Principles of Programming Using C 22pop13/23

Module-1 Introduction to Computers

Introduction

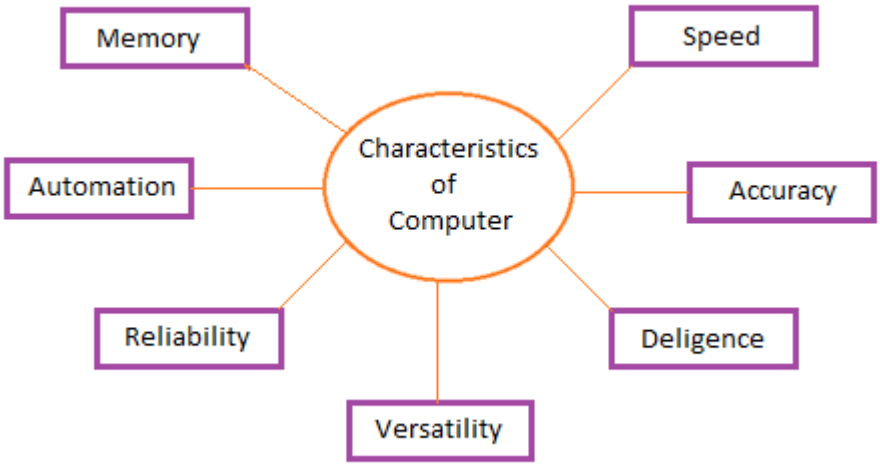
Computer is an electronic device which accepts input, processes data, stores information and produces output.

Data: Raw facts/ figures

Information: **Processed data**

Characteristics of the Computer System

The characteristics of the computer system are as follows −



Speed

A computer works with much higher speed and accuracy compared to humans while performing mathematical calculations. Computers can process millions (1,000,000) of instructions per second. The time taken by computers for their operations is microseconds and nanoseconds.

Accuracy

Computers perform calculations with 100% accuracy. Errors may occur due to data inconsistency or inaccuracy.

Diligence

A computer can perform millions of tasks or calculations with the same consistency and accuracy. It doesn't feel any fatigue or lack of concentration. Its memory also makes it superior to that of human beings

Versatility

Versatility refers to the capability of a computer to perform different kinds of works with same accuracy and efficiency.

Reliability

A computer is reliable as it gives consistent result for similar set of data i.e., if we give same set of input any number of times, we will get the same result.

Automation

Computer performs all the tasks automatically i.e. it performs tasks without manual intervention.

Memory

A computer has built-in memory called primary memory where it stores data. Secondary storage are removable devices such as CDs, pen drives, etc., which are also used to store data.

No IQ:

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 is you to decide what you want to do and in what sequence. So a computer

Storage

The Computer 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, which can be kept outside your computer and can be carried to other computers

History of Computers

Computer Generations

The computer of each generation is smaller, faster and more powerful than preceding generation. **There are five computer generations**.

Generation	Based on	Other Features
First(1942 to 1954)	Vacuum tubes	Magnetic drums for memory
Second(1955 to 1964)	Transistors	Magnetic cores, disks, punched cards and printouts
Third(1965 to 1974)	Integrated circuits(ICs)	Keyboard, monitor and operating system
Fourth(1975– till now)	Microprocessors	Networking
Fifth(**Still in Process)**	ULSI Nano technology.	Mainly unclear

First Generation: The vacuum tubes were used for computation. Magnetic drums were used for memory requirements. It consumed lot of space, power and generated lot of power. ENIAC (Electronic Numerical Integrator and Computer) used 18000 vacuum tubes, 1800 acquired sq. ft. room space and consumed 180KW of power. The machine level language (0s and 1s) was used. Punched cards were used for input and Paper for output. They were used for scientific work.

Main Features:

- Vacuum tube technology
- Unreliable and Not portable
- Supported machine language only
- Consumed lot of electricity Hence Cost is high
- Huge size and Generate lot of heat
- Slow Input/Output device

Second Generation: The transistors was the most important component which replaced vacuum tubes. Magnetic cores were used for memory. It were more reliable than first generation computer. The assembly or symbolic language was used. The input and output mechanism remained same. The stored program concept was introduced which stores both data and program.

Main Features:

- Transistor technology
- Support machine language, assembly language

- Reliable, Smaller in size, Generate less heat, consumed less electricity, fast compared to First generation.

Third Generation: The Integrated circuits(IC) was the most important component. The transistors, diodes, resistors, capacitors were integrated on a single chip. The high-level language was used like BASIC,C, C++ and JAVA. Memory capacity increased and magnetic hard disk was used for secondary generation.The third generation computers also had OS and computer could rum programs invoked by multi users.

Main Features:

- IC used
- Support high level programming languages like FORTRAN, COBAL, PASCAL, BASIC, ALGOL C, C++ and Java.
- More reliable, smaller size, generate less heat, consumed less electricity, fast compared to Second generation.
- High cost

Fourth Generation: The Microprocessor was the most important component. With the help of LSI (Large Scale Integration) and VLSI (Very Large Scale Integration) the entire CPU is on a single chip. OS have moved from MSDOS to GUI (Graphical User Interface) like windows. The networking technology has also been improved. The size was reduced and the speed was increased.

Main Features:

- VLSI Technology
- Very cheap, Portable, reliable, small size
- Networking and Internet

Fifth Generation: Artificial Intelligence and use of natural languages are the main features of this generations. These systems are expected to interact with users in natural language. Speech recognition and speech output should also be possible. Computers must be able to perform parallel processing. The quad-core and octa-core was also introduced. Neural networks and expert systems have been developed.

Main Features:

- ULSI (Ultra Large Scale Integrated circuit) technology

- Development of Artificial Intelligence
- Perform parallel processing
- User friendly interface with multimedia features
- Available at very powerful and compact computers at cheaper rate

Classification of Computers

Classification of computer based on size and speed

- Supercomputers
- Mainframes
- Minicomputers
- Microcomputers
- Smartphones and Embedded Computers

Supercomputers: These are huge machines having most powerful and fastest processors. It uses multiple CPUs for parallel data processing. Speeds are measured in flops (floating point operations per second). The fastest operates at 34 petaflops. They are used for weather forecasting, analysis of geological data. They have enormous storage, uses more power and generate lot of heat. They are used by government agencies.

Mainframes: These are multi-user machines that support many users using the feature of time sharing. It can run multiple programs even with a single CPU. The processor speed is measured in MIPS (Million instructions per second). It is used to handle data, applications related to organization and online transactions in banks, financial institutions and large corporations.

Minicomputers/Midrange computers: It was introduced by DEC (Digital Equipment Corporation). They can serve hundreds of users and are small enough to partially occupy a room. They are used in smaller organizations or a department of a large one. They are not affordable to be used in home.

Microcomputers: The microcomputer or PC is introduced by Apple and endorsed by IBM. This is a single-user machine powered by a single-chip microprocessor. They are very powerful machines having gigabytes of memory. They are both used in standalone mode and in a network. A microcomputer takes the form of desktop, notebook (laptop) or a netbook (smaller laptop). PCs today are powered by 3 types of OS – windows (7, 8 or 10), Mac OS X (Apple)

and Linux. They are used for engineering and scientific applications and for software development.

Smartphones and Embedded Computers: The smartphone is a general purpose computer i.e., capable of making phone calls. It has a powerful processor, with multiple cores, supports GBs of memory, and runs developed OS (Android or iOS). It can be operated with keyboard, touch or stylus.

Embedded Computers or micro-controllers are very small circuits containing a CPU, non-volatile memory, input and output handling facilities. They are embedded into many machines that we use – cars, washing machines, cameras etc. The processor here runs a single unmodifiable program stored in memory.

Classification of computer based on purpose

- Desktop
- Laptop
- Tablets
- Handheld (PDA-personal digital assistant)
- Smartphones and Embedded Computers

Classification of computer based on its operation and function

- Analog Computer
- Digital Computer
- Hybrid Computer

BITS, BYTES AND WORDS

- Computer can understand only two states: 0 and 1.
- A digit can have only 2 states or values known as a binary digit, abbreviated as bit(b).
- The name nibble was coined to represent four bits.
- The name byte (B) was coined to represent eight bits.
- The byte is the standard unit of measurement of computer memory, data storage and transmission speed.
- The CPU handles memory data in larger units, called words and it is usually even multiple of bytes (twobytes, four bytes etc.).
- When referred to a computer it has 32-bit (4 bytes) machine i.e., size of word is 32 bits.

