**Octal!!**

***To convert between Binary and Octal:***

Step 1: group the binary digits by threes, similar to how we use commas with large numbers:

110011001100 becomes 110 011 001 100

11110000 becomes 11 110 000

Step 2: Add zeros to the left (most significant digits) to make all numbers 3 bit numbers:

11 110 000 becomes 011 110 000

Step 3: Now convert each three bit number into a octal number: 0..7

110 011 001 100 becomes 63148

011 110 000 becomes 3608

Likewise we can convert from Octal to Binary:

5778 = 101 111 111

12348 = 001 010 011 100

Now you try!

|  |  |
| --- | --- |
| Binary -> Octal | Octal -> Binary |
| 01101001= 001 101 001=151 | 2648= 010 110 100 |
| 10101010= 010 101 010=252 | 7018= 111 000 001 |
| 11000011=011 000 011 = 303 | 0768= 000 111 110 |
| 10100101= 010 100 101 = 245 | 5678= 101 110 111 |

Hexadecimal!

The hexadecimal (base 16) number systems work as follows:

Base 16: 1 2 3 4 5 6 7 8 9 A B C D E F 10 11 12 13 14 15 16 17 18 19…..

Since base 16 needs more digits (after 9) we add A B C D E F. Therefore, A=10, B=11, C=12, D =13, E=14, F=15. It helps to be able to memorize some hexadecimal digits.

A = 1010 = 10102 B = 1110 = 10112 C = 1210 = 11002

D = 1310 = 11012 E = 1410 = 11102 F = 1510 = 11112

***To convert from binary to hexadecimal:***

Step 1: group the binary digits by fours. A 4-bit number is called a **nibble**:

110011001100 becomes 1100 1100 1100

11110000 becomes 1111 0000

111000111 becomes 1 1100 0111

Step 2: Add zeros to the left (most significant digits) to make all numbers 4 bit numbers:

1 1100 0111 becomes 0001 1100 0111

Step 3: Now convert each four bit number into a hexadecimal number: 0..F

1100 1100 1100 becomes CCC

1111 0000 becomes F0

0001 1100 0111 becomes 1C7

Now you try!

|  |  |  |  |
| --- | --- | --- | --- |
| Binary | Hexadecimal | Binary | Hexadecimal |
| 10011001 = 1001 1001 | 99 | 0011 1100 | 3C |
| 11001110 =  1100 1110 | CE | 0001 1110 | 1E |
| 101111 = 0010 1111 | 2F | 1110 0001 | E1 |
| 0011 0011 | 33 | 1011 0100 | B4 |
| 1100 0011 | C3 | 0110 1001 | 69 |
| 1010 0101 | A5 | 0101 1010 | 5A |
| 1001 1001 | 99 | 1100 0011 | C3 |