***Module 2–Introduction to Programming***

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

**The History and Evolution of C Programming: Its Importance and Continued Relevance**

The C programming language stands as one of the most influential and enduring languages in the history of computer science. Since its creation in the early 1970s, C has shaped software development paradigms, enabled the birth of many modern languages, and remained a critical tool in programming even after five decades. Understanding C’s history and evolution reveals why it retains importance and continues to be widely used today.

**Origins and Development**

C was developed in 1972 by Dennis Ritchie at Bell Labs. It evolved from an earlier language called B, created by Ken Thompson, also at Bell Labs. The original motivation behind C was to provide a powerful yet efficient programming language that could be used to implement the UNIX operating system. Prior to C, operating systems were often written in assembly language, which was cumbersome and machine-specific.

Ritchie designed C to combine the low-level access and efficiency of assembly language with the abstraction and readability of higher-level languages. The result was a language with simple syntax, efficient execution, and the ability to manipulate hardware-level operations directly. This made C uniquely suited for system programming.

**Evolution and Standardization**

The initial spread of C came alongside UNIX, which was also gaining traction. As UNIX and C spread across academic and commercial institutions, a need for standardization arose. The original version of C was not formally documented, which led to variations and portability issues.

In 1978, Brian Kernighan and Dennis Ritchie published *The C Programming Language*, a book often referred to as “K&R C.” This book became the de facto standard for C programmers and widely popularized the language.

Later, to address inconsistencies and support evolving hardware and software requirements, the American National Standards Institute (ANSI) established a committee that produced the ANSI C standard in 1989, also known as C89. The International Organization for Standardization (ISO) adopted it shortly after, ensuring C’s portability and longevity.

Subsequent standards—C99, C11, and C18—added features such as inline functions, improved support for international character sets, multi-threading, and better type safety, allowing C to stay relevant in modern computing environments.

**Importance of C Programming**

The importance of C can be seen in several dimensions:

1. **Foundation for Modern Software:** C is the basis for many other languages, including C++, Objective-C, C#, and even influenced Java and JavaScript. Learning C provides deep insight into computer architecture, memory management, and compilation.
2. **Systems Programming:** C’s ability to provide direct hardware access and efficient execution makes it ideal for operating systems, embedded systems, firmware, and device drivers. Major operating systems like Windows, Linux, and macOS have core components written in C.
3. **Portability:** Programs written in C can be compiled on almost any platform with a compliant compiler. This portability is critical for cross-platform software development.
4. **Performance:** C strikes a balance between abstraction and control, producing highly optimized machine code. This is essential in resource-constrained environments or applications requiring high performance.
5. **Legacy Codebase:** Vast amounts of legacy code and libraries exist in C, especially in critical software infrastructure, ensuring continued demand for C expertise.

**Why C Is Still Used Today**

Despite the emergence of many modern languages with features like garbage collection, object orientation, and advanced abstractions, C remains indispensable for several reasons:

* **Efficiency and Control:** Many performance-critical applications require fine-tuned control over memory and processor instructions, which higher-level languages abstract away.
* **Embedded Systems:** C is the dominant language for microcontrollers, IoT devices, and embedded systems, where hardware constraints and real-time operation are paramount.
* **Interoperability:** C serves as a lingua franca for interfacing different programming languages and systems through well-defined application programming interfaces (APIs) and foreign function interfaces (FFIs).
* **Educational Value:** C is widely taught in computer science curricula as it provides foundational knowledge about how software interacts with hardware, memory management, and low-level computation.
* **Community and Tooling:** A mature ecosystem of compilers, debuggers, and development tools supports C development robustly.

**Conclusion**

The C programming language’s journey from a tool to implement UNIX to a foundational pillar of modern computing underscores its immense impact. Its design principles of efficiency, simplicity, and portability have allowed it to evolve yet remain relevant. Today, C continues to be a vital language in systems programming, embedded applications, and education. Its legacy endures because it uniquely combines power and precision, traits that remain crucial in the ever-expanding domain of computing.

