 256 different combinations of 1 and 0 to choose from.

Why eight bits? The original intention was that, when storing text, 8 bits would be enough to assign a unique number every possible language character you might want to use in your document. The idea was that each character in a file would take up one byte of memory

A word is basically the number of bits a particular computer's CPU can deal with in one go. It varies depending on the computer architecture you're using.

INSIDE THE COMPUTER:-

The brain of the computer is the Central Processing Unit (CPU) represented by a single chip on a PC. The CPU carries out every instruction stored in a program while interacting with other

agencies as and when necessary. Most of the work is done by the Arithmetic and Logic unit (ALU) which is the integral part of the CPU

The CPU needs both fast and slow memory to work with. Fast memory is represented by primary memory known as Random Access Memory (RAM). It is divided into number of contiguously numbered cells. The number represents the address of the cell. The primary memory is used for storing instructions and data of the program currently in execution.

The Computer also supports slower secondary memory called secondary storage or auxiliary memory. This can generally be a hard disk or a CD-ROM or a DVD-ROM. Secondary memory is used to store the data not required currently. Data in secondary memory are stored as files having unique names. The program is executed by loading instructions and data from secondary memory to primary memory. User interact with the computer system using input and output devices. There are three types of data thst move between the various compnants of the computer. the data of a specific type move along a distinct path way called bus. The program instructions and data move along the data bus, Memory address travel along the address bus and control signals use the control bus.

THE CENTRAL PROCESSING UNIT (CPU):-

A **central processing unit** (**CPU**), also called a **central processor** or **main processor**, is the electronic circuitry within a computer that executes instructions that make up a computer program . The CPU performs basic airthmetic , logic, controlling, and input/output (I/O) operations specified by the instructions in the program.

CPU itself has following three components.

Memory or Storage Unit

Control Unit

ALU(Arithmetic Logic Unit)

Memory or Storage Unit

This unit can store instructions, data, and intermediate results. This unit supplies information to other units of the computer when needed. It is also known as internal storage unit or the main memory or the primary storage or Random Access Memory (RAM).

Its size affects speed, power, and capability. Primary memory and secondary memory are two types of memories in the computer. Functions of the memory unit are −

- It stores all the data and the instructions required for processing.
- It stores intermediate results of processing.
- It stores the final results of processing before these results are released to an output device.
- All inputs and outputs are transmitted through the main memory.

Control Unit

This unit controls the operations of all parts of the computer but does not carry out any actual data processing operations.

Functions of this unit are −

- It is responsible for controlling the transfer of data and instructions among other units of a computer.
- It manages and coordinates all the units of the computer.
- It obtains the instructions from the memory, interprets them, and directs the operation of the computer.
- It communicates with Input/Output devices for transfer of data or results from storage.
- It does not process or store data.

ALU (Arithmetic Logic Unit)

This unit consists of two subsections namely,

- Arithmetic Section
- Logic Section

Arithmetic Section

Function of arithmetic section is to perform arithmetic operations like addition, subtraction, multiplication, and division. All complex operations are done by making repetitive use of the above operations.

Logic Section

Function of logic section is to perform logic operations such as comparing, selecting, matching, and merging of data.

Cache Memory:-

Cache Memory is a special very high-speed memory. It is used to speed up and synchronizing with high-speed CPU. Cache memory is costlier than main memory or disk memory but economical than CPU registers. Cache memory is an extremely fast memory type that acts as a buffer between RAM and the CPU. It holds frequently requested data and instructions so that they are immediately available to the CPU when needed.
Cache memory is used to reduce the average time to access data from the Main memory. The cache is a smaller and faster memory which stores copies of the data from frequently used main memory locations. There are various different independent caches in a CPU, which store instructions and data.

Levels of memory:

- **Level 1 or Register –**
  It is a type of memory in which data is stored and accepted that are immediately stored in CPU. Most commonly used register is accumulator, Program counter, address register etc.
- **Level 2 or Cache memory –**
  It is the fastest memory which has faster access time where data is temporarily stored for faster access.
- **Level 3 or Main Memory –**
  It is memory on which computer works currently. It is small in size and once power is off data no longer stays in this memory.
- **Level 4 or Secondary Memory –**
  It is external memory which is not as fast as main memory but data stays permanently in this memory.

Registers:-

Registers are a type of computer memory used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU. The registers used by the CPU are often termed as Processor registers.

A processor register may hold an instruction, a storage address, or any data (such as bit sequence or individual characters).

The computer needs processor registers for manipulating data and a register for holding a memory address. The register holding the memory location is used to calculate the address of the next instruction after the execution of the current instruction is completed.

SECONDARY MEMORY

Secondary memory is where programs and data are kept on a long-term basis. The different secondary memory devices are

Hard disk

Magnetic tape

CD-ROM

DVD-ROM

Blu-ray disc

Flash Memory

The obsoleted floppy disk

The Hard disk

When you save data or install programs on your computer, the information is typically written to your hard disk. The hard disk is a spindle of magnetic disks, called platters, that record and store information. Because the data is stored magnetically, information recorded to the hard disk remains intact after you turn your computer off. This is an important distinction between the hard disk and RAM, or memory, which is reset when the computer's power is turned off.

The hard disk is housed inside the hard drive, which reads and writes data to the disk. The hard drive also transmits data back and forth between the CPU and the disk. When you save data on your hard disk, the hard drive has to write thousands, if not millions, of ones and zeros to the hard disk. It is an amazing process to think about, but may also be a good incentive to keep a backup of your data.

Magnetic Tape:

Magnetic tape is a type of physical storage media for different kinds of data. It is considered an analog solution, in contrast to more recent types of storage media, such as solid state disk (SSD) drives. Magnetic tape has been a major vehicle for audio and binary data storage for several decades, and is still part of data storage for some systems

Originally, magnetic tape was designed to record sound. In computing, it holds binary data. In recent years, magnetic tape devices have become more scarce with the emergence of digital imaging and audiovisual media storage.

Magnetic tape was used in many of the larger and less complex mainframe computers that predated today’s personal computers (PC).

One use of magnetic tape that still exists is tape vaulting for the storage of physical records. In this process, technicians and other professionals back up digital data to magnetic tape to secure it in physical vaults as a redundant strategy in the event of disasters or other emergencies.

Optical disk: The CD-ROM,DVD-ROM and Blu-Ray Disk:-

CD-ROM Stands for "Compact Disc Read-Only Memory." A CD-ROM is a CD that can be read by a computer with an optical drive. The "ROM" part of the term means the data on the disc is "read-only," or cannot be altered or erased. Because of this feature and their large capacity, CD-ROMs are a great media format for retail software. The first CD-ROMs could hold about 600 MB of data, but now they can hold up to 700 MB. CD-ROMs share the same technology as audio CDs, but they are formatted differently, allowing them to store many types of data.

DVD-ROM Digital versatile disc-read only memory (DVD-ROM) is a read-only digital versatile disc (DVD) commonly used for storing large software applications. It is similar to a compact disk-read only memory (CD-ROM) but has a larger capacity. A DVD-ROM stores around 4.38 GB of data.

