Number System in Maths

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Number System is a method of representing Numbers on the Number Line with the help of a set of symbols. Number System is the foundation of Mathematics and it is used in Science and Arithmetic. Number System is used to perform mathematical computations ranging from great scientific calculations to simple calculations. Number System is used to count, measure, and to perform mathematical calculations. Number System consists of Number and Numerals. Number System is the foundation of Mathematics.

What is the Number Line?

The Number Line is a representation of Numbers on a straight line and is represented as a straight line. It denotes the connection of the signed numbers with the points on the straight line. The Number Line is a straight line with a point on it which is called the origin. Numbers are written in the straight line. The origin is at zero. The right side of the origin is the Positive Number and the left side of the origin is the Negative Number.

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Positive Numbers: Numbers that are represented on the right side of the zero are known as Positive Numbers. Positive Numbers are represented by the symbol '+'. Positive Numbers are also known as Natural Numbers. Example: 1, 2, 3, 4, ...

Negative Numbers: Numbers that are represented on the left side of the zero are known as Negative Numbers. Negative Numbers are represented by the symbol '-'. Example: -1, -2, -3, -4, ... Negative numbers are used for financial calculations. Example: -1, -2, -3, -4, ...

Number and its Types

A number is a value utilizing the combination of digits with the help of certain rules. These numbers are used to represent mathematical quantities. A digit is a symbol. There are 10 Symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Numbers are made up of these 10 Symbols. The value of a Number depends on the type of digits that are used in Number.

For Example: 175, 153, 3.965, 1.5, 16, 7.5, etc.

Types of Numbers

Numbers are of various types depending upon the patterns of digits that are used in their creation. Numerical values and sizes are also against the Numbers which classify them into a variety of Numbers.

1. Natural Numbers: Natural Numbers are the most basic type of Numbers that ranges from 1 onwards. Natural Numbers are also called Counting Numbers. Natural Numbers are represented by the symbol 'N'.

Example: 1, 2, 3, 4, 5, 6, 7, 8, ... and so on

2. Whole Numbers: Whole Numbers are basically the Natural Numbers, but they also include zero. Whole Numbers are represented by the symbol 'W'.

Example: 0, 1, 2, 3, 4, 5, 6, ... and so on

3. Integers: Integers are the collection of Whole Numbers plus the negative values of the Natural Numbers. Integers are the Whole Numbers that are without any fractional or decimal form. The range of Integers is from the infinite of the Negative and ends infinite, the Positive and, including zero. Integers are represented by the symbol 'I'.

Example: ..., -4, -3, -2, -1, 0, 1, 2, 3, 4, ...

4. Fractions: Fractions are the numbers that are written in the form of p/q, where p denotes the numerator and q denotes the denominator. Fractions are used to denote a part of a whole. Fractions are written in the form of a/b, where a and b are integers.

Example: 1/2, 1/3, 3/5, 9/11, ...

5. Rational Numbers: Rational numbers are the numbers that can be represented in the form of p/q, where p and q are integers and q is not equal to zero. Rational with the fractions are also known as rational numbers and vice versa.

Example: -1/5, 6/9, 1/3, 1/15, ...

6. Irrational Numbers: Irrational numbers are the numbers that can't be represented in the form of fractions or decimal form. Irrational numbers are represented by the symbol 'P'.

Example: π, √2, √3, √5, √7, √10, √11, ...

7. Real and Imaginary Numbers: Real numbers are the numbers that can be represented on the number line. Real numbers are the combination of Rational and Irrational numbers. Imaginary numbers are the numbers that are not on the number line. Imaginary Numbers are all those Numbers that are not Real numbers. These numbers are represented with iota(i) or (-1)^(1/2). Imaginary Numbers are also known as Complex Numbers.

Example: 2+3i, 5+7i, 3i, 7i, ...

8. Prime Numbers and Composite Numbers: Numbers that do not have any factors other than 1 and itself are called Prime Numbers. All the Prime numbers are Odd Numbers. Composite Numbers are known as Composite Numbers except 2. Zero is neither prime nor a composite number.

Example: 2, 3, 5, 7, 11, ... (PRIME NUMBERS) and 4, 6, 8, 9, 10, 12, ... (COMPOSITE NUMBERS)

Types of Number Systems

Based on the bases used in the number system, there are many number systems and of many types. The most common number systems are:

- **Decimal Number System**
- **Binary Number System**
- **Octal Number System**
- **Hexadecimal Number System**

1. Decimal Number System

Number system with base value 10 is known as decimal number system. It uses 10 digits or, 0 to 9 for representing numbers. The value of a digit in a number is decided by its place and also by a unique power of different powers of 10. Also the place value is increased from right to left and decreased from left to right.

