Number System

Presented by

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Outlines

- Introduction to Number System
- Types of Number System
- Conversion of Number System

What is a Number?

A **number** is a mathematical value used for counting, measuring, or labeling objects. Numbers are used to perform arithmetic calculations. Examples of numbers are natural numbers, positive numbers, negative numbers etc.

1,2,3 …….
-1, -2,-3 …..
1/2, 1/3, 1/4, ….

What is a Number System?

A number system is defined as a system of writing to express numbers. It is the mathematical notation for representing numbers of a given set by using digits or other symbols in a consistent manner.

The value of any digit in a number can be determined by:

- ✓ The digit
- ✓ Its position in the number
- ✓ The base of the number system

Types of Number System

Based on the base value and the number of allowed digits, number systems are of many types. The four common types of Number System are-

- ✓ Decimal Number System
- ✓ Binary Number System
- ✓ Octal Number System
- ✓ Hexadecimal Number System

Decimal Number System

- A number system with a base value of 10 is termed a Decimal number system.
- It uses 10 digits i.e. 0-9 for the creation of numbers.
- Here, each digit in the number is at a specific place with a place value of a product of different powers of 10.
- Here, the place value is termed from right to left as first place value called units, second to the left as Tens, so on Hundreds, Thousands, etc.

Decimal Number System

For example, 10264 has place values as,

$$(1 \times 10^4) + (0 \times 10^3) + (2 \times 10^2) + (6 \times 10^1) + (4 \times 10^0)$$

$$= 1 \times 10000 + 0 \times 1000 + 2 \times 100 + 6 \times 10 + 4 \times 1$$

$$= 10000 + 0 + 200 + 60 + 4$$

$$= 10264$$

Binary Number System

- Number System with base value 2 is termed as Binary number system.
- It uses 2 digits i.e. 0 and 1 for the creation of numbers.
- The numbers formed using these two digits are termed Binary Numbers.
- The binary number system is very useful in electronic devices and computer systems because it can be easily performed using just two states ON and OFF i.e. 0 and 1.
- Example: $(1101)_2$