Blu-Ray Disk Blu-ray is an optical disc format such as CD and DVD. It was developed for recording and playing back high-definition (HD) video and for storing large amounts of data. While a CD can hold 700 MB of data and a basic DVD can hold 4.7 GB of data, a single Blu-ray disc can hold up to 25 GB of data. Even a double sided, dual layer DVD (which are not common) can only hold 17 GB of data. Dual-layer Blu-ray discs will be able to store 50 GB of data. That is equivalent to 4 hours of HDTV.

Flash Memory:

Flash memory is a non-volatile memory chip used for storage and for transfering data between a personal computer (PC) and digital devices. It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.

Flash memory is a type of electronically erasable programmable read only memory (EEPROM), but may also be a standalone memory storage device such as a USB drive. EEPROM is a type of data memory device using an electronic device to erase or write digital data. Flash memory is a distinct type of EEPROM, which is programmed and erased in large blocks.

Floppy Diskette:

Alternatively referred to as a **floppy** or **floppy disk**, a **floppy diskette** is a type of storage media , capable of storing electronic data, like a computer file. The floppy diskette was first created in 1967 by IBM as an alternative to buying hard drives , which were extremely expensive at the time. A 3.5" floppy diskette, which was one of the most commonly used floppydiskettes, capable of storing 1.44 MB of data.

Early computers did not have **CD-ROM** drives or USB , and floppy disks were the only way to install a new program onto a computer or backup your information. If the program was small

(less than 1.44 MB for the 3.5" floppy disk) the program could be installed from one floppy disk. However, since most programs were larger than 1.44 MB, most programs required multiple floppy diskettes.

PORTS AND CONNECTORS :

Universal Serial Bus (USB) : The universal serial bus (USB) is so common connector which enables us to add different types of peripherals to computers. USB is an industry-standard connector and it can carry both data and power for example we connect our smart phones to computer through a USB cable which enables it to transfer data as well as power to charge it.

There are different generations and speeds of USB like USB 2.0, USB 3.x and their types.

Serial Port : The serial port is a type of connection on PCs that is used for peripherals such as mice, gaming controllers, modems, and older printers. It is sometimes called a COM port or an RS-232 port, which is its technical name.

Parallel Port: A parallel port is an external interface commonly found on PCs from the early 1980s to early 2000s. It was used to connect peripheral devices such as printers and external storage devices. It was eventually superseded by USB, which provides a smaller connection and significantly faster data transfer rates.

Video Graphics Array (VGA) Port: It is the standard monitor or display interface used in most PCs. Therefore, if a monitor is VGA-compatible, it should work with most new computers. The VGA standard was originally developed by IBM in 1987 and allowed for a display resolution of 640x480 pixels. Since then, many revisions of the standard have been introduced. The most common is Super VGA (SVGA), which allows for resolutions greater than 640x480, such as 800x600 or 1024x768. A standard VGA connection has 15 pins and is shaped like a trapezoid.\

RJ45 Port: RJ45 is a type of connector commonly used for Ethernet networking. It looks similar to a telephone jack, but is slightly wider. Since Ethernet cables have an RJ45 connector on each end, Ethernet cables are sometimes also called RJ45 cables.The "RJ" in RJ45 stands for "registered jack," since it is a standardized networking interface. The "45" simply refers to the number of the interface standard.

PS/2 Port: The PS/2 port has six pins and is roughly circular in shape. Since each PS/2 port is designed to accept a specific input, the keyboard and mouse connections are typically color-coded. For example, the keyboard port on the back of the computer is often purple, while the mouse port is usually green. Similarly, the connector on the end of the keyboard cord is purple and the mouse cord connector is green.

High Definition Multimedia Interface (HDMI): HDMI is a trademark and brand name for a digital interface used to transmit audio and video data in a single cable. It is supported by modern audio/video equipment, such as 4K televisions, HDTVs, audio receivers,DVD and Blu-Ray players, cable boxes, and video game consoles. While other types of A/V connections

require separate cables for audio and video data, a single HDMI cable carries the audio and video streams together, eliminating cable clutter

INPUT DEVICES:

The Keyboard: A keyboard is defined as the set of typewriter-like keys that enables you to enter data into a computer or other devices. Computer keyboards are similar to electric-typewriters but contain additional typing keys. The standard selection of keys can be classified as Alphanumeric keys, Punctution keys and special keys. The standard layout of letters, numbers, and punctuation is known as QWERTY because the first six typing keys on the top row of letters spell QWERTY. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and was actually designed to slow typists down to avoid jamming the keys on mechanical units.

Pointing Devices: A pointing device, or sometimes called a pointing tool, is a hardware input device that allows the user to move the mouse cursor in a computer program or GUI operating system. Using a pointing device, you can point at or manipulate any object or text on the screen. For example, using a pointing device you could point at and select an icon from a list of icons.

The Scanner: A scanner is an input device that scans documents such as photographs and pages of text. When a document is scanned, it is converted into a digital format. This creates an electronic version of the document that can be viewed and edited on a computer.

OUTPUT DEVICES:

The Monitor: A computer monitor is an output device that displays information in pictorial form. A monitor usually comprises the visual display, circuitry, casing, and power supply. The display device in modern monitors is typically a thin film transistor liquid crystal display (TFT-LCD) with LED backlighting having replaced cold-cathode fluorescent lamp (CCFL) backlighting. Older monitors used a cathode ray tube (CRT). Monitors areconnected to the computer via VGA, Digital Visual Interface (DVI), HDMI, DisplayPort, Thunderbolt, low-voltage differential signaling (LVDS) or other proprietary connectors and signals.

Impact Printers: An impact printer is a type of printer that operates by striking a metal or plastic head against an ink ribbon. The ink ribbon is pressed against the paper, marking the page with the appropriate character , dot, line, or symbol.

Dot matrix Printer: A dot matrix printer (DMP) is a type of printer which uses pins impacting an ink ribbon to print. These printers are generally considered outdated, as they cannot create high-quality prints and are costly as well. they can be used to print multiple copies of text at the same time with the help of carbon copying. Therefore, they are mostly used in places where multipart forms are required. In a dot matrix printer, the characters and letters are formed by a matrix of dots. A print head, which has many pins in it, moves in the required direction and strikes against a cloth ribbon which is soaked in ink, making a mark on the paper. The dots are spaced closely in a particular shape to make the intended character. This looks quite similar to

the printing mechanism of typewriters and daisy wheel printers. However, dot matrix printers are different in the sense that many different characters and graphics can be printed. A character printed by a DMP is actually an accumulation of many such dots on a small area of the paper.

Daisy Wheel Printer: A type of printer that produces letter-quality type. A daisy-wheel printer works on the same principle as a ball-head typewriter. The daisy wheel is a disk made of plastic or metal on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a hammer strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. You can change the daisy wheel to print different fonts. Daisy-wheel printers cannot print graphics , and in general they are noisy and slow, printing from 10 to about 75 characters per second.

Line Printer: A line printer is an impact printer which makes use of a continuous feed of paper and prints one line of text at a time. A line printer is also known as a bar printer. High speed is one of the advantages of line printers. Compared to other printers, they are low in cost and more durable. The consumables of line printers are less harmful to the environment and are less costly as well. The print quality is mostly low and they cannot print graphics. Line printers are very noisy while operating and may need soundproofing.