Unit	Equivalent to	Remarks
1 kilobyte (KB)	1024 bytes	Space used by 10 lines of text
1 megabyte (MB)	1024 kilobytes	Memory of the earliest PCs
1 gigabyte (GB)	1024 megabytes	Storage capacity of a CD-ROM
1 terabyte (TB)	1024 gigabytes	Capacity of today's hard disks
1 petabyte (PB)	1024 terabytes	Space used for rendering of film Avatar

Applications of Computers

Computers play a role in every field of life. They are used in homes, business, educational institutions, research organizations, medical field, government offices, entertainment, Word Processing, Internet, Digital Video or Audio composition ,Destop Publishing ,e-bussiness, Bussiness to consumer, Bussiness to Business, consumer to consumer,Bio-informatics Health Care etc.

- **Home**

  Computers are used at homes for several purposes like online bill payment, watching movies or shows at home, home tutoring, social media access, playing games, internet access, etc. They provide communication through electronic mail. They help to avail work from home facility for corporate employees. Computers help the student community to avail online educational support.

- **Medical Field**

  Computers are used in hospitals to maintain a database of patients' history, diagnosis, X-rays, live monitoring of patients, etc. Surgeons nowadays use robotic surgical devices to perform delicate operations, and conduct surgeries remotely. Virtual reality technologies are also used for training purposes. It also helps to monitor the fetus inside the mother's womb.

- **Entertainment**

  Computers help to watch movies online, play games online; act as a virtual entertainer in playing games, listening to music, etc. MIDI instruments greatly help people in the entertainment industry in recording music with artificial instruments. Videos can be fed from computers to full screen televisions. Photo editors are available with fabulous features.

- **Industry**

  Computers are used to perform several tasks in industries like managing inventory, designing purpose, creating virtual sample products, interior designing, video conferencing, etc. Online marketing has seen a great revolution in its ability to sell various products to inaccessible corners like interior or rural areas. Stock markets have seen phenomenal participation from different levels of people through the use of computers.

- **Education**

  Computers are used in education sector through online classes, online examinations, referring e-books, online tutoring, etc. They help in increased use of audio-visual aids in the education field.

- **Government**

  In government sectors, computers are used in data processing, maintaining a database of citizens and supporting a paperless environment. The country's defense organizations have greatly benefitted from computers in their use for missile development, satellites, rocket launches, etc.

- **Banking**

  In the banking sector, computers are used to store details of customers and conduct transactions, such as withdrawal and deposit of money through ATMs. Banks have reduced manual errors and expenses to a great extent through extensive use of computers.

- **Business**

  Nowadays, computers are totally integrated into business. The main objective of business is transaction processing, which involves transactions with suppliers, employees or customers. Computers can make these transactions easy and accurate. People can analyze investments, sales, expenses, markets and other aspects of business using computers.

- **Training**

  Many organizations use computer-based training to train their employees, to save money and improve performance. Video conferencing through computers allows saving of time and travelling costs by being able to connect people in various locations.

- **Arts**

  Computers are extensively used in dance, photography, arts and culture. The fluid movement of dance can be shown live via animation. Photos can be digitized using computers.

- **Science and Engineering**

  Computers with high performance are used to stimulate dynamic process in Science and Engineering. Supercomputers have numerous applications in area of Research and Development (R&D). Topographic images can be created through computers. Scientists use computers to plot and analyze data to have a better understanding of earthquake.

Basic Organization of a computer

The basic organization of a computer system is the **processing unit, memory unit, and input-output devices.**

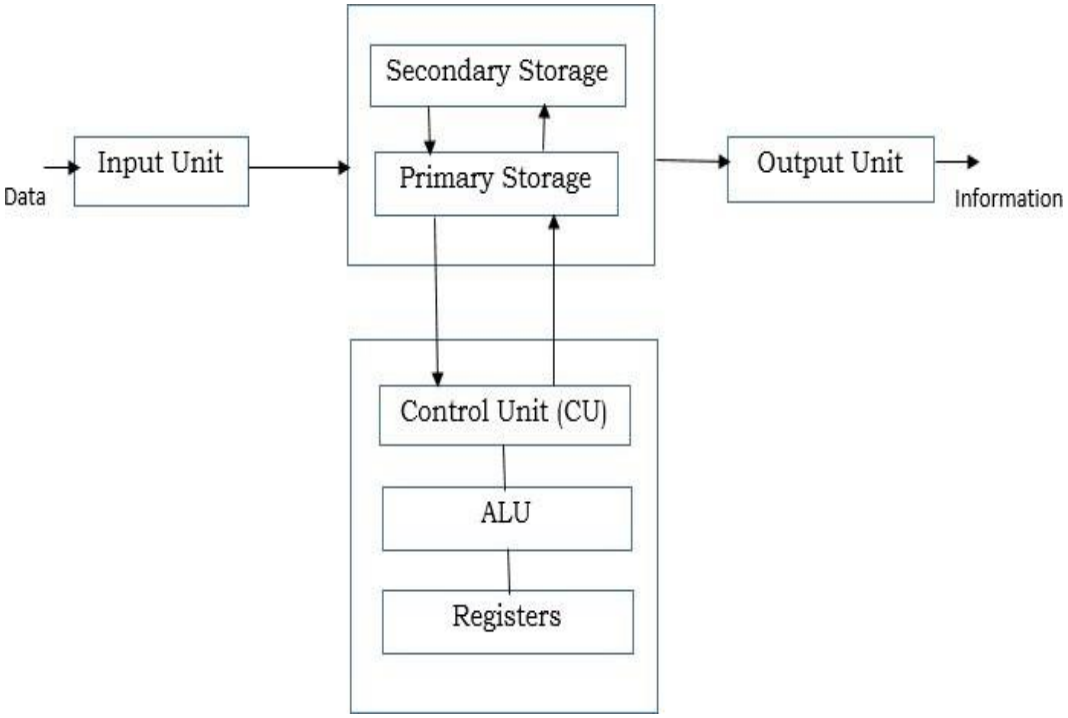


Figure 1: Functional Components of Computer

Central processing unit: CPU is a brain of computer. It controls the computer system. It converts data to information. Arithmetic and logic unit: This is a part of CPU. It consists of two units. One is arithmetic unit and another one is logic unit.

Memory: **Computer memory** is the storage space in the **computer**, where data is to be processed and instructions required for processing are stored

Input unit and output unit: This unit controls input and output devices. Input devices are keyboard, mouse etc and output devices are printer, monitor, plotter, etc.

CPU (CENTRAL PROCESSING UNIT)

- CPU is considered as the brain of the computer.
- CPU performs all types of data processing operations.
- It stores data, intermediate results, and instructions (program).
- It controls the operation of all parts of the computer

The CPU comprises of following components:

- ALU (Arithmetic and Logic Unit)
- CU (Control Unit)
- Special-purpose registers
- A clock

- The *ALU* is a "super calculator" carrying out all arithmetic tasks and Boolean operations.
- The *CU* controls the way data is moved between the various components of computer.
- Both ALU and CU use the service of *clock* for synchronizing their Operations.
- The CPU uses a few high-speed *registers* to store the current instruction and its data. One of the registers, program counter, stores the address of next instruction to be executed.
- All program instructions are executed using the *fetch-decode-execute mechanism.*
- The CPUs are rated in GHz (gigahertz).
- *Input Unit:* It is used to give the input that is data to the computer. It is done with the help of input devices.
- Ex: Mouse, Keyboard
- *Output Unit:* It is used to receive the output (information) from the computer. It is done with the help ofoutput devices. Ex: Printer, Speaker.

- *Memory:* Collection of chips on motherboard, where all computer processing and program instructions arestored. There are two types: Primary Memory and Secondary Memory.

MEMORY

Memory is an essential resource used by the computer and its users. The CPU needs memory for the currently running program. Users need memory to backup programs and data that are not needed.

Computer Memory categorized in to 2 types

1. Primary Memory
2. Secondary Memory

1. Primary memory is the main memory, which stores data and programs, which are currently needed by CPU.The size is less than the secondary memory and it is costly.

The primary memory which includes the following types:

- Random Access Memory (RAM-SRAM and DRAM)
- Read Only Memory (ROM-PROM,EPROM, EEPROM)
- Cache Memory (L1,L2 and L3)
- CPU Registers

RAM (Random Access Memory): It is the main memory, where the user can write information into RAM and read information from it. It is accessible to users. The RAM is randomly accessible by user.It is a volatile memory, which means the data, or information is retained as long as power supply is ON. There are two types of RAM: SRAM and DRAM.

