**BASE-10 NUMBERS FROM 1 TO 17 IN SOME OTHER BASES**

You need to understand base 2 (binary) and base 16 (hexadecimal) to be a computer professional. Base 8 (octal) is also sometimes found but not required for this course. You can understand binary and “hex”, or numbers in any other base, by fully understanding our familiar base-10 system. We tend to use our base-10 numbers casually, but if we think of them in terms of powers of the base-10, other number bases are easier to follow. In the explanation below, **^** signifies an exponent, as in 10^2 means 10 squared.

435 in base-10 = 4 \* 100 + 3 \* 10 + 5 \* 1. Using powers of base 10 is more instructive.

435 in base-10 = 4 \* 10^**2** + 3 \* 10^**1** + 5 \* 10^**0**. Any base to exponent 0 is 1. NOTE the descending powers of base 10 from left to right.

This **descending powers of the base approach applies for any base**.

EXAMPLE: Consider 1101, the base-2 equivalent of 13.

1101 in base-2 (binary) = 1 \* 2^**3** + 1 \* 2^**2** + 0 \* 2^**1** + 1 \* 2^**0.** Add up this expression and you get 8 + 4 + 0 + 1 = 13.

EXAMPLE: Now consider the 23, the base-5 equivalent of 13 in base-10.

23 = 2 \* 5^**1** + 3 \* 5^**0**. Adding up this expression we get 10 + 3 = 13.

EXAMPLE: Look at 122, the base-3 equivalent of 17 in base-10.

122 = 1 \* 3^**2** + 2 \* 3^**1** + 2 \* 3^**0**. Adding this up, we get 9 + 6 + 2 = 17.

IMPORTANT

* The digits available for use in any **base b**, range from **0 to (b-1)**. Note the **red 10** values in the table below.
* Base-2 numbers can use only 0 and 1. Base 5 numbers can use only 0, 1, 2, 3 and 4. Base-10 numbers use 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.
* It follows from this that a hexadecimal number must use a single “digit” for values from 0 to 15. What do we do after 9?
* Rather than devise some new single digits for 10, 11, 12, 13, 14, and 15, it was decided to use A, B, C, D, E, and F for those “digits”.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Base:2 1 **10** 11 100 101 110 111 1000 1001 1010 1011 1100 1101 1110 1111 10000 10001

Base:3 1 2 **10** 11 12 20 21 22 100 101 102 110 111 112 120 121 122

Base:4 1 2 3 **10** 11 12 13 20 21 22 23 30 31 32 33 100 101

Base:5 1 2 3 4 **10** 11 12 13 14 20 21 22 23 24 30 31 32

Base:6 1 2 3 4 5 **10** 11 12 13 14 15 20 21 22 23 24 25

Base:7 1 2 3 4 5 6 **10** 11 12 13 14 15 16 20 21 22 23

Base:8 1 2 3 4 5 6 7 **10** 11 12 13 14 15 16 17 20 21

Base:9 1 2 3 4 5 6 7 8 **10** 11 12 13 14 15 16 17 18

Base:16 1 2 3 4 5 6 7 8 9 **A B C D E F** **10** 11