Number System

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⇒ A number system defines a set of values that is used to represent quantity. The common number system ~~that~~ which is used in our day-to-day work is decimal number system. Although, the most common number system currently in use is the Arabic system. The number systems can be classified into two broad categories as follows:-

① Nonpositional Number Systems:-

In ancient times, people used to count on their fingers. When the fingers became insufficient for counting, stones, pebbles or sticks were used to indicate the values. This method of counting is called the nonpositional number system. It was very difficult to perform arithmetic operations with such a number system, as it had no symbol for zero. The most common nonpositional number system is the 'Roman number system'. In this system, only a few characters are used to represent the numbers, for example, I, V, X, L (for fifty), C (for hundred) and so on. Moreover, since it is very difficult to perform the addition or any other arithmetic operations in this system, no logical or positional techniques are used in this system.

(ii) Positional Number Systems:-

In positional number systems, the value of each digit in a number is defined not only by the symbol, but also by the symbol's position. Positional number systems have a base or radix. The first positional number system was invented by the **Babylonians**. They used a base 60 system. The positional number system, which is currently used is called the decimal number system. This system is a base 10 system, that is, it contains 10 digits

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(0, 1, 2, 3, 4, ----, 8, 9). Apart from the decimal Number system, there are some other positional number systems such as Binary number system, Octal Number System and Hexadecimal number system, each having a Base or Radix of 2, 8 and 16, respectively. However, the principles, which are applied to the decimal number system, are also applicable for the other positional number systems.

⇒ Base (or Radix) of System:-

In the number system, the base or radix tells the number of symbols used in the system. A number system of base (also called radix) r is a system, which have r distinct symbols for r digits. A string of these symbolic digits represents a number. To determine the quantity that the number represents, we multiply the number by an integer power of r depending on the place it is located and then find the sum of weighted digits.

⇒ Types of Number System:-

The number systems that are generally used by the computers are as follows:

1. Decimal number system
2. Binary number system
3. Octal number system
4. Hexadecimal number system

The most important thing about the number systems is that each system is just a different method for representing the quantities. Moreover, the quantities do not change, but the symbols used to represent those

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quantities are changed in each number system.

Types of Number Systems

Number System	Radix Value	Set of Digits	Example
Decimal	$r = 10$	(0,1,2,3,4,5,6,7,8,9)	$(25)_{10}$
Binary	$r = 2$	(0,1)	$(110010)_2$
Octal	$r = 8$	(0,1,2,3,4,5,6,7)	$(31)_8$
Hexadecimal	$r = 16$	(0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F)	$(19)_{16}$

1. Decimal Number System:-

The name Decimal is derived from the Latin word Decem, which means 10. This number system has ten digits represented by 0,1,2,3,4,5,6,7,8 and 9. Any decimal number can be represented as a string of these digits and since there are ten decimal digits, therefore, the base or radix of this system is 10.

Starting at the decimal point and moving to the left, each position is represented by the base (radix) value (10 for decimal) raised to a power. The power starts at 0 (zero) for the position just to the left of the decimal point. The power is incremented for each position that continues to the left. Moving to the right of the decimal point is just like moving to the left except that we will need to place a minus sign in front of each power.

- Thus, a string of number 234.5 can be represented in quantity as:

$$2 \times 10^2 + 3 \times 10^1 + 4 \times 10^0 + 5 \times 10^{-1}$$

Face value Place value

The above expressions can be written in general form as follows:

The weight of the nth digit of the number starting at the decimal point and moving to the left,

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$= n^{th}\ digit \times 10^{n-1}$

$= n^{th}\ digit \times (Base)^{n-1}$

The weight of the n^{th} digit of the number starting at the decimal point and moving to the right,

$= n^{th}\ digit \times 10^{-n}$

$= n^{th}\ digit \times (Base)^{-n}$

2. Binary Number System :-

In binary number system we have two digits 0 and 1 and they can also be represented, as a string of these two- digits. The base of binary number system is 2. In short a binary digit is called a bit. In the binary number system, the weight of n^{th} bit of the number from the right-hand side (RHS) is n^{th} bit $\times 2^{n-1}$. The weighted values for each position are determined as follows:

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
128	64	32	16	8	4	2	1	·5	·25

For converting the value of binary numbers to decimal equivalent we have to find its quantity, which is found by multiplying a digit by its place value. For example, binary number 101010 is equivalent to

$1\times2^5 + 0\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 0\times2^0$

$= 1\times32 + 0\times16 + 1\times8 + 0\times4 + 1\times2 + 0\times1$

$= 32+0+8+0+2+0 = 32+8+2 = 42$ in decimal

Binary Equivalent of Decimal Numbers

Decimal Number	Binary Equivalent	Decimal Number	Binary Equivalent
0	0	6	110
1	1	7	111
2	10	8	1000
3	11	9	1001
4	100	10	1010
5	101	11	1011

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3. Octal Number System:-

An octal number system has eight digit represented as 0, 1, 2, 3, 4, 5, 6 and 7. The base of octal number system is 8.

(In case no subscript is specified then number should be treated as decimal number or else whatever number system is specified before it.)

Weighting for the octal number system up to three decimal places before and two decimal places after the octal point(.).

Octal Weights	8^3	8^2	8^1	8^0	•	8^{-1}	8^{-2}
Values	512	64	8	1	•	0.125	0.015625

Octal Number System

Binary Number	Decimal Number	Octal Number
000	0	0 (0×8^0)
001	1	1 (1×8^0)
010	2	2 (2×8^0)
011	3	3 (3×8^0)
100	4	4 (4×8^0)
101	5	5 (5×8^0)
110	6	6 (6×8^0)
111	7	7 (7×8^0)
1000	8	10 $(1\times8^1+0\times8^0)$
1001	9	11 $(1\times8^1+1\times8^0)$
1010	10	12 $(1\times8^1+2\times8^0)$

→ Example:- Find equivalent decimal number of the octal number $(23.4)_8$

Soln:-
$$(23.4)_8 = 2\times8^1+3\times8^0+4\times8^{-1}$$
$$= 2\times8+3\times1+4\times1/8$$
$$= 16+3+1/2$$
$$= 19+.5$$
$$= (19.5)_{10}$$

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4. Hexadecimal Number System:-

The hexadecimal system has 16 digits, which are represented as 0,1,2,3,4,5,6,7,8,9,A,B,C D, E and F. The base of hexadecimal number system is 16 or H.

Decimal - Hexadecimal - Binary Comparison

Decimal	Hexadecimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

→ Example:- Find equivalent decimal number of a Hexadecimal number $(F2\cdot8)_{16}$

Sol^n:- $(F2.8)_{16} = F\times16^1 + 2\times16^0 + 8\times16^{-1}$

$= 15\times16 + 2\times1 + 8\times1/16$

$= 240 + 2 + 0.5$ [∵ F is equivalent to 15 for decimal]

$= 242 + 0.5$

$= (242.5)_{10}$

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⇒ Conversion between number bases:-

(1) Conversion of Decimal to Binary :-

The method used for the conversion of decimal into binary is often called the remainder method. This method involves the following steps:

(a) Begin by dividing the decimal number by 2 (the base of binary number system).

(b) Note the remainder separately as the rightmost digit of the binary equivalent.

(c) Continually repeat the process of dividing by 2 until the quotient is zero and keep writing the remainders after each step of division (these remainders will either be 1 or 0).

(d) Finally, when no more division can occur, write down the remainders in the reverse order (i.e. last remainder written first).

(1.) Example:- Determine the binary equivalent of $(36)_{10}$

Soln:-

2	36	Remainder	
2	18	0	Least Significant Bit (LSB)
2	9	0	↑
2	4	1	$(100100)_2$
2	2	0	
2	1	0	
	0	1	Most Significant Bit (MSB)

Taking remainders in the reverse order, we have 100100. Thus, the binary equivalent of $(36)_{10}$ is $(100100)_2$.

In every number system

(i) The first bit from the right in any number/binary system has a bit position zero.

