Module 2 – Introduction to Programming

1.Overview of C Programming

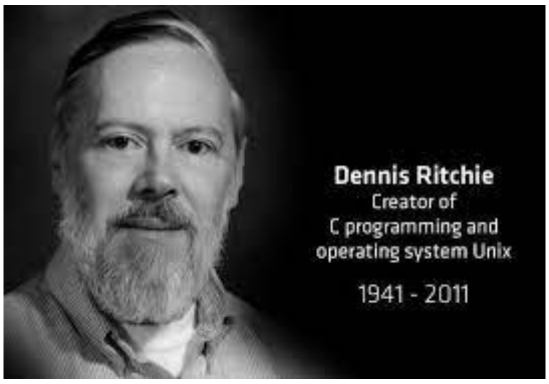
• THEORY EXERCISE:

Write an essay covering the history and evolution of C programming. Explain importance and why it is still used today.

C programming language was developed by Dennis Ritchie in **1972 at Bell Labs**. It was derived from the earlier language called B, which was developed by Ken Thompson. The purpose of C language was to create a more efficient and powerful language for writing operating systems. In the early days, C was used to write system software like the Unix operating system and the C compiler, which was used to compile the source code of C programs.

Over the years, C has become a very popular and versatile language, used for a variety of applications. It is used for writing device drivers, gaming applications, embedded systems, and operating systems. It is also used for creating graphical user interfaces, network programming, database management systems, web development, and many other tasks.

C has also been used to create various high-level programming languages such as C++, Java, and C#. These languages are based on the principles of C and provide a more user-friendly and modern syntax.



C language was developed in the **1970s** by **Dennis Ritchie**, who was an American computer scientist at **AT & T Bell Labs in USA**.

C language was created as a replacement for the 'B' language, which was used for writing operating systems.

C language was designed to be a general-purpose, high-level programming language that is both powerful and efficient.

C language is often used for system programming and embedded systems development, as it provides low-level access to memory and allows for efficient manipulation of hardware resources.

C language has become one of the most widely used programming languages, and it is used for a variety of applications, including operating systems, device drivers, and embedded systems.

- LAB EXERCISE:

Research and provide three real-world applications where C programming is extensively used, such as in embedded systems, operating systems, or game development.

C, the venerable programming language, continues to be a powerhouse in the world of software development. Its efficiency, portability, and low-level control make it an ideal choice for a wide range of applications. In this article, we'll explore real-life examples of C in action, demonstrating its practical applications across various domains.

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2. Setting Up Environment

• THEORY EXERCISE:

Describe the steps to install a C compiler (e.g., GCC) and set up an Integrated Development Environment (IDE) like Dev C++, VS Code, or Code Blocks.

Install C in Your Computer

Installing C in your own computer requires downloading and installing two software that together forms the C development environment:

- **C Compiler**: A compiler is a software that converts your C code into executable programs.
- **Text Editor (IDE)**: A compiler only compiles the C source code into executable code. We also need a code editor (or IDE) for editing and writing C code.

Install C Compiler

There are many C compilers provided by different vendors available. Below are the instructions for installing GCC (GNU Compiler Collection) on different operating systems.

Install GCC on Linux

To **install GCC on Linux** (Ubuntu, Debian, Linux Mint, and Kali Linux), you can use the **apt** package manager. Just enter and run the following commands one by one in the terminal:

```
sudo apt update
```

```
sudo apt install build-essential
```

The above command will download and install GCC in your system.

Install GCC on Windows

To **install GCC on Windows**, we can use MinGW (Minimalist GNU for Windows) installer. Follow these steps:

1. First download MinGW.
2. Run the installer and select the GCC package.

3. Once installed, add the MinGW\bin directory to the system's PATH variable to be able to use GCC from command line.

Install GCC on Mac

On macOS, GCC can be installed using Homebrew package manager. First install Homebrew in macOS using the following command:

/bin/bash-c"$(curl-fsSLhttps://raw.githubusercontent.com/Homebrew/install/HEAD/install.sh)"

Then enter the following command to install GCC:

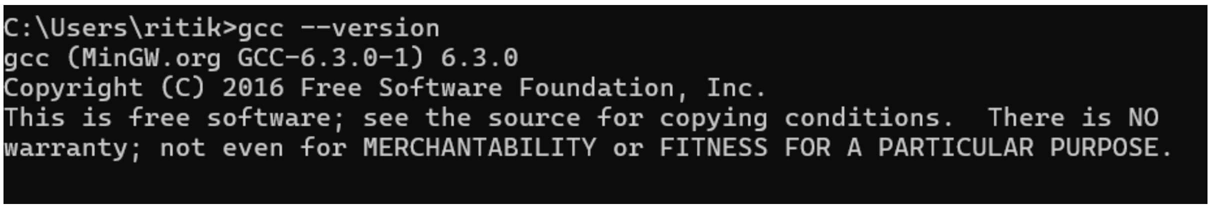
brew install gcc

Verify Installation

We can check if the GCC compiler is successfully installed on the operating system by using the following command in the command line interface:

gcc --version

If the installation was successful, below text is shown:

