1. Introduction

In C++, enum (enumeration) is a **user-defined data type** that consists of a set of named integer constants. It is used to **assign meaningful names to integral values**, which improves code readability and maintainability.

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2. Meaning of ENUM

The word *enumeration* means listing items one by one. In programming, an enumeration allows you to **define a variable that can hold one of a set of predefined constant values**.

Example:

```
enum Day { Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday };
```

Here, Day is a data type, and its possible values are Monday to Sunday.

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3. Need for ENUM

- Makes code more readable and meaningful
- Avoids use of arbitrary numbers
- Helps prevent errors in code
- Improves maintainability
- Suitable for situations where a variable can have **limited predefined values**

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4. Syntax of ENUM

```
enum EnumName { Constant1, Constant2, ..., ConstantN };
```

- EnumName: Name of the enumeration type
- Constant1, Constant2: Named constants (enumerators)

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5. Declaration of ENUM Variables

After defining an enum type, you can declare variables of that type.

```
enum Color { Red, Green, Blue };
Color c1, c2;
c1 = Red;
```

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6. Default Values of ENUM Constants

- By default, the first enumerator is assigned value `0`.
- Subsequent enumerators increase by 1 automatically.

Example

```
enum Color { Red, Green, Blue };
cout << Red;   // 0
cout << Green; // 1
cout << Blue;  // 2
```

---

7. Assigning Custom Values

You can assign specific integer values to enumerators.

```
enum Color { Red = 5, Green = 10, Blue = 15 };
```

- The subsequent values increment automatically unless specified.

```
enum Color { Red = 5, Green, Blue };
// Red=5, Green=6, Blue=7
```

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8. ENUM in Switch Case

ENUM is often used with **switch statements** for better readability.

```
enum Day { Monday, Tuesday, Wednesday };
Day today = Tuesday;

switch(today) {
   case Monday: cout << "First day"; break;
   case Tuesday: cout << "Second day"; break;
   case Wednesday: cout << "Third day"; break;
}
```

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9. ENUM vs #define

Feature	ENUM	#define
Type	Typed (user-defined type)	Untyped constant
Scope	Local to enum or namespace	Global scope
Debugging	Easier	Harder
Values	Integer only	Any literal

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10. ENUM and Type Safety

In **C++11 and later**, `enum class` is introduced for **strongly typed enumerations**. This prevents implicit conversion to integers.

```
enum class Color { Red, Green, Blue };
Color c = Color::Red;
```

- `enum class` members must be accessed using scope resolution (`::`).
- Provides **type safety**.

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11. Size of ENUM

- The size of an enum depends on the compiler (typically `int`).
- It can be specified explicitly in C++11 using `enum EnumName : type { ... }`

```
enum Color : unsigned char { Red, Green, Blue };
```

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12. Implicit Conversion

- Regular enums can be **implicitly converted to int**.

```
enum Color { Red, Green, Blue };
int x = Red; // Allowed
```

- `enum class` **does not allow implicit conversion**, which is safer.

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13. Advantages of ENUM

- Makes code readable and self-explanatory
- Limits the values a variable can take
- Reduces the risk of errors
- Helps in programming tasks like menus, options, days, months, status codes
- Supports type safety with `enum class`

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14. Using ENUM in Functions

You can pass ENUM variables as function arguments for clarity.

```
void displayDay(Day d) {
  switch(d) {
    case Monday: cout << "Monday"; break;
    case Tuesday: cout << "Tuesday"; break;
  }
}
```

---

15. ENUM in Arrays

ENUM values can be used to index arrays.

```
enum Color { Red, Green, Blue };
int colorCount[3] = {5, 10, 15};
cout << colorCount[Green]; // 10
```

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16. ENUM and Loops

You can loop through ENUM values using integer values.

```
for(int i=Red; i<=Blue; i++)
  cout << i << endl;
```

For `enum class`, explicit casting is required:

```
for(int i = (int)Color::Red; i <= (int)Color::Blue; i++)
  cout << i << endl;
```

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17. ENUM in Real Life Applications

- Representing days of the week, months of the year
- Representing menu options in software
- Representing states in a finite state machine
- Status codes (Success, Failure, Pending)
- Colors in graphics programming

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18. Common Mistakes

- Assigning non-integer values to enums
- Using enums without proper scope
- Forgetting that enum constants are essentially integers
- Confusing `enum` with `enum class`

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19. Best Practices

- Use `enum class` in modern C++ for type safety

- Name enumerators clearly
- Avoid using magic numbers; prefer enums
- Use enums for limited, fixed sets of values
- Always initialize enum variables

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20. Conclusion

`ENUM` in C++ is a **powerful tool for defining symbolic names for integral constants**.

- Regular enums are simple and easy to use.
- `enum class` provides type safety in modern C++.

Understanding ENUM helps programmers **write readable, maintainable, and error-free code**, especially in applications with fixed sets of options, status codes, or menu items.