# Number system

**Introduction**

A **Number System** is a method of expressing numbers using a set of symbols and rules. It allows us to represent and perform operations on numbers easily. Every number system has a base or radix, which indicates the number of unique digits used in that system.

**Types of Number Systems**

There are four main types of number systems commonly used:

**a) Binary Number System (Base 2)**

* Digits used: 0 and 1
* Base: 2
* Each digit is called a bit (binary digit).
* Example: (1010)₂ = (10)₁₀
* Widely used in digital devices and electronic systems.

**b) Octal Number System (Base 8)**

* Digits used: 0 to 7
* Base: 8
* Example: (57)₈ = (5 × 8¹) + (7 × 8⁰) = (47)₁₀
* Often used as a compact form of binary representation since 3 binary digits = 1 octal digit.

**c) Decimal Number System (Base 10)**

* Digits used: 0 to 9
* Base: 10
* This is the system used in everyday arithmetic and counting.
* Example: (259)₁₀ = (2 × 10²) + (5 × 10¹) + (9 × 10⁰)

**d) Hexadecimal Number System (Base 16)**

* Digits used: 0 to 9 and A to F (A=10, B=11, C=12, D=13, E=14, F=15)
* Base: 16
* Example: (2A)₁₆ = (2 × 16¹) + (10 × 16⁰) = (42)₁₀
* Commonly used to represent large numbers in a short form.

**Conversion Between Number Systems**

Converting numbers between systems helps in understanding how values relate across different bases.

| **Conversion Type** | **Example** | **Method** |
| --- | --- | --- |
| Binary → Decimal | (1101)₂ = ? | Multiply each bit by powers of 2 |
| Decimal → Binary | (13)₁₀ = ? | Divide by 2 and record remainders |
| Binary → Octal | Group bits in 3s | Each group → Octal digit |
| Binary → Hexadecimal | Group bits in 4s | Each group → Hex digit |

**Importance**

* Helps in representing numbers in different formats.
* Useful for simplifying arithmetic operations.
* Essential for working with electronic systems and logical circuits.
* Provides a foundation for understanding data representation.

**Examples**

| **Type** | **Example** | **Equivalent Decimal** |
| --- | --- | --- |
| Binary | 1010 | 10 |
| Octal | 12 | 10 |
| Decimal | 10 | 10 |
| Hexadecimal | A | 10 |