Al-Mamoon University

College of Science

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lecture (2):

Conversion Systems, Octal and Hexadecimal Systems

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Chapter two

Conversion Systems, Octal and Hexadecimal Systems

Octal Numbers: The octal number system has a base 8 with digits of 0, 1, 2, 3, 4, 5, 6 and 7 (there is no 8 or 9 in the octal number code).

1- Octal - to - Decimal conversion: To convert from octal to decimal, multiply each octal digit by its weight and add the resulting products.

$$\text{etc} \ldots 8^4\ 8^3\ 8^2\ 8^1\ 8^0\ .\ 8^{-1}\ 8^{-2}\ 8^{-3}\ 8^{-4} \ldots \text{etc}$$

Meaning we multiply each number by the power it represents. The first number from the right is represented by the power 8^0, the second number is represented by 8^1, and so on. If there are fractions, the first number from the left after the decimal point is represented by 8^{-1}, the second number is represented by 8^{-2}, and so on. Then we sum the results.

Ex: Convert octal 23 to decimal equivalent?

$2(8)^1 + 3(8)^0 = 16 + 3 = 19$

Ex: Convert octal 257 to its decimal equivalent?

$2(8)^2 + 5(8)^1 + 7(8)^0 = 128 + 40 + 7 = 175$

The following table illustrates the number system of the binary system:

Octal	Decimal
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
10	8
11	9
12	10
13	11
14	12
15	13
16	14
17	15
20	16
21	17
22	18
23	19
24	20
25	21
26	22
27	23
30	24
31	25

2- Decimal - to - Octal Conversion: Octal - dabble, a method similar to double dabble, is used with octal numbers. Instead of dividing by 2 (the base of binary number), you divide by 8 (the base of octal numbers) writing downward the remainders after each division. The remainders are in reverse order from the octal number.

Meaning the same previous method for the binary number but the division here is by 8, and to write the octal number we take the remaining numbers and write them starting from bottom to top.

Ex: Convert decimal 175 to its octal equivalent?

Division	Result	Remaining
175 ÷ 8	21	7
21 ÷ 8	2	5
2 ÷ 8	0	2

So, the octal equivalent is 257

With decimal fraction, multiply instead of divide, writing the carry into the integer position:

Meaning the same previous method for the binary number but the multiplication here is by 8, and to write the octal number we take the carry numbers and write them starting from bottom to top.

Ex: Convert decimal 0.23 into an octal fraction?

Multiplication	Product	Fraction	Integer
0.23 × 8	1.84	0.84	1
0.84 × 8	6.72	0.72	6
0.72 × 8	5.76	0.76	5
0.76 × 8	6.08	0.08	6
0.08 × 8	0.64	0.64	0

The carries read downward give the octal fraction 0.16560

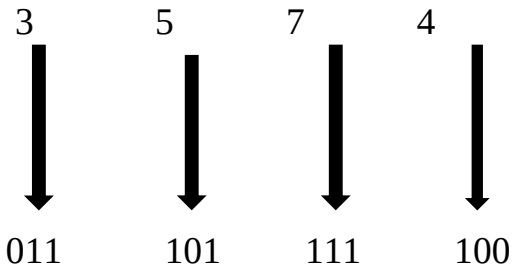
3- Octal – to – Binary Conversion: Because 8 (the base of octal numbers) is the third power of 2 (the base of binary numbers), we can convert from octal digit to its binary equivalent:

Ex: Change octal 23 to its binary equivalent?

The binary equivalent of octal 23 is 010 011, or 010 011

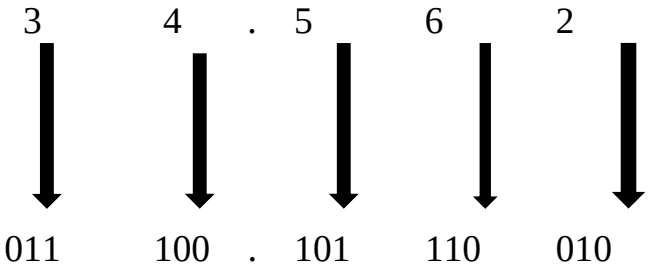
Often a space is left between groups of 3 bits; this makes it easier to read the binary number.

Ex: Convert octal 3574 to binary number?



Hence, the binary 011 101 111 100 is equivalent to octal 3574

Ex: Convert octal 34.562 to binary number?



So, the equivalent binary number is 011 100.101 110 010

Ex: What is the binary equivalent of decimal 363?