SRAM (Static)	**DRAM (Dynamic)**
Stores information as long as power supply is on, reloads every 2ms.	Loses data in a very short time.
Multiple transistors are used to store 1 bit.	One transistor is used to store 1 bit.
It is expensive, faster, and bigger.	It is inexpensive, slower, and smaller.
It requires more power.	It requires less power.
It is not required to be refreshed.	It requires refresh.

ROM (Read Only Memory): It is a permanent memory that can be read but not written. It is a nonvolatile memory, which means the data or information is retained even power supply is not there.It contains a startup program BIOS (Basic Input Output System) which transfers control to OS.

PROM (Programmable Read Only Memory): It is programmed as per requirement of customer's choice. The programmer burns the data into PROM. The data once written cannot be changed.

EPROM (Erasable Programmable Read Only Memory): It can be rewritten (but only once) even though it has been previously burned. It is erased by exposing it to UV-rays.

EEPROM (Electrically Erasable Programmable Read Only Memory): It can be erased and rewritten multiple times. The electric voltage is used to erase the data. The pen drive we use today is of EEPROM.

Cache Memory: It holds those portions of program that are frequently used by CPU. It acts as a buffer between CPU and RAM. The CPU first looks for the instructions in cache. It executes faster thanRAM, expensive and limited in size. It has multiple levels:

- **L1 (Level 1)** – smallest and fastest – 32 KB
- **L2 (Level 2) –** present closer to CPU – 256 KB
- **L3 (Level 3) –** shared by cores – 8 MB

Registers: The small number of ultra-fast registers integrated into the CPU represent the fastestmemory of the computer. The CPU does all its work here. Each register has the length of the computer. The data is loaded into register before processing. Registers are numbered and a program instruction specifies these numbers. Ex: OR1R2R3 which means multiplication operation is performed on R1 and R2 is performed and stored in R3.

2. <u>SECONDARY MEMORY</u>

Secondary memory is not directly connected to CPU. It exists inside the machine and also externally. It is a non-volatile, offline and long-term storage memory. It is slower, cheaper than primary memory but the capacity is higher.

Hard disk/ Hard drive/ Fixed disk: It is the oldest secondary storage device. It has more capacity but, the cost is less comparatively. It is commonly present in laptop with 500GB and desktop with 1TB. It contains a spindle, which holds one or more platters made up of non-magnetic material. It has two surfaces which is coated with magnetic material. Each surface has serially numbered tracks and further broken into sectors or blocks. The disk runs with the speed of 5400 and 7200 rpm.

Magnetic tape: The magnetic tape is made up of plastic film with one side coated with magnetic material. It supports 1 TB or more, but 200 TB are also expected. The device is not fully portable though because, a separate tape drive is required. The data is accessed sequentially. This makes it unsuitable for backup.

Optical Disks (CD-ROM, DVD ROM, Blu-ray Disk): It is non-volatile read-only memory. The CD- ROM and DVD-ROM, can hold large volumes of data (700MB to 8.5 GB). The Blu-ray disk has the capacity upto 50 GB. A laser beam in their drives controls the read and write operations. A laser beamis used to construct pits and lands by burning selected areas along its tracks.CD-R, DVD-R: Data can be recorded only once.CD-RW, DVD-RW: Data can be recorded multiple times.

Flash Memory: It doesn't have any moving parts, is based on the EEPROM. It is available in various forms- pen drive, magnetic card (SD Card), solid state disk (SSD). They are portable, need little power and quite reliable.

The **memory stick or pen drive** is the most common type of flash memory used on the computer. It is a small, removable piece of circuit and it connects to the USB port of computer. The **solid state disk** is a bigger device meant to replace the traditional magnetic hard disk. The **magnetic card** is used mainly in cameras and the most popular is the micro-SD card.

Floppy Diskette: This is represented by a rectangular plastic case containing a thin magnetic disk. It was available in two sizes (5.25" and 3.5"), offering capacities of 1.2 MB and 1. MB. It is unsuitable for backup purpose.

Difference between Primary memory and Secondary memory

Primary Memory	Secondary Memory
The size of the primary memory is small.	The size of the secondary memory is larger.
Stores the programs and data currently needed by the CPU.	It is used to store large amount of data and programs
Expensive.	Inexpensive.
Volatile in nature.	Non-volatile in nature.
Ex: RAM, ROM	Ex: Hard disk, Optical disk

INPUT DEVICES

Input devices are needed to interact with the OS to perform tasks. Ex: Keyboard, Mouse, Joystick, Stylus, Scanner etc.

1.Keyboard: Every computer supports a keyboard – either a physical or touchscreen. For entering data into a computer, the keyboard is the most common and commonly used input device. It contains various keys for entering letters, numbers, characters. Although there are some additional keys for completing various activities, the keyboard layout is identical to that of a standard typewriter. It is generally available in two different sizes: 84 keys or 101/102 keys and for Windows and the Internet, it is also available with 104 keys or 108 keys. It is connected to a computer system with the help of a USB or a Bluetooth device.

The keyboard has QWERTY layout and contains large number of symbols. Each letter, numeral or symbol is known as a character, which represents smallest piece of information. Each character has a unique values called the ASCII (American Standard Code for Information Interchange) value.

The keys on the keyboard are:

- **Numeric Keys:** These keys are used to enter numeric data and move the cursor. It is typically made up of 17 keys.
- **Keyboard Shortcuts:** These keys include the letter keys (A-Z) and the number keys (09).
- **Control Keys:** The pointer and the screen are controlled by these keys. It comes with four directional arrow keys. Control keys include Home, End, Insert, Alternate(Alt), Delete, Control(Ctrl), and Escape.

- **Special Keys:** Enter, Shift, Caps Lock, NumLk, Tab, and Print Screen are some of the special function keys on the keyboard.
- **Function Keys:** The 12 keys from F1 to F12 are on the topmost row of the keyboard.

2.Pointing Devices: GUI (Graphical User Interfaces) like windows need a pointing device to control the movement of cursor on the screen. This is implemented as mouse in desktop and touchpad in laptop. The earliest form has a rotating ball and two buttons. The left button is used for selecting (by clicking once) and execute (by clicking twice). The right button is used to check and change attributes. The optical mouse uses infrared laser/LED, the wireless mouse uses radio frequency technology.

Mouse: The mouse is the most used pointing device. While clicking and dragging, the mouse moves a little cursor across the screen. If you let off of the mouse, the cursor will come to a halt. You must move the mouse for the computer to move; it will not move on its own. As a result, it's a device that accepts input. Or we can say that a mouse is an input device that allows you to control the coordinates and movement of the on-screen cursor/pointer by moving the mouse on a flat surface. The left mouse button can be used to pick or move items, while the right mouse button displays additional menus when clicked. It was invented in 1963 by Douglas C. Engelbart.

Types of mouse: Generally, the mouse is of four types:

- Trackball Mouse
- Mechanical Mouse
- Optical Mouse
- Wireless Mouse

Joystick

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.

Light Pen

Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube.

Track Ball

Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on the ball, the pointer can be moved.

3. Scanner:

A scanner is a type of input device that works in the same way as a photocopier. It's used when there's data on paper that needs to be transferred to the computer's hard disc for further processing. The scanner collects images from the source and translates them to a digital version that can be saved on the hard disks. These graphics can be changed before they are printed. A scanner is a device that creates a digital image of a document by optically scanning it. The flatbed scanner doesn't exceed more than A4 size. It is operated with by using special software. The document to be scanned is placed on a glass plate covered by lid.

Types of Scanner: Generally, the scanner is of five types:

- Flatbed Scanner
- Handheld Scanner
- Sheetfed Scanner
- Drum Scanner
- Photo Scanner

Modern scanners have **OCR (Optical Character Recognition)** facility which extracts text as a stream of characters i.e. converting image file to text file and **MICR (Magnetic Ink Character Recognition)** reads the codes using hand held barcode readers.

Magnetic Ink Card Reader (MICR):MICR input device is generally used in banks as there are large number of cheques to be processed every day. The bank's code number and

cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.

4. Audio-visual Input Devices Examples of audiovisual input devices include**microphones,digital cameras, anddigital video cameras**. Microphones permit audio input, whether spoken words or ambient sound

Microphone: Microphone is an input device to input sound that is then stored in a digital form.

OUTPUT DEVICES

The information produced can be heard or seen with the help of output devices. Some of the output devices are monitor, speaker, printer, plotter etc.

1. Monitor: The monitor is an integral part of computer which displays both text and graphics. The performance is measured in terms of image quality, resolution, energy consumption.

