

# Number Systems (Chapter 3)



Repeatedly divide by two and record the remainder for each division then read the answer upwards

**Example:** Rewrite the decimal number  $500_{10}$  as a binary number

$$\begin{array}{r}
 500/2 = 250 + 0 \\
 250/2 = 125 + 0 \\
 125/2 = 62 + 1 \\
 62/2 = 31 + 0 \\
 31/2 = 15 + 1 \\
 15/2 = 7 + 1 \\
 7/2 = 3 + 1 \\
 3/2 = 1 + 1 \\
 1/2 = 0 + 1
 \end{array}$$

↑  
Read the reminders upwards

The answer is  $500_{10} = 111110100_2$ , we can check the answer by transferring the result back to decimal number

$$111110100_2 = 1 * 2^8 + 1 * 2^7 + 1 * 2^6 + 1 * 2^5 + 1 * 2^4 + 0 * 2^3 + 1 * 2^2 + 0 * 2^1 + 0 * 2^0 = 500_{10}$$



Repeatedly divide by eight and record the remainder for each division then read the answer upwards

**Example:** Rewrite the decimal number  $263_{10}$  as an octal number

$$\begin{array}{r}
 263/8 = 32 + 7 \\
 32/8 = 4 + 0 \\
 4/8 = 0 + 4 \\
 0/8 = 0 + 0
 \end{array}$$

↑  
Read the reminders upwards

The answer is  $263_{10} = 407_8$ , we can check the answer by transferring the result back to decimal number

$$407_8 = 4 * 8^2 + 0 * 8^1 + 7 * 8^0 = 256 + 0 + 7 = 263_{10}$$

Note that we did not consider the 0 on the left because it dose not effect the answer  $0407_8 = 407_8$

## Decimal Number Hexadecimal Number

Repeatedly divide by eight and record the remainder for each division then read the answer upwards

**Example:** Rewrite the decimal number  $6121_{10}$  as a hexadecimal number

$$\begin{array}{l}
 612/16 = 382 + 9 \\
 382/16 = 23 + 14 \\
 23/16 = 1 + 7 \\
 1/16 = 0 + 1
 \end{array}$$

Note that  $14_{10} = E_{16}$   
 Read the reminders upwards and replace 14 by

The answer is  $6121_{10} = 17E9_{16}$ , we can check the answer by transferring the result back to decimal number

$$17E9_{16} = 1 * 16^3 + 7 * 16^2 + 14 * 16^1 + 9 * 16^0 = 4096 + 1792 + 224 + 9 = 6121$$

Note that  $10_{10} = A_{16}$ ,  $11_{10} = B_{16}$ ,  $12_{10} = C_{16}$ ,  $13_{10} = D_{16}$ ,  $14_{10} = E_{16}$ ,  $15_{10} = F_{16}$ .

## Binary Number Octal Number

Note  $8 = 2^3$  that means we need only 3 bits to represent 8 possibilities {0,1,2,3,4,5,6,7}

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

بس إحتجنا 3 خانات عشان نكتب الاعداد بالصيغة الثنائية

Count off from right to left by three and translate each triad into base 10.

**Example:** Rewrite the binary number  $1101101011_2$  as an octal number

نضيف أصفار على اليسار لتكوين مجموعة ثلاثية

$1101101011 \rightarrow 1101101011 \rightarrow 001\ 101\ 101\ 011 \rightarrow 1\ 5\ 5\ 3$

قسم العدد الثنائي الى مجموعات كل مجموعة تحوي 3 خانات

نستبدل كل مجموعة ثلاثية بعددها عشري

The answer is  $1101101011_2 = 1553_8$ , We change an octal number to a binary number by changing each digit of octal number to 3 bits binary number, e.g,  $643_8 = 110\ 100\ 011_2$ .

## Binary Number



## Hexadecimal Number

Note  $16 = 2^4$  that means we need only 4 bits to represent 16 possibilities {0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F}

0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A <sub>16</sub> =10	1010
B <sub>16</sub> =11	1011
C <sub>16</sub> =12	1100
D <sub>16</sub> =13	1101
E <sub>16</sub> =14	1110
F <sub>16</sub> =15	1111

Count off from right to left by four and translate each quad into base 10.

**Example:** Rewrite the binary number 11011101111<sub>2</sub> as a hexadecimal number

نضيف اصفار على اليسار لتكوين مجموعة رباعية

11011101111 → 11011101111 → 0110 1110 1111 → 6 14 15

قسم العدد الثنائي الى مجموعات كل مجموعة تحوي 4 خانات

نستبدل كل مجموعة رباعية بعددها عشري

The answer is 11011101111<sub>2</sub> = 6EF<sub>16</sub>, We change an octal number to a binary number by changing each digit of binary number to 4 bits binary number, e.g. 5A2<sub>16</sub> = 0101 1010 0010<sub>2</sub>.

## Octal Number



## Hexadecimal Number

We can changing an Octal number to/from a Hexadecimal number by simply transfer the number to binary number then use the methods above to change it to the requested base.

**Example:** Rewrite the octal number 374<sub>8</sub> as a hexadecimal number.

$$374_8 = 011\ 111\ 100_2 = 0\ 1111\ 1100_2 = 0\ F\ C_{16} = FC_{16}$$

To check your answer change both octal and hexadecimal to decimal number:

$$374_8 = 3 * 8^2 + 7 * 8^1 + 4 * 8^0 = 192 + 56 + 4 = 252$$

$$FC_{16} = 15 * 16^1 + 12 * 16^0 = 240 + 12 = 252$$