MODULE-1
INTODUCTION TO COMPUTER AND OVERVIEW OF C

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.

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 computersuntil 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.

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 monitorswhich 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.

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 ofeveryday products.

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 thefuture, 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 machineswhich 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 pointoperations per second) super computers are too powerful to be used for transaction processing. They are mainly usedin 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.

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 forscientific 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.

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 andextensive 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) .

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. Itvaries 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 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 mainmemory or the primary storage or Random Access Memory (RAM).

Its size affects speed, power, and capability. Primary memory and secondary memory are twotypes 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 outputdevice.
- 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 unitsof a computer.
- It manages and coordinates all the units of the computer.
- It obtains the instructions from the memory, interprets them, and directs the operationof 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 synchronizingwith 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 asa buffer between RAM

and the CPU. It holds frequently requested data and instructions so that they are immediately available to the CPU when needed.

Levels of memory:

- **Level 1 or Register –**
  It is a type of memory in which data is stored and accepted that are immediately storedin 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 storedfor faster access.
- **Level 3 or Main Memory –**
  It is memory on which computer works currently. It is small in size and once power isoff 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 permanentlyin 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).

SECONDARY MEMORY

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

Hard disk Magnetic

tapeCD-ROM

DVD-ROM

Blu-ray disc Flash

Memory

The obsoleted floppy disk

PORTS AND CONNECTORS :

- Universal Serial Bus (USB) :
- Parallel Port
- Video Graphics Array (VGA) Port
- RJ45 Port
- PS/2 Port
- High Definition Multimedia Interface (HDMI)

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 inputdevice 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 impactingan 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 arespaced 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 characterprinted 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 printerworks on the same principle as a ball-head typewriter. The daisy wheel is a disk made of plasticor 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 charactersper second.

Line Printer: A line printer is an impact printer which makes use of a continuous feed of paperand prints one line of text at a time. A line printer is also known as a bar printer. High speed isone 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. Usingstatic 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 fora 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 uniformcolor density on the page. For each color of ink, all of the nozzles on the carriage are typicallyformed 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 everycolor of ink are formed together in a single step. The nozzles are all formed as orifices througha 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 movingcarriage 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 standard inkjet 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.

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 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:

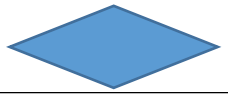
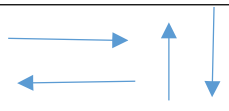
Pseudocode: is a detailed yet readable description of what a computer program must do, expressed in a formally-styled natural language rather than in a programming language. Pseudocode is sometimes used as a detailed step in the process of developing a program. It allows designers or lead programmers 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 multiplesteps, which the process "flows" through from start to finish. Common uses for flowcharts include developing business plans, defining troubleshooting steps, and designing mathematicalalgorithms.

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

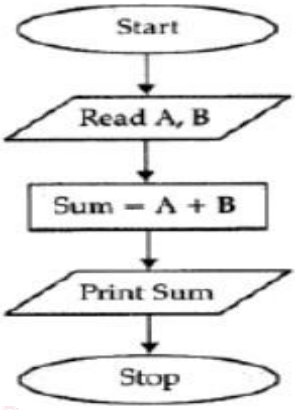
Step 2: Read a,b

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

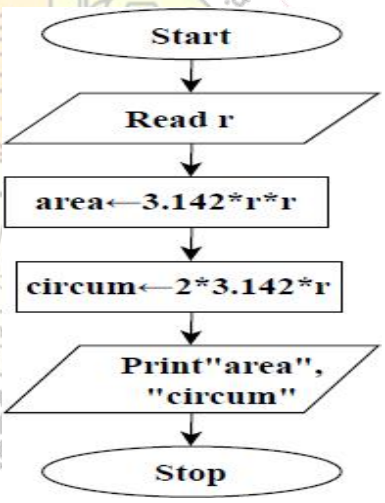
Step 3: area←3.142*r*r

Step 4: circum←2*3.142*r

Step 5: Print “area,circum”

sStep 6: Stop

Flowchart:-



Example:

3. Design an algorithm and flowchart to compute simple interest

Algorithm:-

Step 1: Start

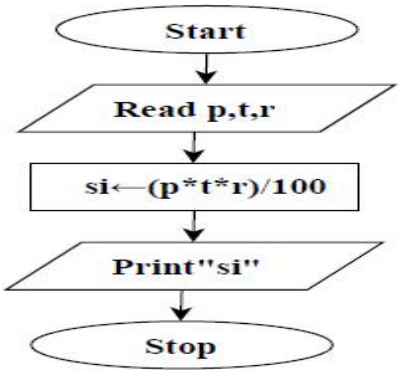
Step 2: Read p,t,r

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:

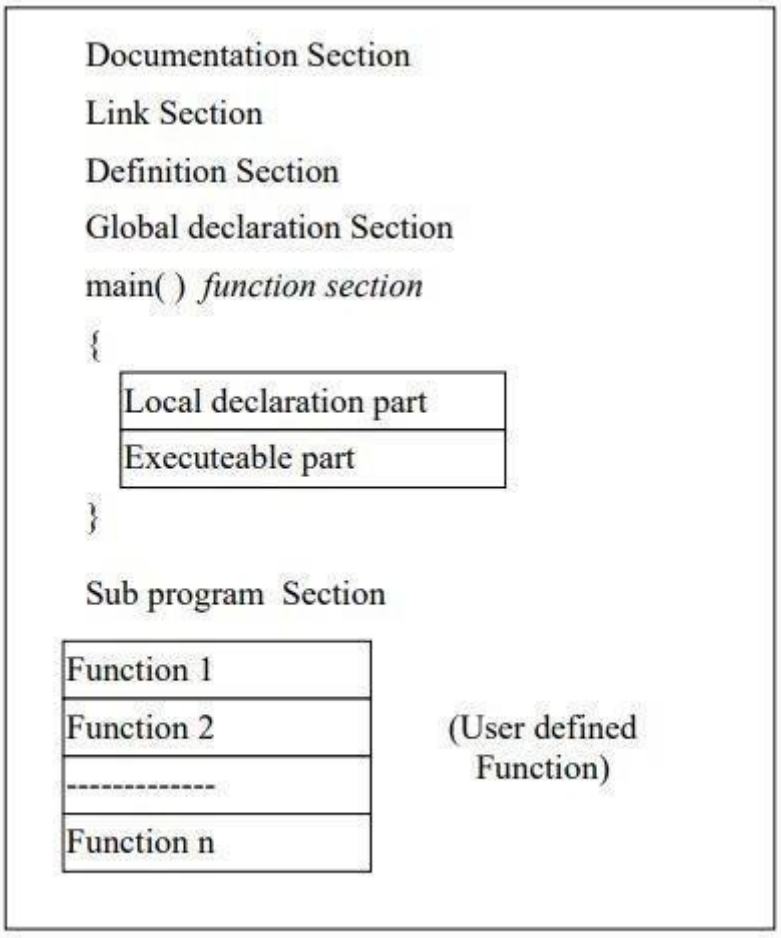
- Operating system
- Language compilers
- Assemblers
- Text editors
- Databases

C Character Set:
A C character set defines the valid characters that can be used in a source program. The basicC 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, formfeed 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, andone or more functions.

Documentation section :consists of a set of comment line giving the name of the program, theauthor, and other details. Compiler ignores these comments when it translates the program intoexecutable 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 thatis 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 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. Thereare 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

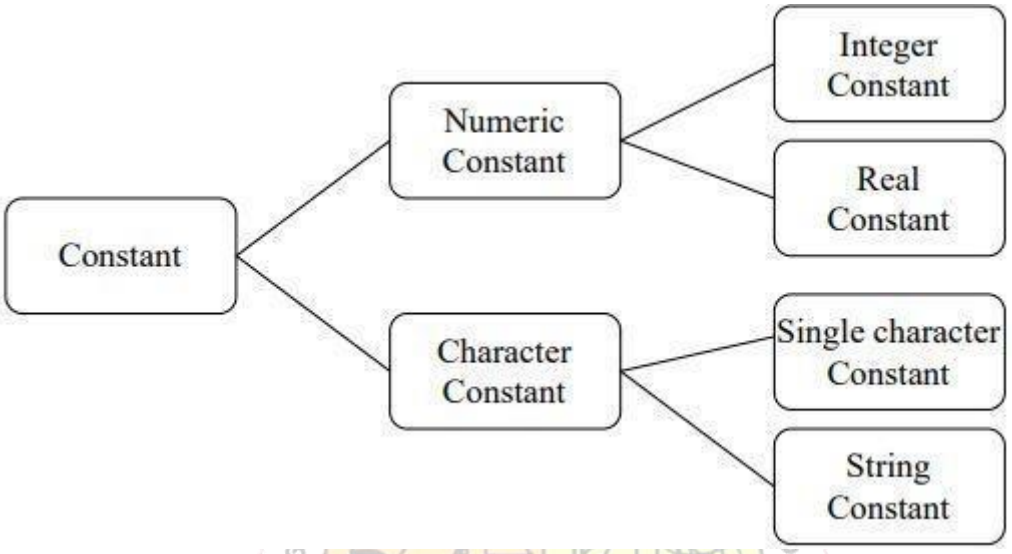
4. Whitespaces and special symbols cannot be used to name the identifiers.

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

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

sss2021	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 beeither 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 positiveor negative or both.

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

Character Constants:

Character Constant: can be single character enclosed within single quotes

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 blankspace. a String literal always ends with a Null character (**'\0'**)

Example:

A	I	E	M	S	**'\0'**

5. Operators: An operator is a symbol that tells the compiler to perform specific mathematicaland 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 onlyone input.

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

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

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 isassigned 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 isassigned 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

(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 declaringvariables.

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 thetype 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 functionThe

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 floatingpoint value. It provides 16 digits after the decimal point. this data type is used when performingcomplex 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	(Empty)

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 ofthem is assigned with a specific name. **enum** keyword is used to create the enumerated data type.