Octal Number System

Octal Number System has a base of eight and uses the numbers from 0 to 7. The octal numbers, in the number system (https://byjus.com/maths/number-system/), are usually represented by binary numbers when they are grouped in pairs of three. For example, an octal number 12_8 is expressed as 001010_2 in the binary system, where 1 is equivalent to 001 and 2 is equivalent to 010.

Octal Number System
Base – 8
Octal Symbol – 0, 1, 2, 3, 4, 5, 6 and 7

Table of Contents:

Apart from the octal number system, there are other number systems in Maths, such a

- Binary Number System (https://byjus.com/maths/binary-number-system/)
- Hexadecimal Number System (https://byjus.com/maths/hexadecimal-number-system/)
- Decimal Number System (https://byjus.com/maths/decimal-number-system/)

Definition

A number system which has its base as 'eight' is called an Octal number system. It uses numbers from 0 to 7. Let us take an example, to understand the concept. As we said, any number with base 8 is an octal number like 24_8, 109_8, 55_8, etc.

Like Octal number is represented with base 8, in the same way, a binary number is represented with base 2, a decimal number with base 10 and the hexadecimal number is represented with base 16.

Examples of these number systems are:

- 22_2 is a binary number
- 100_{10} is a decimal number
- 40_{16} is a hexadecimal number

If we solve an octal number, each place is a power of eight.

- $124_8 = 1 \times 8^2 + 2 \times 8^1 + 4 \times 8^0$

Octal Numbers System Table

We use only 3 bits to represent Octal Numbers. Each group will have a distinct value between 000 and 111.

Octal Digital Value	***Binary Equivalent***
0	000
1	001
2	010
3	011
4	100
5	101
6	110

7	111

Note: Octal number system supports digits from 0 to 7. Beyond 7, such as 8 and 9 are not octal digits. For example, 19 is not an octal number.

Decimal to Octal Number

To convert decimal to octal numbers, the octal dabble method is used. In this method, the decimal number is divided by 8 each time, it yields or gives a remainder. The first remainder we get is the least significant digit(LSD) and the last remainder is the most significant digit(MSD). Let us understand the conversion with the help example.

Example on Decimal to Octal

Problem: Suppose 560 is a decimal number, convert it into an octal number.

Solution: If 560 is a decimal number, then,

560/8 = 70 and the remainder is 0

70/8 = 8 and the remainder is 6

8/8 = 1 and the remainder is 0

And 1/8 = 0 and the remainder is 1

So the octal number starts from MSD to LSD, i.e. 1060

Therefore, $560_{10} = 1060_8$

Problem: Convert 0.52 into an octal number.

Solution: The fraction part of the decimal number has to be multiplied by 8.

0.52 × 8 = 0.16 with carry 4

0.16 × 8 = 0.28 with carry 1

0.28 × 8 = 0.24 with carry 2

0.24 × 8 = 0.92 with carry 1

So, for the fractional octal number, we read the generated carry from up to down.

Therefore, 4121 is the octal number.

Octal to Decimal

To convert an octal number to a decimal number we need to multiply each digit of the given octal with the reducing power of 8.

Let us learn here, the conversion of Octal number to Decimal Number or base 8 to base 10.

Examples on Octal to Decimal

Example 1: Suppose 215_8 is an octal number, then it's decimal form will be,

$215_8 = 2 \times 8^2 + 1 \times 8^1 + 5 \times 8^0$

$= 2 \times 64 + 1 \times 8 + 5 \times 1 = 128 + 8 + 5$

$= 141_{10}$

Example 2: Let 125 is an octal number denoted by 125_8. Find the decimal number.

$125_8 = 1 \times 8^2 + 2 \times 8^1 + 5 \times 8^0$

$= 1 \times 64 + 2 \times 8 + 5 \times 1 = 64+16+5$

$=85_{10}$

Binary To Octal Number

A binary number can be converted into an octal number, with the help of the below-given table.

Octal Number	Equivalent Binary Number
0	0
1	1
2	10
3	11
4	100
5	101
6	110

7	111

Example on Binary to Octal

Example: Convert $(100010)_2$ to an octal number.

Solution: With the help of the table we can write,

100→4

and 010→2

Therefore, $(100010)_2 = 42$

Similarly, we can convert an octal number to a binary number with the help of the table.

Octal to Hexadecimal Number

Hexadecimal numbers consist of numbers and alphabets. It is represented with base 16. The numbers from 0-9 are represented in the usual form, but from 10 to 15, it is denoted as A, B, C, D, E, F. Conversion of the octal number to hexadecimal requires two steps.

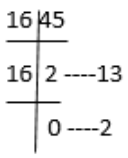
- First, convert octal numbers to decimal numbers.
- Then, convert decimal numbers to hexadecimal numbers.