Non-Impact Printers: These address the drawbacks of Impact printers. The Non-impact printers are generally much quieter than impact printers and produce documents of high resolution.

Laser Printer: The printers laser beams your print onto a metal cylinder called a drum. Using static electricity, the drum attracts powdered toner from its cartridge to the drum. The drum rolls the toner onto the paper in the form of your print. The toner is melted onto the paper by heat from a fuser as it passes underneath. Your print comes out of the printer

Inkjet Printer: At the heart of an ink jet printer are a large number of high-precision microscopic nozzles which eject ink onto the paper. These nozzles are typically about 10 micrometers in diameter (roughly 1/10th of the diameter of a human hair). It is not unusual for a home ink jet printer to contain thousands of nozzles in all, several hundred for each color of ink. The diameter of each of these nozzles is fabricated with sub-micrometer accuracy to achieve consistent and uniform ink drop volume, which is essential for consistent and uniform color density on the page. For each color of ink, all of the nozzles on the carriage are typically formed in a single fabrication step to precisely control their relative positions, which is important to achieve uniform print without banding. In some cases, all of the nozzles for every color of ink are formed together in a single step. The nozzles are all formed as orifices through a single planar sheet of a material. This material is selected for its compatibility with the particular fabrication method chosen. The ink jet nozzles are all mounted together on a moving carriage assembly that moves at high velocity (typically > 1 meter per second) back and forth across the paper. The nozzles are mounted about 1 mm from the paper, and ink ejection

velocities are in the range of 5 to 10 meters per second. Ink is ejected from a nozzle by applying a pulse of pressure to the fluid ink in the supply tube, upstream of that nozzle

Plotters: A plotter is a printer designed for printing vector graphics. Instead of printing individual dots on the paper, plotters draw continuous lines. This makes plotters ideal for printing architectural blueprints, engineering designs, and other CAD drawings. There are two main types of plotters – drum and flatbed plotters. Drum plotters (also called roller plotters) spin the paper back and forth on a cylindrical drum while the ink pens move left and right. By combining these two directions, lines can be drawn in any direction. Flatbed plotters have a large horizontal surface on which the paper is placed. A traveling bar draws lines on the paper as it moves across the surface.

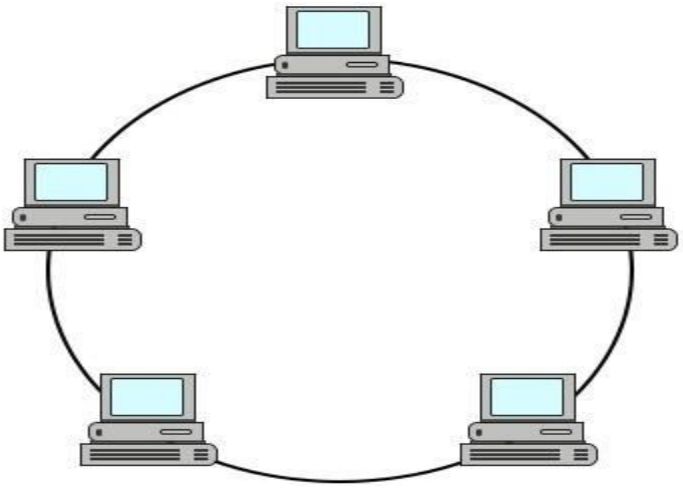
Most drum and flatbed plotters provide output sizes that are much larger than standardinkjet and laser printer. The length of a document printed by a drum plotter is only limited by the size of the paper. Documents printed by flatbed plotters are constrained to the length and width of the printing surface.

Network Topology: Network topology refers to the physical or logical layout of a network. It defines the way different nodes are placed and interconnected with each other. Alternately, network topology may describe how the data is transferred between these nodes.

Star Topology: A star topology is a topology for a Local Area Network (LAN) in which all nodes are individually connected to a central connection point, like a hub or a switch.

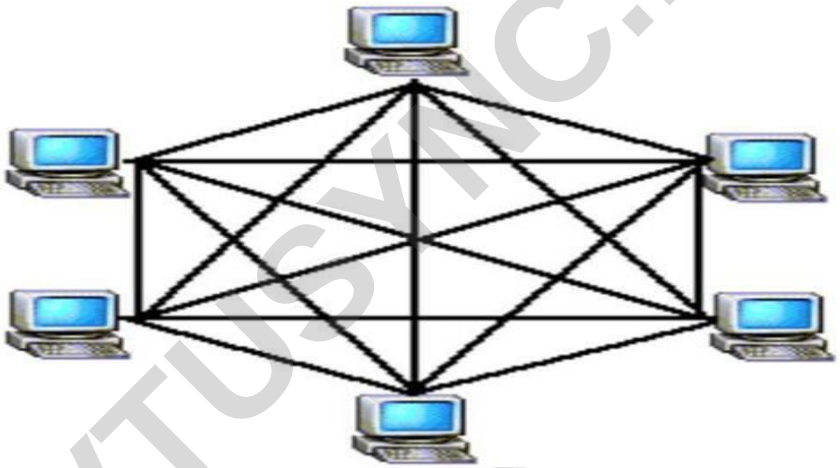
Star Topology

Token Ring topology: A ring network is a network topology in which each node connects to exactly two other nodes, forming a single continuous pathway for signals through each node in a ring. Data travels from node to node, with each node along the way handling every packet.



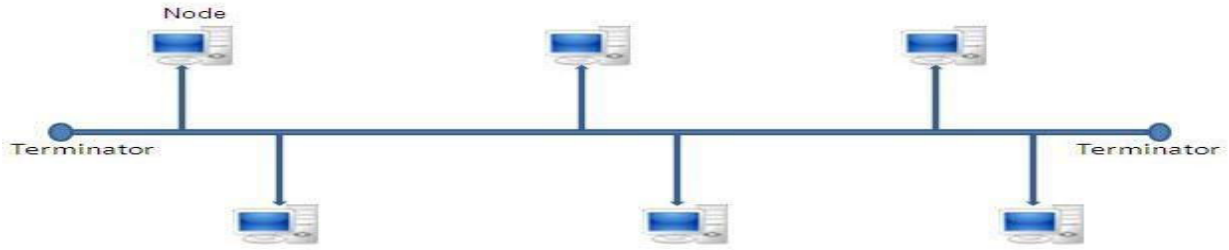
Ring Topology

• **Mesh topology:** A network setup where each computer and network device is interconnected with one another, allowing for most transmissions to be distributed even if one of the connections go down. It is a topology commonly used for wireless networks.



MeshTopology

Bus topology: A bus topology is a topology for a Local Area Network (LAN) in which all the nodes are connected to a single cable. The cable to which the nodes connect is called a "backbone". If the backbone is broken, the entire segment fails.



Bus Topology

Network Types: Networks types are broadly classified into

1. Local Area Networks(LAN) :- is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building.

2. Wide Area Networks(WAN) :- is a telecommunications network or computer network that extends over a large geographical distance/place. Wide area networks are often established with leased telecommunication circuits.