(ii) Each bit to the left is given as the next successive bit number.

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Here, bit at position zero is usually referred to as the least significant bit (LSB). The first bit from the left is typically called the most significant bit (MSB).

⇒ **Conversion of Decimal Fractions to Binary Fractions:-**
In this technique instead of division, we do mathematical process of multiplication. Moreover, instead of looking for a remainder, we look for a whole number. This method involves the following steps:
1. Multiply the decimal fraction by 2 (the base of the binary number system).
2. If a whole number is generated, place 1 in that position, if not then place 0.
3. Remove the whole number and continue steps ① and ② with fraction value until it becomes 0.
4. Finally, when no more multiplication can occur, write down the remainders in the downward direction (as shown by the arrow mark).

1. Example:- Determine the binary equivalent of $(0.375)_{10}$.

Soln:-

0.375×2	$= 0.750$	0
0.750×2	$= 1.500$	1
0.500×2	$= 1.000$	1

Taking the remainders in the downward direction, we have 011. Thus, the binary equivalent of $(0.375)_{10}$ is $(.011)_2$.

NOTE:- Remember to strip-off the whole number before you multiply again for the next digit

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⇒ Problems in Conversion of Decimal to Binary:- Since, the binary number system is often used in the computer system, the conversion of decimal to binary is imperative (आदेशात्मक). However, there are certain problems in the conversion.

(i) Binary takes a large number of digits to represent the numerical values, so it is very cumbersome to write down.

(ii) It is very difficult to represent the fractional values. It cannot represent these values accurately and needs many digits to even come close to value approximation.

→ Example:- Determine the binary equivalent of $(0.29)_{10}$.

Solⁿ:-

0.29×2	$= 0.58$	0
0.58×2	$= 1.16$	1
0.16×2	$= 0.32$	0
0.32×2	$= 0.64$	0
0.64×2	$= 1.28$	1
0.28×2	$= 0.56$	0
0.56×2	$= 1.12$	1
0.12×2	$= 0.24$	0
0.24×2	$= 0.48$	0
0.48×2	$= 0.96$	0
0.96×2	$= 1.92$	1
0.92×2	$= 1.84$	1
0.84×2	$= 1.68$	1
0.68×2	$= 1.36$	1
0.36×2	$= 0.72$	0
0.72×2	$= 1.44$	1

∞

The conversion is not ended and still continuing. So, the approximation of $(0.29)_{10}$ in 16 bits is $(.0100101000111101)_2$.

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⇒ Conversion of Decimal to Octal :-

To convert a decimal number into its octal equivalent, the same procedure is adopted as in decimal to binary conversion, but the decimal number is divided by 8 (the base of the octal number system).

1. Example :- Determine the octal equivalent of $(359)_{10}$.

→ Solⁿ :-

		Remainder	
8	359		
8	44	7	↑ Least Significant Bit (LSB)
8	5	4	
	0	5	Most Significant Bit (MSB)

Taking remainders in the reverse order, we get 547.
Thus, the octal equivalent of $(359)_{10}$ is $(547)_8$.

→ 2. Example :- Determine the octal equivalent of $(432267)_{10}$.

Solⁿ :-

		Remainder	
8	432267		
8	54033	3	↑ LSB
8	6754	1	
8	844	2	
8	105	4	
8	13	1	
8	1	5	
	0	1	MSB

Taking remainders in the reverse order, we get 1514213. Thus, the octal equivalent of $(432267)_{10}$ is $(1514213)_8$.

⇒ Conversion of Decimal Fractions to Octal Fractions :-

The method used for the conversion of decimal to octal fractions is similar to the method used for the conversion of decimal to Binary fractions.

NOTE :- 1. In the whole conversion, the first carry produced is the MSB, while the last carry is LSB.

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2. During conversion of decimal to octal fractions, we must remember that the octal point always precedes the MSB (Most Significant Bit).

1. Example :- Determine the octal equivalent of $(0.3125)_{10}$.

Soln :-

0.3125 × 8	= 2.5000	2	↓
0.5000 × 8	= 4.0000	4	

Taking remainders in the downward direction, we have 24. Thus, the octal equivalent of $(0.3125)_{10}$ is $(0.24)_8$.