- **CRT (Cathode Ray Tube) Monitors:** The CRT monitors have a rarefied tube containing three electron guns. The guns emit electrons create images. They usually have resolution of 640*840 pixels. They are large, heavy, energy efficient and produces lot of heat.
- **LCD (Liquid Crystal Display) Monitors:** The image is formed by applying voltage on crystals. The backlight is provided by fluorescent light. They consume less power, generate less heat and have increased life span.

2. Impact Printers: It produces the hardcopy of output. The impact printers are old, noisy. But, still dot-matrix printer is in usage.

- **Dot-Matrix Printer:** The print head of the dot-matrix printer has either 9 or 24 pins. When the pins fire against the ribbon, an impression is created on the paper. The speed is 300 cps and doesn't produce high quality output. It can produce multiple copies.
- **Daisy-wheel Printer:** It employs a wheel with separate characters distributed along its outer edge. The wheels can be changed to obtain different set of fonts.
- **Line Printer:** For heavy printing, the line printer is used. It uses a print chain containing the characters. Hammers strike the paper to print and it rotates at the speed of 1200 lpm. It is also noisy and is of low-quality.

3. Non-Impact Printers: They are fast, quiet and of high resolution. The most commonly used non- impact printers are laser and ink-jet printers. The thermal printer is not discussed here because it uses heat to print on high-sensitive paper.

- **Laser Printer:** It works like a photocopier and uses toner i.e. black magnetic powder. The image is createdin the form of dots and passed from drums on to the paper. It has built-in RAM which acts as buffer and RAM to store fonts. The resolution varies from 300 dpi to 1200 dpi and the speed is about 20 ppm.
- **Ink-jet Printer:** These are affordable printers. It sprays tiny drops of ink at high pressure as it moves along the paper. The separate cartridges are available for different colors. The resolution is about 300 dpi, can print1 to 6 pages/min.

4. Plotters: The plotter can make drawings. It uses one or more automated pens. The commands are taken from special file called vector graphic files. Depending on type of plotter either paper or pen moves. It can handle large paper sizes and it is used for creative drawings like buildings and machines. They are slow and expensive.

Design and implementation of efficient programs

Figure 8.6 Phases in software development life cycle

The design and development of correct, efficient, and maintainable programs depend on the approach adopted by the programmer to perform various activities that need to be performed during the development process. The entire program or software (collection of programs) development process is divided into a number of phases, where each phase performs a well-defined task. Moreover, the output of one phase provides the input for its subsequent phase.

The phases in the software development life cycle (SDLC) process is shown in Figure 8.6.

The phases in the SDLC process can be summarized as follows:

Requirements analysis In this phase, the user's expectations are gathered to know why the program/software has to be built. Then, all the gathered requirements are analysed to arrive at the scope or the objective of the overall software product. The last activity in this phase includes documenting every identified requirement of the users in order to avoid any doubts or uncertainty regarding the functionality of the programs.

The functionality, capability, performance, and availability of hardware and software components are all analysed in this phase.

Design The requirements documented in the previous phase acts as an input to the design phase. In the design phase, a plan of actions is made before the actual development process can start. This plan will be followed throughout the development process. Moreover, in the design phase, the core structure of the software/program is broken down into modules. The solution of the program is then specified for each module in the form of algorithms

or flowcharts. The design phase, therefore, specifies how the program/software will be built.

Implementation In this phase, the designed algorithms are converted into program code using any of the high-level languages. The particular choice of language will depend on the type of program, such as whether it is a system or an application program. While C is preferred for writing system programs, Visual Basic might be preferred for writing an application program. The program codes are tested by the programmer to ensure their correctness.

This phase is also called construction or code generation phase as the code of the software is generated in this phase. While constructing the code, the development team checks whether the software is compatible with the available hardware and other software components that were mentioned in the Requirements Specification Document created in the first phase .

Testing In this phase, all the modules are tested together to ensure that the overall system works well as a whole product. Although individual pieces of codes are already tested by the programmers in the implementation phase, there is always a chance for bugs to creep into the program when the individual modules are integrated to form the overall program structure. In this phase, the software is tested using a large number of varied inputs, also known as test data, to ensure that the software is working as expected by the user's requirements that were identified in the requirements analysis phase.

Software deployment, training, and support After the code is tested and the software or the program has been approved by the users, it is installed or deployed in the production environment. This is a crucial phase that is often ignored by most developers. Program designers and developers spend a lot of time to create software but if nobody in an organization knows how to use it or fix up certain problems, then no one would like to use it. Moreover, people are often resistant to change and avoid venturing into an unfamiliar area, so as a part of the deployment phase, it has become very crucial to have training classes for the users of the software.

Maintenance Maintenance and enhancements are ongoing activities that are done to cope with newly discovered problems or new requirements. Such activities may take a long time to complete as the requirement may call for the addition of new code that does not fit the

Introduction to C

- C is a general purpose, procedural, structured computer programming language developed by **DennisRitchie** 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 Programming Language: :

1. Procedural Language
2. Fast and Efficient
3. Modularity
4. Statically Type
5. General-Purpose Language
6. Rich set of built-in Operators
7. Libraries with rich Functions
8. Middle-Level Language
9. Portability
10. Easy to Extend

- **Procedural Language:** In a procedural language like C step by step predefined instructions are carried out. C program may contain more than one function to perform a particular task.
- **Fast and Efficient:** C programming language as the been middle-level language provides programmers access to direct manipulation with the computer hardware but higher-level languages do not allow this. That's one of the reasons C language is considered the first choice to start learning programming languages. It's fast because statically typed languages are faster than dynamically typed languages.
- **Modularity:** The concept of storing C programming language code in the form of libraries for further future uses is known as modularity.
- **Statically Type:** C programming language is a statically typed language. Meaning the type of variable is checked at the time of compilation but not at run time.

- **General Purpose Language:** From system programming to photo editing software, the C programming language is used in various applications. Some of the common applications where it's used are as follows:
  - Operating systems: Windows, Linux, iOS, Android, OXS
  - Databases: PostgreSQL, Oracle, MySQL, MS SQL Server etc.
- **Rich set of built-in Operators:** It is a diversified language with a rich set of built-in operators which are used in writing complex or simplified C programs.
- **Libraries with rich Functions:** Robust libraries and functions in C help even a beginner coder to code with ease.
- **Middle-Level Language:** As it is a middle-level language so it has the combined form of both capabilities of assembly language and features of the high-level language.
- **Portability:** C language is lavishly portable as programs that are written in C language can run and compile on any system with either none or small changes.
- **Easy to Extend:** Programs written in C language can be extended means when a program is already written in it then some more features and operations can be added to it.

Examples of C :Databases ,Operating system, Language compilers, Assemblers, Text editors,.

There are three tools to Program development, the solution involves a multi step process which requires steps like understanding theproblem, developing a solution, writing the program and testing it.

1. Pseudo code
2. Flowchart
3. Algorithm

1.Pseudo code:

- It is an outline of the program that is expressed in a formally styled natural language. It expresses the design in detail.It is used in planning of computer program development, for sketching out the structure of the programbefore the actual coding takes place.

- It is a restatement of the problem as a list of steps in English like format, describing what must be done to solve the problem.
- It is not a programming language but informal way of describing a program andit does not require strict syntax.
- It consists of statements which are a combination of English and C.
- Using the pseudo code, a programmer then writes the actual program.

Advantages:

1. It can be written easily
2. It can be read and understood easily
3. Modification is easy

Disadvantages:

1. There is no standard form.
2. One Pseudocode may vary from other for same problem statement.

Examples:

Pseudocode: Addition of two numbers	**Pseudocode:** Area of rectangle
1. Begin 2. Read two numbers a, b 3. Calculate sum = a+b 4. Display sum 5. End	1. Begin 2. Read the values of length, breadth 3. Calculate area = l x b 4. Display area 5. End

2. Algorithm

A logical and concise list of steps required to solve a problem is called algorithm.

The representation of the various steps involved in solving problem is called algorithm.