3. Metropolitan Area Networks(MAN) :- is a computer network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term MAN is applied to the interconnection of networks in a city into a single larger network which may then also offer efficient connection to a wide area network.

Internet and Intranet

Internet is a worldwide/global system of interconnected computer networks. It uses the standard Internet Protocol (TCP/IP). Every computer in Internet is identified by a unique IP address. IP Address is a unique set of numbers which identifies a computer's location. A special computer DNS (Domain Name Server) is used to provide a name to the IP Address so that the user can locate a computer by a name.

Intranet is the system in which multiple PCs are connected to each other. PCs in intranet are not available to the world outside the intranet. Usually each organization has its own Intranet network and members/employees of that organization can access the computers in their intranet. Each computer in Intranet is also identified by an IP Address which is unique among the computers in that Intranet.

NETWORK HARDWARE:

Network Interface Card (NIC): A Network Interface Card (NIC) is a computer hardware component that allows a computer to connect to a network. NICs may be used for both wired and wireless connections. A NIC is also known as a network interface controller (NIC), network interface controller card, expansion card, computer circuit board, network card, LAN card, network adapter or network adapter card (NAC)

Hub and Switch: Hub is a networking devices which is used to transmit the signal to each port (except one port) to respond from which the signal was received. Hub is operated on Physical layer. In this packet filtering is not available. It is of two types: Active Hub, Passive Hub

Switch is a network device which is used to enable the connection establishment and connection termination on the basis of need. Switch is operated on Data link layer. In this

packet filtering is available. It is type of full duplex transmission mode and it is also called efficient bridge.

Bridge and Router: Bridge is a network device, which works in data link layer. Through bridge, data or information is store and sent in the form of packet. Whereas **Router** is also a network device which works in network layer. Through router, data or information is store and sent in the form of packet.

SOFTWARE BASICS:

Software, instructions that tell a computer what to do. Software comprises the entire set of programs, procedures, and routines associated with the operation of a computer system. The term was coined to differentiate these instructions from hardware—*i.e.,* the physical components of a computer system. A set of instructions that directs a computer's hardware to perform a task is called a program, or software program.

Software is broadly classified into two types

1. System Software

2. Application Software

System Software: System software refers to the files and programs that make up your computer's operating system. System files include libraries of functions, system services, drivers for printers and other hardware, system preferences, and other configuration files. The programs that are part of the system software include assemblers, compilers, file management tools, system utilities, and debuggers.

Types of System Software:

- **Basic Input Output System (BIOS):** is the program a personal computer's microprocessor uses to get the computer system started after you turn it on.
- **Operating System:** An operating system, or "OS," is software that communicates with the hardware and allows other programs to run. It is comprised of system software, or the fundamental files your computer needs to boot up and function.
- **Device Driver:** A device driver is a special kind of software program that controls a specific hardware device attached to a computer. Device drivers are essential for a computer to work properly.
- **Compilers and associated programs:** A compiler is a special program that processes statements written in a particular programming language and turns them into machine language or "code" that a computer's processor uses.

Application Software: An application is any program, or group of programs, that is designed for the end user.

Types of Application Software:

- **Office Software:** An office suite is a collection of applications bundled together, intended to be used by knowledge workers in an organization. It is used to simplify tasks and processes of office workers and increase their productivity. An office suite is also known as an office application suite or office productivity software
- **Database Software:** Database software is the phrase used to describe any software that is designed for creating databases and managing the information stored in them. Sometimes referred to as database management systems (DBMS), database software tools are primarily used for storing, modifying, extracting, and searching for information within a database.
- **Communications Software:** Communication software is an application or program designed to pass information from one system to another. Such software provides remote access to systems and transmits files in a multitude of formats between computers.
- **Entertainment Software:** Home entertainment on the PC has also seen the rise of software related to gaming and multimedia. The Video LAN (VLC) software serves as a one stop shop for playing most audio and video formats. Gaming software remains extremely popular and challenging for software developers.
- **Antivirus software:** Antivirus software is a type of utility used for scanning and removing viruses from your computer. While many types of antivirus (or "anti-virus") programs exist, their primary purpose is to protect computers from viruses and remove any viruses that are found.
- **Special-purpose software:** Apart from general purpose software mentioned previously, application software are also available for desktop publishing, computer aided design/manufacturing (CAD/CAM).

System Software Vs Application Software

System Software	Application Software
System software is used for operating computer hardware.	Application software is used by user to perform specific task.
System softwares are installed on the computer when operating system is installed.	Application softwares are installed according to user's requirements.
In general, the user does not interact with system software because it works in the background.	In general, the user interacts with application softwares.
System software can run independently. It provides platform for running application softwares.	Application software can't run independently. They can't run without the presence of system software.
Some examples of system softwares are compiler, assembler, debugger, driver, etc.	Some examples of application softwares are word processor, web browser, media player, etc.

Problem solving techniques:

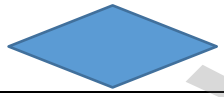
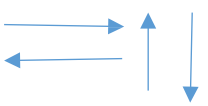
Pseudocode: is a detailed yet readable description of what a computer program must do, expressed in a formally-styled natural language rather than in a programming language. Pseudocode is sometimes used as a detailed step in the process of developing a program. It allows designers or lead programmers to express the design in great detail and provides programmers a detailed template for the next step of writing code in a specific programming language.

Algorithm: In its purest sense, an algorithm is a mathematical process to solve a problem using a finite number of steps. In the world of computers, an algorithm is the set of instructions that defines not just what needs to be done but how to do it. In an algorithm,

- Each step should be numbered in a hierarchical manner,
- Every step must be complete, unambiguous and error free

Flow Chart: A flowchart is a diagram that describes a process or operation. It includes multiple steps, which the process "flows" through from start to finish. Common uses for flowcharts include developing business plans, defining troubleshooting steps, and designing mathematical algorithms.

Basic flow chart symbols:

Symbol	Geometric Name	Description
	Oval	Represents Terminals (start and stop)
	Rectangle	Represents, initialization, computation and process steps
	parallelogram	Represents input and output operations
	Rhombus	Represents decision making conditions
	Hexagon	Represents looping conditions
	Circle	Off page flow connector.
	Double-ended Rectangle	Represents function call and definition i.e. operations which are more fully described in a separate flowchart.
	Arrows	Represents flowchart direction and connects various components of the flow chart.