**2. 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.**

**1. Installing GCC Compiler**

GCC (GNU Compiler Collection) is the most widely used C compiler. How you install it depends on your operating system:

**On Windows:**

* **Option 1: Install MinGW (Minimalist GNU for Windows)**
  1. Go to [MinGW official website](http://www.mingw.org/).
  2. Download the MinGW installer (mingw-get-setup.exe).
  3. Run the installer and select the gcc-core, gcc-g++, and binutils packages.
  4. Complete the installation.
  5. Add MinGW's bin directory (e.g., C:\MinGW\bin) to your system's **Environment Variables** → **Path**.
  6. Open Command Prompt and type gcc --version to confirm installation.
* **Option 2: Install WSL (Windows Subsystem for Linux)**
  1. If you prefer a Linux-like environment on Windows, install WSL and then install GCC through Linux package managers like apt (Ubuntu) or yum (Fedora).

**2. Setting Up an IDE**

You can choose any IDE for C programming. Below are instructions for three popular options:

**A. Dev C++ (Windows Only)**

1. Download Dev C++ from Bloodshed or Orwell Dev C++.
2. Run the installer and follow the prompts.
3. Dev C++ usually comes bundled with MinGW, so the compiler is ready to use.
4. Open Dev C++, create a new C project or file.
5. Write your code and press **Compile & Run** (usually F9).

**B. Visual Studio Code (Cross-platform)**

1. Download and install VS Code from <https://code.visualstudio.com/>.
2. Install the C/C++ extension by Microsoft from the Extensions Marketplace.
3. Ensure GCC is installed and accessible from your command line (as per step 1).
4. Set up your project folder in VS Code.
5. Create a tasks.json file in the .vscode folder to configure build commands, e.g., compile with GCC.
6. You may also configure launch.json for debugging support.
7. Use the terminal inside VS Code to compile and run your C programs.

**C. Code::Blocks (Cross-platform)**

1. Download Code::Blocks from http://www.codeblocks.org/downloads.
2. Choose the installer with MinGW included (e.g., codeblocks-20.03mingw-setup.exe).
3. Run the installer.
4. Code::Blocks will automatically configure the bundled GCC compiler.
5. Open Code::Blocks, create a new console project.
6. Write your C code and press **Build and Run**.

**Summary**

| **Step** | **Windows** | **macOS** | **Linux** |
| --- | --- | --- | --- |
| **Install compiler** | MinGW or WSL | Xcode Command Line Tools/Homebrew GCC | Su do apt install build-essential |
| **IDE Options** | Dev C++, VS Code, Code::Blocks | VS Code, Code::Blocks | VS Code, Code::Blocks |
| **Configure IDE** | Usually auto-configured (Dev C++, Code::Blocks) or manual setup (VS Code) | Manual setup for VS Code | Manual setup for VS Code |

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

**Basic Structure of a C Program**

A simple C program includes the following key elements:

1. **Header Files**
2. **Main Function**
3. **Comments**
4. **Data Types**
5. **Variables**
6. **Header Files:** Header files tell the compiler which libraries to include for specific functions (like input/output, math operations, etc.)
7. **Main Function:** Every C program must have a main() function — this is the entry point of the program. int means the function returns an integer. return 0; indicates the program ended successfully.
8. **Comments:** Comments are used to make code more understandable. The compiler ignores them.
9. **Data Types**

C has several basic data types used to declare variables.

| **Type** | **Description** | **Example** |
| --- | --- | --- |
| int | Integer values | 5, -3 |
| float | Floating-point numbers | 3.14, -2.5 |
| char | Single character | 'a', 'Z' |
| double | Double precision float | 3.14159265 |

1. **Variables:** Variables store data. They must be declared before use.