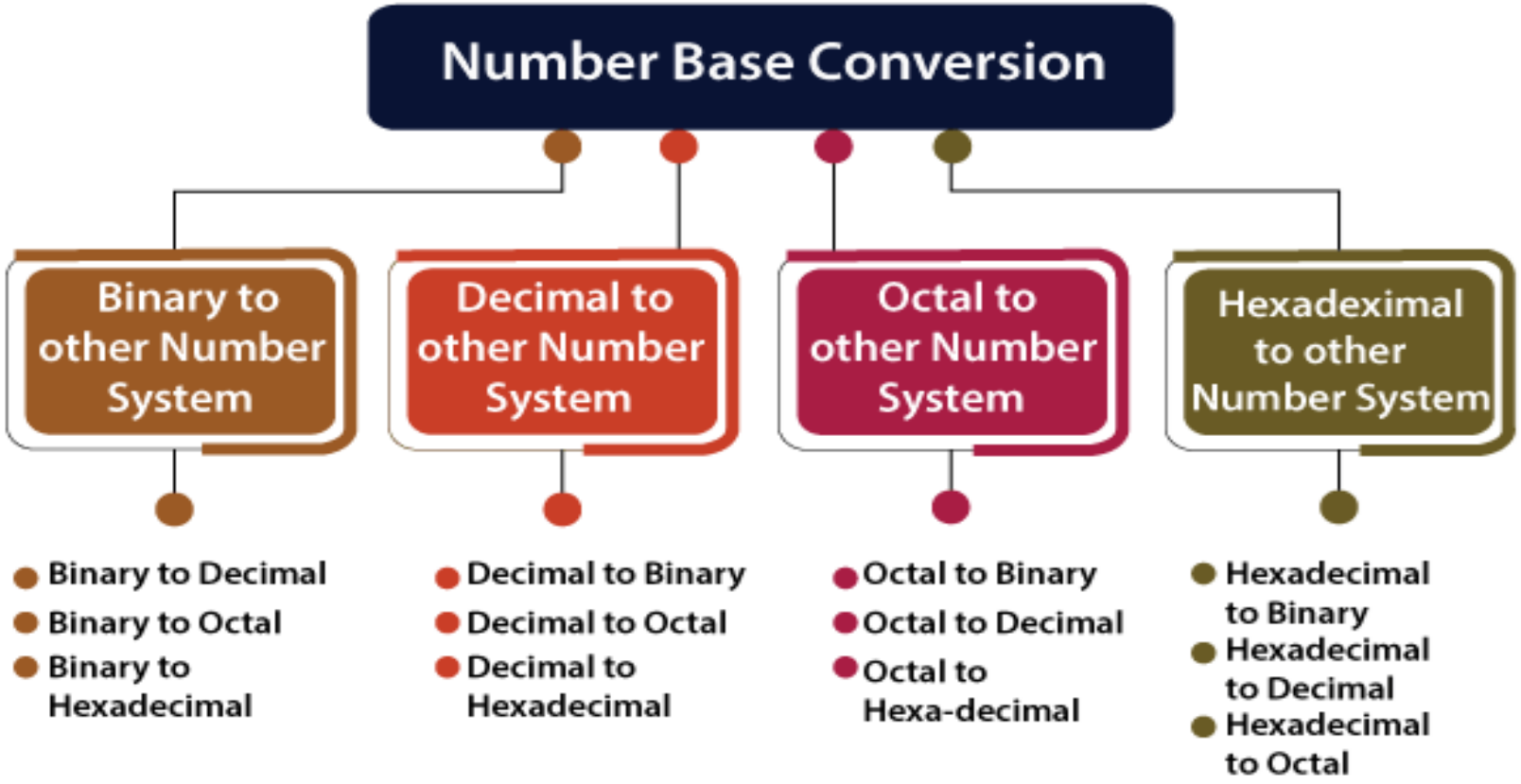
Octal Number System

- The Octal Number System is one in which the base value is 8.
- It uses 8 digits i.e. 0-7 for the creation of Octal Numbers.
- Octal Numbers can be converted to Decimal values by multiplying each digit with the place value and then adding the result.
- Example: $(207)_8$

Hexadecimal Number System

- A Number System with a base value 16 is termed as Hexadecimal Number System.
- It uses 16 digits for the creation of its numbers.
- Digits from 0-9 are taken like the digits in the decimal number system but the digits from 10-15 are represented as A-F i.e. 10 is represented as A, 11 as B, 12 as C, 13 as D, 14 as E, and 15 as F.
- Hexadecimal Numbers are useful for handling memory address locations.
- The hexadecimal number system provides a condensed way of representing large binary numbers stored and processed.
- Example: $(207B)_{16}$

Number System Conversion



Binary to Decimal Conversion

To convert a binary number to decimal we need to perform a multiplication operation on each digit of a binary number from right to left with powers of 2 starting from 0 and add each result to get the decimal number of it.

Decimal Number = n^{th} bit × 2^{n-1}

Binary to Decimal Formula

$$n = b_n q + b_{n-1}q^{n-2} + \ldots\ldots\ldots + b_2 q^2 + b_1 q^1 + b_0 q^0 + b_{-1}q^{-1} + b_{-2}q^{-2}$$

Where,

- *N is Decimal Equivalent*
- *b is the Digit*
- *q is the Base Value*

Binary to Decimal Conversion

Example 1: $(10110.001)_2$

We multiplied each bit of (10110.001)2 with its respective positional weight, and last we add the products of all the bits with its weight.

(10110.001)2 = (1×2^4)+(0×2^3)+(1×2^2)+(1×2^1)+(0×2^0)+(0×2^-1)+(0×2^-2)+(1×2^-3)
(10110.001)2 = (1×16)+(0×8)+(1×4)+(1×2)+(0×1)+(0×1⁄2)+(0×1⁄4)+(1×1⁄8)
(10110.001)2 = 16+0+4+2+0+0+0+0.125
(10110.001)2 = $(22.125)_{10}$

Binary to Octal Conversion

The base numbers of binary and octal are 2 and 8, respectively. In a binary number, the pair of three bits is equal to one octal digit. There are only two steps to convert a binary number into an octal number which are as follows:

- In the first step, we have to make the pairs of three bits on both sides of the binary point. If there will be one or two bits left in a pair of three-bit pairs, we add the required number of zeros on extreme sides.

- In the second step, we write the octal digits corresponding to each pair.

Binary to Octal Conversion

Example 1: $(111110101011.0011)_2$
Firstly, we make pairs of three bits on both sides of the binary point.

111110 101 011.001 1

On the right side of the binary point, the last pair has only one bit. To make it a complete pair of three bits, we added two zeros on the extreme side.

