Contents

The Octal Numbering System

Octal comes into a close second as a numbering system to use instead of binary.

The **Octal Numbering System** is very similar in principle to the previous hexadecimal numbering system except that in Octal conversions, a binary number is divided up into **groups of only 3 bits**, with each group or set of bits having a distinct value of between 000 (0) and 111

Octal Numbers

Decimal Number	3-bit Binary Number	Octal Number
0	000	0
1	001	1
2	010	2
3	011	3
4	100	4
5	101	5
6	110	6
7	111	7
8	001 000	10 (1+0)
9	001 001	11 (1+1)
Continuing upwards in groups of three		

In octal, you can represent, at most, 3 bits with a single octal digit.

So it's easy to equate: $311_8 \approx 11\ 001\ 001_2$.

The problem with octal, as you can see, is that the 3rd octal digit can only goes as high as 3, so it does not represent a byte as cleanly as hex.

Octal is used in **Unix for permissions** due to its 3-bit nature.

If we take the three specific entitlements (read, write, execute) for a file, we find that it coincides very well with octal.

That's why we've used "chmod 744" commands, because they are octal representation of permissions

$chmod	7	4	4
	111	100	100
	R-W-E	Read	Read
	User	group	others respectively

So if you wanted the permission for read-write, it would be 110, or 6. Read and execute would be 101 or 5.

EXERCISE: What is the chmod command if you want user to have read, write and execute, and the group and others to have write and execute only?

Consider any binary number. A binary number consists of only 0's and 1's
Group all the bits in the binary number, as a set of 3 bits. Start from the right: approaching from least significant bit to the most significant bit.

- If any bit remains ungrouped in a set of 3 bits then you can add a leading '0' to it on the left, to make it a perfect set.

EXERCISE: Why groups of 3 for Octal and groups of 4 for Hex?

Octal to Decimal:

Find the octal numbers and their equivalent binary numbers

Replace each 3-bit binary number set to its equivalent octal number

Decimal Number	3-bit Binary Number	Octal Number
0	000	0
1	001	1
2	010	2
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Octal Digit Value	2322_8
In polynomial form	$=(2\times8^3)+(3\times8^2)+(2\times8^1)+(2\times8^0)$
Add the results	$=(1024)+(192)+(16)+(2)$
Decimal number form equals: 1234_{10}	

Binary to Octal:

a) 100101111010_2
b) 1111110011_2
c) 101010101010_2
d) 000011001111_2

(a) 100101111010_2

100 101 111 010_2

4 5 7 2_8

So, $100101111010_2 = 4572_8$

(b) 1111110011_2

1 111 110 011_2

001 111 110 011_2

1 7 6 3_8

EXERCISE: Complete for (c) and (d) calculations above

Number Bases Reference Table

BASE 10	BASE 2	BASE 16	BASE 8
DECIMAL	**BINARY**	**HEXADECIMAL**	**OCTAL**
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	8	10
9	1001	9	11
10	1010	A	12
11	1011	B	13
12	1100	C	14
13	1101	D	15
14	1110	E	16
15	1111	F	17