Points for developing an algorithm

- Name of the algorithm
- Step number
- Explanatory statement following the step number
- Termination

Example:

Algorithm: To find sum of 2 number

Step 1:Start

Step 2: [input the values of a and b]Read a, b

Step 3:[find the sum]sum=a+b

Step 4:[output the result]print sum

Step 5:[finished]Stop

Flowchart

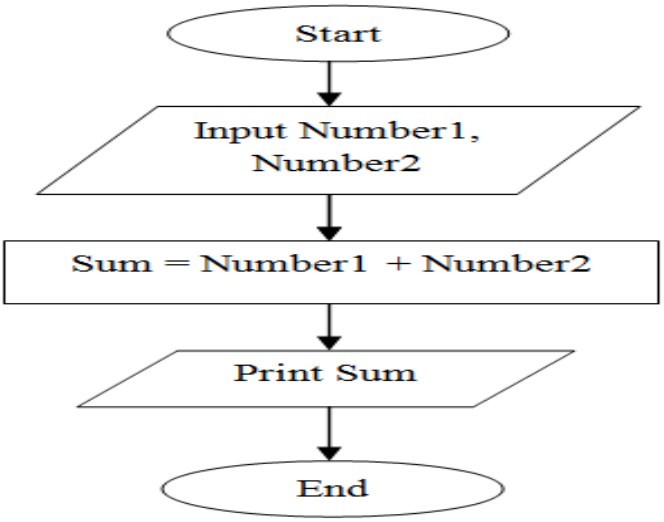
- A flowchart is a pictorial representation of an algorithm.

Benefits of using flowcharts are

- Being a pictorial representation they are easier to understand.
- We can review our logic and debug the program with the help of flowcharts.
- Easy to explain a program or discuss the solution.
- It separates the logic development and program syntax.

Symbol Name	Symbol	function
Oval		Used to represent start and end of flowchart
Parallelogram		Used for input and output operation
Rectangle		Processing: Used for arithmetic operations and data-manipulations
Diamond		Decision making. Used to represent the operation in which there are two/three alternatives, true and false etc
Arrows		Flow line Used to indicate the flow of logic by connecting symbols
Circle		Page Connector
		Off Page Connector
		Predefined Process /Function Used to represent a group of statements performing one processing task.
		Preprocessor
		Comments

Example



STRUCTURE OF 'C' PROGRAM

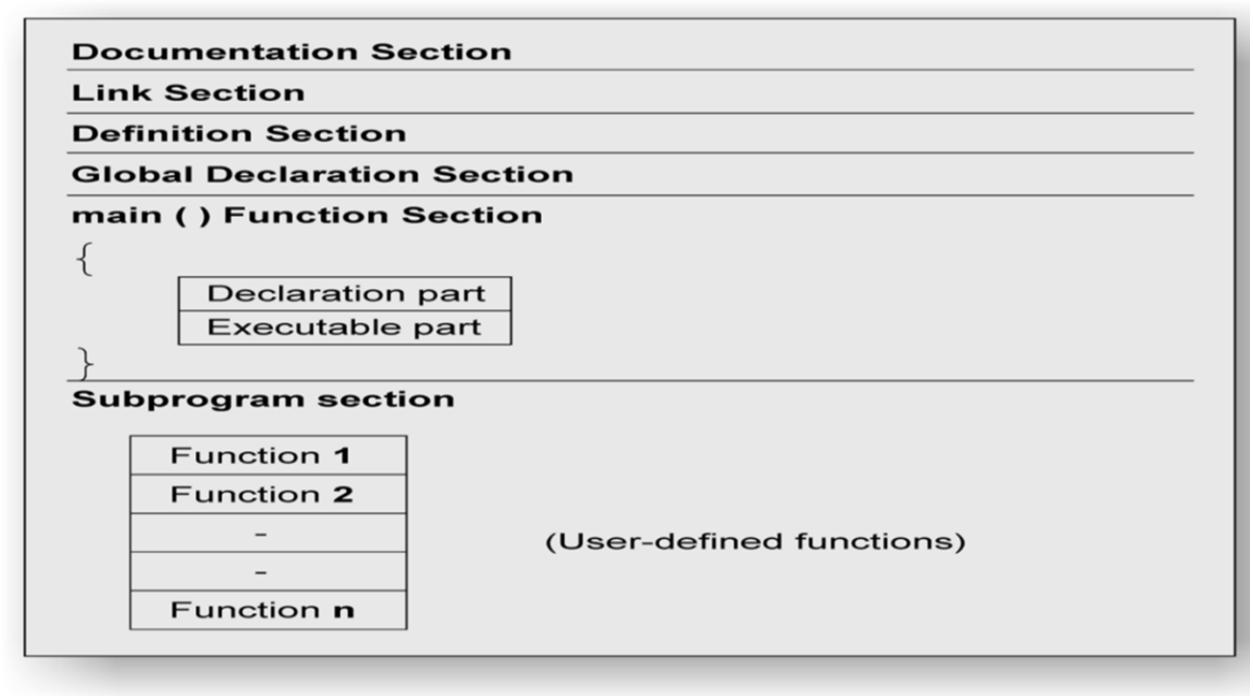


Fig. 1.9 *An overview of a C program*

C program consists of different sections. The structure of C program is as shown below.

Documentation Section: It consists of a set of comment line giving the name of the program, theauthor and other details. Compiler ignores these comments. There are two formats:

1.Line comments //Single line comment

2.Block comments /*Multi line comment*/

Link Section: It provides instruction to the compiler to link functions from system library.

Definition Section: It defines all symbolic constants.

Global Declaration Section: The variables which are used in more than one function are called globalvariables and are declared in this section.

main( ) Section: Every 'C' program has one main( ) function and it contains two parts:

1.Declaration Part: Here, all the variables used are declared.

2. Executable Part: Here, it contains at least one executable statement.

PREPROCESSOR DIRECTIVES

- Every C program is made of one or more preprocessor commands.
- This command is present in the beginning of the program
- All the preprocessor commands starts with a pound sign[#].
- The preprocessor directives are the special instructions that tells the compilerabout what libraries have to be included in the program.

Ex: #include<stdio.h>

The above command tells the compiler to include the standard input/output library file to the program.

Where, # is pound sign

include is a keyword used to include library files stdio is standard input/output library .h is header file

Some of the preprocessor directive given below

#include<conio.h> this is to include console input/output libraryfunctions.

#include<math.h> this is to include mathematical library functions.

#include<string.h> this is to include string library functions.

- The executable part of the program begins with the main() function.
- Ex: void main()

void : says that the function doesn't return any value to the operatingsystem

main: is the function name.

- Note: there should be no semicolon after the function header.
- All the functions in the program are divided into 2 parts:
  - Declaration section: it describe the data that we are using in thefunction. It is also called as local declaration.

- Statement section: it contains the instruction to perform specifictask such as reading input, printing output etc.

The function main starts with an open brace '{' and terminates with a closebrace '}'.

GLOBAL DECLARATIONS

- It includes the variables that are used in more than one function.
- The variable declared here are visible to all parts of the program
- The global variables are declared after preprocessor directives and before main.

COMMENTS

- They help the readers to place some program documentations
- The compiler ignores the comments when it translates the program toexecutable code.

There are two different formats of comment

1.Block comment

A block comment is used when the comment has several lines .

Sntax: /*-

---

*/

Everything between the token is ignored by compiler.

2. Line comments

The line comment is used when the comment has only oneline i.e for short comments. It uses two slashes(//). This format does not require an end-of-comment token.

EXAMPLE:

WRITE A C PROGRAM TO ADD TWO NUMBER

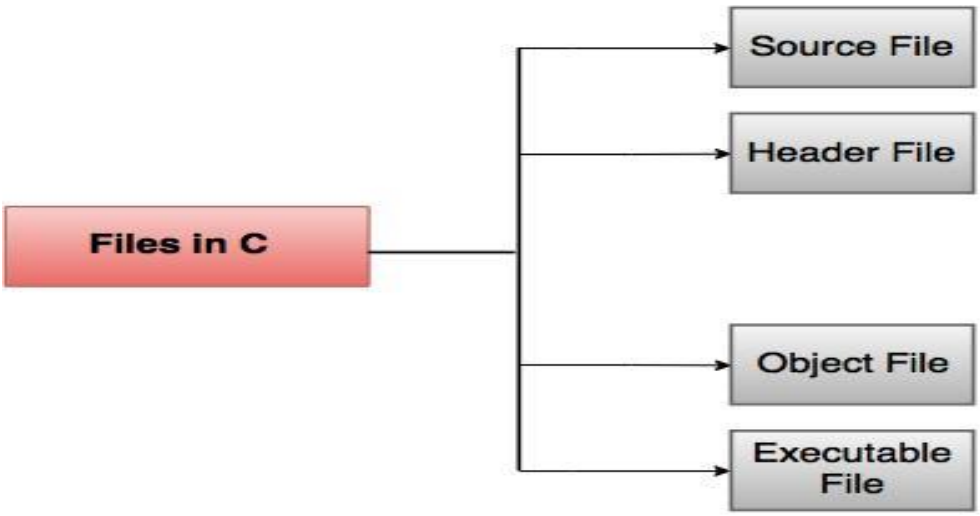
```
#include<stdio.h>
void main()
{
int a=5,b=6,sum;
 sum=a+b;
printf("sum=%d\n",sum);
}
```

or

```
#include<stdio.h>main()
{
int a,b,sum;
 scanf("%d%d",&a,&b);
sum=a+b;
 printf("sum=%d\n",sum);
}
```

Files used in a C program

A C program uses four types of files as follows:



1. Source Code File

- This file includes the source code of the program.
- The extension for these kind of files are '.c'. It defines the main and many more functions written in C.
- main() is the starting point of the program. It may also contain other source code files.