111 110 101 011.001 100

Then, we wrote the octal digits, which correspond to each pair.

$(111110101011.0011)2=(7653.14)_8$

Binary to Hexadecimal Conversion

The base numbers of binary and hexadecimal are 2 and 16, respectively. In a binary number, the pair of four bits is equal to one hexadecimal digit. There are also only two steps to convert a binary number into a hexadecimal number which are as follows:

- ✓ In the first step, we have to make the pairs of four bits on both sides of the binary point. If there will be one, two, or three bits left in a pair of four-bit pair, we add the required number of zeros on extreme sides.

- ✓ In the second step, we write the hexadecimal digits corresponding to each pair.

Binary to Hexadecimal Conversion

Example 1: $(10110101011.0011)_2$
Firstly, we make pairs of four bits on both sides of the binary point.

111 1010 1011.0011

On the left side of the binary point, the first pair has three bits. To make it a complete pair of four bits, add one zero on the extreme side.

0111 1010 1011.0011

Then, we write the hexadecimal digits, which correspond to each pair.

$(011110101011.0011)_2=(7AB.3)_{16}$

Example :

Convert the following binary numbers to decimal, octal and hexadecimal:

1. 11010100
2. 1011.001
3. 1010.1011
4. 10010.0101

Example :

Convert the following binary numbers to decimal, octal and hexadecimal:

1. 11010100 **Ans: 212, 324, D4**
2. 1011.001
3. 1010.1011
4. 10010.0101

Example :

Convert the following binary numbers to decimal, octal and hexadecimal:

1. 11010100 **Ans: 212, 324, D4**
2. 1011.001 **Ans: 11.125, 13.1, B.2**
3. 1010.1011
4. 10010.0101

Example :

Convert the following binary numbers to decimal, octal and hexadecimal:

1. 11010100 **Ans: 212, 324, D4**
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3. 1010.1011 **Ans: 10.6875, 12.54, A.B**
4. 10010.0101

Example :

Convert the following binary numbers to decimal, octal and hexadecimal:

1. 11010100 **Ans: 212, 324, D4**
2. 1011.001 **Ans: 11.125, 13.1, B.2**
3. 1010.1011 **Ans: 10.6875, 12.54, A.B**
4. 10010.0101 **Ans: 18.3125, 22.24, 12.5**

Decimal to Binary Conversion

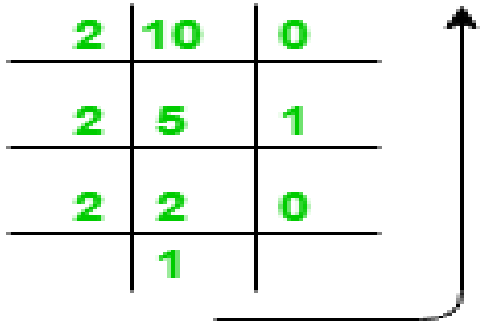
For converting decimal to binary, there are two steps required to perform, which are as follows:

- In the first step, we perform the division operation on the integer and the successive quotient with the base of binary(2).

- Next, we perform the multiplication on the fraction.

Decimal to Binary Conversion

Integer part :



$(10)_{10} = (1010)_2$

Fractional part

0.25x2 = 0.50
0.50x2 = 1.00

$(0.25)_{10} = (0.01)_2$

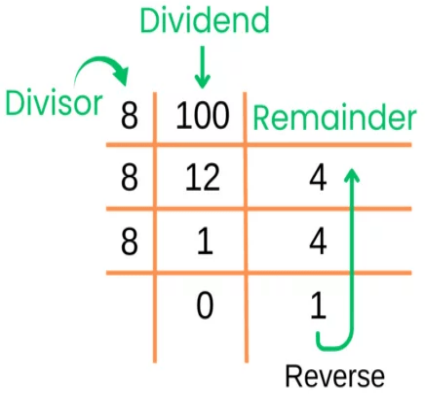
Decimal to Octal Conversion

For converting decimal to octal, there are two steps required to perform, which are as follows:

- In the first step, we perform the division operation on the integer and the successive quotient with the base of octal(8).
- Next, we perform the multiplication on the fraction and the successive quotient with the base of octal(8).

Decimal to Octal Conversion

Decimal= 100 ⟶ Octal ?