**🧠 Summary**

| **Component** | **Role** |
| --- | --- |
| #include | Includes external libraries |
| main() | Entry point of the program |
| // or /\* \*/ | Comments for documentation |
| int, float | Data types for variable declarations |
| printf() | Function to print output |

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

**1. Arithmetic Operators**

Used for mathematical operations.

| **Operator** | **Description** | **Example** | **Result** |
| --- | --- | --- | --- |
| + | Addition | 5 + 3 | 8 |
| - | Subtraction | 5 - 3 | 2 |
| \* | Multiplication | 5 \* 3 | 15 |
| / | Division | 5 / 2 | 2 |
| % | Modulus (remainder) | 5 % 2 | 1 |

**2. Relational (Comparison) Operators**

Used to compare values; result is either 1 (true) or 0 (false).

| **Operator** | **Meaning** | **Example** |
| --- | --- | --- |
| == | Equal to | a == b |
| != | Not equal to | a != b |
| > | Greater than | a > b |
| < | Less than | a < b |
| >= | Greater or equal | a >= b |
| <= | Less or equal | a <= b |

**3**. Logical Operators

Used to combine multiple conditions.

| Operator | Description | Example |
| --- | --- | --- |
| && | Logical AND | a > 0 && b > 0 |
| ` |  | ` |
| ! | Logical NOT | !(a > 0) |

4. Assignment Operators

Used to assign values to variables.

| Operator | Example | Equivalent |
| --- | --- | --- |
| = | a = 10 | Assign 10 to a |
| += | a += 5 | a = a + 5 |
| -= | a -= 3 | a = a - 3 |
| \*= | a \*= 2 | a = a \* 2 |
| /= | a /= 2 | a = a / 2 |
| %= | a %= 3 | a = a % 3 |

**5. Increment and Decrement Operators**

Used to increase or decrease value by 1.

| **Operator** | **Example** | **Description** |
| --- | --- | --- |
| ++ | a++ | Post-increment (use, then add) |
| -- | --a | Pre-decrement (subtract, then use) |

**6. Bitwise Operators**

Operate on binary bits of integers.

| **Operator** | **Meaning** | **Example** |
| --- | --- | --- |
| & | AND | a & b |
| ` | ` | OR |
| ^ | XOR | a ^ b |
| ~ | NOT (1's complement) | ~a |
| << | Left shift | a << 1 |
| >> | Right shift | a >> 1 |

**7. Conditional (Ternary) Operator**

A compact form of if-else.

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(condition) ? value\_if\_true : value\_if\_false;

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

In C programming, **decision-making statements** allow the program to take different actions based on certain conditions. These are essential for controlling the flow of the program. Here's a detailed explanation of the main types.

1. **if Statement:** The if statement executes a block of code only if the condition is true.

**Example:**

#include <stdio.h>

int main() {

int number = 10;

if (number > 0) {

printf("The number is positive.\n");

}

return 0;

}

1. **if-else Statement:** The if-else statement chooses between two blocks of code based on the condition.

**Example:**

#include <stdio.h>

int main() {

int number = -5;

if (number >= 0) {

printf("The number is non-negative.\n");

} else {

printf("The number is negative.\n");

}

return 0;

}

1. **Nested if-else Statement:** An if or else block can contain another if-else statement.

**Example:**

#include <stdio.h>

int main() {

int number = 0;

if (number >= 0) {

if (number == 0) {

printf("The number is zero.\n");

} else {

printf("The number is positive.\n");

}

} else {

printf("The number is negative.\n");

}

return 0;

}

**4. switch Statement:** The switch statement selects for execution one block of code out of many options based on the value of an expression (usually an integer or char).

**Example:**

#include <stdio.h>

int main() {

int day = 3;

switch (day) {

case 1:

printf("Monday\n");

break;

case 2:

printf("Tuesday\n");

break;

case 3:

printf("Wednesday\n");

break;

default:

printf("Another day\n");

}

return 0;

}

**Summary Table:**

| **Statement** | **Use Case** |
| --- | --- |
| if | Executes block if condition is true |
| if-else | Executes one of two blocks depending on condition |
| Nested if-else | Multiple conditions, complex decision making |
| switch | Efficient multiple-value comparison (especially with integers and characters) |

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

In C programming, loops are used to execute a block of code repeatedly under certain conditions. The main types of loops in C are:

* while loop
* for loop
* do-while loop

Each has different syntax and is best suited for particular scenarios. Here's a comparison and contrast of these loops, along with examples and use-case scenarios.

