Number System

What is Number System in Maths?

A number system is defined as a system of writing to express numbers. It is the mathematical notation for representing numbers of a given set by using digits or other symbols in a consistent manner. It provides a unique representation of every number and represents the arithmetic and algebraic structure of the figures. It also allows us to operate arithmetic operations like addition, subtraction and division.

The value of any digit in a number can be determined by:

- The digit
- Its position in the number
- The base of the number system

Types of Number System

There are various types of number systems in mathematics. The four most common number system types are:

Numbers	Base/Radix(r)	Digit	Positional Value
Decimal	10	0,1,2,3,4,5,6,7,8, 9	10^i, 10^{-f}
Binary	2	0,1	2^i, 2^{-f}
Octal	8	0,1,2,3,4,5,6,7	8^i, 8^{-f}
Hexadecimal	16	0,1,2,3,4,5,6,7,8, 9,A,B,C,D,E,F	16^i, 16^{-f}

$$X_{i-1} \ldots\ldots\ldots\ldots X_0 \;\; X_1 \;\; X_2 \;\; X_i \;\; (N)_r \;\; X_{-1} \;\; X_{-2} \;\; X_{-3} \;\; X_{-f} \ldots\ldots\ldots\ldots X_{m-1}$$

What is Radix or Base of a Number System?

The number of independent digits used in the number system is known as ***Radix* or *Base*** of the number system.

- **Decimal:** a radix-10 number system and therefore has 10 different digits or symbols. These are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. All higher numbers after '9' are represented in terms of these 10 digits only.
- **Binary:** a radix-2 number system (2 different digits are 0 and 1).
- **Hexadecimal:** a radix-16 number system (16 different digits are 0 to 9 and A,B,C,D,E,F representing 10, 11, 12,13,14,15 respectively).
- **Octal:** a radix-8 number system (8 different digits are 0 to 7).
- **Radix-r:**
- Formula (r-1)

Decimal Number System (Base 10 Number System)

The decimal number system has a base of 10 because it uses ten digits from 0 to 9. In the decimal number system, the positions successive to the left of the decimal point represent units, tens, hundreds, thousands and so on. This system is expressed in decimal numbers. Every position shows a particular power of the base (10).

Example of Decimal Number System:

$(96)_{10}$ $(384)_{10}$ $(7810)_{10}$

Binary Number System (Base 2 Number System)

The base 2 number system is also known as the Binary number system wherein, only two binary digits exist, i.e., 0 and 1. Specifically, the usual base-2 is a radix of 2. The figures described under this system are known as binary numbers which are the combination of 0 and 1.

For example, 110101 is a binary number.

$$(110101)_2$$

Octal Number System (Base 8 Number System)

In the octal number system, the base is 8 and it uses numbers from 0 to 7 to represent numbers. Octal numbers are commonly used in computer applications. Converting an octal number to decimal is the same as decimal conversion and is explained below using an example.

Example: Convert 215_8 into decimal.

Hexadecimal Number System (Base 16 Number System)

In the hexadecimal system, numbers are written or represented with base 16. In the hex system, the numbers are first represented just like in the decimal system, i.e. from 0 to 9. Then, the numbers are represented using the alphabet from A to F. The below-given table shows the representation of numbers in the hexadecimal number system.

Hexadecimal	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
Decimal	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**