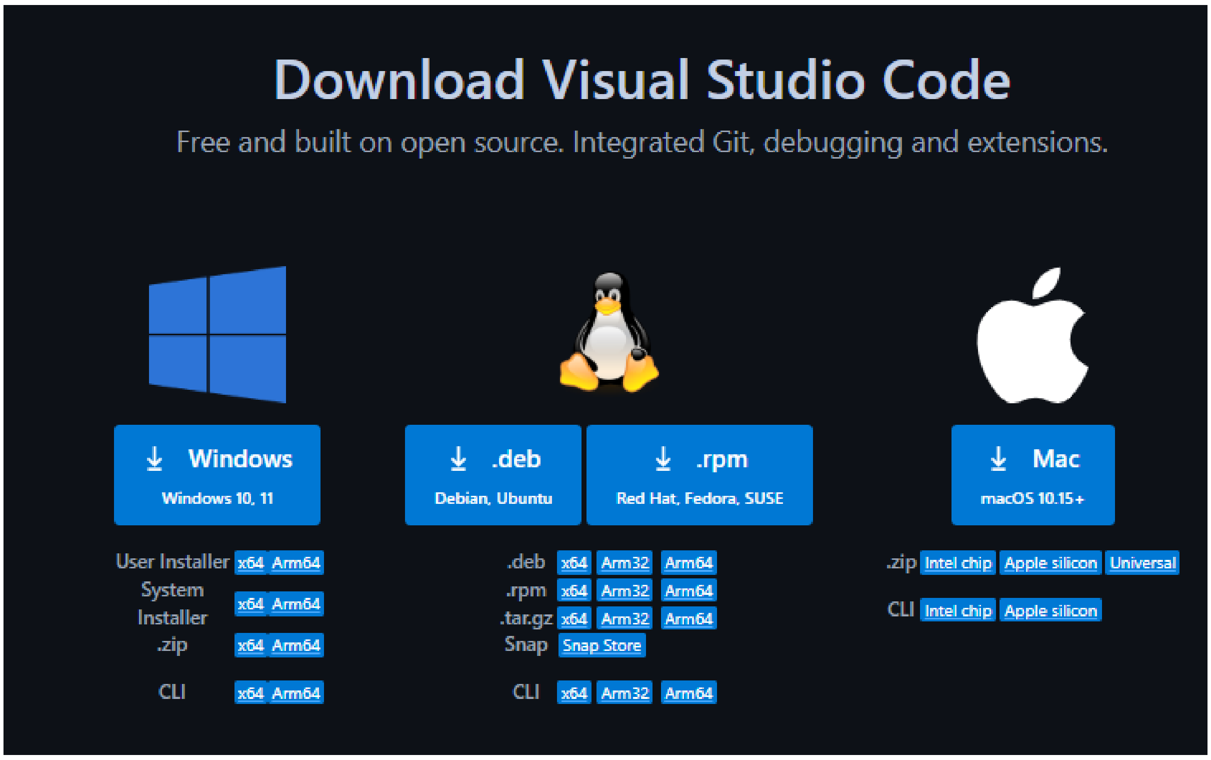


```
C:\Users\ritik>gcc --version
gcc (MinGW.org GCC-6.3.0-1) 6.3.0
Copyright (C) 2016 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

Install Code Editor (IDE)

There are many IDEs available on the internet for free use. One popular code editor is VS Code, which is an excellent and lightweight code editor. Follow the below steps to install VS code:

Step 1: Download the suitable VS Code installer according to your **operating system.**



Step 2: Once downloaded, open it and install the VS Code with recommended settings.

For installing different IDEs, you can refer to the articles given below:

- *Install Atom Text Editor in Linux*
- *Install Code Blocks on Windows*
- *Install Code Blocks on Linux*
- *Install Sublime Text in Windows*

• LAB EXERCISE:

Install a C compiler on your system and configure the IDE. Write your first program to print "Hello, World!" and run it.

Input:

```
#include<stdio.h>
#include<conio.h>
void main()
{
        clrscr();
        printf("Hello World");
        getch();
}
```

3.Basic Structure of a C Program

• THEORY EXERCISE:

Explain the basic structure of a C program, including headers, main function, comments, data types, and variables. Provide examples.

The basic structure of a C program is divided into 6 parts which makes it easy to read, modify, document, and understand in a particular format. C program must follow the below-mentioned outline in order to successfully compile and execute. Debugging is easier in a well-structured C program.

Sections of the C Program

There are 6 basic sections responsible for the proper execution of a program. Sections are mentioned below:

1. Documentation
2. Preprocessor Section
3. Definition
4. Global Declaration
5. Main() Function
6. Sub Programs

1. Documentation

This section consists of the description of the program, the name of the program, and the creation date and time of the program. It is specified at the start of the program in the form of comments. Documentation can be represented as:

// description, name of the program, programmer name, date, time etc.

or

/*
  description, name of the program, programmer name, date, time etc.
*/

Anything written as comments will be treated as documentation of the program and this will not interfere with the given code. Basically, it gives an overview to the reader of the program.

2. Preprocessor Section

All the header files of the program will be declared in the preprocessor section of the program. Header files help us to access other's improved code into our code. A copy of these multiple files is inserted into our program before the process of compilation.

Example:

```
#include<stdio.h>
#include<math.h>
```

3. Definition

Preprocessors are the programs that process our source code before the process of compilation. There are multiple steps which are involved in the writing and execution of the program. Preprocessor directives start with the '#' symbol. The #define preprocessor is used to create a constant throughout the program. Whenever this name is encountered by the compiler, it is replaced by the actual piece of defined code.

Example:

```
#define long long ll
```

4. Global Declaration

The global declaration section contains global variables, function declaration, and static variables. Variables and functions which are declared in this scope can be used anywhere in the program.

Example:

```
int num = 18;
```

5. Main() Function

Every C program must have a main function. The main() function of the program is written in this section. Operations like declaration and execution are performed inside the curly braces of the main program. The return type of the main() function can be int as well as void too. void() main tells the compiler that the program will not return any value. The int main() tells the compiler that the program will return an integer value.

Example:

void main()

or

int main()

6. Sub Programs

User-defined functions are called in this section of the program. The control of the program is shifted to the called function whenever they are called from the main or outside the main() function. These are specified as per the requirements of the programmer.

Structure of C Program with example

Example: Below C program to find the sum of 2 numbers:

```
#include<stdio.h>

#include<conio.h>

void main()

{

    //addition

    int a=10,b=20,c;

    //data type and variable

    clrscr();

    c=a+b;

    printf("%d",c);

    getch();

}
```

- LAB EXERCISE:

Write a C program that includes variables, constants, and comments. Declare and use different data types (int, char, float) and display their values.