1. **while Loop:**

**Key Characteristics:**

* Entry-controlled loop (condition is checked before executing the loop body)
* May execute zero or more times
* Best for situations where the number of iterations is not known in advance

**Use Case:**

* Reading user input until a valid value is entered
* Reading data until EOF (end of file)

1. **for Loop**

**Key Characteristics:**

* Entry-controlled loop
* Best when the number of iterations is known
* Initialization, condition check, and increment are all in one line

**Use Case:**

* Iterating over arrays
* Running a loop a fixed number of times (e.g., print a table from 1 to 10)

1. **do-while Loop**

**Key Characteristics:**

* Exit-controlled loop (condition is checked after executing the loop body)
* Loop body always executes at least once
* Useful when the loop body needs to run before the condition is checked

**Use Case:**

* Menu-driven programs
* Prompting the user at least once (e.g., "Do you want to continue?")

**Comparison Table:**

| Feature | while loop | for loop | do-while loop |
| --- | --- | --- | --- |
| Condition checked | Before loop body | Before loop body | After loop body |
| Executes at least once | ❌ Not guaranteed | ❌ Not guaranteed | ✅ Always executes once |
| Use case | Unknown iterations | Known iterations | Must run once before checking |
| Syntax compactness | Moderate | Most compact | Slightly verbose |

**Choosing the Right Loop**

| **Scenario** | **Recommended Loop** |
| --- | --- |
| Run a block **at least once**, then repeat based on user input | do-while |
| Run a loop a **known number of times** | for |
| Run a loop with an **unknown number of iterations**, check condition first | while |

**7.Explain the use of break, continue, and go to statements in C. Provide examples of each.**

In C programming, break, continue, and go to are **jump control statements** that alter the normal flow of control in loops or code blocks.

**1. break Statement**

**Purpose:**

* Immediately **terminates** the nearest enclosing loop (for, while, or do-while) or switch statement.

**Use Cases:**

* Exiting a loop when a condition is met
* Terminating a switch case after execution

**2. continue Statement**

**Purpose:**

* **Skips** the rest of the loop body for the current iteration and jumps to the next iteration of the loop.

**Use Cases:**

* Ignoring specific cases in a loop
* Filtering values without breaking the loop

**3. goto Statement**

**Purpose:**

* Transfers control to a **labeled statement** anywhere in the same function.
* Often discouraged due to making code harder to read and debug.

**Use Cases:**

* Breaking out of deeply nested loops
* Handling errors in low-level or performance-critical code

**⚖️ Comparison Summary:**

| **Statement** | **Effect** | **Use Case** |
| --- | --- | --- |
| break | Exits the nearest loop or switch | Stop loop early |
| continue | Skips to next iteration of the loop | Skip specific iterations |
| goto | Jumps to a labeled part of code | Unstructured jump (not recommended) |

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

In **C programming**, a **function** is a **self-contained block of code** that performs a specific task. Functions help to organize code, reduce redundancy, and improve readability and maintainability.

**Use of Functions:**

* **Modularity**: Breaks code into manageable pieces.
* **Reusability**: Write once, use many times.
* **Abstraction**: Hides implementation details.
* **Testing and Debugging**: Easier to test individual parts of code.

**🔹 Components of a Function in C**

**1. Function Declaration (Prototype)**

* Tells the compiler about the function **name**, **return type**, and **parameters** before it's used.
* Typically placed before main().

**Example:**

int add(int a, int b);

**2. Function Definition**

* Contains the actual code (body) of the function.
* Can be written before or after main() (declaration required if after).

**Example:**

int add(int a, int b)

{

return a + b;

}

**3. Function Call**

* Executes the function.
* Must match the function's parameters in number and type.

**Example:**

int result = add(5, 3);

**Complete Example: Function that Adds Two Numbers**

#include <stdio.h>

// Function Declaration

int add(int a, int b);

int main() {

int x = 10, y = 20;

int sum = add(x, y); // Function Call

printf("Sum = %d\n", sum);

return 0;

}

// Function Definition

int add(int a, int b) {

return a + b;

}

**📝 Notes:**

* Functions **can** return any type (int, float, char, etc.) or void if no value is returned.
* If the function is defined **before** main(), the declaration is optional.
* You can also have **user-defined** and **standard library functions** (printf(), scanf(), etc.).