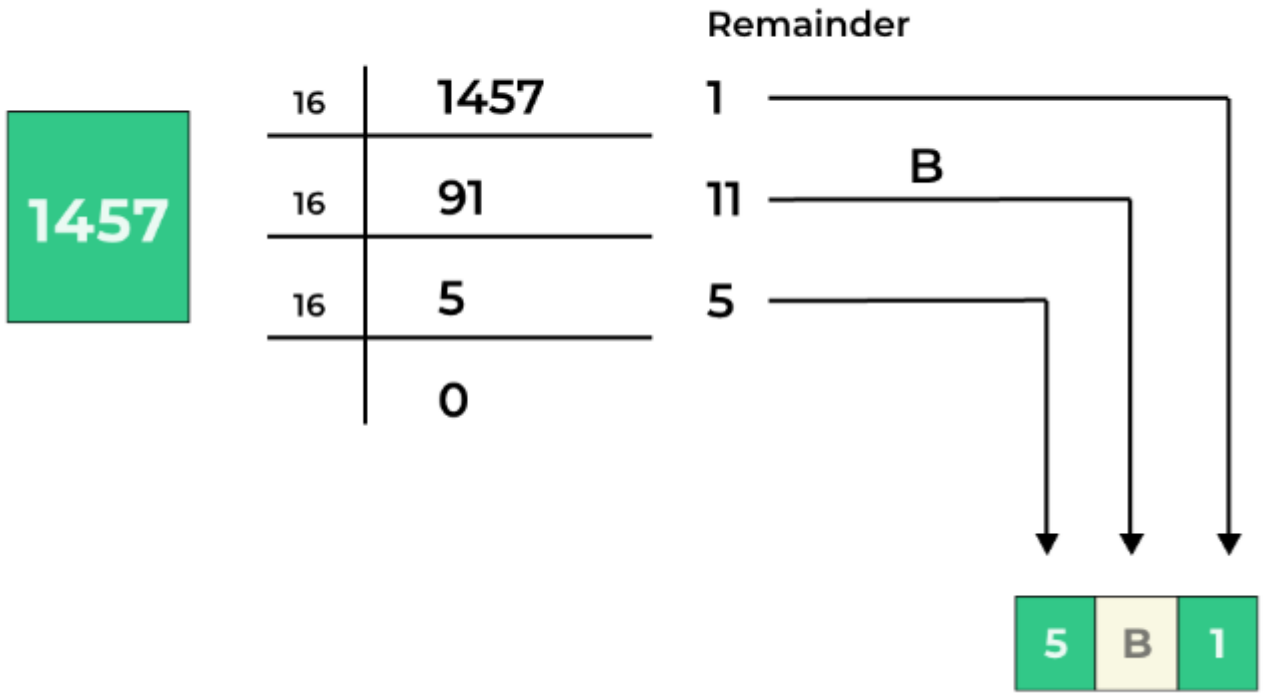
100 ⟶ 144

Decimal to Hexadecimal Conversion

For converting decimal to hexadecimal, there are two steps required to perform, which are as follows:

- In the first step, we perform the division operation on the integer and the successive quotient with the base of hexadecimal (16).
- Next, we perform the multiplication on the fraction and the successive quotient with the base of hexadecimal (16).

Decimal to Hexadecimal Conversion



Example :

Convert the following decimal numbers to binary, octal and hexadecimal:

1. 94.327
2. 755
3. 185.15
4. 390.919

Example :

Convert the following decimal numbers to binary, octal and hexadecimal:

1. 94.327 **Ans: 1011110.0101, 136.2473 , 5E.53B6**
2. 755
3. 185.15
4. 390.919

Example :

Convert the following decimal numbers to binary, octal and hexadecimal:

1. 94.327 **Ans: 1011110.0101, 136.2473 , 5E.53B6**
2. 755 **Ans: 1011110011, 1363, 2F3**
3. 185.15

Example :

Convert the following decimal numbers to binary, octal and hexadecimal:

1. 94.327 **Ans: 1011110.0101, 136.2473 , 5E.53B6**
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Example :

Convert the following decimal numbers to binary, octal and hexadecimal:

1. 94.327 **Ans: 1011110.0101, 136.2473 , 5E.53B6**
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3. 185.15 **Ans: 10111001.001, 271.1146,**