2. Header Files

They have an extension '.h'. They contain the C function declarations and macro definitions that are shared between various source files.

Advantages of header files:

1. At times the programmer may want to use the same subroutines for different programs. To do this, he would just compile the code of the subroutine once and link to the resulting object file in any file in which the functionalities of this subroutine are required.

2. At times the programmer may want to change or add the subroutines and reflect those changes in all the programs. For doing this, he will have to only change the source file for the subroutines, recompile the source code and then recompile and re-link the program.
This tells us that including a header file will make it easier at all levels of the program. If we need to modify anything then changes are made only in the subroutines after which all the changes will be reflected.

Common standard header files are:

i) string.h – used for handling string functions.

ii) stdlib.h – used for some miscellaneous functions.

iii) stdio.h – used for giving standardized input and output.

iv) math.h – used for mathematical functions.

v) alloc.h – used for dynamic memory allocation.

vi) conio.h – used for clearing the screen.

The header files are added at the start of the source code so that they can be used by more than one function of the same file.

3. Object files

- They are the files that are generated by the compiler as the source code file is processed.
- These files generally contain the binary code of the function definitions.
- The object file is used by the linker for producing an executable file for combining the object files together. It has a '.o' extension.

4. Executable file

- This file is generated by the linker.
- Various object files are linked by the linker for producing a binary file which will be executed directly.
- They have an '.exe' extension.

Compiling and Executing a C Program

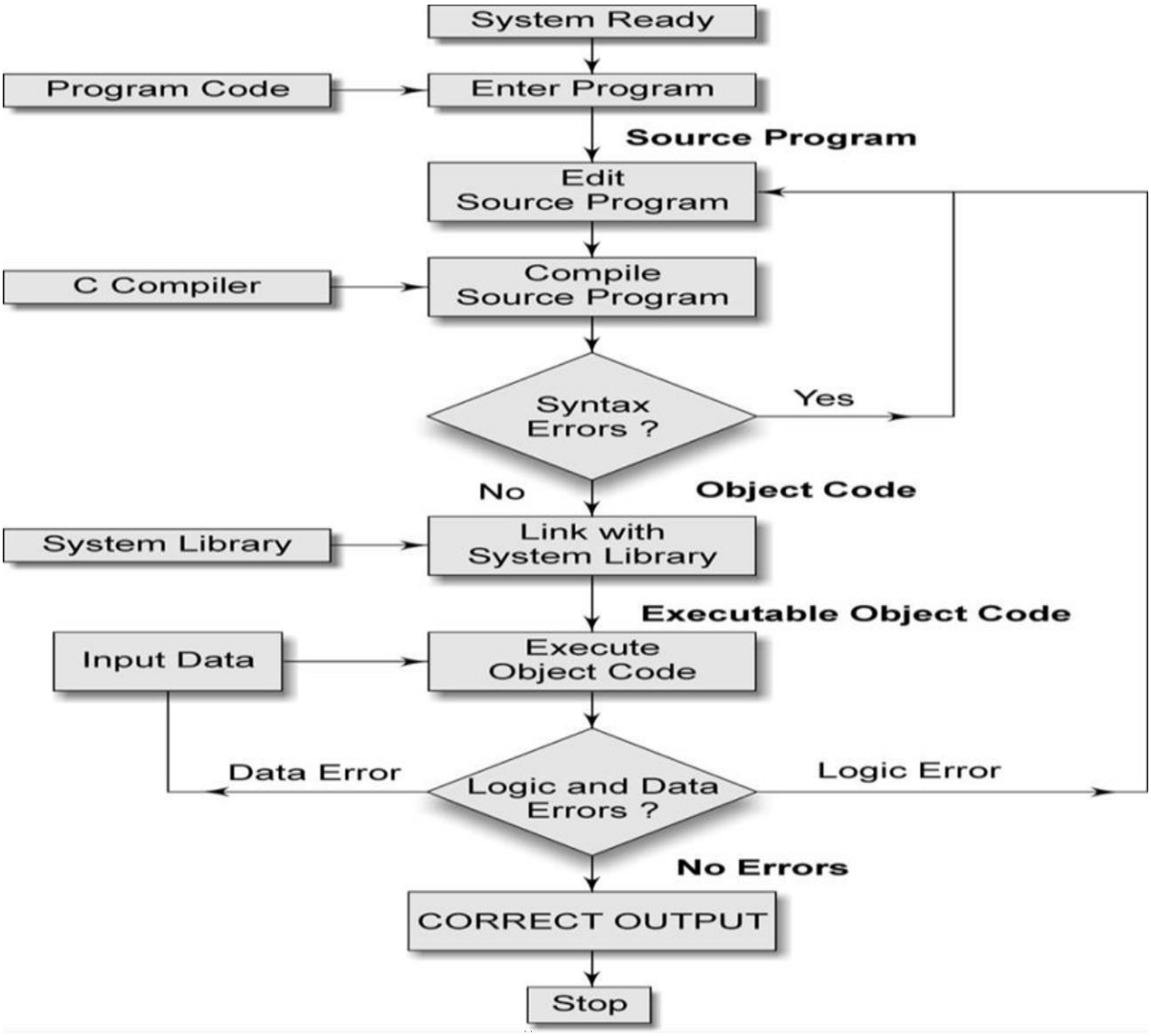


Fig. 1.10 *Process of compiling and running a C program*

THE BASIC 'C' CHARACTERS

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

1. Letters: Uppercase: A,B,C,….,ZLowercase: a,b,c,…..,z

2. Digits: 0,1,2,…..,9

3. Special characters: ! , . # $ ( ) } { etc

4.White spaces: Blank space, Horizontal tab space (\t), carriage return, new line character (\n), form feedcharacter.

C – TOKENS

- It is also called as *lexical unit.*
- The smallest individual unit in 'C' program is called as C-Token.
- These are the building blocks of 'C' program.

There are 6 types of 'C' tokens:

1. Keywords
2. Identifiers
3. Constants
4. Strings
5. Operators
6. Special symbols

1. Keywords

- Keywords are also called as *reserved words.*
- They already have pre-defined meaning.
- Keywords should always be written in lowercase.
- The keywords meaning can't be changed.
- Keywords cannot be used as identifiers.
- There are 32 keywords in 'C' program.

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

2. Identifiers

- It refers to the name of the objects.
- These are the names given to variables, functions, macros etc.

The rules to write an identifier are as follows:

1. It must contain only alphabets (A to Z, a to z), numbers (0 to 9) and underscore (_).
2. It must start with alphabet or underscore but not numeric character.
3. It should not contain any special symbols apart from underscore.
4. It should not have any space.
5. Keywords cannot be used as identifiers.
6. Identifiers are case sensitive.
7. Maximum length of an identifier is 31 characters.

Examples:

Valid Identifiers: integer, minimum, sum_ total, row1, _cpps

Invalid Identifiers:float → It is a keyword.

I am → It has space

123_Abc → It is starting with number

N1 + n2 →It contains special symbol (+)

3. Constants

Constants are the values that doesn't changes during the execution of a program.

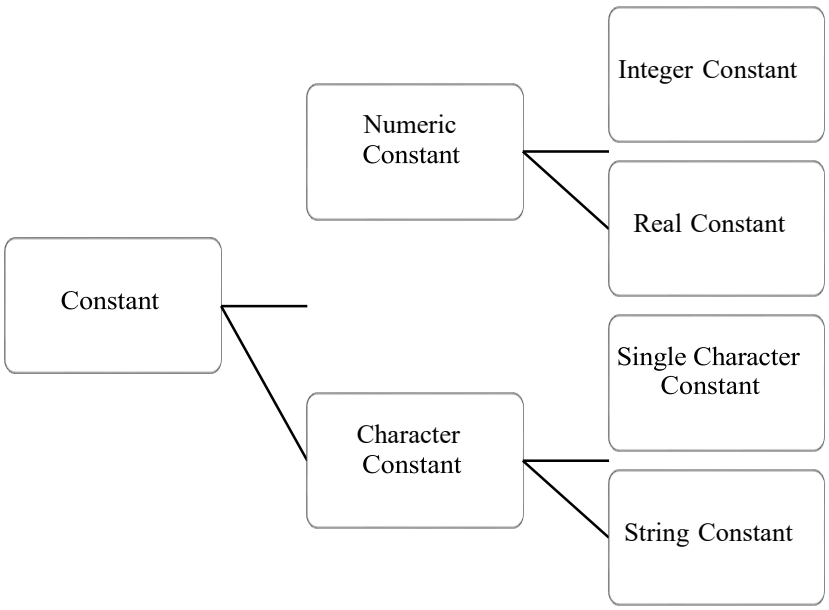


Figure 3: Types of Constants

Numerical Constant

Integer Constant: These are the numbers without decimal part.