Examples:

1a can be written as 1*10
2a can be written as 2*10
3a can be written as 3*10*10

2. Octal Number System

Octal Number System is a system that has base value 8. It uses digits 0 - 7 for creation of Octal Numbers. Octal Numbers can be converted to Decimal value by multiplying each digit by its place value and then adding the results together. Octal Numbers are of 3*1, 3*2, 3*3 Number and are known for the representation of 256 Numbers.

Examples:

(255)₈ can be written as (255)₁₀
(1000)₈ can be written as (512)₁₀

3. Hexadecimal Number System

Number System with base value 16 is termed as Hexadecimal Number System. It uses 16 digits for the creation of its numbers. Digits from 0 to 9 are taken as the digits in the decimal system and letters A to F are taken as digits for the remaining numbers. The letters A, B, C, D, E, F are 10, 11, 12, 13, 14, 15 and 16 in Hexadecimal Numbers and used for naming, denoting, referring, relation to others.

Examples:

(255)₁₆ can be written as (255)₁₀
(1AB)₁₆ can be written as (427)₁₀
(ABC)₁₆ can be written as (2748)₁₀

Conversion of Number Systems

Conversion between two number systems is a process in which a number from one number system can be converted into another number system with the help of a proper method that will be discussed below.

1. Conversions from Decimal Number System to Other Number Systems

Decimal Numbers are represented with digits 0-9 and with base 10. Conversion of a number system from decimal to other bases is done as follows. Following are the conversions of the Decimal Number System to other Number Systems.

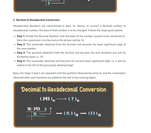
2. Decimal to Binary Conversion

Decimal numbers are represented in base 10, but the binary numbers are of base 2. Hence, to convert a decimal number to binary, follow the steps:

- **Step 1:** Divide the Decimal Number with the base of the number system to be converted to binary (here converted to binary, hence the divisor will be 2).
- **Step 2:** The quotient obtained from the division will become the next dividend.
- **Step 3:** The quotient obtained from the division will become the next dividend and so on until the division becomes 0.
- **Step 4:** The remainder obtained and the quotient obtained from the last step will be used to find the previously obtained digits.

Now, the binary digits are represented with the quotient obtained becomes 0, and the remainders obtained after each iteration are added to the left of the existing digits.

After all the iterations are over, the last obtained remainder will be termed as the Most significant digit.



3. Decimal to Octal Conversion

Decimal Numbers are represented in base 10, but the octal numbers are of base 8. Hence, to convert a decimal number to octal, follow the steps:

- **Step 1:** Divide the Decimal Number with the base of the number system to be converted to octal (here converted to octal, hence the divisor will be 8).
- **Step 2:** The quotient obtained from the division will become the next dividend.
- **Step 3:** The quotient obtained from the division will become the next dividend and so on until the division becomes 0.
- **Step 4:** The remainder obtained and the quotient obtained from the last step will be used to find the previously obtained digits.

Now, the octal digits are represented with the quotient obtained becomes 0, and the remainders obtained after each iteration are added to the left of the existing digits.

4. Decimal to Hexadecimal Conversion

Decimal Numbers are represented in base 10, but the hexadecimal numbers are of base 16. Hence, to convert a decimal number to hexadecimal, follow the steps:

- **Step 1:** Divide the Decimal Number with the base of the number system to be converted to hexadecimal (here converted to hexadecimal, hence the divisor will be 16).
- **Step 2:** The quotient obtained from the division will become the next dividend.
- **Step 3:** The quotient obtained from the division will become the next dividend and so on until the division becomes 0.
- **Step 4:** The remainder obtained and the quotient obtained from the last step will be used to find the previously obtained digits.

Now, the hexadecimal digits are represented with the quotient obtained becomes 0, and the remainders obtained after each iteration are added to the left of the existing digits.

5. Conversion From Binary Numbers System to Other Number Systems

Binary Numbers are represented with digits 0 and 1 and with base 2. Conversion of a number system binary numbers from base 2 to other bases is done as follows. Following are the conversions of Binary Number System to other Number System.

6. Binary to Decimal Conversion

Binary numbers are represented in base 2, but the decimal numbers are of base 10. Hence, to convert a binary number to decimal, follow the steps:

- **Step 1:** Multiply each digit of the Binary number with the place value of that digit, starting from right to left.
- **Step 2:** Add the result of the multiplication and the decimal number will be formed.