Octal to Decimal Conversion

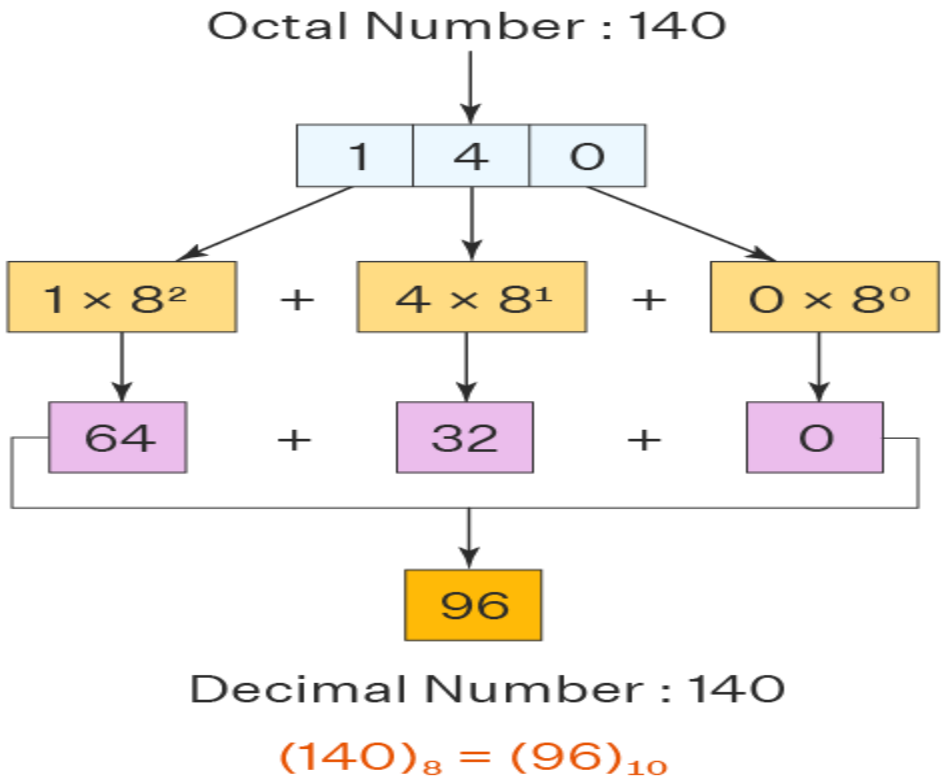
Step 1: Since an octal number only uses digits from 0 to 7, we first arrange the octal number with the power of 8.

Step 2: We evaluate all the power of 8 values such as 80 is 1, 81 is 8, etc., and write down the value of each octal number.

Step 3: Once the value is obtained, we multiply each number.

Step 4: The final step is to add the product of all the numbers to obtain the decimal number.

Octal to Decimal Conversion

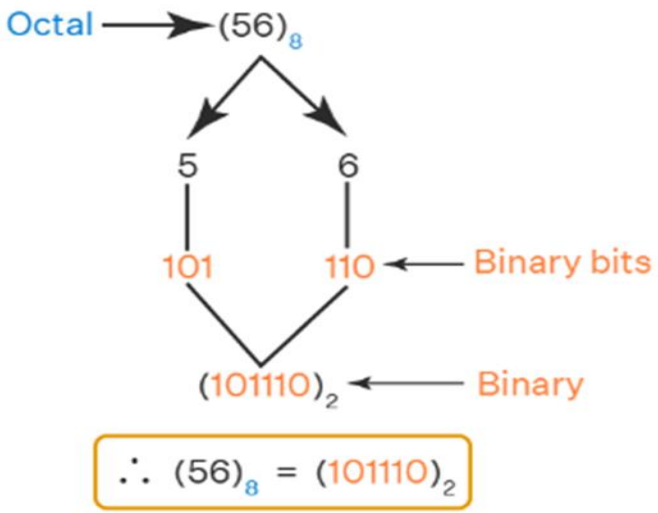


Octal to Binary Conversion

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.



Octal to Hexadecimal Conversion

Step 1: We need to convert the Octal number to Binary first. For that, follow the steps given in the above conversion.