```
#include<stdio.h>
#include<conio.h>
void main()
{
        //declaring integer variable
        int a=10;
        //declare float variable
        float b=5.4;
        //declare character variable
        char c='A';
        //clear screen
        clrscr();
        //print all variable and contractor
        printf("Age: %d\n",a);
        printf("Grade: %c\n",c);
        printf("Height: %f\n",b);
        getch();
}
```

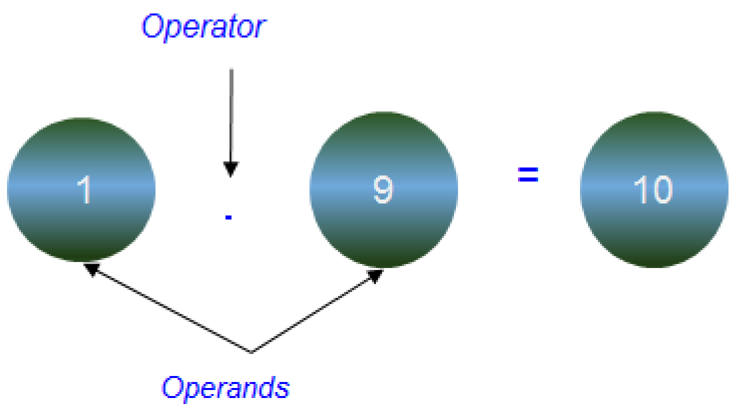
4. Operators in C

• THEORY EXERCISE:

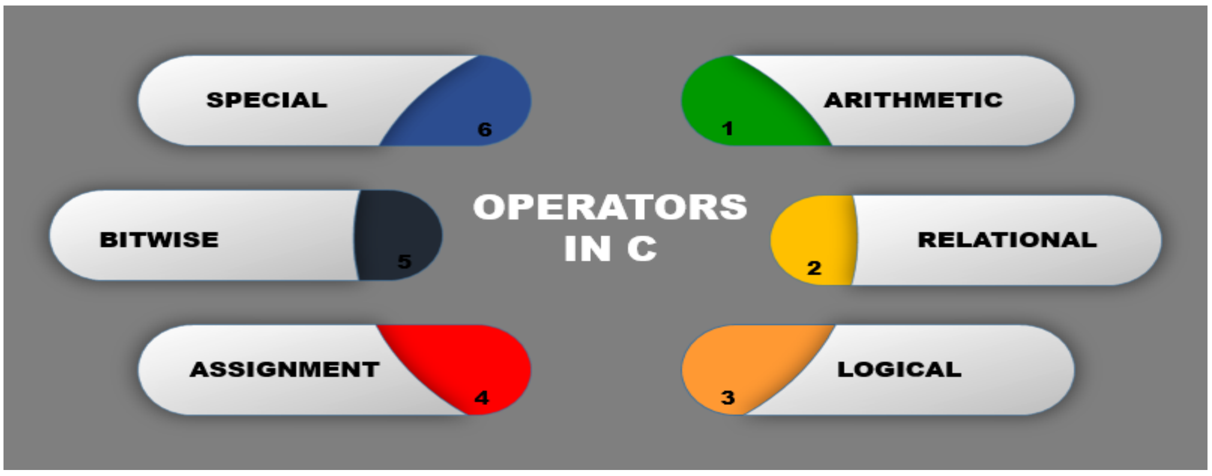
Write notes explaining each type of operator in C: arithmetic, relational, logical, assignment, increment/decrement, bitwise, and conditional operators.

In this tutorial you will grasp the skill to work with different operators used in C to perform logical and arithmetical calculations with the aid of simple & easy.

Operators are unique symbols that perform some sort of computation. The objects or values on which operators act are known as operands and the combination of operators and operands are termed as expressions in c.



C language support a wide range of built-in operators to manipulate data and values and hence is broadly categorised as follows:



Arithmetic Operators:

Like real life mathematics, arithmetic operators of C do the job of division, multiplication, addition, and subtraction. The involved operators are '/', '*', '+' and '-' respectively. Except these, there are other three operators modulus, increment and decrement operator. Modulus or '%' outputs the remainder of any division of numbers.

Operator	Meaning	Description	Example
+	Addition	Adds two operands or unary plus	10+2=12
-	Subtraction	Subtracts right operand from left operand or unary minus	10-2=8
*	Multiplication	Multiplies two operands	10*2=20
/	Division	Divides left operand by right operand	10/2=5
%	Modulus	Remainder after division	10%2=0
++	Increment	increases value by one unit	++a **or** a++= a+1
--	Decrement	decreases value by one unit	--b **or** b-- = b-1

Increment and Decrement Operators

Increment operator '++' increases the value of integer by one unit, whereas the decrement operator '--' decreases the same by one unit. These operators can be either prefixed or postfixed with the operand and are used extensively in a different type of loops in C .

Relational Operators:

Relational operators do compare the data to give binary outputs i.e. True or False. Here are the six operators demonstrated using the two operands a and b.

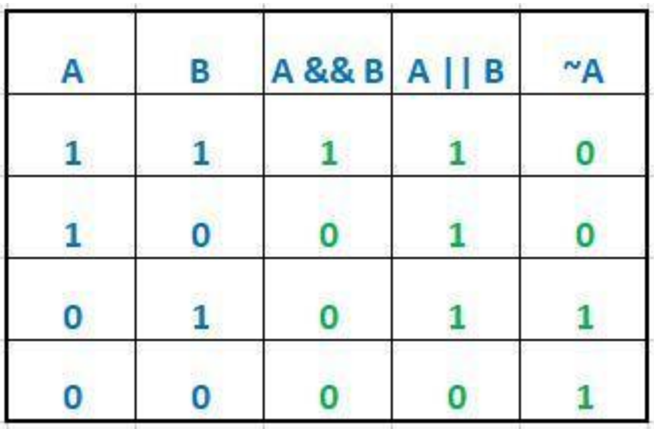
Operator	Meaning	Description	Examples
==	Equal to	Returns True if two operands are equal	a==b
!=	Not Equal to	Returns True if two operands are not equal	a!=b
