Number System: A Stretch From Definition To Conversions

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Numbers are used for counting/checking/labeling objects and to perform various arithmetic calculations. The examples of numbers are natural numbers, whole numbers, rational and irrational numbers, prime and composite numbers, in mathematics etc.

The number system can be understood as a system of writing or expressing numbers in different forms and vice versa. For example binary, decimal, etc.

A number system presents a unique representation of numbers. It also allows users to perform arithmetic operations like addition, subtraction, and division which play an essential role in computer applications and digital domains. Learn about the basics of the number system, conversion, and implementation.

Also check [Linear Algebra] concepts here once you are through with Number System concepts!

Classification of Number System

Decimal Number System

The decimal number system is also known as the base 10 numbers system because it uses ten digits from 0 to 9. The decimal number system is the one we use frequently in our day-to-day life. In the decimal number system, the position progressive is towards the left of the decimal point represented by units, tens, hundreds, thousands, and so on.

Every position outlines a specific power of the base (10). For example, the decimal number 1245 consists of the digit 5 in the units position, 4 in the tens position, 2 in the hundreds position, and 1 in the thousands position. Its value can be formulated as

$(1.\,1000) + (2.\,100) + (4.\,10) + (5.\,1)$

$(1.\,10^3) + (2.\,10^2) + (4.\,10^1) + (5.10^0)$

$1000 + 200 + 40 + 5$

1245

Binary Number System

The binary numbers system or the base 2 system constitutes only two digits that are 0 and 1.

Octal Number System

numbers.

Hexadecimal Number System

A hexadecimal system is represented with base 16. This implies in the hexadecimal system there are 16 hex numbers.

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

Summary

S.No.	**Number System with Description**
1	Binary Number System The base is 2. Digits used : 0, 1
2	Octal Number System The base is 8. Digits used : 0 to 7
3	HexaDecimal Number System The Base is 16. Digits used: 0 to 9, Letters used: A- F

With a clear knowledge about the numbers system, let's proceed towards the conversion of one form to another.

Conversion in Number System

Decimal to Binary Conversion

Steps to be followed

Conversion of Integral Decimal Numbers

- Divide the number by 2.
  Get the integer quotient for the next iteration

Next is the conversion of the fraction part.

Conversion of Fractional Decimal Numbers

Fractional numbers can be transformed to binary form by successive multiplication by 2. That is in every step, the digit before the decimal point is being transferred to a binary record and the same process is replicated among the remaining fraction.

The last step is decided when the fraction part is zero or it is terminated when the desired precision is achieved.

Note: The first bit received is the most significant and the last is the least significant bit.

Binary to Decimal Conversion

Conversion of Integral Binary Numbers

For transforming a binary number to its decimal number equivalent, we start from the least significant bit i.e from right by multiplying them with the powers of 2 in increasing order, i.e with $2^0, 2^1, \cdots$ and so on. This method is repeated till the most significant bit i.e left bit has been processed.

Conversion of Fractional Binary Numbers

To convert the binary fractions to their decimal equivalent, we will use negative powers of 2 to the right of the binary point.

Arithmetic Operations of Binary Numbers

The respective rules of binary operations are as follows

Binary Addition
0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 10

Binary subtraction
0 − 0 = 0
0 − 1 = 1

Binary Multiplication
$0 \times 0 = 0$ $0 \times 1 = 0$ $1 \times 0 = 0$ $1 \times 1 = 0$

Binary Division
1 by 1 = 1 0 by 1 = 0 0 by 0 = Not defined 1 by 0 = Not defined

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Number System FAQs

Q.1 Find the binary equivalent of decimal number 21.

Ans.1

So, the binary equivalent of 21 is 10101
i.e $(21)_{10} = (10101)_2$

2	21	
2	10	1
2	5	0
2	2	1
	1	0

Q.2 Find the decimal equivalent of the binary number (0.1101)2

Ans.2

Here, we have to find the decimal equivalent of the binary number $(0.1101)_2$
$0.1101 = 2^{-1} \times 1 + 2^{-2} \times 1 + 2^{-3} \times 0 + 2^{-4} \times 1 = (1/2) + (1/4) + 0 + (1/16) = 0.8125$

So, the decimal equivalent of the binary number 0.1101 is 0.8125
i.e $(0.1101)_2 = (0.8125)_{10}$

Q.3 Find the value of the expression (1111)2 + (1001)2 – (1010)2

Ans.3

Here we have to find the value of the expression::$(1111)_2 + (1001)_2 – (1010)_2$ First let's convert $(1111)_2$ to decimal number system
$(1111)_2 = 2^0 \times 1 + 2^1 \times 1 + 2^2 \times 1 + 2^3 \times 1 = 1 + 2 + 4 + 8 = (15)_{10}$
Similarly, let's convert $(1001)_2 and (1010)_2$
to decimal number system
$(1001)_2 = 2^0 \times 1 + 2^1 \times 0 + 2^2 \times 0 + 2^3 \times 1 = 1 + 0 + 0 + 8 = (9)_{10}$
$(1010)_2 = 2^0 \times 0 + 2^1 \times 1 + 2^2 \times 0 + 2^3 \times 1 = 0 + 2 + 0 + 8 = (10)_{10}$
$(1111)_2 + (1001)_2 – (1010)_2 = 15 – 9 + 10 = (14)_{10}$
The binary equivalent of $(14)_{10} is (1110)_2$
So, $(1111)_2 + (1001)_2 – (1010)_2 = (1110)_2$

Q.4 Evaluate the decimal equivalent of the binary number (10010)2

Ans.4

Here, we have to calculate the decimal equivalent of the binary number $(10010)_2$

$10010 = 2^0 \times 0 + 2^1 \times 1 + 2^2 \times 0 + 2^3 \times 0 + 2^4 \times 1 = 0 + 2 + 0 + 0 + 16 = 18$

So, the decimal equivalent of 10010 is 18

A hexadecimal system is represented with base 16.