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Concept of Number Systems

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ABSTRACT

This article explains what the counting system is, what it is divided into, what non-positional and positional counting systems are. Transferring numbers from one number system to another, performing arithmetic operations in number systems, binary-octal and binary-hexadecimal number systems are given and given examples.

A number system is a way of writing numbers using a special set of symbols (numbers). There are positional and non-positional views of the number system. The non-positional Number system is written with Roman numerals, while the positional Number system is written with the symbols we have learned and called Arabic numerals (actually Indian numerals)[1]. In the positional numbering system, the value of a number changes depending on its position. For example, the number 34 means 4 ones and 3 tens. If their positions are changed, the number 43 is formed. This number has 3 ones and 4 decimals, that is, the value of 3 has decreased by 10 times, and vice versa, the value of 4 has increased by 10 times. The digits of the numbers in such a decimal number system are the coefficients of its representation in the sum of the degrees of base 10. Calculators usually use the binary number system proposed by G.V. Leibniz. To describe such numbers, 2 numbers are used - 0 and 1. The use of the 2-digit numbering system is due to the fact that the elements of which the EHMs are built are only in 2 stable working states. These elements are similar to keys, and can be written or deleted. There is no third case. If one of these cases corresponds to 1 and 2 to 0, then the sequence of such elements corresponds to a number in the Number System of 2.

In the positional number system, the quantitative value of each number depends on its place (position) in the number. The table below shows examples of positional numbering systems:

The basis	The basis	The basis
2	Binary	0,1
3	Pointed	0,1.2
4	Four	0,1,2,3
5	Five	0,1,2,3,4
8	Eight	0,1,2,3,4,5,6,7
10	Ten	0,1,2,3,4,5,6,7,8,9

12	Twelve	0,1,2,3,4,5,6,7,8,9,A,B
16	Sixteen	0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

In a positional number system, the number of different digits used to represent the number (N) is called the base of the number system. The numeric value ranges from 0 to N-1. In general, writing an arbitrary number in the base N number system has the following summation form: AnAn-1An-2 … A1A0,A-1A-2 =AnVn + An-1Bn-1 + ... + A1B1 + A0V0 + A- 1B-1 + A-2V-2 + ... (1) here, subscripts determine the location (discharge) of the number in the number:

- ✓ B — basis of counting systems;
- ✓ n — position of numbers;
- ✓ An , An-1, An-2 ... A1, A0, A-1, A-2 — numbers of the given number;
- ✓ positive values of the indices — for the whole part of the number;
- ✓ negative values — for the fractional part;
- ✓ Example: 23.4310=2*101+3*100+4*10-1+3*10-2

In a non-positional number system, numbers do not change their quantitative value when their position in the number changes. Roman numerals can be used as an example of this kind of numbering system. This numbering system uses 7 symbols: I, V, X, L, C, D, M.

Their corresponding values in the decimal system: I(1) V(5) X(10) L(50) S (100) D(500) M(1000)

Example: III – 3 LIX – 59 DLV – 555

The difficulty of expressing Roman numerals and the lack of rules for performing arithmetical operations on them are their disadvantages. Therefore, it is used in some places. We mainly work on numbers in the positional number system.

2. Transferring numbers from one counting system to another counting system. In order to convert the numbers in the decimal number system that we have learned to the number form in another number system, a separate method is used for its whole and fractional parts. To transfer the whole part of a number to another number system, the given number is divided by the base of the number system to be transferred. The remainder of the division is determined. The division is further divided on the basis of the number system. This process is continued until the division is smaller than the base of the number system. The resulting remainders are written in order starting from the end. To transfer the fractional part of numbers in the decimal system to another system of counting, the fractional part is multiplied by the base of the system of counting, the whole part of the resulting number is marked and the fraction and the part is again multiplied by the base of the number system. This process is continued until it is calculated with sufficient accuracy.

Example-1.2. a) 267.6810 →X2 b) 267.6810 →Y8 c) 267.6810 →X16

3. Performing arithmetic operations in number systems. Just as we perform arithmetic operations on numbers in the 10 number system, we can perform arithmetic operations on numbers in other number systems. To perform arithmetic operations on numbers in the binary number system, the following tables should be used:

Example-1.4 Calculate the following sums:

a) 1001100.0012+10101010.1012

+ 1001100,001

10101010,101

11110110,110

1001100.0012+10101010.1012=11110110.1102

c) 81A,9216+235,7616

+ 81A, 92

235.76

A50,08

81A.9216+235.7616=A50.0816

b) 354,728+23,128

+ 354.72

23.12

400.04

354,728+23,128=400,048

4. Binary-octal and binary-hexadecimal number systems. In computers, all information is expressed in the binary number system. However, this does not mean that all numerical data will be transferred to the binary number system in the way we have given above. As a result of using binary-octal and binary-hexadecimal counting systems, it is possible to reduce the number of operations of division by 2.

In the binary-octal number system, numbers from 0 to 7 are represented by three zeros and ones. Rather, this number is transferred to the binary number system and filled to three by adding 0s from the left side. The following table is used for this:

Eight	**Eight**	**Eight**	**Eight**
0	000	4	100
1	001	5	101
2	010	6	110
3	011	7	111

Any number given in the decimal number system is first converted to the octal number system. Then each digit in the resulting number is replaced by a triple of digits in the binary-octal system based on the table above.

Example-7. Convert the number 123 to binary-octal number system.

Solution: First, we transfer the number 123 to the 8-digit number system. . now we will replace each number of the generated using the table above. So, the number is written in the form of 001 111 011 in the binary-octal number system.

In the binary-hexadecimal number system, numbers from 0 to 15 are represented by four zeros and ones. Rather, this number is transferred to the binary number system and filled to four by adding 0s from the left side. The following table is used for this:

sixteen	**sixteen**	**sixteen**	**sixteen**
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101

6	0110	E	1110
7	0111	F	1111

Any number given in the decimal number system is first converted to the hexadecimal number system. Then, each digit in the resulting number is replaced by four digits in the binary-hexadecimal system based on the table above.

Example-8. transfer the number to the binary-hexadecimal system.

Solving. First, we transfer the number to the hexadecimal number system. . After that, we replace the numbers in the number, respectively, using the table of binary-hexadecimal numbers:

So, the number is written as 0100 1101 0010 in the binary-hexadecimal number system.

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