>	Greater than	Returns True if left operands is greater than the right	a>b
<	Less than	Returns True if left operand is less than the right	a<b
>=	Greater than or equal to	Returns True if left operands is greater than or equal to the right	a>=b
<=	Less than or equal to	Returns True if left operand is less than or equal to the right	a<=b

Logical Operators:

These operators perform binary operations to process data at machine level (logic gates like AND, OR, NOR, NAND etc.). If the result is true, it is denoted by returning '1'. The negative result is expressed by '0'. Here is the description of three basic logical operators in C which are extensively used in decision making.

Operator	Meaning	Description	Example
&&	Logical AND/ Conjunction	Returns True if and only if both statements are true	X and Y
||	Logical OR / Disjunction	Returns True if any of the statement is true	X or Y
!	Logical NOT/ Negation	Returns true if operand is a negation	not X

For better understanding of Logical operators you should know about the truth table.



A	B	A && B	A || B	~A
1	1	1	1	0
1	0	0	1	0
0	1	0	1	1
0	0	0	0	1

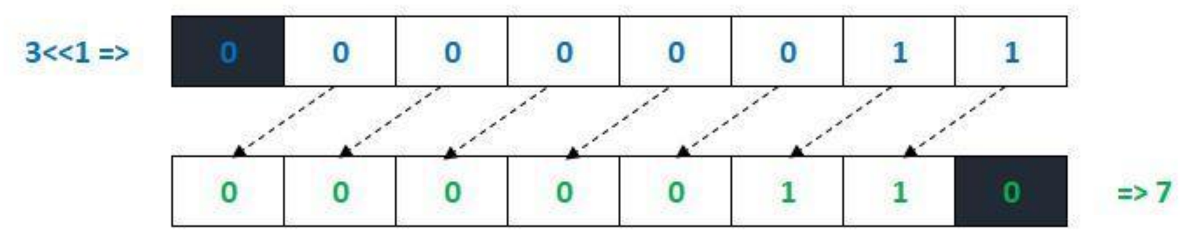
Truth Table for Logical Operators

The complement of AND is called NAND and OR is called NOR. They are used in conjunction with other operators like A! &B, A! =B etc.

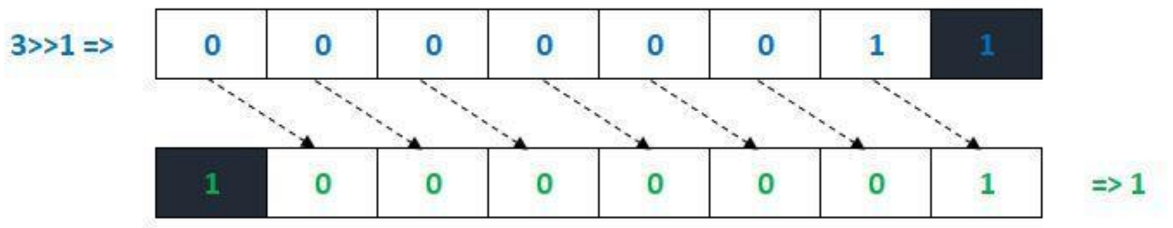
Operators	Meaning	Description
&	Binary AND	Result is 1 if both operands are true otherwise 0
|	Binary OR	Result is 1if any one operand is true otherwise 0
^	Binary XOR	Result is 1 if it's both operands are different and 0 if both operands are same
~	Binary Ones Complement	Result is the negation of the operand
<<	Binary Left Shift	Aligns the bits to the left
>>	Binary Right Shift	Aligns the bits to the right

Shift Operators in C

Bitwise Shift operators '<<' and '>>' are called binary left shift and the right shift operators respectively. The value of the operands is the left side of moved by the amount specified on the right-hand side of the operator.



Bitwise Shift Left Representation



Assignment Operators

As its name indicates , assignment operators are used to assign values to variables. '=' (equals) is the most basic type of them assigning the value at the right-hand side to the left-hand side. C=A+B will impose the value of (A+B) to C. Below table gives you the other assignment operators used in C to perform arithmetic operations.

Operators	Example	Meaning
=	a = 10	
+=	a+=10	a=a+10
-=	a-=10	a=a-10
*=	a*=10	a=a*10
/=	a/=10	a=a/10
%=	a%=10	a=a

• LAB EXERCISE:

Write a C program that accepts two integers from the user and performs arithmetic, relational, and logical operations on them. Display the results. 5. Control Flow Statements in C