Example:

1. Design an algorithm and flowchart to find sum of two numbers

Algorithm:-

Step 1: Start

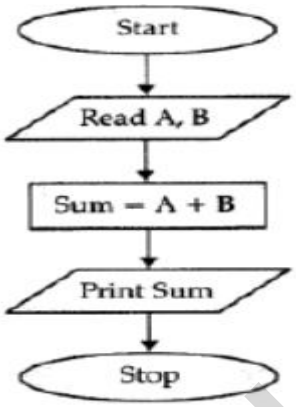
Step 2: Read a,b

Step 3: sum←a+b

Step 4 : Print "sum"

Step 5: Stop

Flowchart:-



Example:

2. Design an algorithm and flowchart to find area and circumference of circle

Algorithm:-

Step 1: Start

Step 2: Read r

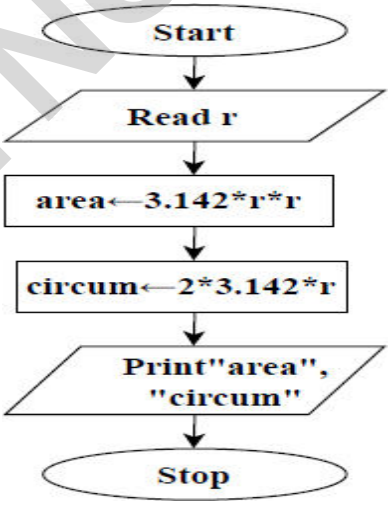
Step 3: area←3.142*r*r

Step 4: circum←2*3.142*r

Step 5: Print "area,circum"

Step 6: Stop

Flowchart:-



Example:

3. Design an algorithm and flowchart to compute simple interest

Algorithm:-

Step 1: Start

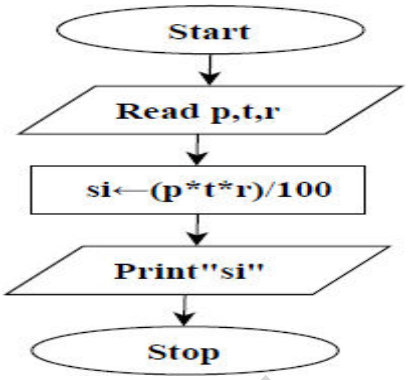
Step 2: Read p,t,r

Step 3: si←(p*t*r)/100

Step 4 : Print "si"

Step 5: Stop

Flowchart:-



HISTORY OF C

C is a general purpose, procedural, structured computer programming language developed by **Dennis Ritchie** in the year 1972 at AT&T Bell Labs.
C language was developed on UNIX and was invented to write UNIX system software.
C is a successor of B language.
There are different C standards: K&R C std, ANSI C, ISO C.

Characteristics of C:

- C is easy to learn.
- C is a general purpose language.
- C is a structured and procedural language.
- It is portable.
- It can extend itself

Examples of C:

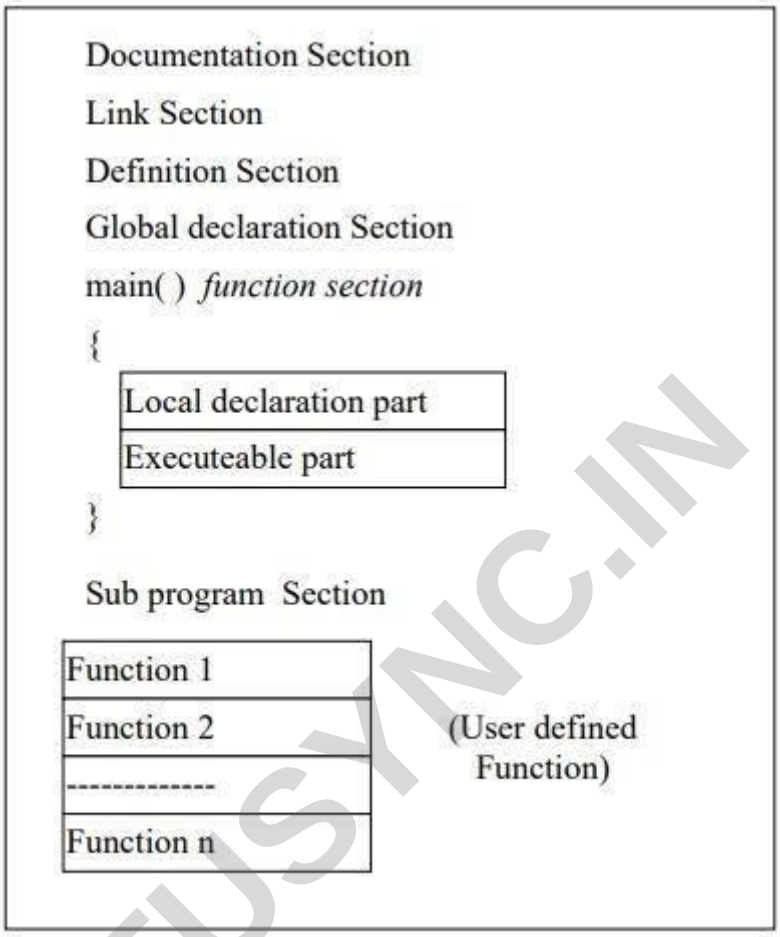
- Operating system
- Language compilers
- Assemblers
- Text editors
- Databases

C Character Set:
A C character set defines the valid characters that can be used in a source program. The basic C character set are:

1. Letters: Uppercase: A, B, C, ……, Z Lowercase: a, b, c ……, z
2. Digits: 0, 1, 2,….., 9
3. Special characters:! , . # $ (,), }, { etc.

4. White spaces: Blank space, Horizontal tab space, carriage return, new line character, form feed character.

Basic structure of C Program



Structure of C Program

Every c program is made up of one or more pre-processor commands, global declarations, and one or more functions.

Documentation section :consists of a set of comment line giving the name of the program, the author, and other details. Compiler ignores these comments when it translates the program into executable code. C uses 2 different formats

1. Block comments /*this is multi line comments*/
2. Line comments //this is single line comments

The Link section: provides instruction to the compiler to link functions from system library. This Section is also called as pre-processor Statements.

The definition section: defines all symbolic constants

Global Declaration section: there are some variables that are used in more than on function, such a variable are called global variable and are declared in the global declaration section that is outside of all functions. This section also defines user defined functions.

Every C program must have one **main () function section**. This section contains two parts declaration part and executable part
Declaration part declares all the variables used in the executable part
There is at least one statement in an executable part. These two part must appear at the beginning of the brace and ends at the closing brace. All statement in the declaration and executable part ends with semicolon (;).

The sub program section: contains all the user defined functions that are called in the main function although they appear in any order.

Here is a small program that displays a sentence "Welcome to C Programming for Problem solving" on the monitor screen:

```
/* C program to display a welcome message */
#include<stdio.h>
void main( )

{
        printf("Welcome to C Programming for Problem solving");
}
```

This program doesn't have all the parts of typical C program.
The first line begins with /* and ending with */ is the comment line which is used to enhance program readability and understanding.
The second line it has pre-processor directive #include which includes a header file stdio.h, the standard input /output header file. The definitions of printf and scanf functions are defined in this header file. Hence this line is always necessary.
The third line is main(), this is the special function used by C system to tell where the program starts. Every program have exactly one main function. The empty pair of parenthesis following main indicates that main has no arguments. Void indicates that main function does not return any value to operating system. By default main returns integer value to operating system.
The opening brace "}" in the 4th line marks the beginning of the function main and closing brace "}" at the last line indicates the end of the function.
All the statements between these braces form the function body. The function body contains set of instruction to perform the given task.
In this program the function body contains only one executable statement printf. The printf is a predefined function for printing output. It prints everything within the double quote. In this it will print **Welcome to C Programming for Problem solving** on the monitor

C Tokens: In C program the smallest logically meaning full individual units are known as c tokens. These are also called as the basic building blocks of C program which cannot be further broken into subparts. C has 6 Different types of tokens. C programs are written using these tokens and syntax of the language.

i. Keywords

ii. Identifiers

iii. Constants

iv. Strings

v. Operators

vi. Special symbols

1. Keywords: These are predefined words in C compiler which are ment for specific purpose. These words are also called as reserved words. These words cannot be used as variable names. These words are usually case sensitive and are usually written in lower case letters only. There are 32 keywords in C.

auto	break	case	char	const	continue	default	do
double	else	enum	extern	float	for	goto	if
int	long	register	return	short	signed	sizeof	static
struct	switch	typedef	union	unsigned	void	volatile	while

2. Identifiers: These are the names given to various elements of the C program like variables, functions, arrays, etc. These are user defined names and consist of sequence letters, digits or underscore.