Division	Result	Remaining
363 ÷ 8	45	3
45 ÷ 8	5	5
5 ÷ 8	0	5

Next convert octal 553 to binary

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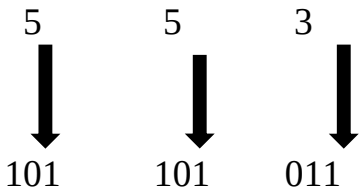


So, $(553)_8 = (101\ 101\ 011)_2$

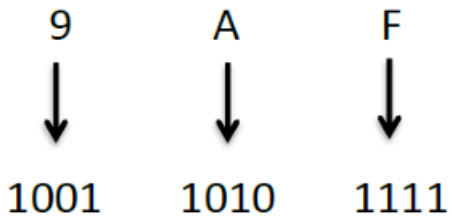
Hexadecimal Numbers

The hexadecimal number system has a base of 16. Although any 16 digits may be used, everyone uses 0 to 9 and A to F as shown in down table. In other hand, after reaching 9 in hexadecimal system, you continue counting as follows: A, B, C, D, E, F.

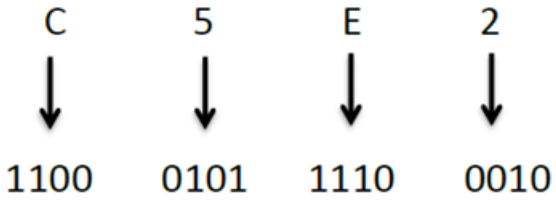
Decimal	Binary	Hexadecimal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

1- Hexadecimal – to – Binary Conversion: To convert a hexadecimal number to a binary number, convert each hexadecimal digit to its 4-bits equivalent.

Ex: How 9AF convert to binary?

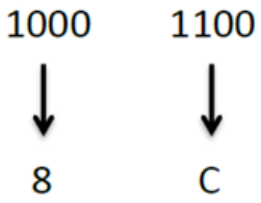


Ex: Convert the hexadecimal C5E2 to its binary equivalent?

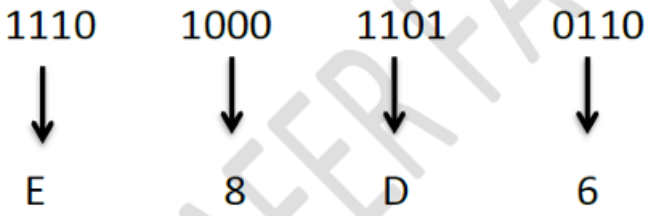


2- Binary – to – Hexadecimal Conversion: You can use the last table to convert from binary to hexadecimal:

Ex: Convert the binary 1000 1100 to its hexadecimal equivalent?



Ex: Convert the binary 1110100011010110 to its hexadecimal equivalent?



3- Hexadecimal – to – Decimal Conversion: In the hexadecimal number system each digit position corresponds to a power of 16. The weights of the digit position in a hexadecimal number are as follows:

$$\text{etc} \ldots 16^3\ 16^2\ 16^1\ 16^0\ .\ 16^{-1}\ 16^{-2}\ 16^{-3} \ldots \text{etc}$$

To convert from hexadecimal to decimal, multiply each hexadecimal digit by its weight and add the resulting products.

Meaning we multiply each number by its power according to the rule and add the results.

Ex: How to convert hexadecimal F8E6.39 to its decimal equivalent?

$F8E6.39 = F\ (16^3) + 8\ (16^2) + E\ (16^1) + 6\ (16^0) + 3\ (16^{-1}) + 9\ (16^{-2})$

$= 15\ (16^3) + 8\ (16^2) + 14\ (16^1) + 6\ (16^0) + 3\ (16^{-1}) + 9\ (16^{-2})$

$= 61440 + 2048 + 244 + 6 + 0.1875 + 0.0352$

$= 63718.2227$

4- Decimal – to – Hexadecimal Conversion: One way to convert from decimal to hexadecimal is the hex – dabble. The idea is to divide by 16, writing down the remainders.

Meaning the same previous methods but we replace the remainder with its equivalent from the hexadecimal numbers table, and to write the hexadecimal number we start from bottom to top.

Ex: Convert decimal 2479 to hexadecimal?

Division	Result	Remaining	Hexadecimal
2479 ÷ 16	154	15	F
154 ÷ 16	9	10	A
9 ÷ 16	0	9	9

Therefore, the hexadecimal 9AF is the equivalent of decimal 2479

Ex: Convert decimal 65535 to hexadecimal equivalent?

Division	Result	Remaining	Hexadecimal
65535 ÷ 16	4095	15	F
4095 ÷ 16	255	15	F
255 ÷ 16	15	15	F
15 ÷ 16	0	15	F

Therefore, the hexadecimal FFFF is the equivalent of decimal 65535

Note that in the last example, the numbers in the hexadecimal number system are all equal to F, because the remainder of the division is greater than or equal to 15.