**Summary Table**

| **Part** | **Purpose** | **Location in Code** |
| --- | --- | --- |
| Declaration | Tells the compiler about the function | Before main() (usually) |
| Definition | Provides actual implementation | Anywhere (usually after main) |
| Call | Executes the function | Inside another function |

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

**Concept of Arrays in C**

In C programming, an array is a collection of elements of the same data type, stored in contiguous memory locations. Arrays allow you to store multiple values under a single variable name and access them using an index.

**Key Features of Arrays:**

* Elements are of the same type (e.g., all integers or all floats).
* The size must be defined at the time of declaration (either explicitly or implicitly).
* Indexing starts at 0.
* Arrays can be of one dimension (1D) or multi-dimensions (2D, 3D, etc.).

**1. One-Dimensional Array**

A **1D array** is like a list of elements, accessed using a single index

Example:

#include <stdio.h>

int main() {

int numbers[5] = {10, 20, 30, 40, 50};

// Accessing elements

printf("First element: %d\n", numbers[0]); // Output: 10

printf("Third element: %d\n", numbers[2]); // Output: 30

return 0;

}

Here, numbers is a one-dimensional array of 5 integers.

**2. Multi-Dimensional Array**

A **multi-dimensional array** is an array of arrays. The most common type is the **two-dimensional array**, often used to represent **matrices**.

**Example (2D Array):**

#include <stdio.h>

int main() {

int matrix[2][3] = {

{1, 2, 3},

{4, 5, 6}

};

// Accessing elements

printf("Element at [0][2]: %d\n", matrix[0][2]); // Output: 3

printf("Element at [1][1]: %d\n", matrix[1][1]); // Output: 5

return 0;

}

Here, matrix is a 2D array with 2 rows and 3 columns

**Key Differences:**

| **Feature** | **One-Dimensional Array** | **Multi-Dimensional Array** |
| --- | --- | --- |
| Structure | Linear (list) | Tabular (grid, matrix, cube, etc.) |
| Indexing | Single index (e.g., a[i]) | Multiple indices (e.g., a[i][j]) |
| Use Case | List of items (e.g., scores) | Tables, matrices, images, etc. |
| Memory Layout | Sequential elements | Row-wise or column-wise blocks |

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

In **C programming**, a **pointer** is a variable that stores the **memory address** of another variable. Pointers allow direct access to memory, enabling powerful and flexible programming techniques.

**Declaration and Initialization of Pointers:**

* data\_type refers to the type of variable the pointer will point to.
* The \* indicates that the variable is a pointer.

**Example:**

**int \*p; // p is a pointer to an integer**

**Initialization:**

A pointer is typically initialized with the address of a variable using the address-of operator &.

int a = 10;

int \*p = &a; // p now stores the address of a

**Accessing Value using Dereferencing (\*)**

**printf("Value of a: %d\n", \*p); // Dereferencing pointer p to get value of a**

**Illustration Example:**

**#include <stdio.h>**

**int main() {**

**int a = 42;**

**int \*ptr = &a;**

**printf("Address of a: %p\n", ptr); // prints address of a**

**printf("Value of a: %d\n", \*ptr); // prints value at address (42)**

**return 0;**

**}**

**Why Are Pointers Important in C?**

1. Direct Memory Access:
   * Pointers allow programs to manipulate memory directly, making C powerful and efficient.
2. Efficient Array and String Handling:
   * Arrays and strings are often handled using pointers for performance and flexibility.
3. Function Arguments (Call by Reference):
   * Pointers allow you to modify variables inside functions, enabling pass-by-reference behavior.
4. Dynamic Memory Allocation:
   * Pointers are essential when working with memory allocation functions like malloc(), calloc(), and free().
5. Data Structures:
   * Pointers are used to create complex data structures like linked lists, trees, and graphs.

Summary Table:

| Concept | Description |
| --- | --- |
| Pointer | Stores the memory address of a variable |
| Declaration | int \*p; – pointer to an int |
| Initialization | p = &a; – stores address of variable a |
| Dereferencing | \*p – accesses the value at the address |
| Importance | Enables low-level memory access, efficient data manipulation, dynamic memory, and advanced data structures |

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

**String Handling Functions in C**

In C, strings are arrays of characters terminated by a null character ('\0'). The C Standard Library provides several functions in the <string.h> header for handling strings.