```
#include<stdio.h>

#include<conio.h>

void main()

{

    int a,b,c;

    clrscr();

    printf("\nEnter value A:");

    scanf("%d",&a);

    printf("\nEnter value B:");

    scanf("%d",&b);

    c=a+b;

    printf("\nAddition of %d & %d is: %d ",a,b,c);

    c=a-b;

    printf("\nSubraction of %d & %d is: %d ",a,b,c);

    c=a*b;

    printf("\nMultiplication of %d & %d is: %d ",a,b,c);

    c=a/b;

    printf("\ndivision of %d & %d is: %d ",a,b,c);

    c=a%b;

    printf("\nModule of %d & %d is: %d",a,b,c);

    getch();

}
```

5. Control Flow Statements in C

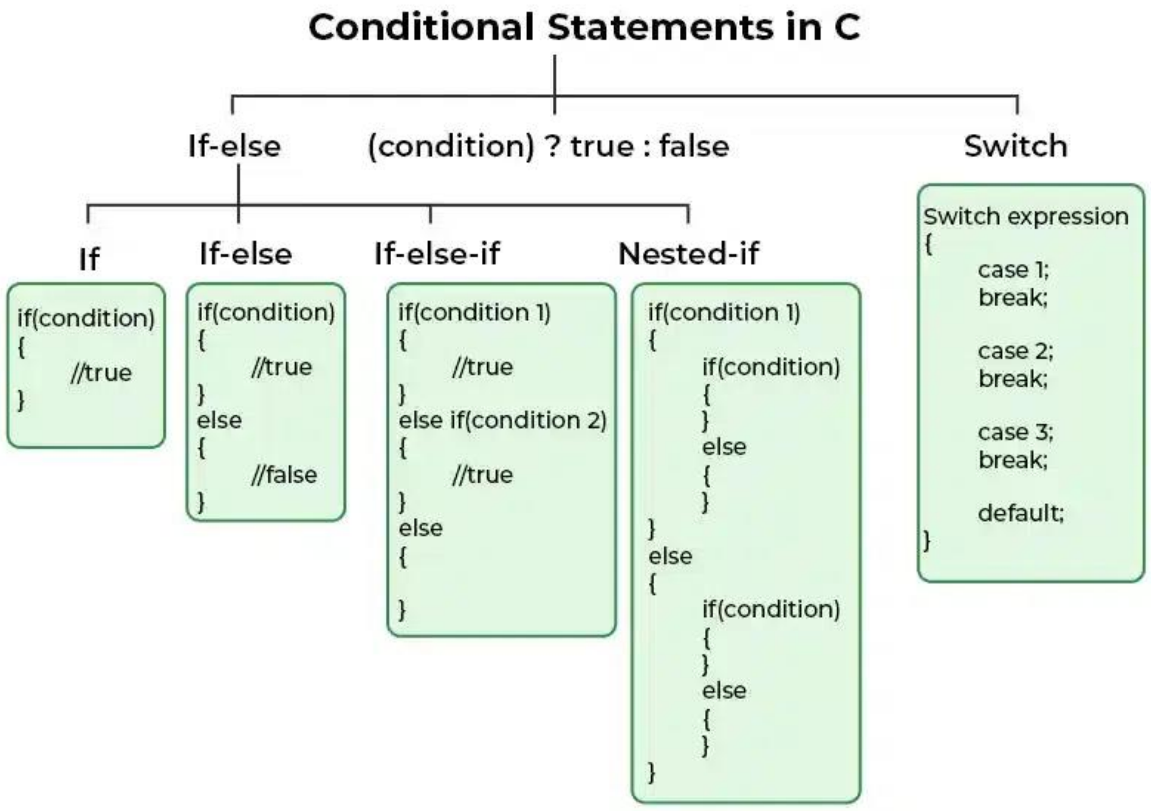
• THEORY EXERCISE:

Explain decision-making statements in C (if, else, nested if-else, switch). Provide examples of each.

In C, programs can choose which part of the code to execute based on some condition. This ability is called **decision making** and the statements used for it are called **conditional statements.** These statements evaluate one or more conditions and make the decision whether to execute a block of code or not.

Types of Conditional Statements in C

In the above program, we have used if statement, but there are many different types of conditional statements available in C language:



```
if(condition)
{
        //true
}
```

```
if(condition)
{
        //true
}
else
{
        //false
}
```

```
if(condition 1)
{
        //true
}
else if(condition 2)
{
        //true
}
else
{

}
```

```
if(condition 1)
{
        if(condition)
        {
        }
        else
        {
        }
}
else
{
        if(condition)
        {
        }
        else
        {
        }
}
```

```
Switch expression
{
        case 1;
        break;

        case 2;
        break;

        case 3;
        break;

        default;
}
```

1. if in C

The if statement is the simplest decision-making statement. It is used to decide whether a certain statement or block of statements will be executed or not i.e if a certain condition is true then a block of statements is executed otherwise not.

2. if-else in C

The **if** statement alone tells us that if a condition is true, it will execute a block of statements and if the condition is false, it won't. But what if we want to do something else when the condition is false? Here comes the C **else** statement. We can use the **else** statement with the **if** statement to execute a block of code when the condition is false. The if-else statement consists of two blocks, one for false expression and one for true expression.

3. Nested if-else in C

A nested if in C is an if statement that is the target of another if statement. Nested if statements mean an if statement inside another if statement. Yes, C allow us to nested if statements within if statements, i.e, we can place an if statement inside another if statement.

4. if-else-if Ladder in C

The if else if statements are used when the user has to decide among multiple options. The C if statements are executed from the top down. As soon as one of the conditions controlling the if is true, the statement associated with that if is executed, and the rest of the C else-if ladder is bypassed. If none of the conditions is true, then the final else statement will be executed. if-else-if ladder is similar to the switch statement.

5. switch Statement in C

The switch case statement is an alternative to the if else if ladder that can be used to execute the conditional code based on the value of the variable specified in the switch statement. The switch block consists of cases to be executed based on the value of the switch variable.

6. Conditional Operator in C

The conditional operator is used to add conditional code in our program. It is similar to the if-else statement. It is also known as the ternary operator as it works on three operands.

7. Jump Statements in C

These statements are used in C for the unconditional flow of control throughout the functions in a program. They support four types of jump statements:

A) break

This loop control statement is used to terminate the loop. As soon as the break statement is encountered from within a loop, the loop iterations stop there, and control returns from the loop immediately to the first statement after the loop.

B) continue

This loop control statement is just like the break statement. The *continue* statement is opposite to that of the break *statement*, instead of terminating the loop, it forces to execute the next iteration of theloop.
As the name suggests the continue statement forces the loop to continue or execute the next iteration. When the continue statement is executed in the loop, the code inside the loop following the continue statement will be skipped and the next iteration of the loop will begin.

C) return

The return in C returns the flow of the execution to the function from where it is called. This statement does not mandatorily need any conditional statements. As soon as the statement is executed, the flow of the program stops immediately and returns the control from where it was called. The return statement may or may not return anything for a void function, but for a non-void function, a return value must be returned.

6. Looping in C

• THEORY EXERCISE:

Compare and contrast while loops, for loops, and do-while loops. Explain the scenarios in which each loop is most appropriate.

While Loop

Initialization is not the integral part The loop continuation condition test is done at the beginning of the loop. The Loop variable is not the integral part of the loop. It should be handled explicitly.

The loop body is never executed if the condition is false. That is loop body is executed zero or more times.

Syntax:

while (testexpression) statement1;

Do- While Loop

Initialization is not the integral part The loop continuation condition test is done at the end of the loop.

The loop variable is not the integral part of the loop. It should be handled explicitly.

The loop body is executed at least once if the condition is false. That is loop body is executed one or more times.

Syntax:

```
do{
statement1;
} while (test expression);
```

For Loop

Initialization is within loop constructor. The loop continuation condition test is done at the beginning of the loop. The loop variable is an integral part of the loop. It is handled within the loop construct.

The loop body is never executed if the condition is false. That is loop body is executed zero or more times.

Syntax:

```
for(expression1;expression2;expression3)
{
statement1;
}
```

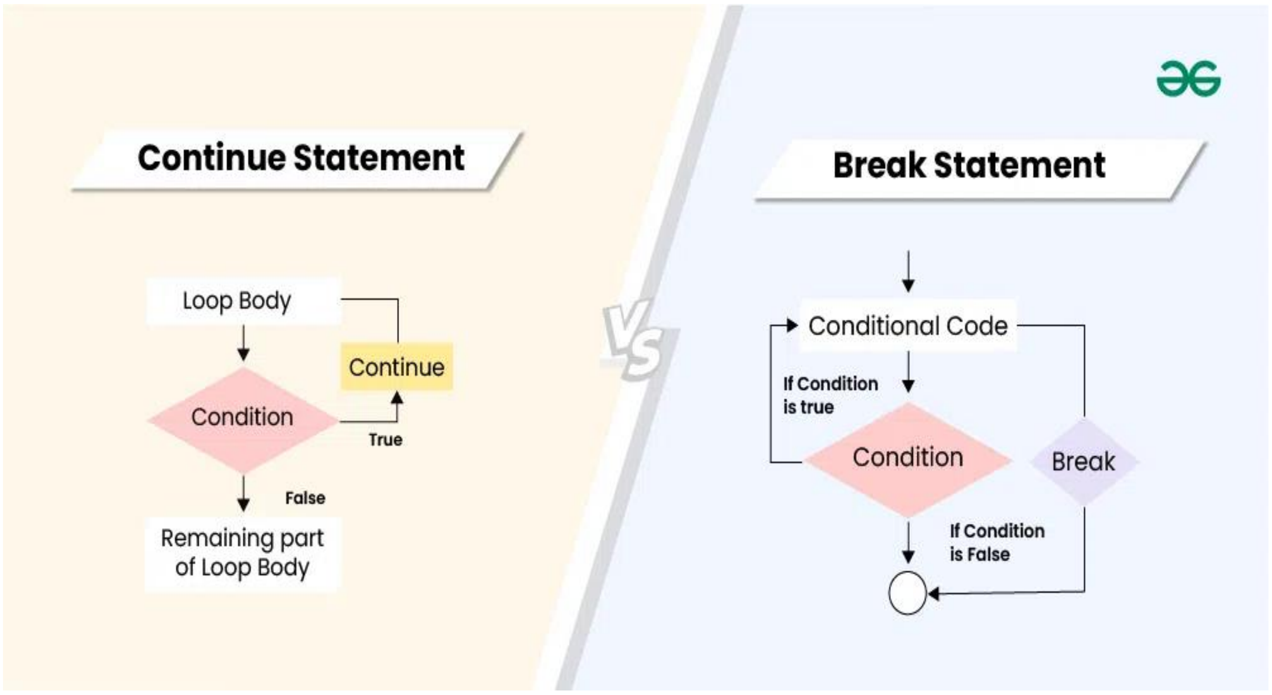
7. Loop Control Statements

• THEORY EXERCISE:

Explain the use of break, continue, and goto statements in C. Provide examples of each.

Break and **Continue** statements are the keywords that are used always within a loop. The purpose of a break and continue statement is to stop a running loop or to continue a particular iteration. In this article we will see what are the break and continue statements, what is their use and what are the differences between them.

Break vs Continue Statement



Break Statement:

A break statement is used when we want to terminate the running loop whenever any particular condition occurs. Whenever a break statement occurs loop breaks and stops executing.

Example:

```
#include<stdio.h>
#include<conio.h>
void main()
{
    int i;
    clrscr();
    printf("break Statement:");
    for(i=0;i<10;i++)
    {
            if(i==5)
            {
                    break;
            }
            printf("\n %d",i);
    }
    getch();
}
```

Continue Statement:

On the other side continue statement is used when we have to skip a particular iteration. Whenever we write continue statement the whole code after that statement is skipped and loop will go for next iteration.

Example:

```
#include<stdio.h>
#include<conio.h>
void main()
{
    int i;
    clrscr();
    printf("continue Statement:");
    for(i=0;i<10;i++)
    {
            if(i==5)
            {
                    continue;
            }
            printf("\n %d",i);
    }
    getch();
}
```

8.Function in C

• THEORY EXERCISE:

What are functions in C? Explain function declaration, definition, and how to call a function. Provide examples.

A **function in C** is a set of statements that, when called, perform some specific tasks. It is the basic building block of a C program that provides modularity and code reusability. They are also called subroutines or procedures in other languages.

Function Definition

A function definition informs the compiler about the function's name, its return type, and what it does. It is compulsory to define a function before it can be called.

- **return_type:** type of value the function return.
- **name:** Name of the function
- **Body of function:** Statements inside **curly brackets { }** are executed when function call.

- **Example:**

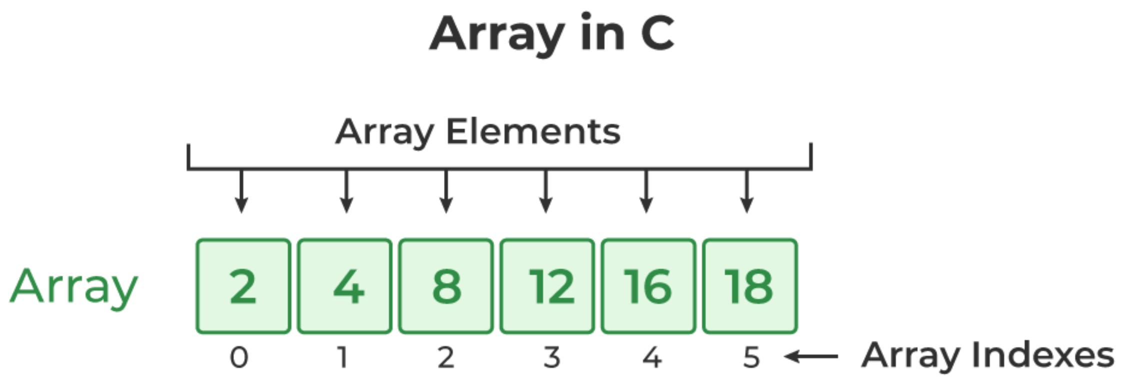
```
#include <stdio.h>
#include <conio.h>
main()
{
    clrscr();
   printf("hello world");
    return 0;
    getch();

