≤Module 2 – Introduction to Programming≥

Overview of C Programming

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

The Importance of C

✓ Step 1: Install a C Compiler (GCC)

GCC (GNU Compiler Collection) is one of the most widely used C compilers.

For Windows:

You need to install a distribution of GCC like MinGW or TDM-GCC.

🔹 Option 1: Install MinGW (Minimalist GNU for Windows)

1. **Go to https://osdn.net/projects/mingw/releases/**
2. **Download `mingw-get-setup.exe` and run it.**
3. **In the installer:**
   - **Select the base packages: `mingw32-gcc-g++`, `mingw32-gcc-objc`, and `msys-base`.**
   - **Click Install.**
4. **After installation, add the path to `bin` directory to your System Environment Variables:**
   - **Example: `C:\MinGW\bin`**
   - **Go to Control Panel > System > Advanced system settings > Environment Variables → edit `Path`.**

To check if it's installed:

bash
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```
gcc --version
```

You should see version info in the terminal/command prompt.

✓ Step 2: Choose and Install an IDE

You can write and compile C code using various IDEs. Here's how to set up three popular ones:

🔹 A. Dev-C++

1. Download from https://sourceforge.net/projects/orwelldevcpp/
2. Run the installer and follow the prompts.
3. GCC is bundled with Dev-C++, so it works right out of the box.
4. Open Dev-C++ → File > New > Source File → write your C code → Save it as .c.
5. Click Compile & Run to test your code.

🔹 B. Visual Studio Code (VS Code)

VS Code is a lightweight editor that requires some setup to work with C.

Step-by-step setup:

1. Download and install VS Code: https://code.visualstudio.com/
2. Install GCC (MinGW) as shown above.
3. Open VS Code → Go to Extensions (Ctrl+Shift+X) → Search and install:
   - C/C++ by Microsoft
   - Optionally: Code Runner for easy code execution
4. Add a .c file, and save it.
5. Create a simple tasks.json file in .vscode folder to configure build settings. Example setup available upon request.

Tip: Run the program in a terminal using:

bash
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```
gcc filename.c -o output.exe
./output.exe
```

🔹 C. Code::Blocks

1. Download from http://www.codeblocks.org/downloads
2. Choose the version with mingw-setup (e.g., codeblocks-XX.XXmingw-setup.exe)
3. Install it. It includes GCC, so no need for separate compiler installation.
4. Open Code::Blocks → File > New > Project > Console Application → Choose C.
5. Follow the wizard and start coding.

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3. Basic Structure of a C Program THEORY EXERCISE: o Explain the basic structure of a C program, including headers, main function, comments, data types, and variables. Provide examples.

Dev-C++			
VS Code	✗ **No**	**Medium**	✓ **High**

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Tools

C became the foundation for many important developments in computing:

- **Operating Systems: Unix, Linux, and parts of Windows are written in C.**
- **Embedded Systems: Due to its low-level memory control and efficiency, C is widely used in microcontrollers and firmware.**
- **Programming Languages: Many popular languages such as C++, Java, and Python have roots in or are influenced by C.**
- **Compilers and Tools: Many compilers and development tools are themselves written in C.**

Its syntax and structure have also influenced nearly all modern programming languages, making C a critical language to understand for computer science students and professionals.

Why C Is Still Used Today

Despite the rise of newer languages, C remains widely used for several reasons:

1. **Performance: C programs are fast and efficient, making it ideal for resource-constrained environments.**
2. **Portability: Code written in C can run on many different types of systems with minimal changes.**
3. **Low-Level Access: C allows direct manipulation of hardware resources like memory, making it perfect for systems programming.**

4. **Simplicity: While C requires careful management of memory and pointers, its syntax is relatively simple and clean.**
5. **Legacy Code: Many critical systems have been written in C and continue to be maintained in it.**

In education, C remains a popular first language because it teaches fundamental programming concepts like pointers, memory management, and data structures at a low level.

Conclusion

The C programming language has had a profound impact on the development of modern computing. From operating systems and embedded systems to the creation of other languages, its legacy is unmatched. Even today, C is valued for its speed, control, and portability. Understanding C is not just about learning a language—it's about understanding the foundation of how computers and software work.

Let me know if you'd like this in a more academic format (with citations), or need a version tailored for a school or college assignment.

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1. Header Files

- **These are included at the top of the program using the `#include` directive.**
- **Header files contain functions and macros used in the program (e.g., input/output functions).**

2. Main Function

- **Every C program must have a `main()` function.**
- **This is the starting point of execution.**

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3. Comments

- **Comments are used to explain the code.**
- **Single-line comment: `// This is a comment`**
- **Multi-line comment:**

4. Data Types

- **Data types define the type of data a variable can hold.**
- **Common types:**
  - `int` **– integers**
  - `float` **– decimal numbers**

- char – single characters
- double – double-precision decimal numbers

5. Variables

- **Variables are named memory locations used to store data.**
- **Declaration follows the format:**
  data_type variable_name = value;

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5. Operators in C

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

1. Arithmetic Operators

Used to perform basic mathematical operations.

Operator	Description	Example	Result
+	Addition	a + b	Adds a and b
-	Subtraction	a - b	Subtracts b from a
*	Multiplication	a * b	Multiplies a and b
/	Division	a / b	Divides a by b (integer division if both are integers)
%	Modulus (remainder)	a % b	Remainder after a / b

2. Relational (Comparison) Operators

Used to compare two values.