**1. strlen() — String Length**

**Description:**

Returns the **length** of a string (number of characters before '\0'), **excluding** the null terminator.

**Example:**

#include <stdio.h>

#include <string.h>

int main() {

char str[] = "Hello";

printf("Length of string: %lu\n", strlen(str)); // Output: 5

return 0;

}

**Use Case:**

When you need to know how many characters are in a string (e.g., before allocating memory or looping through it).

**2. strcpy() — String Copy**

**Description:**

Copies the contents of one string into another.

**Example:**

#include <stdio.h>

#include <string.h>

int main() {

char src[] = "World";

char dest[20];

strcpy(dest, src);

printf("Copied string: %s\n", dest); // Output: World

return 0;

}

**Use Case:**

Used to copy string content (e.g., when storing user input or duplicating strings).

**3. strcat() — String Concatenation**

**Description:**

Appends (concatenates) the source string to the end of the destination string.

**Example:**

**#include <stdio.h>**

**#**include <string.h>

int main() {

char greeting[20] = "Hello ";

char name[] = "Alice";

strcat(greeting, name);

printf("Greeting: %s\n", greeting); // Output: Hello Alice

return 0;

}

**Use Case:**

To build messages or full sentences by joining multiple strings.

**4. strcmp() — String Comparison**

**Description:**

Compares two strings **lexicographically**.

* Returns 0 if both strings are equal.
* Returns < 0 if str1 < str2.
* Returns > 0 if str1 > str2.

**Example:**

**#include <stdio.h>**

**#include <string.h>**

**int main() {**

**char a[] = "apple";**

**char b[] = "banana";**

**int result = strcmp(a, b);**

**if (result < 0)**

**printf("a comes before b\n");**

**else if (result > 0)**

**printf("a comes after b\n");**

**else**

**printf("a and b are equal\n");**

**return 0;**

**}**

**Use Case:**

Used for sorting, searching, or checking equality of strings.

**5. strchr() — Find Character in String**

**Description:**

Searches for the **first occurrence** of a character in a string.

**Example:**

**#include <stdio.h>**

**#include <string.h>**

**int main() {**

**char text[] = "Hello, World!";**

**char \*ptr = strchr(text, 'W');**

**if (ptr != NULL)**

**printf("Found 'W' at position: %ld\n", ptr - text); // Output: 7**

**else**

**printf("Character not found.\n");**

**return 0;**

**}**

**Use core**

To locate specifc characters in a string (e.g., delimiter detection in parsers).

**Summary Table:**

| **Function** | **Purpose** | **Example Use Case** |
| --- | --- | --- |
| strlen() | Get length of a string | Loop through characters |
| strcpy() | Copy one string to another | Assign user input to a variable |
| strcat() | Append one string to another | Form a full name or message |
| strcmp() | Compare two strings lexicographically | Sort a list of strings |
| strchr() | Find first occurrence of a character | Find delimiter or specific letter |

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

**Structures in C**

A **structure** in C (struct) is a **user-defined data type** that allows grouping variables of **different data types** under a single name. Structures are useful for representing a record or an entity with multiple attributes.

**Why Use Structures?**

Structures help you:

* Combine different types of data.
* Organize complex data (e.g., representing a person, book, or employee).
* Build data structures like linked lists, trees, and stacks.
  1. **Declaring a Structure: This defines a structure named Person with three members: name, age, and height.**

**Example:**

struct Person {

char name[50];

int age;

float height;

};

**2. Declaring Structure Variables**

You can declare structure variables in two ways:

**A. Separately:**

struct Person p1;

**B. Combined with the structure:**

struct Person {

char name[50];

int age;

float height;

} p1, p2;

**3. Initializing a Structure**

You can initialize structure variables when declaring them:

struct Person p1 = {"Alice", 30, 5.6};

Or assign values individually:

strcpy(p1.name, "Alice");

p1.age = 30;

p1.height = 5.6;

Note: strcpy() is used for copying strings in C since = does not work for character arrays.