1. **Decimal:** It is an integer constant consisting of numbers from 0-9. It can be preceded by + or –
2. **Octal:** It is an integer constant consisting of numbers from 0-7. It is preceded by o
3. **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

Boolean constants

- A Boolean data type can take only two values: true[1] and false[0].
- If we want to use Boolean datatype in the program then we mustinclude the Boolean library stdbool.h

Real Constant:

- These are the numbers with decimal part.
- These are also called as floating point constant.
- The floating values can be identified by the suffix 'F' or 'f'
- It can be expressed in exponential form.
  Ex: 21.5, 2.15 x 10^2 → 2.15e2

Complex constants

- They are coded as 2 parts: real and imaginary separated by + sign.
- Real part: is coded as a real format rules.
- Imaginary part: is coded as a real number multiplied withimaginary constant [I].
- To use the imaginary constant, we have to include complex.h header file
- Both real and imaginary parts should be of same type.

Character Constant

Single Character Constant:

- These are the values enclosed within single quotes.
  Ex:'a' , '1' etc
- Each character have an integer value called as ASCII (American Standard Code for InformationInterchange) → A: 65, a: 97
- *Printable Character:* All characters are printable except backslash(\) character or escapesequence.

- *Non-Printable Character:* The characters with backslash (\) are non printable. Ex: \n, \t
- When a backslash [\] is used before the character then thatbackslash is known as the 'escape character'.
- The escape character says that what follows is not the normalcharacter but it has some special meaning.
- Even though they look like 2 characters , they represent only one.
- The escape characters are normally used in printf statement to format the output.

Ex: 'n'

\n-newline

\t-horizontal tab

\v-vertical tab

\b-backspace

\0-null

\a-alert

\f-formfeed

\r-carriage return

\"

\'

\?

\\

String Constant:

- A group of characters together form string.
- Strings are enclosed within double quotes. Ex: "h", "hello", " "this refers as empty string
- They end with NULL character (\0).
- Ex: "CPPS

C	P	P	S	\0

CODING CONSTANTS

There are three ways to code/define constants in program

- **Literal constant**

  A literal is an unnamed constant used to specify data.

  If there is some data that cannot be changed in the program, thenwe can simply code the data value itself in a statement.

  Ex: a=b+5;

- **Symbolic Constants/ Defined constant**

  Another way to designate a constant is to use the preprocessorcommand "#define".

  The define commands are usually placed at the beginning of theprogram.

  Ex: #define Pi 3.14main()

  {

  A=b*Pi

  }

  In program whenever it finds Pi, it is replaced by value3.142

- **Qualified Constant /Memory constant**

  It uses C type qualifier "const" to indicate data cannot be changed.

  Syntax: const type identifier=value;

  Ex: const float cpi=3.14;

  It is same as literals, but we are giving a symbolic name to it.

  Usually to represent the constant variable we prefix 'c' with the variable name.

Example program:

```
#include<stdio.h>
#define PI 3.1416  // define constant
void main()
{
        const float cpi=3.1416;              //memory constant
        printf("literal constant:%f\n",3.1416);  //literal constant
        printf(" defined constant:%f\n",PI);
        printf("memory constant:%f\n"cpi);
}
```

Output:

literal constant: 3.1416

defined constant: 3.1416

memory constant: 3.1416

DATA TYPES

√ Data type defines the types of data that is stored in a variable.

√ There are 3 types:

i. Primary/ Built-in/ Fundamental data type int, float, double, char, void

ii. Derived data type array, structure

iii. User defines data type enum, typedef

♦ **Primary/ Built-in/ Fundamental data type**: These are the built in data types available in C. There are 5 types. Namely:

1. Integer (int)
2. Floating point (float)
3. Character (char)
4. Double precision floating point (double)
5. Void (void)

1. Integer type:

- It is used to store whole numbers.
- The keyword int is used to declare variable of integer type.
- Int type takes 2B or 4B of storage depending on machine size.
- The classes of integer are:

Unsigned			Signed		
Data type	**Keyword**	**Size**	**Data type**	**Keyword**	**Size**
Short Integer	short int	1B	Signed short integer	signed short int	1B
Integer	int	2B	Signed integer	signed int	2B
Long Integer	long int	4B	Long integer	long int	4B

2. Floating point data type:

- It is used to store decimal numbers.
- The keyword float is used to declare variable of floating point data type.
- Float type takes 4B or 8B of storage depending on machine size.
- It can be expressed in fractional or exponential form.

Data type	Keyword	Size
Floating point	float	4B
Double	double	8B
Long double	long double	10B

3. **Double:**
   - It is used to store double precision floating point numbers.
   - The keyword double is used to declare variable of floating point data type.
   - Double type takes 8B of storage.
   - Double precision is related to accuracy of data.

4. **Char:**
   - It is used to store character type of data.
   - The keyword char is used to declare variable of character type.
   - Char type takes 1B of storage.

5. **Void:**
   - It is a special data type that has no value.
   - It doesn't have size.
   - It is used for returning the result of function that returns nothing.

VARIABLES

√ A variable is a name given to memory location whose value changes during execution.

Declaration:

Syntax: datatype variable_list;
Where,
datatype Any built in data type
variable_list Identifiers that specifies variable name.

Example: int a;
Where,
int is the built in data type
a is variable of type int.

Initialization:

Syntax: datatype variable_name = value;

Where,

datatype →Any built in data type
variable_name →Identifier that specifies variable name. value →The data which will be stored in variable name.

Example: int a = 10;
Where,
int →data type
a →variable name
10→ value

MANAGING INPUT AND OUTPUT OPERATIONS

- √ Reading, processing and writing of data are three essential functions of a computer program.
- √ There are two methods. The first method is to assign the values and the second method is to use input function scanf to read data and output function printf to write data.
- √ Ex: **#include<stdio.h>** Includes function calls such as printf() and scanf() into the source code when compiled.

READING A CHARACTER

- √ The simplest way of all input/output operations is reading a character from the 'standard input' unit (usually keyboard) and writing it to the 'standard output' (usually the screen).
- √ Reading a single character can be done by using the function getchar and it does not have any parameter.

Syntax: variable_name = getchar( );

Where, variable_name is valid and has been declared in char type.

Example: char name;
name = getchar( );

- √ The getchar function can also be used to read the characters successively until the return key is pressed.
- √ The character function are contained in the file type ctype.h and therefore the preprocessor directive #include<ctype.h> is included.
- √ And the functions of ctype.h returns 1 if (TRUE) and 0 if (FALSE).

Function	Test
isalnum(c)	Is c alphanumeric character?

isalpha(c)	Is c alphabetic character?
isdigit(c)	Is c a digit?
islower(c)	Is c a lower case letter?
isupper(c)	Is c a upper case letter?
isspace(c)	Is c a white case character?
ispunct(c)	Is c a punctuation mark?
isprint(c)	Is c a printable character?

Example Program:

```
#include<stdio.h>

#include<ctype.h>

void main( )
{
        char key;
        printf("Enter any key\n");
        key=getchar( );
        if(isalpha(key))
                printf("The entered key is a letter\n");
        else if(isdigit(key))
                printf("The entered key is a digit\n");
        else
                printf("The entered key is not alphanumeric\n");
}
```

OUTPUT:

Enter any key A The entered key is a letter	Enter any key 7 The entered key is a digit	Enter any key $ The entered key is not alphanumeric

WRITING A CHARACTER

√ Writing a single character can be done by using the function putchar.

Syntax: putchar(variable_name);

Where, variable_name is valid and has been declared in char type.

Example: name='y';
putchar(name);

Will display the character y on the screen

√ The characters entered can be converted into reverse i.e., from upper to lower case and vice versa.
√ The functions used to convert are toupper, tolower.