2. Determine the octal equivalent of $(0.1325)_{10}$

Soln :-

0.1325 × 8	= 1.0600	1	↓
0.0600 × 8	= 0.4800	0	
0.4800 × 8	= 3.8400	3	
0.8400 × 8	= 6.7200	6	
0.7200 × 8	= 5.7600	5	
0.7600 × 8	= 6.0800	6	
0.0800 × 8	= 0.6400	0	
0.6400 × 8	= 5.1200	5	
0.1200 × 8	= 0.9600	0	
0.9600 × 8	= 7.6800	7	
0.6800 × 8	= 5.4400	5	
0.4400 × 8	= 3.5200	3	
0.5200 × 8	= 4.1600	4	
0.1600 × 8	= 1.2800	1	
⋮			
∞			

Since the conversion is not ended, the approximate octal equivalent of $(0.1325)_{10}$ is $(0.10365605075341)_8$.

⇒ Conversion of Decimal to Hexadecimal :- To convert a decimal number to its hexadecimal equivalent, the same

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procedure is adopted as decimal to binary conversion, but the decimal number is divided by 16 (the base of the hexadecimal number system).

1. Example:- Determine the hexadecimal equivalent of $(5112)_{10}$.

Soln:-

		Remainder	
16	5112		
16	319	8 = 8	↑ Least Significant Bit (LSB)
16	19	15 = F	
16	1	3 = 3	
	0	1 = 1	Most Significant Bit (MSB)

Taking remainders in the reverse order, we have 13F8. Thus, the hexadecimal equivalent of $(5112)_{10}$ is $(13F8)_{16}$.

2. Example:- Determine the hexadecimal equivalent of $(584666)_{10}$

Soln:-

		Remain
16	584666	
16	36541	10 = A ↑
16	2283	13 = D
16	142	11 = B
16	8	14 = E
	0	8 = 8

Thus, the hexadecimal equivalent of $(584666)_{10}$ is $(8EBDA)_{16}$.

⇒ Conversion of Decimal Fractions to Hexadecimal Fractions:-

The Conversion of decimal fractions to hexadecimal fractions uses the same technique, which has been used for the conversion of decimal fractions to Binary or Octal fractions.

1. Example:- Determine the hexadecimal equivalent of $(0.625)_{10}$.

Soln:-

$0.625 \times 16 = 10.000$ 10

$0.000 \times 16 = 0.000$ 0 ↓

Taking the remainders in the downward direction, we get 100 or 10. Thus, the hexadecimal equivalent of $(0.625)_{10}$ is $(0.A0)_{16}$ or $(0.A)_{16}$.

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⇒ Conversion of Binary to Decimal :- In the binary to decimal conversion, each digit of the binary number is multiplied by its weighted position, and each of the weighted values is added together to get the decimal number.

1. Example :- Determine the decimal equivalent of $(11010)_2$.

Sol^n:-

Binary Number	1	1	0	1	0
Weight of Each Bit	2^4	2^3	2^2	2^1	2^0
Weighted Value	$2^4 \times 1$	$2^3 \times 1$	$2^2 \times 0$	$2^1 \times 1$	$2^0 \times 0$
Solved Multiplication	16	8	0	2	0

Sum of Weight of all bits $= 16 + 8 + 0 + 2 + 0 = 26$

Thus, the decimal equivalent of $(11010)_2$ is $(26)_{10}$.

⇒ Conversion of Binary Fractions to Decimal Fractions :-

The Conversion of binary fractions is similar to the conversion of Binary to Decimal numbers. The only difference is the negative exponents, which are used to denote the negative powers of two. Here, instead of a 'decimal' point we have a 'binary' point. The exponential expressions of each fractional placeholder are 2^{-1}, 2^{-2}, and in this way the exponent notation proceeds. The rest of the steps are similar to the conversion of the decimal numbers.

