DIGITAL NUMBER SYSTEM

A digital system can understand positional number system only where there are a few symbols called digits and these symbols represent different values depending on the position they occupy in the number.

A value of each digit in a number can be determined using

- The digit
- The position of the digit in the number
- The base of the number system *wherebaseisdefinedasthetotalnumberofdigitsavailableinthenumbersystem*.

Decimal Number System

The number system that we use in our day-to-day life is the decimal number system. Decimal number system has base 10 as it uses 10 digits from 0 to 9. In decimal number system, the successive positions to the left of the decimal point represents units, tens, hundreds, thousands and so on.

Each position represents a specific power of the base 10. For example, the decimal number 1234 consists of the digit 4 in the units position, 3 in the tens position, 2 in the hundreds position, and 1 in the thousands position, and its value can be written as

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(1&times1000) &plus; (2&times100) &plus; (3&times10) &plus; (4&timesl)
(1&times10^3) &plus; (2&times10^2) &plus; (3&times10^1)  &plus; (4&timesl0^0)
1000 &plus; 200 &plus; 30 &plus; 1
1234
```

As a computer programmer or an IT professional, you should understand the following number systems which are frequently used in computers.

S.N.	Number System & Description
1	**Binary Number System** Base 2. Digits used: 0, 1
2	**Octal Number System** Base 8. Digits used: 0 to 7
3	**Hexa Decimal Number System** Base 16. Digits used: 0 to 9, Letters used: A- F

Binary Number System

Characteristics

- Uses two digits, 0 and 1.
- Also called base 2 number system
- Each position in a binary number represents a 0 power of the base 2. Example: 2^0

- Last position in a binary number represents an x power of the base 2. Example: 2^x where x represents the last position - 1.

Example

Binary Number: 10101_2

Calculating Decimal Equivalent −

Step	Binary Number	Decimal Number
Step 1	10101_2	$((1 \times 2^4)$ + (0×2^3) + (1×2^2) + (0×2^1) + $(1 \times 2^0))_{10}$
Step 2	10101_2	16 + 0 + 4 + 0 + 1 $_{10}$
Step 3	10101_2	21_{10}

Note: 10101_2 is normally written as 10101.

Octal Number System

Characteristics

- Uses eight digits, 0,1,2,3,4,5,6,7.
- Also called base 8 number system
- Each position in an octal number represents a 0 power of the base 8. Example: 8^0
- Last position in an octal number represents an x power of the base 8. Example: 8^x where x represents the last position - 1.

Example

Octal Number − 12570_8

Calculating Decimal Equivalent −

Step	Octal Number	Decimal Number
Step 1	12570_8	$((1 \times 8^4)$ + (2×8^3) + (5×8^2) + (7×8^1) + $(0 \times 8^0))_{10}$
Step 2	12570_8	4096 + 1024 + 320 + 56 + 0 $_{10}$
Step 3	12570_8	5496_{10}

Note: 12570_8 is normally written as 12570.

Hexadecimal Number System

Characteristics

- Uses 10 digits and 6 letters, 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F.

- Letters represents numbers starting from 10. A = 10, B = 11, C = 12, D = 13, E = 14, F = 15.
- Also called base 16 number system.
- Each position in a hexadecimal number represents a 0 power of the base 16. Example 16^0.
- Last position in a hexadecimal number represents an x power of the base 16. Example 16^x where x represents the last position - 1.

Example −

Hexadecimal Number: $19FDE_{16}$

Calculating Decimal Equivalent −

Step	Binary Number	Decimal Number
Step 1	$19FDE_{16}$	((1 × 16^4) + (9 × 16^3) + (F × 16^2) + (D × 16^1) + (E × 16^0))$_{10}$
Step 2	$19FDE_{16}$	((1 × 16^4) + (9 × 16^3) + (15 × 16^2) + (13 × 16^1) + (14 × 16^0))$_{10}$
Step 3	$19FDE_{16}$	65536 + 36864 + 3840 + 208 + 14$_{10}$
Step 4	$19FDE_{16}$	106462_{10}

Note − $19FDE_{16}$ is normally written as 19FDE.