Example Program:

```
#include<stdio.h>
#include<ctype.h>
void main( )
{
    char alphabet;
    printf("Enter any alphabet\n");
    alphabet=getchar( );
    if(islower(alphabet))
        putchar(toupper(alphabet));
    else
        putchar(tolower(alphabet));
}
```

OUTPUT:

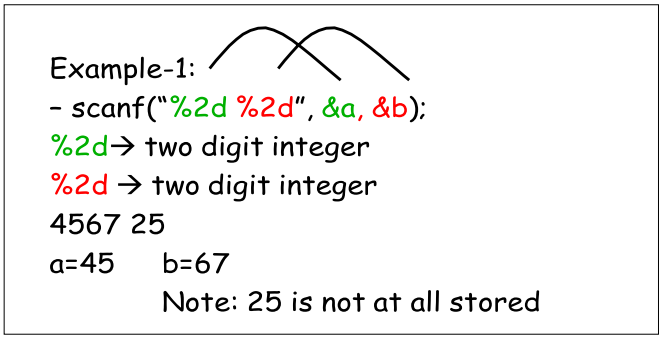
Enter any alphabet A a	Enter any alphabet a A

FORMATTED INPUT

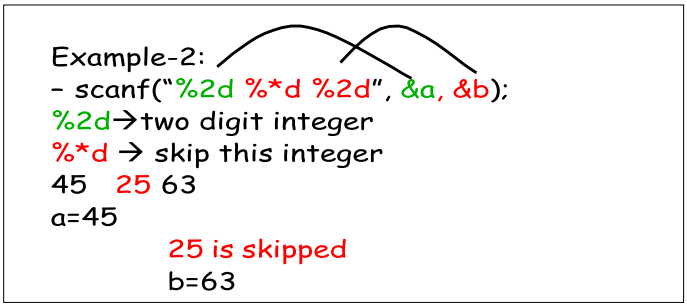
√ Formatted input refers to an input data that has been arranged in particular format.
√ Ex: 152 Rajesh
√ In the above example the first part contains integer and the second part contains characters. This ispossible with the help of scanf function.

Syntax: scanf("control string", arg1, arg2,…..,argn);

√ The control string specifies the field form in which data should be entered and the arguments arg1,arg2,…..,argn specifies the address of the location where the data is stored.
√ The width of the integer number can be specified using %wd.



√ The input field may be skipped using * in the place of field width.



√ The scanf function can read single character or more than one character using %c or %s.

Rules for scanf:

√ Each variable to be read must have a specification
√ For each field specification, there must be a address of proper type.
√ Never end the format string with whitespace. It is a fatal error.
√ The scanf will read until:
- A whitespace character is found in numeric specification.
- The maximum number of characters have been read
- An error is detected
- The end of file is reached

√ Any non-whitespace character used in the format string must have a matching character in the user input.

♦ The below table shows the scanf format codes commonly used.

Code	Meaning
%c	Read a single character
%d	Read a decimal integer
%e, %f, %g	Read a floating point value
%h	Read a short integer
%i	Read a decimal integer
%o	Read a octal integer
%s	Read a string
%u	Read an unsigned decimal integer
%x	Read a hexadecimal integer
%[ ]	Read a string of word

The l can be used as a prefix for long integer. Ex: %ld

FORMATTED OUTPUT

√ The printf function is used for printing the captions and results.

Syntax: printf("control string", arg1, arg2, ….., argn);

√ Control string contains three types of items:

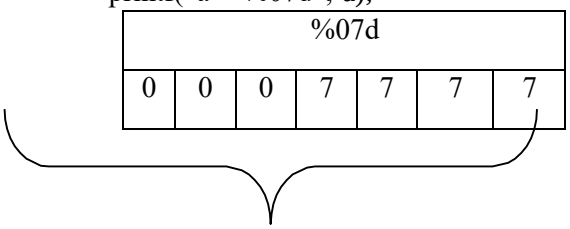
1. Characters that will be printed on the screen as they appear.
2. Format specifications that define the output format for display of each item.
3. Escape sequence characters such as \n, \t and \b.

√ The printf can contain flags (0 + -)

0 → fill in extra positions with 0's instead of spaces

a=7777

printf("a = %07d", a);

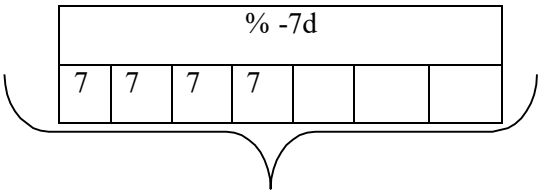


Width of 7 memory space is allocated and padded with leading zeroes

- → Left justify text instead of right justify text

a= 7777;

printf("a = % -7d", a);



Width of 7 memory space is allocated and printed from left side (left justify)

+→Print sign of number (whether positive or negative)

- Example with format specifier %d:

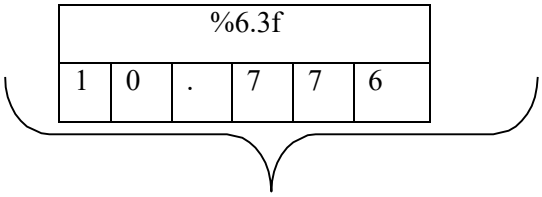
```
a=10, b=77;
printf("%d %d", a , b);
```

Output:

10 77

- Example with format specifier %f:

```
x=10.776;
printf("%6.3f %", x );
```



6.3f means totally 6 locations are allocated out of which 3 is for number of decimal places.

- Example with \n and \t:

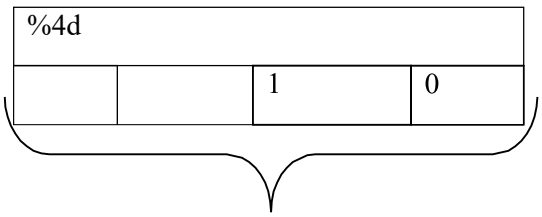
```
a=10, b=77, c=88;
printf("a=%d\n b=%d\tc=%d", a , b, c);
```

Output:

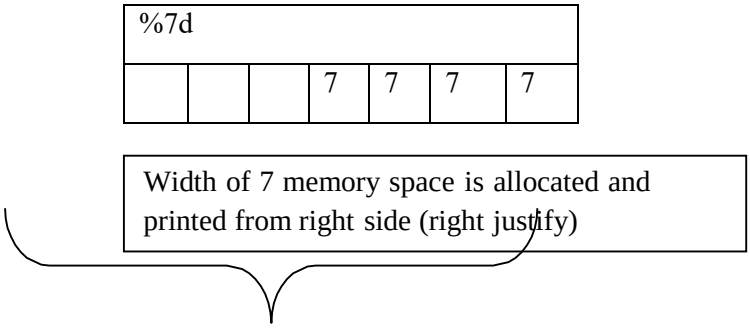
a=10
b=77
c=88

- Example with size value:

```
a=10, b=7777, c=88;
printf("a=%4d\n b=%7d", a , b);
```



Width of 4 memory space is allocated and printed from right side



- The below table shows the scanf format codes commonly used.

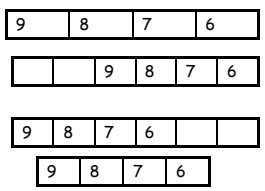
Code	Meaning
%c	Print a single character
%d	Print a decimal integer
%e	Print a floating point value in exponent form
%f	Print a floating point value without exponent
%g	Print a floating point value with or without exponent
%h	Print a short integer
%i	Print a decimal integer
%o	Print a octal integer
%s	Print a string
%u	Print an unsigned decimal integer
%x	Print a hexadecimal integer
%[ ]	Print a string of word

The l can be used as a prefix for long integer. Ex: %ld

- General syntax of field-width/size for different data types:

- %wd → Example: %6d
- %w.pf → Example %6.2f
- %w.ps →Example %10.4s
  - w means total field size/width
  - P means precision (tells how many decimal places to be printed in case of float) and
  - How many characters to be printed in case of strings

```
Examples:
a=9876;
printf("%d", a);
printf("%6d",a);
printf("%-6d",a);
printf("%3d",a);
```



NOTE: String input/output function: gets() and puts( )

- gets and puts are line oriented input output functions available in the <stdio.h> header file.
- **gets():**Alternative method to read strings is ***gets() (read it as get string)*** function which is

anunformatted string input function. Advantage of ***gets()***is it can read multi-word strings.

- Example: charname[10];
  gets(name);

Say input is:

N	E	W		Y	O	R	K

The complete string "NEW YORK" is read by ***gets( ).***

- **puts():**This function can be used to display entire string on monitor screen without the help of **%s** specifier.
  - Example: char name[ ] = "Bengaluru"

    puts(name);

puts( ) will display the string value stored in parameter passed to it on monitor. In this case it is—Bengaluru.