**4. Accessing Structure Members**

Use the **dot (.)** operator to access members of a structure variable:

printf("Name: %s\n", p1.name);

printf("Age: %d\n", p1.age);

printf("Height: %.1f\n", p1.height);

**5. Structures and Pointers**

You can also create a **pointer to a structure** and access members using the **arrow (->)** operator:

struct Person \*ptr = &p1;

printf("Name: %s\n", ptr->name);

printf("Age: %d\n", ptr->age);

struct Person \*ptr = &p1;

printf("Name: %s\n", ptr->name);

printf("Age: %d\n", ptr->age);

**Example Program:**

**#include <stdio.h>**

**#include <string.h>**

**struct Person {**

**char name[50];**

**int age;**

**float height;**

**};**

**int main() {**

**struct Person p1;**

**strcpy(p1.name, "Bob");**

**p1.age = 25;**

**p1.height = 6.1;**

**printf("Name: %s\n", p1.name);**

**printf("Age: %d\n", p1.age);**

**printf("Height: %.1f\n", p1.height);**

**return 0;**

**}**

**Summary**

| Concept | Syntax / Use |
| --- | --- |
| Declare structure | struct Person { char name[50]; int age; }; |
| Declare variable | struct Person p1; |
| Initialize | struct Person p1 = {"Alice", 30, 5.6}; |
| Access member | p1.name, p1.age |
| Pointer access | ptr->name, ptr->age |

**13.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**

**File handling** in C allows programs to **read from** and **write to** files on the disk. This is essential for:

* Storing data permanently (beyond the program's execution)
* Reading large datasets
* Creating logs and reports
* Transferring data between programs

C provides a set of functions from the **<stdio.h>** header for file operations.

**Basic File Operations in C**

| **Operation** | **Function** |
| --- | --- |
| Open a file | fopen() |
| Close a file | fclose() |
| Read a file | fscanf(), fgets(), fgetc() |
| Write to file | fprintf(), fputs(), fputc() |

**1. Opening a File – fopen()**

Common Modes:

| Mode | Description |
| --- | --- |
| "r" | Read (file must exist) |
| "w" | Write (creates file or truncates) |
| "a" | Append (adds to the end of file) |
| "r+" | Read & Write (file must exist) |
| "w+" | Read & Write (creates or overwrites) |
| "a+" | Read & Append |

Example:

FILE \*fp = fopen("data.txt", "w");

* 1. Writing to a File – fprintf(), fputs(), fputc()

fprintf(fp, "Name: %s\n", "Alice");

fputs("Hello, file!\n", fp);

fputc('A', fp);

* 1. Reading from a File – fscanf(), fgets(), fgetc()

char name[50];

fscanf(fp, "%s", name); // Reads formatted input

fgets(name, 50, fp); // Reads a line

char c = fgetc(fp); // Reads a single character

* 1. Closing a File – fclose()

fclose(fp);

Always close files after operations to free resources and flush output buffers.

**Complete Example: Writing and Reading a File**

**#include <stdio.h>**

**int main() {**

**FILE \*fp;**

**// Writing to a file**

**fp = fopen("sample.txt", "w");**

**if (fp == NULL) {**

**printf("Error opening file!\n");**

**return 1;**

**}**

**fprintf(fp, "Hello, World!\n");**

**fclose(fp);**

**// Reading from a file**

**fp = fopen("sample.txt", "r");**

**if (fp == NULL) {**

**printf("Error opening file!\n");**

**return 1;**

**}**

**char buffer[100];**

**fgets(buffer, 100, fp);**

**printf("Read from file: %s", buffer);**

**fclose(fp);**

**return 0;**

**}**

**Why File Handling Is Important in C**

1. Persistent Storage: Keeps data even after the program ends.
2. Data Logging: Records program activity (e.g., logs, reports).
3. Large Data Sets: Enables working with data larger than memory.
4. Communication: Shares data between programs or systems.

**Tips:**

* Always check if the file pointer is NULL after fopen().
* Use appropriate file modes.
* Don’t forget to fclose() every opened file.
* Prefer fgets() over fscanf() for reading strings to avoid buffer overflows.