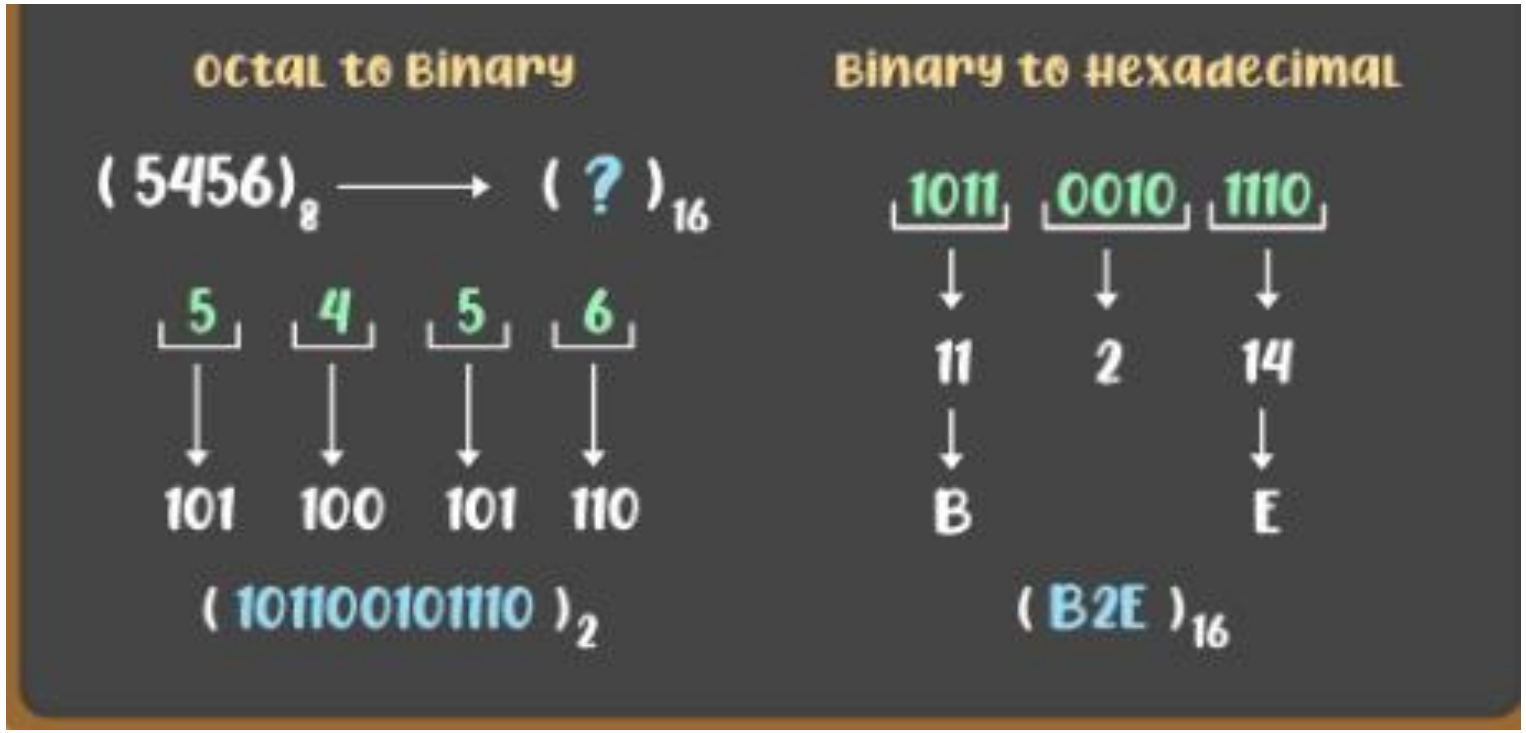
Step 2: Now to convert the binary number to Hex number, divide the binary digits into groups of four digits starting from right to left i.e. from LSB to MSB.

Step 3: Add zeros prior to MSB to make it a proper group of four digits(if required)

Step 4: Now convert these groups into their relevant decimal values.