1. Example :- Determine the decimal equivalent of $(0.01101)_2$.

Sol^n:-

Number	0	1	1	0	1
Weight of Each Bit	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}
Weighted Value	$1/2 \times 0$	$1/4 \times 1$	$1/8 \times 1$	$1/16 \times 0$	$1/32 \times 1$
Solved Multiplication	0	$1/4$	$1/8$	0	$1/32$

Sum of weight of all bits $= 0 + 1/4 + 1/8 + 0 + 1/32$

$= 0 + 0.25 + 0.125 + 0 + 0.03125$

$= 0.40625$

Thus, the decimal equivalent of $(0.01101)_2$ is $(0.40625)_{10}$.

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⇒ Conversion of Binary to Octal :-

The conversion of an integer binary number to octal is accomplished by the following steps:

1. Break the binary number into three-bit sections starting from the LSB to the MSB.
2. Convert the three-bit binary number to its Octal equivalent.

NOTE:- (i) For whole numbers, it may be necessary to add a zero to the MSB to complete a grouping of three bits. (ii) By adding a zero, the MSB will not change the value of the binary number.

1\. Example:- Determine the octal equivalent of $(010111)_2$.

Soln:-

Binary Number	010 (MSB)	111 (LSB)
Octal Number	2	7

The octal equivalent of $(010111)_2$ is $(27)_8$.

2\. Determine the octal equivalent of $(1010111110110010)_2$.

Soln:-

Binary Number	001 (MSB)	010	111	110	110	010 (LSB)
Octal Number	1	2	7	6	6	2

The octal equivalent of $(1010111110110010)_2$ is $(127662)_8$.

NOTE:- In the above example, we have added two 0s (zero) in the MSB so as to complete the required grouping of three bits.

⇒ Conversion of Binary Fractions to Octal Fractions :-

The conversion of binary fractions to octal fractions is also a straightforward process. Moreover, while representing fractions, it may be necessary to add a zero in the LSB to form a complete grouping of three bits. The rest of the steps are similar to that of binary whole numbers conversions.

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1. Example:- Determine the octal equivalent of $(0.110101)_2$.

Sol^n:-

Binary Number	000	110 (MSB)	101 (LSB)
Octal Number	0	6	5

The octal equivalent of $(0.110101)_2$ is $(0.65)_8$.

⇒ **Conversion of Binary to Hexadecimal :-**

The Conversion of an integer binary number to hexadecimal is accomplished by the following steps:

1. Break the binary number into four-bit sections starting from the LSB to the MSB.
2. Convert the four-bit binary number to its hexadecimal equivalent.

NOTE:- (i) For whole numbers, it may be necessary to add a zero to the MSB to complete a grouping of four bits. (ii) By adding a zero, the MSB will not change the value of the binary number.

1. Example:- Determine the hexadecimal equivalent of $(1010111110011011001)_2$.

Sol^n:-

Binary Number	0010	1011	1100	1101	1001
Decimal Number	2	11	12	13	9
Hexadecimal Number	2(MSB)	B	C	D	9(LSB)

The hexadecimal equivalent of $(1010111110011011001)_2$ is $(2BCD9)_{16}$.

⇒ **Conversion of Binary Fractions to Hexadecimal Fractions :-**

The conversion of binary fractions to Hexadecimal fractions is a simple process. While representing fractions, it may be necessary to add zero in the LSB to form a complete grouping of four bits. The rest of the steps are similar to that of binary whole numbers Conversion.

1. Ex:- Determine the hexadecimal equivalent of $(0.11101000)_2$.

Sol^n:-

Binary Number	0000	1110	1000 (LSB)
Hexadecimal Number	0	E	8

The Hexadecimal equivalent of $(0.11101000)_2$ is $(0.E8)_{16}$

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⇒ **Conversion of Octal to Decimal :-** In the Octal to Decimal conversion, each digit of the octal number is multiplied by its weighted position, and each of the weighted values is added together to get the decimal number.