Number System Conversion

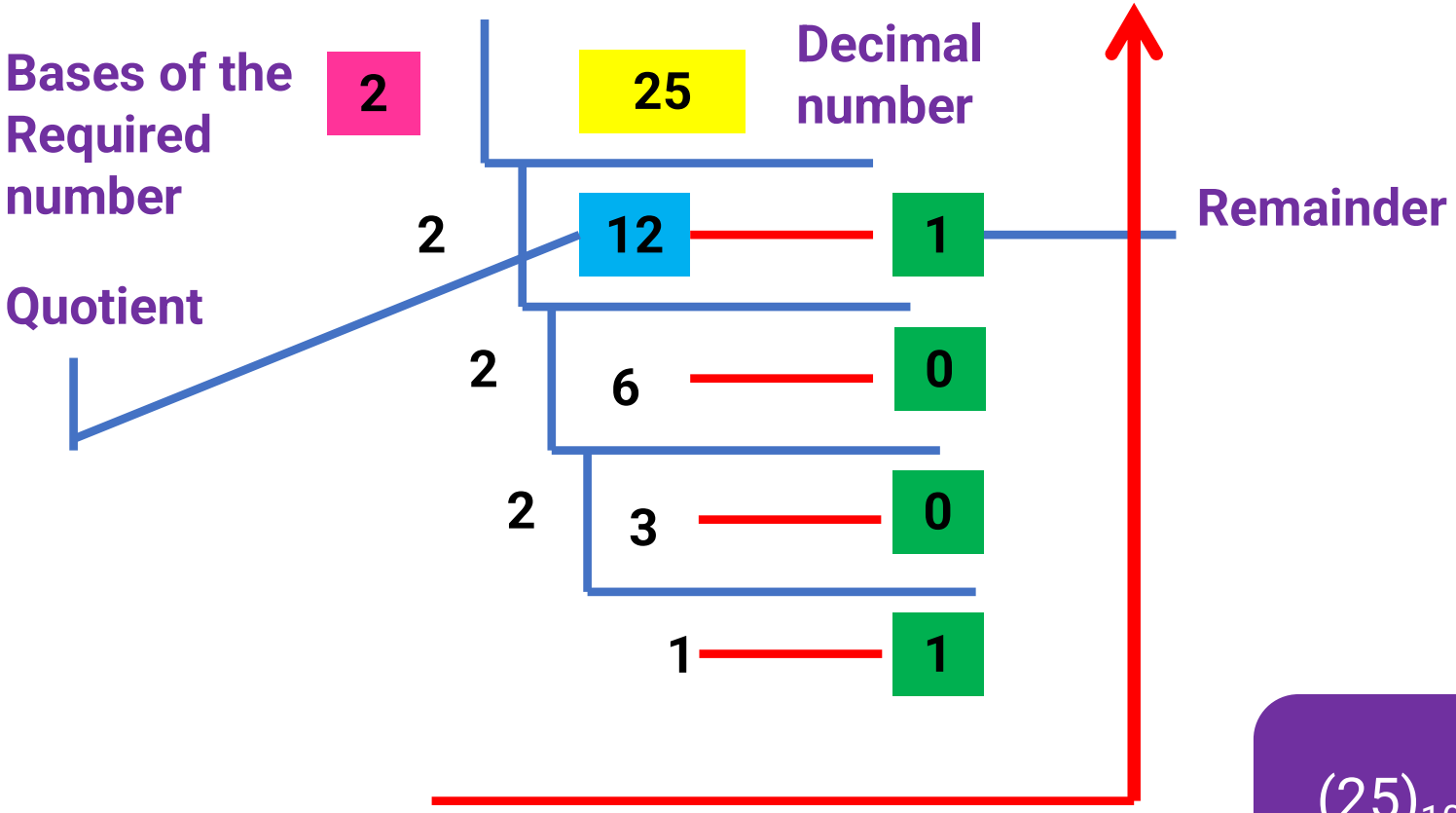
Decimal to Any NS Conversion

Decimal to Binary Conversion

For converting decimal to binary, there are two steps required to perform, which are as follows:

1. In the first step, we perform the division operation on the integer and the successive quotient with the base of binary(2).
2. Next, we perform the multiplication on the integer and the successive quotient with the base of binary(2).

Convert 25 in to binary system?



$(25)_{10}$ Binary is $(11001)_2$

Convert the Given Decimal Number to Binary Number:

Example 1: $(152.25)_{10}$

Example 2: $(262)_{10}$

Example 3: $(18.625)_{10}$

Example 4: $(172.878)_{10}$

Example 5: $(139.2)_{10}$

Decimal to Octal Conversion

Example 1: $(152.25)_{10}$

Decimal to Hexa Conversion

Example 1: $(424.28)_{10}$

Octal to Any NS Conversion

Octal to Decimal Conversion

1. multiplying the digits of octal numbers with its corresponding positional weights.
2. we add all those products.

Example 1: $(327)_8$

Example 2: $(152.25)_8$

Octal to Binary Conversion

Convert each octal digit to 3 bit binary digits

Example 1: $(327)_8$

Example 2: $(152.25)_8$

Octal to Hexa Conversion

Step 1: Convert every octal digit to **3 bit** binary digit
Step 2: Then Differentiate the numbers in every **4 bit binary digit**
Step 3: Then Convert Every **4 Bit Binary** number into **decimal number**
Step 4: **Combine** all **4 bit** converted number together
Step 5: Convert the **decimal number** into **hexadecimal**

Example 1: $(154)_8$

Example 2: $(327)_8$

Binary to Any NS Conversion

Binary to Octal Conversion

1. First Convert the given binary number into decimal with base value of 2
2. After that, convert the decimal number into octal

Example 1: $(1010120)_2$

Binary to Decimal Conversion

Example 1: $(1101)_2$

Binary to Hexa Conversion

Example 1: $(1101)_2$

Hexa to Any NS Conversion

Hexa to Decimal Conversion

Example 1: $(152A.25)_{16}$

Hexa to Binary Conversion

Example 1: $(152A.25)_{16}$

Hexadecimal to Octal Conversion

1.In the first step, we will find the binary equivalent of the hexadecimal number.

2.Next, we have to make the pairs of three bits on both sides of the binary point. If there will be one or two bits left in a pair of three bits pair, we add the required number of zeros on extreme sides and write the octal digits corresponding to each pair.

Example 1: $(152A.25)_{16}$