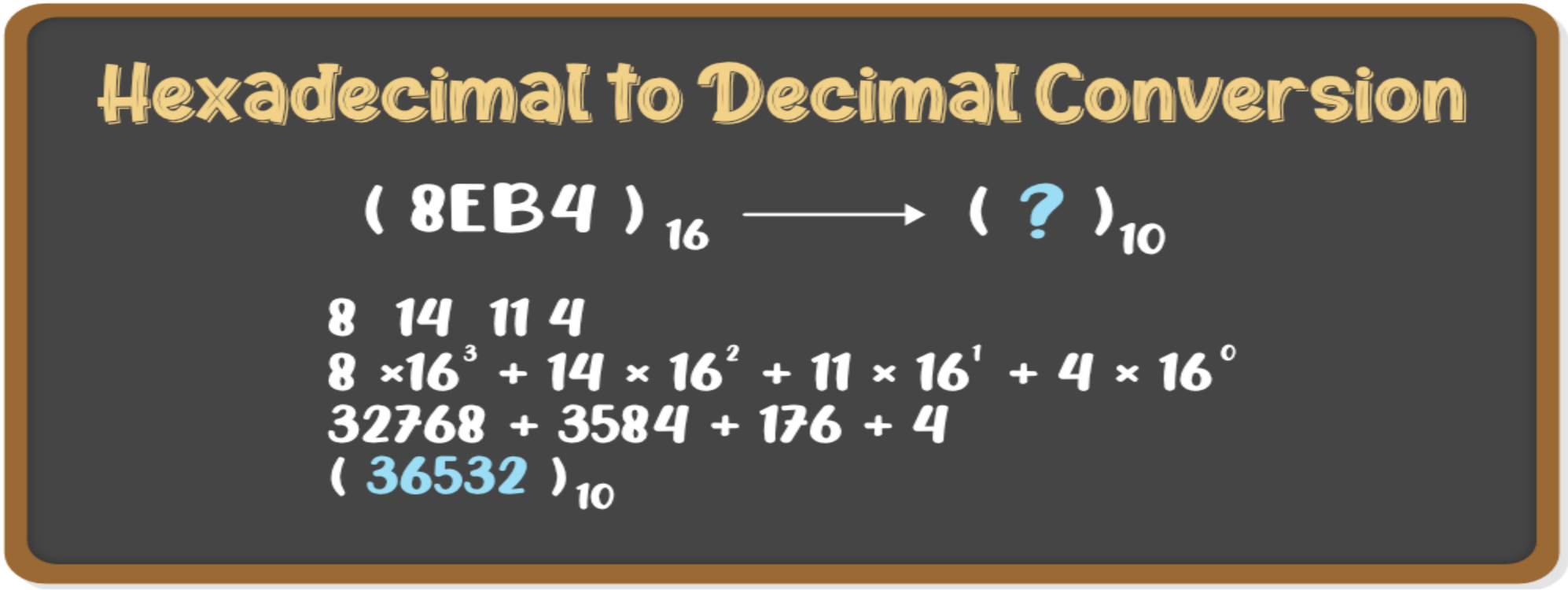
Step 5: For values from 10-15, convert it into Hex symbols i.e from A-F