1. Ex:- Determine the decimal equivalent of $(456)_8$.

Sol^n:-

Octal Number	4	5	6
Weight of Each Bit	8^2	8^1	8^0
Weighted Value	$8^2 \times 4$	$8^1 \times 5$	$8^0 \times 6$
Solved Multiplication	256	40	6

Sum of weight of all bits $= 256 + 40 + 6 = 302$

Thus, the decimal equivalent of $(456)_8$ is $(302)_{10}$.

⇒ **Conversion of Octal Fractions to Decimal Fractions :-** The Conversion of Octal fractions follows the same steps as that of Conversion of binary fractions. Here the negative exponents are used to denote the negative powers of 8.

1. Ex:- Determine the decimal equivalent of $(237.04)_8$.

Sol^n:-

Octal Number	2	3	7	0	4
Weight of each bit	8^2	8^1	8^0	8^{-1}	8^{-2}
Weighted Value	64×2	8×3	1×7	$1/8 \times 0$	$1/64 \times 4$
Solved Multiplication	128	24	7	0	0.0625

Sum of weight of all bits $= 128 + 24 + 7 + 0 + 0.0625$
$= 159.0625$

Thus, the decimal equivalent of $(237.04)_8$ is $(159.0625)_{10}$.

⇒ **Conversion of Octal to Binary :-** Each octal digit can be represented by a three bit binary number. The following steps are involved in the conversion process:

1. Convert the Octal number to its three-bit binary equivalent.
2. Combine the three-bit sections by removing the spaces to get the binary number.

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1. Ex:- Determine the binary equivalent of $(231)_8$.

Sol^n:-

Octal Number	2	3	1
Binary Coded Value	010	011	001

Combining the three bits of the binary coded values, we have 010011001.

Thus, the binary equivalent of $(231)_8$ is $(10011001)_2$.

⇒ Conversion of Octal Fractions to Binary Fractions:– The steps of this conversion are similar to that of octal to binary conversions.

1. Ex:- Determine the binary equivalent of $(2.335)_8$.

Sol^n:-

Octal Number	2	3	3	5
Binary Coded Value	010	011	011	101

Combining the three bits of the binary coded values, we have 010.011011101.

Thus, the binary equivalent of $(2.335)_8$ is $(10.011011101)_2$.

⇒ Conversion of Octal to Hexadecimal:– This conversion involves the following steps:

1. Convert each octal digit to three-bit binary form.
2. Combine all the three-bit binary numbers.
3. Divide the binary numbers into the four-bit binary form by starting the first number from the right bit to the first number from the left bit.
4. Finally, convert these four-bit blocks into their respective hexadecimal symbols.

NOTE:– We can add necessary number of 0s in the MSB to get the desired grouping of bits.

1. Ex:- Determine the hexadecimal equivalent of $(2327)_8$.

Sol^n:-

Octal Number	2	3	2	7
Binary Coded Value	010	011	010	111

Combining the three-bit binary blocks, we have 010011010111.

Dividing the group of binary numbers into the four-bit binary blocks and by converting these blocks into their respective hexadecimal symbols, we have:

0100	1101	0111
4	D	7

Thus, the hexadecimal equivalent of $(2327)_8$ is $(4D7)_{16}$.

⇒ **Conversion of Octal Fractions to Hexadecimal Fractions:-** The steps of this conversion are similar to that of Octal to Hexadecimal Conversions.

1. Ex:- Determine the hexadecimal equivalent of $(31.57)_8$.

Soln:-

Octal Number	3	1	5	7
Binary Coded Value	011	001	101	111

Combining the three-bit binary blocks, we have 011001.101111

Dividing the group of binary numbers into the four-bit binary blocks and by converting these blocks into their respective hexadecimal symbols, we have:

0001	1001	1011	1100
1	9	B	C

Thus, the hexadecimal equivalent of $(31.57)_8$ is $(19.BC)_{16}$.

⇒ **Conversion of Hexadecimal to Decimal:-** In the hexadecimal to decimal conversion, each digit of the hexadecimal number is multiplied by its weighted position, and each of the weighted values is added together to get the decimal number.

