Decimal Number System

The number system that represents a number in terms of 0 to 9 digits is a **decimal number system**. A decimal number system has ten digits, i.e., 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The base of a number in this system is 10. In the decimal number system, a number is expressed in terms of powers of 10, i.e., the positions of successive digits to the left of the decimal point represent units, tens, hundreds, thousands, and so on. Some examples of numbers in the decimal number system are $(23)_{10}$, $(123)_{10}$, $(5547)_{10}$, $(6531)_{10}$, and so on. In everyday life, we most frequently represent numbers using the decimal number system.

For example, $(123)_{10}$ in powers of 10 is expressed as $1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$. 1 is in the hundreds place, 2 is in the tens place and 3 is in the units place.

Binary Number System

A number system that expresses a number in terms of 0 and 1 digits is a **binary number system**. A binary system has only two digits, i.e., 0 and 1. The base of a number in this system is 2. In a binary number system, a number is expressed in terms of powers of 2. For example, a decimal number 26 is expressed as $(11010)_2$ in a binary system. The binary digits 0 and 1 are used in all computer coding and languages like C, C++, Java, etc., to write a program and encode any digital data.

A binary number $(1011)_2$ is expressed in powers of 2 as $(1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$.

Conversion of Binary to Decimal and Vice Versa

Binary numbers can be converted to Decimal numbers and Decimal numbers can be converted back to Binary numbers by using the following rules:

Binary to Decimal Conversion

The number system that expresses a number in terms of 0 and 1 digits is a binary number system, whereas a decimal number system represents a number in terms of 0 to 9 digits. Now, to convert a binary number into a decimal number, multiply each digit of the binary number by the power of 2.

If $B = a_{n-1}...a_3a_2a_1a_0$ is a binary number that has n digits, then the respective decimal number will be

$D = (a_{n-1} \times 2^{n-1}) +...+(a_3 \times 2^3) + (a_2 \times 2^2) + (a_1 \times 2^1) + (a_0 \times 2^0)$.

Example: Convert $(11001)_2$ to a decimal number.
Solution:
The given binary number is $(11001)_2$.

$(11001)_2 = (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$
$= 16 + 8 + 0 + 0 + 1 = (25)_{10}$
Therefore, the binary number $(11001)_2$ is expressed as $(25)_{10}$.

Decimal to Binary Conversion

To convert a decimal number into a binary number, divide the given number by 2 continuously till we get the quotient as 1. Note that we have to write the numbers from downwards to upwards.

Example: Convert $(31)_{10}$ into a binary number.
Solution:

$(31)_{10} = (11111)_2$

Therefore, $(31)_{10}$ is expressed as $(11111)_2$

Difference between the binary and decimal systems

Binary Number System	Decimal Number System
A number system that expresses a number in terms of 0 and 1 digits is a binary number system.	The number system that represents a number in terms of 0 to 9 digits is a decimal number system.
A binary system has only two digits, i.e., 0 and 1.	A decimal number system has ten digits, i.e., 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Binary Number System	Decimal Number System
The base of a number in this system is 2.	The base of a number in this system is 10.
In a binary number system, a number is expressed in terms of powers of 2.	In the decimal number system, a number is expressed in terms of powers of 10.
The decimal number 26 is expressed as $(11010)_2$ in a binary system.	The binary number $(11010)_2$ is 26 in the decimal number system.

Solved Example on Conversion of Binary to Decimal and Vice Versa

Example 1: Convert $(65)_{10}$ into a binary number.
Solution:

$(65)_{10} = (1000001)_2$

Therefore, $(65)_{10}$ is expressed as $(1000001)_2$

Example 2: Convert $(10101)_2$ to a Decimal number.
Solution:
The given binary number is $(10101)_2$.
$(10101)2 = (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$
$= 16 + 0 + 4 + 0 + 1 = (21)_{10}$
Therefore, the binary number $(10101)_2$ is expressed as $(21)_{10}$.

Example 3: Convert $(111001)_2$ to a Decimal number.
Solution:

The given binary number is (111001)₂.

$(10101)2 = (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$

$= 32 + 16 + 8 + 0 + 0 + 1 = (57)_{10}$

Therefore, the binary number (111001)₂ is expressed as (57)₁₀.

Example 4: Convert (46)₁₀ into a binary number.
Solution:

$(46)_{10} = (101110)_2$

Therefore, (46)₁₀ is expressed as (101110)₂.

FAQs on Decimal and Binary Number System

Question 1: What are binary and decimal number systems?
Answer:
The number system that expresses a number in terms of 0 and 1 digits is a binary number system, whereas a decimal number system represents a number in terms of 0 to 9 digits.

Question 2: How can you convert a binary number into a decimal number?
Answer:
To convert a binary number into a decimal number, multiply each digit of the binary number by the power of 2. If $B = a_{n-1}...a_3a_2a_1a_0$ is a binary number that has n digits, then the respective decimal number will be
$D = (a_{n-1} \times 2^{n-1}) +...+(a_3 \times 2^3) + (a_2 \times 2^2) + (a_1 \times 2^1) + (a_0 \times 2^0).$

Question 3: How can you convert a decimal number into a binary number?
Answer:

To convert a decimal number into a binary number, divide the given number by 2 continuously till we get the quotient as 1. Note that we have to write the numbers from downwards to upwards.

Question 4: What are the differences between binary and decimal number systems?

Answer:

The number system that expresses a number in terms of 0 and 1 digits is a binary number system, whereas a decimal number system represents a number in terms of 0 to 9 digits. In a binary number system, a number is expressed in terms of powers of 2, whereas in a decimal number system a number is expressed in terms of powers of 10.

Question 5: What is the equivalent decimal number to the binary number 11010?

Answer:

$11010 = (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 16 + 8 + 0 + 2 + 0 = 26$

So, $(11010)_2$ is 26 in the decimal number system.