Octal to Hexadecimal Conversion



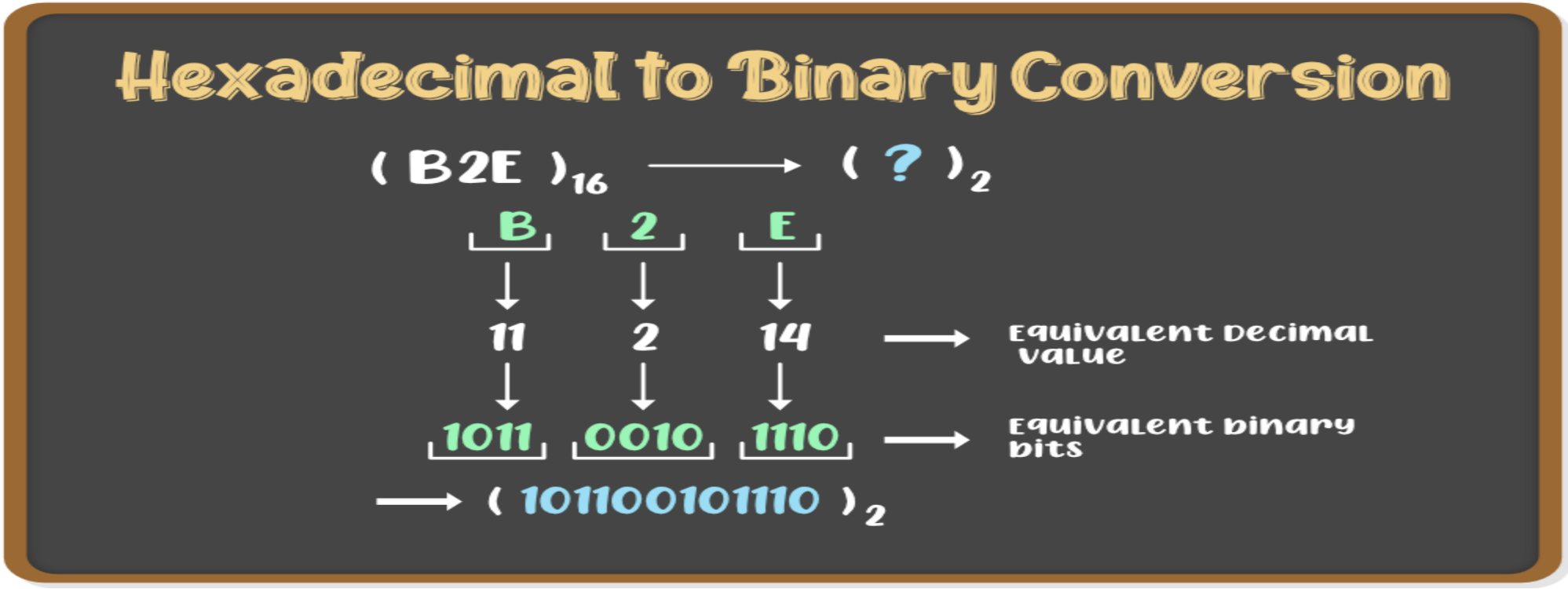
Hexadecimal to Decimal Conversion

Step 1: Write the decimal values of the symbols used in the Hex number i.e. from A-F
Step 2: Multiply each digit of the Hex number with its place value. starting from right to left i.e. LSB to MSB.
Step 3: Add the result of multiplications and the final sum will be the decimal number.



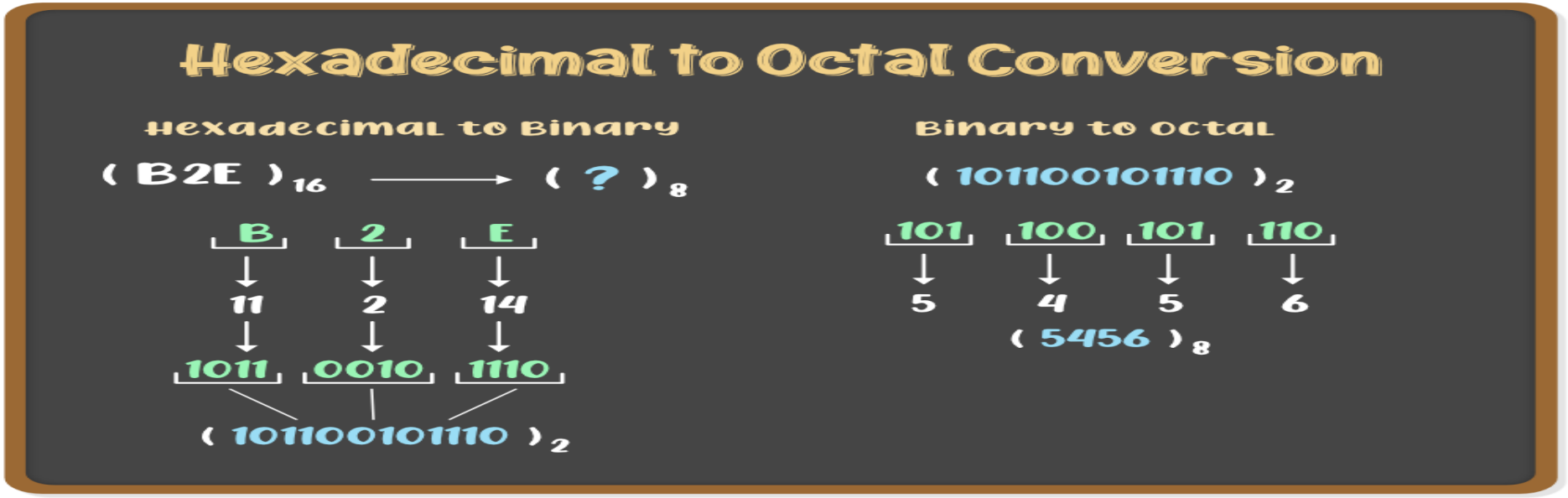
Hexadecimal to Binary Conversion

Step 1: Convert the Hex symbols into its equivalent decimal values.
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.



Hexadecimal to Octal Conversion

Step 1: We need to convert the Hexadecimal number to Binary first. For that, follow the steps given in the above conversion.
Step 2: Now to convert the binary number to Octal number, divide the binary digits into groups of three digits starting from right to left i.e. from LSB to MSB.
Step 3: Add zeros prior to MSB to make it a proper group of three digits(if required)
Step 4: Now convert these groups into their relevant decimal values.



Any Questions?

Thank You