1. Ex:- Determine the decimal equivalent of $(B14)_{16}$.

Soln:-

Hexadecimal Number	B=11	1	4
Weight of Each bit	16^2	16^1	16^0
Weighted Value	256×11	16×1	1×4
Solved Multiplication	2816	16	4

Sum of weight of all bits = 2816 + 16 + 4 = 2836

Thus, the decimal equivalent of $(B14)_{16}$ is $(2836)_{10}$.

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⇒ **Conversion of Hexadecimal Fractions to Decimal Fractions:-** The Conversion of hexadecimal fractions follows the same steps as that of binary fractions. Here, the negative exponents are used to denote the negative powers of 16. The exponential expressions of each fractional place-holder are 16^{-1}, 16^{-2}, and in this way the exponent notation proceeds.

1. Ex:- Determine the decimal equivalent of $(A.23)_{16}$.

Sol^n:-

Hexadecimal Number	A = 10	2	3
Weight of each Bit	16^0	16^{-1}	16^{-2}
Weight Value	1×10	$1/16 \times 2$	$1/256 \times 3$
Solved Multiplication	10	0.125	0.01171875

Sum of weight of all bits = 10 + 0.125 + 0.01171875
= 10.13671875

Thus, the decimal equivalent of $(A.23)_{16}$ is $(10.13671875)_{10}$

⇒ **Conversion of Hexadecimal to Binary:-** Each hexadecimal digit can be represented by a four bit binary number. The following steps are involved in the conversion process:

1. Convert each hexadecimal digit to its four-bit binary equivalent.
2. Combine the four-bit sections by removing the spaces to get the binary number.

1. Ex:- Determine the binary equivalent of $(5AF)_{16}$

Sol^n:-

Hexadecimal Number	5	A	F
Binary Coded Value	0101	1010	1111

Combining the four bits of the binary-coded values, we have 010110101111.

Thus, the binary equivalent of $(5AF)_{16}$ is $(010110101111)_2$.

2. Ex:- Determine the binary equivalent of $(86DB45C)_{16}$.

Sol^n:- The binary equivalent of $(86DB45C)_{16}$ is $(1000011011011011010001011100)_2$

Number System

⇒ **Conversion of Hexadecimal Fractions to Binary Fractions :-**
The procedure of this conversion is similar to that of hexadecimal to binary conversion.

1\. Ex:- Determine the binary equivalent of $(2B.6C)_{16}$.

Solⁿ:-

Hexadecimal Number	2	B	6	C
Binary Coded Value	0010	1011	0110	1100

Combining the four bits of the binary-coded values, we have
00101011 · 01101100

Thus, the binary equivalent of $(2B.6C)_{16}$ is $(00101011.01101100)_2$.

⇒ **Conversion of Hexadecimal to Octal :-** This conversion follows the same steps of Octal to hexadecimal conversion except that each hexadecimal digit is converted into a four-bit binary form and then after grouping of all the four-bit binary blocks, it is converted into three-bit binary form. Finally, these three-bit binary forms are converted into octal symbols.

1\. Ex:- Determine the octal equivalent of $(2B6)_{16}$.

Solⁿ:-

Hexadecimal Number	2	B	6
Binary Coded Value	0010	1011	0110

Combining all the four-bit binary blocks, we have 001010110110.
Dividing the group of binary numbers into the three-bit binary blocks and by converting these blocks into their respective octal symbols, we have:

001	010	110	110
1	2	6	6

Thus, the octal equivalent of $(2B6)_{16}$ is $(1266)_8$.

⇒ **Conversion of Hexadecimal Fractions to Octal Fractions :-** The steps of this conversion are similar to the conversion of hexadecimal to Octal.

1\. Ex:- Determine the octal equivalent of $(4.3C)_{16}$.

Solⁿ:-

Hexadecimal Number	4	3	C
Binary Coded value	0100	0011	1100

Dividing in three-bit binary blocks, we have: 000 100 001 111 000

000	100	001	111	000
0	4	1	7	0

Thus, the hexadecimal equivalent of $(4.3C)_{16}$ is $(4.17)_8$.