Operator	Description	Example	Result
==	Equal to	a == b	true if equal
!=	Not equal to	a != b	true if not equal
>	Greater than	a > b	true if a > b
<	Less than	a < b	true if a < b
>=	Greater than or equal	a >= b	true if a ≥ b
<=	Less than or equal	a <= b	true if a ≤ b

⚙️ 3. Logical Operators

Used to combine multiple conditions (true/false values).

Operator	Description	Example	Result
&&	Logical AND	a > 0 && b > 0	true if both are true
`		`	Logical OR
!	Logical NOT	!a	true if a is false

📝 4. Assignment Operators

Used to assign values to variables.

Operator	Description	Example	Equivalent To
=	Simple assignment	a = 5	-
+=	Add and assign	a += 2	a = a + 2
-=	Subtract and assign	a -= 3	a = a - 3
*=	Multiply and assign	a *= 4	a = a * 4
/=	Divide and assign	a /= 2	a = a / 2
%=	Modulus and assign	a %= 3	a = a % 3

5. Increment and Decrement Operators

Used to increase or decrease a variable's value by 1.

Operator	Description	Example	Effect
++	Increment by 1	a++ or ++a	Adds 1 to a
--	Decrement by 1	a-- or --a	Subtracts 1 from a

++a (pre-increment): Increments first, then uses value
a++ (post-increment): Uses value first, then increments

6. Bitwise Operators

Operate on individual bits of data (useful in low-level programming).

Operator	Description	Example	Meaning
&	AND	a & b	1 if both bits are 1
`	`	OR	`a
^	XOR	a ^ b	1 if bits are different
~	NOT (One's complement)	~a	Inverts bits
<<	Left shift	a << 1	Shifts bits left
>>	Right shift	a >> 1	Shifts bits right

7. Conditional (Ternary) Operator

Used to replace simple if-else statements in a single line.

Syntax:

```
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condition ? expression_if_true : expression_if_false;
```

6. **Control Flow Statements in C THEORY EXERCISE: o Explain decision-making statements in C (if, else, nested if-else, switch). Provide examples of each.**

1. if Statement

The if statement checks a condition. If it's true, the code inside the block runs.

2. if-else Statement

The if-else statement allows two possibilities: if the condition is true, do something; otherwise, do something else.

3. Nested if-else Statement

Used when multiple conditions must be checked. An if or else if block can contain another if-else structure.

4. switch Statement

The switch statement allows a variable to be tested for multiple values, each defined in a case.

7. **Looping in C THEORY EXERCISE: o Compare and contrast while loops, for loops, and do-while loops. Explain the scenarios in which each loop is most appropriate.**

1. while Loop

Description:

- **Repeats a block of code as long as a condition is true.**
- **The condition is checked before each iteration.**

2. for Loop

Description:

- **Best for looping a known number of times.**
- **Has initialization, condition, and update in one line.**

3. do-while Loop

Description:

- **Executes the loop body at least once, then checks the condition.**
- **Condition is evaluated after the loop body.**

8. **Loop Control Statements THEORY EXERCISE: o Explain the use of break, continue, and goto statements in C. Provide examples of each.**

1. break Statement

Purpose:

- **Immediately terminates a loop (for, while, do-while) or exits a switch case.**

2. continue Statement

Purpose:

- **Skips the current iteration of the loop and proceeds to the next one.**

3. goto Statement

Purpose:

- **Transfers control to a labeled statement in the program.**
- **Generally discouraged due to the risk of creating unreadable "spaghetti code", but may be useful in certain low-level or error-handling situations**

9. **Functions in C THEORY EXERCISE: o What are functions in C? Explain function declaration, definition, and how to call a function. Provide examples**

✓ What Are Functions in C?

Functions in C are blocks of code that perform a specific task. They help in modular programming, making code more readable, reusable, and easier to debug.

Why Use Functions?

- **Avoid code repetition**
- **Break complex problems into simpler parts**
- **Improve code organization and maintenance**

1. Function Declaration (Prototype)

- **Tells the compiler about the function name, return type, and parameters.**
- **Placed before `main()`.**

2. Function Definition

- **Actual code block that defines what the function does.**

3. Calling a Function

- **Used to execute the function's code from `main()` or another function.**

10. **Arrays in C THEORY EXERCISE: o Explain the concept of arrays in C. Differentiate between one-dimensional and multi-dimensional arrays with examples.**

✓ What is an Array in C?

An array is a collection of variables of the same data type, stored in contiguous memory locations. It allows storing multiple values using a single variable name, accessed via indices.

Why Use Arrays?

- **To store large amounts of data efficiently.**
- **To handle multiple values of the same type using loops.**
- **Useful for tasks like storing lists, matrices, tables, etc.**

1. One-Dimensional Array

□ Definition:

A linear list of elements stored in a single row.

2. Multi-Dimensional Array

□ Definition:

An array of arrays. The most common form is the 2D array, which is essentially a table (matrix).

Differences Between 1D and Multi-Dimensional Arrays

Feature	One-Dimensional Array	Multi-Dimensional Array
Structure	Single row/list	Table-like (rows × columns)
Syntax Example	int a[5];	int b[3][4];
Accessing Elements	a[2]	b[1][3]
Use Case	Lists, scores, names	Matrices, tables, grids

📝 Notes:

- **Indexing starts at 0 in C.**
- **Arrays in C have fixed size; dynamic resizing isn't built-in (use pointers/dynamic memory for that).**
- **For 3D arrays, you can define them as `int a[x][y][z];`, and so on.**