Example: To convert (11001)₂ into a decimal number

7. Binary to Octal Conversion

Binary numbers are represented in base 2, but the octal numbers are of base 8. Hence, to convert the binary number into octal, follow the steps:

- **Step 1:** Divide the binary number into groups of three digits starting from right to left. (Add zeroes if required).
- **Step 2:** Convert these groups into equivalent three digits.

Example: To convert (11101101)₂ into octal number

8. Binary to Hexadecimal Conversion

Binary numbers are represented in base 2, but the hexadecimal numbers are of base 16. Hence, to convert the binary number into hexadecimal, follow the steps:

- **Step 1:** Divide the binary number into groups of four digits starting from right to left. (Add zeroes if required).
- **Step 2:** Convert these groups into equivalent four digits.

Example: To convert (11101101)₂ into hexadecimal number

9. Conversion From Octal Number System to Other Number Systems

Octal Numbers are represented with digits 0 - 7 and with base 8. Conversion of a number system octal numbers from base 8 to other bases is done as follows. Following are the conversions of the Octal Number System to other Number System.

10. Octal to Decimal Conversion

Octal numbers are represented in base 8, but the decimal numbers are of base 10. Hence, to convert an octal number to decimal, follow the steps:

- **Step 1:** Multiply each digit of the Octal number with the place value of that digit, starting from right to left.
- **Step 2:** Add the result of the multiplication and the decimal number will be formed.

Example:

11. Octal to Binary Conversion

Octal numbers are represented in base 8, but the binary numbers are of base 2. Hence, to convert an octal number to binary number, the base of the octal number is to be changed. Follow the steps given below:

- **Step 1:** Write each digit of the octal number separately.
- **Step 2:** Convert each digit into an equivalent group of three binary digits.
- **Step 3:** Combine these groups to form the whole binary number.

Example: (377)₈ is converted into (11111111)₂

12. Octal to Hexadecimal Conversion

Octal numbers are represented in base 8, but the hexadecimal numbers are of base 16. Hence, to convert an octal number to hexadecimal, follow the steps:

- **Step 1:** Convert the octal number into a binary number, the base of the number is to be changed. Follow the steps given below.
- **Step 2:** Write each digit of the octal number separately.
- **Step 3:** Convert each digit into an equivalent group of three binary digits.
- **Step 4:** Combine these groups to form the whole binary number.

Example: (377)₈ is converted into (FF)₁₆

13. Conversion from Hexadecimal Number System to Other Number Systems

Hex Numbers are represented with digits 0 - 9 and letters A - F and with base 16. Conversion of a number system hexadecimal numbers from base 16 to other bases is done as follows. Following are the conversions of the Hexadecimal Number System to other Number System.

14. Hexadecimal to Decimal Conversion

Hexadecimal numbers are represented in base 16, but the decimal numbers are of base 10. Hence, to convert a hexadecimal number to decimal number, the base of the number is to be changed. Follow the steps given below:

- **Step 1:** Write each digit of the hexadecimal number separately.
- **Step 2:** Multiply each digit of the hexadecimal number with the place value of that digit, starting from right to left.
- **Step 3:** Add the results of the multiplication and the decimal number will be formed.

Example: (FF)₁₆ is converted into (255)₁₀

15. Hexadecimal to Binary Conversion

Hexadecimal numbers are represented in base 16, but the binary numbers are of base 2. Hence, to convert a hexadecimal number to a binary number, the base of the number is to be changed. Follow the steps given below:

- **Step 1:** Convert the hexadecimal number into decimal.
- **Step 2:** Write each digit of the hexadecimal number separately.
- **Step 3:** Convert each digit into an equivalent group of four binary digits.
- **Step 4:** Combine these groups to form the whole binary number.

Example: (FF)₁₆ is converted into (11111111)₂

16. Hexadecimal to Octal Conversion

Hexadecimal numbers are represented in base 16, but the octal numbers are of base 8. Hence, to convert a hexadecimal number to a binary number, the base of the number is to be changed. Follow the steps given below:

- **Step 1:** Convert the hexadecimal number into decimal.
- **Step 2:** Write each digit of the hexadecimal number separately.
- **Step 3:** Convert each digit into an equivalent group of three binary digits.
- **Step 4:** Combine these groups to form the whole binary number.

Example: (FF)₁₆ is converted into (377)₈

17. Hexadecimal to Hex Conversion

Hexadecimal numbers are represented in base 16, but the octal numbers are of base 8. Hence, to convert a hexadecimal number to a binary number, the base of the number is to be changed. Follow the steps given below:

- **Step 1:** Write each digit of the hexadecimal number separately.
- **Step 2:** Convert each digit into an equivalent group of four binary digits.
- **Step 3:** Combine these groups to form the whole binary number.

Example: (FF)₁₆ is converted into (DD)₁₆

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