Codes :

The binary number is the most natural system , but people are familiar to the decimal system . one way to solve this conflict is to convert all input decimal numbers into binary numbers and then convert the binary results back to decimal for the human user to understand . However , it is also possible for the computer to perform arithmetic operations directly with decimal numbers provided they are placed in registers in a coded form . When decimal numbers are used for internal arithmetic computations , they are converted to a binary code with four bits per digit .

It is very important to understand difference between the conversion of decimal numbers into binary and the binary coding for decimal numbers .

BCD (binary – coded – decimal) :

These are codes that combine some of the features of both decimal and binary numbers.

There are different types of BCD codes :

1- Excess-3 code :

It is an important BCD code . To encode decimal number to it's excess-3 , we add (3) to each decimal digit before converting to binary :

Decimal	ex-3
0	0011
1	0100
2	0101
3	0110
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100
10	0100 0011
11	0100 0100

Note : It is un weighted code .

أكثر رقم نحتاجه هو 12 ←

2- BCD 8421 code :

It is weighted code .

Decimal	BCD 8421
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	0001 0000
11	0001 0001

← أكثر رقم نحتاجه هو 9

3- Other 4-bit BCD codes :

Many other 4-bit codes exists , such as 7421 , 6311 , 5421 ,5311 , 5211 , 2421 …..

All are weighted codes .

EX: $(16)_D$ to 2421 code

1 6

0001 1100

$(75)_D$ to 5421 code

1010 1000

$(693)_D$ to 6311 code

1000 1100 0100

D	2421	6311	7421
0	0000	0000	0000
1	0001	0001	0001
2	0010	0011	0010
3	0011	0100	0011
4	0100	0101	0100
5	1011	0111	0101
6	1100	1000	0110
7	1101	1001	1000
8	1110	1011	1001
9	1111	1100	1010

Decimal	5421	5311
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0100
4	0100	0101
5	1000	1000
6	1001	1001
7	1010	1011
8	1011	1100
9	1100	1101

Gray code :

It is un weighted code the main characteristic of this code is that each gray number differs from the preceding number by single bit .

Decimal	Gray	Binary
0	0000	0000
1	0001	0001

2	0011	0010
3	0010	0011
4	0110	0100
5	0111	0101
6	0101	0110
7	0100	0111
8	1100	1000
9	1101	1001
10	1111	1010
11	1110	1011
12	1010	1100
13	1011	1101
14	1001	1110
15	1000	1111

EX: