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◆ Definition of Number System

A **number system** is a way of **representing numbers using symbols (digits)** and a **base (radix)**.

It tells us:

1. What **symbols (digits)** can be used.
2. What each digit's **place value** means.

👉 In simple terms:

It's a **method to express numbers** in different forms like **decimal, binary, octal, hexadecimal**, etc.

◆ Main Types of Number Systems in Computer Science

Computers work with **different bases**, not just decimal. The most common ones are:

Number System	Base	Digits Used	Example
Decimal	10	0–9	$245 \rightarrow (2 \times 10^2 + 4 \times 10^1 + 5 \times 10^0)$
Binary	2	0, 1	$1011 \rightarrow (1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 11)$
Octal	8	0–7	$745 \rightarrow (7 \times 8^2 + 4 \times 8^1 + 5 \times 8^0)$
Hexadecimal	16	0–9, A–F (A=10, ... F=15)	$2F \rightarrow (2 \times 16^1 + 15 \times 16^0 = 47)$

◆ Why Number Systems are Important in CSE

- Humans use **decimal (base 10)**.
- Computers use **binary (base 2)** (everything is 0s and 1s at hardware level).
- **Octal (base 8)** and **Hexadecimal (base 16)** are often used as *shortcuts* for binary because they are more compact and readable.

☒ Example:

- Binary: 1111 1111
 - Hexadecimal: FF (much shorter!)
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◆ Conversion Between Number Systems

1. Decimal → Binary

Divide by 2 repeatedly, write remainders backwards.

Example: 13 → Binary

$$13 \div 2 = 6 \text{ remainder } 1$$

$$6 \div 2 = 3 \text{ remainder } 0$$

$$3 \div 2 = 1 \text{ remainder } 1$$

$$1 \div 2 = 0 \text{ remainder } 1$$

Answer: 1101 (binary)

2. Binary → Decimal

Multiply each bit by powers of 2.

Example: 1011 → Decimal

$$(1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 11$$

◆ Quick Summary

- **Number System** = A way to represent numbers using digits + base.
- **Base (radix)** = Number of unique digits.
- Common types: Decimal (10), Binary (2), Octal (8), Hexadecimal (16).
- Computers → Binary, Programmers → often use Hex.