}
```

9.Arrays in C

• THEORY EXERCISE:

Explain the concept of arrays in C. Differentiate between one-dimensional and multi-dimensional arrays with examples.

An array in C is a fixed-size collection of similar data items stored in contiguous memory locations. It can be used to store the collection of primitive data types such as int, char, float, etc., as well as derived and user-defined data types such as pointers, structures, etc.

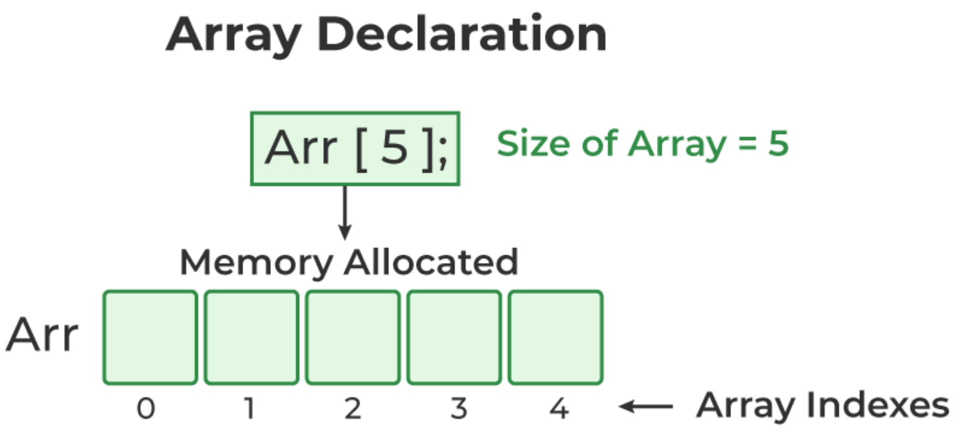


Creating an Array in C

The whole process of creating an array in C language can be divided in to two primary sub processes i.e.

1. Array Declaration

Array declaration is the process of specifying the type, name, and size of the array. In C, we have to declare the array like any other variable before using it. When we declare an array in C, the compiler allocates the memory block of the specified size to the array name.



2. Array Initialization

Initialization in C is the process to assign some initial value to the variable. When the array is declared or allocated memory, the elements of the array contain some garbage value. So, we need to initialize the array to some meaningful values. Which can be done using initializer list, which is the list of values enclosed within braces { } separated by a comma.

- One dimensional array

Example:

```
#include<stdio.h>
#include<conio.h>
void main()
{
int a[5],i;
clrscr();
for(i=0;i<5;i++)
{
printf("\nEnter value:");
scanf("%d",&a[i]);
}
for(i=0;i<5;i++)
{
printf("\nA[%d]:",a[i]);
}
getch();
}
```

- Two dimensional:

Example:

```
#include<stdio.h>
#include<conio.h>
void main()
{
    int a[3][3],b[3][3],c[3][3],i,j;
    clrscr();
    printf("Enter 2D array A:\n");
    for(i=0;i<3;i++)
    {
            for(j=0;j<3;j++)
            {
                    printf("Enter value for A[%d][%d]:",i,j);
                    scanf("%d",&a[i][j]);
            }
    }
    printf("\nEnter 2D array B:\n");
    for(i=0;i<3;i++)
    {
            for(j=0;j<3;j++)
            {
                    printf("Enter value for A[%d][%d]:",i,j);
                    scanf("%d",&b[i][j]);
            }
    }
    for(i=0;i<3;i++)
    {
        for(j=0;j<3;j++)
        {
            c[i][j]=a[i][j]+b[i][j];
        }
    }
    printf("\nAddition of two matrix:\n");
    for(i=0;i<3;i++)
    {
        for(j=0;j<3;j++)
        {
            printf("\t%d",c[i][j]);
        }
        printf("\n");
    }
    getch();
}
```

10.Pointers in C

- THEORY EXERCISE:

Explain what pointers are in C and how they are declared and initialized. Why are pointers important in C?

A **pointer** is a variable that stores the **memory address** of another variable. Instead of holding a direct value, it has the address where the value is stored in memory. This allows us to manipulate the data stored at a specific memory location without actually using its variable. It is the backbone of low-level memory manipulation in C.

Declare a Pointer

A pointer is declared by specifying its name and type, just like simple variable declaration but with an **asterisk (*)** symbol added before the pointer's name.

Example:

int *ptr;

Initialize the Pointer

Pointer initialization means assigning some address to the pointer variable. In C, the **(&) addressof operator** is used to get the memory address of any variable. This memory address is then stored in a pointer variable.

Example:

int var = 10;

// Initializing ptr

int *ptr = &var;

Features of Pointers:

1. Pointers save memory space.

2. Execution time with pointers is faster because data are manipulated with the address, that is, direct access to memory location.
3. Memory is accessed efficiently with the pointers. The pointer assigns and releases the memory as well. Hence it can be said the Memory of pointers is dynamically allocated.
4. Pointers are used with data structures. They are useful for representing two-dimensional and multi-dimensional arrays.
5. An array, of any type, can be accessed with the help of pointers, without considering its subscript range.
6. Pointers are used for file handling.
7. Pointers are used to allocate memory dynamically.
8. In C++, a pointer declared to a base class could access the object of a derived class. However, a pointer to a derived class cannot access the object of a base class.

Uses of pointers:

1. To pass arguments by reference
2. For accessing array elements
3. To return multiple values
4. Dynamic memory allocation
5. To implement data structures
6. To do system-level programming where memory addresses are useful

11. Strings in C

• THEORY EXERCISE:

Explain string handling functions like strlen(), strcpy(), strcat(), strcmp(), and strchr(). Provide examples of when these functions are useful.

C language provides various built-in functions that can be used for various operations and manipulations on strings. These string functions make it easier to perform tasks such as string copy, concatenation, comparison, length, etc. The **<string.h>** header file contains these string functions.

The below table lists some of the most commonly used string functions in the C language**:**

Function	**Description**	**Syntax**
strlen()	Find the length of a string excluding '\0' NULL character.	**strlen**(str);
strcpy()	Copies a string from the source to the destination.	**strcpy**(dest, src);
strncpy()	Copies n characters from source to the destination.	**strncpy**(dest, src, n);
strcat()	Concatenate one string to the end of another.	**strcat**(dest, src);

Function	**Description**	**Syntax**
strncat()	Concatenate n characters from the string pointed to by src to the end of the string pointed to by dest.	**strncat**(dest, src, n);
strcmp()	Compares these two strings lexicographically.	**strcmp**(s1, s2);
strncmp()	Compares first n characters from the two strings lexicographically.	**strncmp**(s1, s2, n);
strchr()	Find the first occurrence of a character in a string.	**strchr**(s, c);
strrchr()	Find the last occurrence of a character in a string.	**strchr**(*s*, *ch*);
strstr()	First occurrence of a substring in another string.	**strstr**(s, subS);
sprintf()	Format a string and store it in a string buffer.	**sprintf**(s, format, ...);
strtok()	Split a string into tokens based on specified delimiters.	**strtok**(s, delim);

12. Structures in C

• THEORY EXERCISE:

Explain the concept of structures in C. Describe how to declare, initialize, and access structure members.

In C, a **structure** is a user-defined data type that can be used to group items of possibly different types into a single type. The **struct** keyword is used to define a structure. The items in the structure are called its **member** and they can be of any valid data type.

Syntax of Structure

There are two steps of creating a structure in C:

1. Structure Definition
2. Creating Structure Variables

Structure Definition

A structure is defined using the **struct** keyword followed by the structure name and its members. It is also called a structure **template** or structure **prototype**, and no memory is allocated to the structure in the declaration.

***struct**structure_name{*
data_type1member1;
data_type2member2;
…
};

- **structure_name:** Name of the structure.
- **member1, member2, ...:** Name of the members.
- **data_type1**, **data_type2**, ...: Type of the members.

Be careful not to forget the semicolon at the end.

Creating Structure Variable

After structure definition, we have to create variable of that structure to use it. It is similar to the any other type of variable declaration:

struct *strcuture_name var;*

We can also declare structure variables with structure definition.

struct*structure_name{*
…
}var1, var2....;

Basic Operations of Structure

Following are the basic operations commonly used on structures:

1. Access Structure Members

To access or modify members of a structure, we use the **(.) dot operator**. This is applicable when we are using structure variables directly.

structure_name.member1;
strcuture_name.member2;

In the case where we have a pointer to the structure, we can also use the **arrow operator** to access the members.

structure_ptr->member1
structure_ptr -> member2

2. Initialize Structure Members

Structure members **cannot be** initialized with the declaration. For example, the following C program fails in the compilation.

struct*structure_name{*
data_type1 member1 = value1; // COMPILER ERROR: cannot initializemembershere
data_type2 member2 = value2; // COMPILER ERROR: cannot initializemembershere
…
};

The reason for the above error is simple. When a datatype is declared, no memory is allocated for it. Memory is allocated only when variables are created. So there is no space to store the value assigned.

We can initialize structure members in 4 ways which are as follows:

Default Initialization

By default, structure members are not automatically initialized to 0 or NULL. Uninitialized structure members will contain garbage values. However, when a structure variable is declared with an initializer, all members not explicitly initialized are zero-initialized.

struct structure_name = {0}; // Both x and y are initialized to 0

Initialization using Assignment Operator

structstructure_namestr;
str.member1=value1;
....

Note: We cannot initialize the arrays or strings using assignment operator after variable declaration.

Initialization using Initializer List

***struct** structure_name str = {value1, value2, value3 ....};*

In this type of initialization, the values are assigned in sequential order as they are declared in the structure template.

Initialization using Designated Initializer List

Designated Initialization allows structure members to be initialized in any order. This feature has been added in the C99 standard.

***struct** structure_name str = { .member1 = value1, .member2 = value2, .member3 = value3 };*

13. File Handling in C

• THEORY EXERCISE:

Explain the importance of file handling in C. Discuss how to perform file operations like opening, closing, reading, and writing files.

File handling in C is the process in which we create, open, read, write, and close operations on a file. C language provides different functions such as **fopen()**, **fwrite()**, **fread()**, **fseek()**, **fprintf()**, etc. to perform input, output, and many different C file operations in our program.

Need of File Handling in C

So far, the operations in C program are done on a prompt/terminal in which the data is only stored in the temporary memory (RAM). This data is deleted when the program is closed. But in the software industry, most programs are written to store the information fetched from the program. The use of file handling is exactly what the situation calls for.

File handling allows us to read and write data on files stored in the secondary memory such as hard disk from our C program.

C File Operations

C language provides the following different operations that we can perform on a file from our C program:

1. **Creating a new file.**
2. **Opening an existing file.**
3. **Reading from file.**
4. **Writing to a file.**
5. **Moving to a specific location in a file.**
6. **Closing a file.**

Components in C File Handling

Before we move on to the file handling, we need to understand a few concepts that are essential in file handling.

1. **Text Files**: A text file contains data in the **form of ASCII characters** and is generally used to store a stream of characters.
    - Each line in a text file ends with a new line character ('\n').
    - It can be read or written by any text editor.
    - They are generally stored with **.txt** file extension.
    - Text files can also be used to store the source code.
2. **Binary Files**: A binary file contains data in **binary form (i.e. 0's and 1's)** instead of ASCII characters. They contain data that is stored in a similar manner to how it is stored in the main memory.
    - The binary files can be created only from within a program and their contents can only be read by a program.
    - More secure as they are not easily readable.
    - They are generally stored with **.bin** file extension.

More Functions for C File Operations

The following table lists some more functions that can be used to perform file operations or assist in performing them.

Functions	Description
fopen()	It is used to create a file or to open a file.
fclose()	It is used to close a file.
fgets()	It is used to read a file.
fprintf()	It is used to write blocks of data into a file.
fscanf()	It is used to read blocks of data from a file.
getc()	It is used to read a single character to a file.
putc()	It is used to write a single character to a file.
fseek()	It is used to set the position of a file pointer to a mentioned location.
ftell()	It is used to return the current position of a file pointer.
rewind()	It is used to set the file pointer to the beginning of a file.
putw()	It is used to write an integer to a file.
getw()	It is used to read an integer from a file.