

1.2

1 Decimal Number System (Base 10)

A decimal number consists of digits from 0 to 9, with each digit's place value determined by powers of 10. For example, the number 7392 can be expressed as:

$$7 \times 10^3 + 3 \times 10^2 + 9 \times 10^1 + 2 \times 10^0 \quad (1)$$

2 Number Systems and Radix (Base)

A number system's radix (or base) determines the set of digits and the positional values of those digits:

- **Decimal System (Base 10):** Uses digits 0-9.
- **Binary System (Base 2):** Uses only two digits: 0 and 1.
- **Octal System (Base 8):** Uses digits 0-7.
- **Hexadecimal System (Base 16):** Uses digits 0-9 and letters A-F.

3 Binary Number System (Base 2)

In the binary system, each digit is either 0 or 1 and is multiplied by a power of 2. For example, converting 1100.11_2 to decimal:

$$(1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (0 \times 2^0) + (1 \times 2^{-1}) + (1 \times 2^{-2}) = 12.75_{10} \quad (2)$$

4 Octal Number System (Base 8)

The octal system has eight digits (0 to 7). For example, converting $(127.4)_8$ to decimal:

$$(1 \times 8^2) + (2 \times 8^1) + (7 \times 8^0) + (4 \times 8^{-1}) = 87.5_{10} \quad (3)$$

5 Hexadecimal Number System (Base 16)

The hexadecimal system has sixteen symbols (0-9 and A-F). For example, converting $(B65F)_{16}$ to decimal:

$$(11 \times 16^3) + (6 \times 16^2) + (5 \times 16^1) + (15 \times 16^0) = 46687_{10} \quad (4)$$

6 Powers of Two and Storage in Computers

The binary system is widely used in computing. Common memory sizes:

- $2^{10} = 1024$ bytes = 1 KB
- $2^{20} = 1,048,576$ bytes = 1 MB
- $2^{30} = 1,073,741,824$ bytes = 1 GB
- $2^{40} = 1,099,511,627,776$ bytes = 1 TB

7 Arithmetic Operations in Binary

Binary arithmetic follows similar principles as decimal arithmetic but uses only 0s and 1s.

7.1 Binary Addition Example

$$\begin{array}{r} 101011 + 100111 \\ \hline 1010000 \end{array}$$

7.2 Binary Subtraction Example

$$\begin{array}{r} 101010 \\ - 100111 \\ \hline 000011 \end{array}$$

7.3 Binary Multiplication Example

$$\begin{array}{r} 1011 \\ \times 101 \\ \hline 1011 \\ 0000 \\ + 1011 \\ \hline 110111 \end{array}$$