Example

Let us understand with the help of an example. We will take the same example, where we have converted the octal numbers to decimal, such as;

$(55)_8 = (45)_{10}$

Now, convert $(45)_{10}$ into a hexadecimal number by dividing 45 by 16 until you get a remainder less than 16.



Therefore, we can write, $(45)_{10} = (2D)_{16}$

Or $(55)_8 = (2D)_{16}$

Octal Multiplication Table

*	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7
2	0	2	4	6	10	12	14	16
3	0	3	6	11	14	17	22	25
4	0	4	10	14	20	24	30	34
5	0	5	12	17	24	31	36	43
6	0	6	14	22	30	36	44	52
7	0	7	16	25	34	43	52	61

Applications

The octal Number system is widely used in computer application sectors and also in the aviation sector to use the number in the form of code.

Based on octal number system applications, several computing systems are developed. All the modern generation computing system uses 16-bit, 32-bit or 64-bit word which is further divided into 8-bit words. Similarly, for various programming languages, octal numbers are used to do coding or to write the encrypted language, which is only understood by the computing machine.

Also in the aviation sector or field or say aviation industry, Transponders used in the aircraft transmit a code which is expressed as four octal digit number. These codes are interrogated by ground radar.

Importance

The octal number system uses less digits (3-bits) than hexadecimal numbers (4-bits), which is one of the advantages. It is therefore, there will be less computations and the possibility of the occurrence of error will degrade.

Because of less digits, it is also easy to convert octal to any other number system and vice-versa.

One of the disadvantages is that computers do not understand the octal numbers in a direct way and hence it has to be converted into binary numbers first.

Problems and Solutions

Q.1: Convert 275_8 to a decimal number.

Solution: $2 \times 8^2 + 7 \times 8^1 + 5 \times 8^0$

$= 64 \times 2 + 8 \times 7 + 1 \times 5$

$= 128 + 56 + 5$

$= 189$

Therefore, $275_8 = 189_{10}$

Q.2: Convert decimal number 139 into an equivalent octal number.

Solution: We need to divide 139 by 8 repeatedly, till the quotient is 0.

8	139	Remainder
8	17	3
8	2	1
	0	2

Now take the remainders from down to up to get the equivalent octal number.

$139_{10} = 213_8$

Q.3: Convert the octal number 540 into a binary number.

Solution: Given, 540 is the octal number

By the octal number table, we can get the binary equivalent of each digit.

5 → 101

4 → 100

0 → 000

Therefore,

$540_8 = 101100000_2$

Practice Questions

Convert the following octal numbers into their equivalent decimal number.

- 23_8 (Answer: 19_{10})
- 770_8 (Answer: 504_{10})
- 152_8 (Answer: 106_{10})

Convert the following octal numbers into hexadecimal numbers.

- 23_8 (Answer: 13_{16})
- 770_8 (Answer: $1F8_{16}$)
- 152_8 (Answer: $6A_{16}$)

Also, study-related topics on number systems by downloading BYJU'S -The Learning App.

Frequently Asked Questions – FAQs

Q1 **What is an octal number system?**

A number system expressed with base-8 and whose range is from 0 to 8 only, is called an octal number system. It is represented as N8.

Q2 **What is the use of octal numbers?**

The octal Number system is widely used in computer application sectors. All the modern generation computing system uses 16-bit, 32-bit or 64-bit word which is further divided into 8-bit words. Also in the aviation sector, the octal numbers are used in the form of code.

Q3 **What is the importance of the octal number system?**

Since the octal numbers use less number of digits as compared to decimal numbers and hexadecimal numbers, therefore it is easy to do computations in fewer steps and also less chances of occurrence of error.

Q4 **What is the octal form of decimal number 19?**

To convert a decimal number into an octal number, we need to divide the given decimal number by 8 until the output is 0. At last, we need to write the remainder from LSD to MSD in reverse order.
19/8 = 2, Remainder = 3
2/8 = 0, Remainder = 2
Therefore, $19_{10} = 23_8$

Q5 **What are the 4 types of number systems?**

Binary number system
Octal Number system
Decimal number system
Hexadecimal number system

Q6 **What is 13_8 in binary?**

For octal number 13,
1 → 001
3 → 011
Therefore, clubbing both the numbers we get:
$13_8 = 001011_2$
Or $13_8 = 1011_2$

Q7 **What is the binary number 1111 equivalent to in the octal number system?**

1111 can be written in groups of three digits by adding 0's, such as;
001111 → 001 111 → 17
$(1111)_2 \rightarrow (17)_2$

Test your knowledge on Octal Number System

Put your understanding of this concept to test by answering a few MCQs.
Click 'Start Quiz' to begin!

Select the correct answer and click on the "Finish" button
Check your score and answers at the end of the quiz