Rules to define an Identifiers

1. The first character of the identifier must always be a letter or an underscore followed by any number of letters digits or underscore.

2. Keywords cannot be used as identifiers or variables.

3. An Identifier or a variable should not contain two consecutive underscores

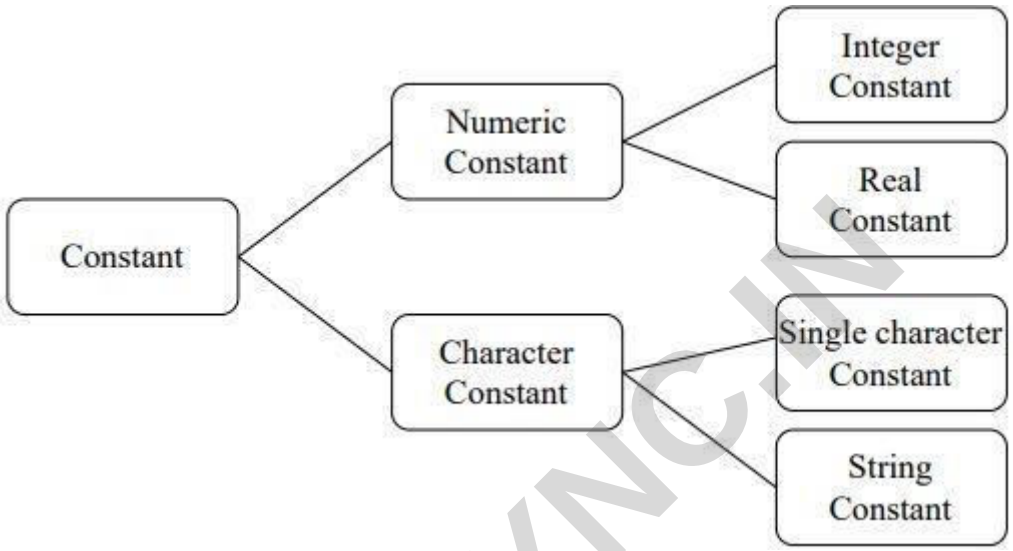
4. Whitespaces and special symbols cannot be used to name the identifiers.

5. Identifiers are case sensitive (A same variable name declared in uppercase letters and lower case letters are two different variables in C program).

Examples	
food_court	valid identifier
$num	Invalid identifier ($ is a special symbol)

_mite2021	valid identifier
mite mangalore	Invalid identifier (white spaces are not allowed)
continue	Invalid identifier (continue is a keyword)

3. Constants: These are the fixed values assigned to the variables which cannot be cannot be changed or modified in the program. Constants are broadly classified as



Numeric Constants:

Integer Constant: These contain digits or whole numbers without decimal point which can be either positive or negative.

(i) Decimal: It is an integer constant consisting of numbers from 0-9. It can be preceded by + or –

(ii) Octal: It is an integer constant consisting of numbers from 0-7. It is preceded by o

(iii) Hexadecimal: It is an integer constant consisting of numbers from 0-9, A-F (A=10, B=11, C=12, D=13, E=14, F=15). It is preceded by 0x

Real Constant: These contain an decimal point or an exponent or both. It can be either positive or negative or both.

Example: 21.5, 3.142, $6.6260X10^{-34}$, $2.15X10^{2} \rightarrow 2.15e2$

Character Constants:

Single Character Constant: can be single character enclosed within single quotes or a '\' (backslash) followed by any character. '\' is called escape character as it alters the meaning of character following it. Following are the complete list of escape sequence.

'\a'	alert (bell)character	**'\ \'**	backslash character
'\b'	backspace	**'\?'**	Question mark
'\f'	formfeed	**'\' '**	Single quote
'\n'	newline character	**'\"'**	double quotes
'\r'	carriage return	**'\ooo'**	octal number
'\t'	horizontal tab	**'\xxh'**	hexadecimal number
'\v'	vertical tab	**'\0'**	Null character

String Constant: String constants also termed as string literal are sequences of characters enclosed in double quotes. The character may be letters, numbers, special characters and blank space. a String literal always ends with a Null character (**'\0'**)
Example:

M	I	T	E	**'\0'**

5. Operators: An operator is a symbol that tells the compiler to perform specific mathematical and logical functions. The different operators supported in 'C' are:
(i) Arithmetic Operators
(ii) Relational Operators
(iii) Logical Operators
(iv) Assignment Operators
(v) Bitwise Operators
(vi) Unary Operators→ Increment and Decrement
(vii) Ternary/ Conditional Operator
(viii) Special Operators

(i) Arithmetic Operators: These operators are used to perform basic arithmetic operations

Operator	Name	Result	Syntax	Example (b=5, c=2)
+	Addition	Sum	a = b + c	a = 7
-	Subtraction	Difference	a = b - c	a = 3
*	Multiplication	Product	a = b * c	a = 10
/	Division	Quotient	a = b / c	a = 2
%	Modulus	Remainder	a = b % c	a = 1

(ii) Relational Operators: This operator compares two operands inorder to find out the relation between them. The output will be either 0 (False) or 1 (True).

Operator	Name	Syntax	Example (b=5, c=2)
<	Lesser than	a = b < c	a = 0 (False)
>	Greater than	a = b > c	a = 1 (True)
<=	Lesser than or Equal to	a = b <= c	a = 0 (False)
>=	Greater than or Equal to	a = b >= c	a = 1 (True)
= =	Equal to	a = b = = c	a = 0 (False)
!=	Not equal to	a = b!= c	a = 1 (True)

(iii) Logical Operators: These are used to test more than one condition and make decision. The different logical operators are:

- Logical NOT
- Logical AND
- Logical OR

- **Logical NOT (!)** The *output is true* when *input is false* and vice versa. It accepts only one input.

Input	Output
X	**!X**
0	1
1	0

- **Logical AND (&&)** The *output is true* only if *both inputs are true*. It accepts two or more inputs.

Input		Output
X	**Y**	**X && Y**
0	0	0
0	1	0
1	0	0
1	1	1

- **Logical OR (||)** The *output is true* only if *any of its input is true*. It accepts two or more inputs.

Input		Output
X	**Y**	**X || Y**
0	0	0
0	1	1
1	0	1
1	1	1

(iv) Assignment Operators: The assignment operator is used to assign the values to the variables on the left hand side. The symbol "=" is used as an assignment operator.

Example: **x = 10**, **c = a+b**

Shorthand Assignment: An expression can be written in a compact manner i.e. if the operand on the left hand side of the assignment operator is same as the first operand of the right hand side expression it can be written using the shorthand assignment operator

Example: x = x+2 → **x+=2**

Multiple Assignment: If more than one variable holds the same value we can use multiple assignment to avoid rewriting of the same values repeatedly.

Example: a=10,b=10,c=10 → **a=b=c=10**

(v) Bitwise Operators:

These works on bits and performs bit by bit operations. The different types of bitwise operators are:

Bitwise NOT (~) Bitwise AND (**&**)

Bitwise OR (|)

Bitwise XOR (^) → Output is True when odd number of 1's are present.

Bitwise left shift (**<<**) Bitwise right shift (**>>**)

Bitwise NOT (~)

X	~X
0	1
1	0

Bitwise AND (&), Bitwise OR (|),Bitwise XOR (^)

X	Y	X & Y	X | Y	X ^ Y
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

Bitwise Left Shift (<<): Shift specified number of bits to left side

X	0	1	0	0	0	1	1	0
X<<2	0	0	0	1	1	0	0	0

Bitwise Right Shift (>>): Shift specified number of bits to right side.

X	0	1	0	0	0	1	1	0
X>>2	0	0	0	1	0	0	0	1

(vi) Unary Operators:

Unary Plus Operator Unary Minus Operator

Increment (++) Decrement (--)

Unary Plus and Unary Minus Operator : These operators are used to determine the sign of the operand the only unary operators are + and –

Increment (++): An increment operator adds one to the operand. The types of increment are Pre increment and Post increment

Pre increment: The increment operator followed by an operand is called Pre increment operator here the value on the right hand side is first incremented by one and then the value is assigned to the variable at the left.

Example: If a=8, b= ++a what will be the value of a and b?

Since ++a is a pre increment operator first the value of a is incremented by 1 hence the new value of **a=9** now this new value is assigned to the variable b i.e. **b=9** Therefore **a=9** and **b=9**

Post increment: An Operand followed by an increment operator is called post increment operator here the value is first assigned to the variable at the left and then the value of the variable in the right will be incremented by 1

Example: If q=6, p= q++ what will be the value of p and q?

Since q++ is a post increment operator first the value of q is assigned to the variable p i.e. **p=6** now the value of q is incremented by 1 hence the new value of **q=7**, this new value of q will be used for the upcoming iteration Therefore **p=6** and **q=7**

Decrement (--): A decrement operator subtracts 1 from the operand. The types of increment are Pre decrement and Post decrement

Pre decrement: The decrement operator followed by an operand is called Pre decrement operator here the value on the right hand side is first decremented by one and then the value is assigned to the variable at the left.

Example: If y=4, x= --y what will be the value of x and y?

Since --y is a pre decrement operator first the value of y is decremented by 1 hence the new value of **y=3** now this new value is assigned to the variable x i.e. **x=3** Therefore **x=3** and **y=3**

Post decrement: An Operand followed by an decrement operator is called post decrement operator here the value is first assigned to the variable at the left and then the value of the variable in the right will be decremented by 1

Example: If n=5, m= n-- what will be the value of m and n?

Since n-- is a post decrement operator first the value of n is assigned to the variable m i.e. **m=5** now the value of n is decremented by 1 hence the new value of **n=4**, this new value of n will be used for the upcoming iteration Therefore **m=5** and **n=4**

(vii) Ternary/ Conditional Operator: It takes three arguments
Expression1 ? Expression2 : Expression3
Where,
Expression1→ Condition
Expression2→ Statement followed if condition is true
Expression3→ Statement followed if condition is false
Example:
large = (4 > 2) ? 4: 2 →large = 4

(viii) Special Operators:
Comma Operator: It can be used as operator in expression and as separator in declaring variables.

sizeof() operator: It is used to determine the size of variable or value in bytes.

Address Operator: It is used to find the address of the operators

Data Types: These are the keywords that are used to assign the type of a variable based on the type of data stored in it. Data types are used to

- ❖ Identify the type of variable when it is used
- ❖ Identify the type of return value of the function
- ❖ Identify the type of parameter expected by the function

The data types are broadly classified into 3 types
I. Primary or built-in or primitive data type
II. Derived data type
III. User defined data type

I. Primary or built-in or primitive data type: These are the data types which are already predefined by the compiler.
(i) Integer data type: It is used to store whole numbers and its range depends on the word length defined for a computer. It usually occupies 2 bytes of memory, for signed integers the value ranges from -2^{n-1} to $+2^{n-1}-1$ and for unsigned integers the value ranges from 0 to 2^n-1. Keyword **int** is used to declare variables of integer data type.

(ii) Floating point data type: It is used to store decimal numbers that have single precision floating point value. It provides 6 digits after the decimal point and occupies 4 bytes of memory. Keyword **float** is used to declare variables of floating point data type.

(iii) Double data type: These are used to store real numbers that have double precision floating point value. It provides 16 digits after the decimal point. this data type is used when performing complex calculations to get accurate results. It occupies 8 bytes of memory. Keyword **double** is used to store the variables of double data type.

(iv) Char data type: This data type basically stores character type of data. the character data can be an Alphabet [a to z or A to Z] , digits [0 to 9] and all special characters or symbols[@,$,&,#,...]which is enclosed with in single quotes. It occupies one byte of memory. Keyword **char** is used to declare variables of character data type.

(v) Void data type: It does not store any value hence we cannot store any operation on the variable declared as void. It has no range. Keyword **void** is used to specify non return data type.

Type	Data type	Size (Bytes)	Range
Character	char	1	Signed: -128 to +127
			Unsigned: 0 to 255
Integer	int	2	Signed -32768 to +32767
			Unsigned 0 to 65535
Floating point or real	float	4	$3.4e^{-38}$ to $3.4e^{+38}$
Double precision floating point	double	8	$1.7e^{-308}$ to $1.7e^{+308}$
Non specific	void	0	-

II. Derived data type: These are the data types which are derived from the primitive data types. There are mainly three derived data types
(i) Arrays: Sequence of data items having homogeneous values.

(ii) References: Function pointers allow referencing with a particular signature.

(iii) Pointers: These are used to access the memory and deal with their addresses

III. User defined data type: The type definition feature of C allows the user to define an identifier which acts as data type using an existing basic data type. Such identifier is called as user defined data types.
(i) Structure: It is a package of variable of different types under a single name. **struct** keyword is used to define a structure.

(ii) UNION: This allows storing various data types in the same memory locations.

(iii) ENUM: Enumeration is a special data type that consists of integral constants and each of them is assigned with a specific name. **enum** keyword is used to create the enumerated data type.

Data type Qualifiers and Data type Modifiers

Data type Qualifiers: American National Standard Institute (ANSI) introduced two types of data type qualifiers

const: The value of the variable is constant during execution of the program. Such variables are declared using keyword "const".

Example: const float pi = 3.142

volatile: The value of a variable might change at any time by an outside factor such variables are declared using keyword "volatile".

Example: volatile float a; volatile int b = 10;

Data type Modifiers: Built in data types except void data type can easily be modified by using data type modifier. There are mainly 4 data type modifiers:

(i) Signed (ii) Unsigned (iii) Long (iv) Short

(i) Signed: it indicates that the variable is capable of storing the negative numbers. The values will be in this range. -2^{n-1} to $+2^{n-1}-1$. Where, n is the size of the particular data type in bits. In declaration we have to use signed keyword. Example: signed int a;

(ii) Unsigned: it indicates that the variable is capable of storing only positive numbers The values will be in this range. 0 to $2^{n}-1$. Where, n is the size of the particular data type in bits. In declaration we have to use unsigned keyword. Example: unsigned int a;

(iii) Long: It is used to increase the storage capacity of the variable. long keyword can be used as shown long int a; //long int occupies 4 bytes of memory.

(iv) Short: It is used to decrease the storage capacity of the variable (capacity is reduced to half). short keyword can be used as shown short int a; //short int occupies 1 bytes of memory.

Format Specifiers: These are used to tell the compiler about the type of data being used

Data Type	Format Specifier	Meaning
Integer (int)	%d	Decimal integer
	%o	Octal integer
	%x	Hexadecimal integer
	%i	Decimal, hex or octal int
	%u	Unsigned integer
	%h	Short integer
Floating Point (float)	%e	floating point
	%f	

	%g	
Character (char)	%c	Single character
	%s	String data
Double (double)	%lf	Floating point number or double
Long Integer	%ld	long integer value

Type Conversion: It is a process of converting an expression from one data type to another data type
There are two types:
Implicit Type conversion
Explicit Type Conversion

Implicit Type Conversion: This type of conversion is done by the compiler, so it is called as implicit type conversion. Without user intervention this process is carried out. Whenever we are converting narrow operand (lower data type variable) into wide operand (higher data type variable) then compiler will do it implicitly.
Example:

```
#include<stdio.h>
void main( )
{
        char b= 'A';
        int a;
        a=b;
        printf("%d",a);
}
```

OUTPUT: 65

Explicit Type Conversion: This type of conversion is done by the user so it is called explicit type conversion. Whenever we are converting wider operand (higher data type variable) into a narrower operand (lower data type variable) then its called explicit conversion.
Example:

```
#include<stdio.h>
void main()
{
        int  a=4;
        float b;
        b=1/(float)a;
        printf("%f",b);
}
```

OUTPUT: 0.250000

Expressions: It is combination of operands (variables, constants) and operators.
Precedence: The order in which operators are evaluated is based on the priority value.
Associativity: It is the parsing direction used to evaluate an expression. It can be left to right or right to left.
Evaluation of expressions: Expressions are evaluated using an assignment statement.
Example: variable = expression
sum = a + b

Following table provides the Precedence and Associativity of operators:

Operator	Description	Associativity	Precedence(Rank)
( ) [ ]	Function call Array element reference	Left to right	1
+ - ++ -- ! ~ * & Sizeof (type)	Unary plus Unary minus Increment Decrement Logical negation Ones complement Pointer to reference Address Size of an object Type cast (conversion)	Right to left	2
* / %	Multiplication Division Modulus	Left to right	3
+ -	Addition Subtraction	Left to right	4
<< >>	Left shift Right Shift	Left to right	5
< <= > >=	Less than Less than or equal to Greater than Greater than or equal to	Left to right	6
== |=	Equality Inequality	Left to right	7
&	Bitwise AND	Left to right	8
^	Bitwise XOR	Left to right	9
|	Bitwise OR	Left to right	10
&&	Logical AND	Left to right	11
||	Logical OR	Left to right	12
?:	Conditional expression	Right to left	13

= *= /= %= += -= &= ^= |= <<= >>=	Assignment operators	Right to left	14
,	Comma operator	Left to right	15

Examples:

1. If a=8, b=15 and c=4 calculate the expression

2 * ((a % 5) * (4 + (b – 3) / (c + 2)))

= 2 * (**(8 % 5)** * (4 + (15 – 3) / (4 + 2))) //Substitution of values

= 2 * (3 * (4 + **(15 – 3)** / (4 + 2))) //Brackets having the highest priority

= 2 * (3 * (4 +12 /**(4 + 2)**)) //inner most brackets are evaluated first

= 2 * (3 * (4 +**12 / 6**)) //Brackets having the highest priority

= 2 * (3 * **(4 + 2)**) //within the brackets **'/'** has the highest priority

= 2 * **(3 * 6)** // inner most brackets are evaluated

= **2 * 18** // Brackets having the highest priority

= 36 //**Final Result**

2. Evaluate the expression

a += b *= c -=5 , Given a=3, b=5, c=8.

a += b *= **c -=5** //Apply Associativity i.e. evaluate from right to left

a += b *= (c = **c – 5**) //Deduce the short hand Expression

a += b *= (c = **8 – 5**) //Substitute the given value of c

a += b *= **(c = 3)** //Reduce the equation to simplified form

a += **b *= 3** //Apply Associativity i.e. evaluate from right to left

a += (b = **b * 3**) //Deduce the short hand Expression

a += (b = **5 * 3**) //Substitute the given value of b

a += **(b = 15)** //Reduce the equation to simplified form

a + = 15 //Apply Associativity i.e. evaluate from right to left

a = **a + 15** // Deduce the short hand Expression

a = **3 + 15** //Substitute the given value of a

a =18 // **Final Result**

3. Evaluate the expression

100 / 20 <= 10 – 5 + 100 % 10 – 20 == 5 >= 1 != 20

→ **100 / 20** <= 10 – 5 + 100 % 10 – 20 == 5 >= 1 != 20

→ 5 <= 10 – 5 + **100 % 10** – 20 == 5 >= 1 != 20

→ 5 <= **10 – 5** + 0 – 20 == 5 >= 1 != 20

→ 5 <= **5 + 0** – 20 == 5 >= 1 != 20

→ 5 <= **5 – 20** == 5 >= 1 != 20

→ **5 <= -15** == 5 >= 1 != 20 // Simplify the relational operators

→ 0 == **5 >= 1** != 20 //True is given by 1 and false is given by 0

→ **0 == 1** != 20

→ **0 != 20**

→ 1

Writing C expressions for Mathematical Expressions

Basic Conversions

$\frac{x}{y}$ → x/y

$\sqrt{v}$ → sqrt(v)

| h | → abs(h)

g^t → pow(g,t)

e^x → exp(x)

sin x → sin (x)

sin 45° → sin ((45 * 3.142) / 180) /*converting degrees to radians*/

Write the C equivalent expressions for the following mathematical Expressions

1. A= $\frac{5x+3y}{a+b}$ → A = ((5 * x) + (3 * y)) / (a + b)

2. $C = e^{|x+y-10|}$ → C = exp (abs (x + y – 10))

3. $P = \frac{e^{\sqrt{x}}+e^{\sqrt{y}}}{xsin\sqrt{y}}$ → P = (exp (sqrt (x)) + exp (sqrt (y))) / (x * sin (sqrt (y))

4. $X = \frac{-b+\sqrt{b^2-4ac}}{2a}$ → X= ((-b) + sqrt (b * b – 4 * a * c)) / (2 * a)