

→ BCD code (Binary coded decimal):-

It is represented in only single decimal digit.

	<u>Binary</u>	<u>BCD</u>
12	→ 1100	1 → 0001 2 → 0010 00010010 or 10010

BCD to decimal:-

divide BCD in 4 bit format, it will give one digit.

ex. -

$$\underline{1001} \rightarrow \underline{0001}_1 \underline{0011}_3 \rightarrow 13$$

$$\underline{0011} \underline{0011} \rightarrow \underline{0011}_3 \underline{0011}_3 \rightarrow 33$$

33 in binary → 100001 → 6 bit required
33 in BCD → 00110011 → 6 bit required

In case of BCD, each digit in decimal require 4 bit ~~code~~ in form of '8421' format.

→ BCD addition:-

Rule 1:- To add two BCD numbers, add corresponding ~~and~~ digits of two bcd numbers.

Rule 2:- After adding first see the result, if the result is greater than 9 or any carry generated, the result is invalid BCD.

Rule 3:- To correct invalid BCD ~~add~~ by adding 6.

Q. add:-

BCD 8 and BCD 4

→

8 → 1000

4 → 0100

1100

as 1100 is greater than 9, so it is invalid BCD

So, add 6 in BCD

1100

0110

10010 → 12 BCD

$$\begin{array}{r} 00010010 \\ \hline 1 \quad 2 \end{array} \quad \text{is the binary} = 12 \text{ BCD}$$

Q. BCD 9 + BCD 6

$$\begin{array}{r} 1001 \\ 0110 \\ \hline 1111 \rightarrow 15 \end{array}$$

1111 is greater than 9
So,

$$\begin{array}{r} 1101 \\ + 0110 \\ \hline 00010101 \rightarrow 15 \text{ BCD} \\ 1 \quad 5 \end{array}$$

NOTE:- While adding ~~the~~ carry from 1 digit (4 bit) can't be added to next digit (next 4 bit).

→ 9's complement :-

It can be obtained by subtracting each decimal digit by decimal 9.

ex-

for 28, 9's complement is 71

$$\begin{array}{r} 99 \\ 28 \\ \hline 71 \end{array}$$

For BCD, you have to write it
in BCD so,

9's complement of 28 is

● 111 0001

Q. 36's 9's .

$$\begin{array}{r} \rightarrow \quad 99 \\ \quad 36 \\ \hline 63 \end{array} \rightarrow 01100011$$

So, 9's complement of 36 is

● 110 0011

NOTE:- In writing BCD Formates
we ignore zeros in left.

→ 10's complement:-

To get 10's complement add 1 to 9's complement.

ex. -

10's complement of 12

$$\begin{array}{r} 99 \\ 12 \\ \hline 9's \rightarrow 87 \\ +1 \end{array}$$

$$10's \rightarrow 88 \rightarrow 1000/000$$

So, ans. as

$$\underline{\underline{1000/000}}$$

Q. 46 10's complement

$$\begin{array}{r} 99 - 46 = 53 \\ +1 \\ \hline 54 \end{array}$$

$$01010100$$

So ans is,

$$1010100$$

→ BCD Subtraction:-

Rule 1:- Take 9's Complement for ~~the~~ Subtrahend.

Rule 2:- add it to the minuend using BCD addition

Rule 3:- If Result is invalid BCD then correct by adding 6.

Rule 4:- Shift the carry to new bits

Rule 5:- If end around carry generated then add it to the result.

~~Can~~ Find 9's Complement of result.

In Subtraction

minuend \leftarrow $X - Y \rightarrow$ Subtrahend

Q. \rightarrow $98.3 - 81.2$

Subtrahend - 81.2

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9's complement of 81.2

$$99.9 - 81.2 = 18.7$$

↓

00011000.0111

minuend - 98.3 → 10011000.0011

adding 98.3 and 18.7

0 0 0 1 1 0 0 0 . 0 1 1 1

1 0 0 1 1 0 0 0 . 0 0 1 1

1010 10000 . 1010

→ this carry 1 is not added to next as next bit is for other digit.

@ now, see, each 4 bit is greater than 9 so, we add BCD 6 in them.

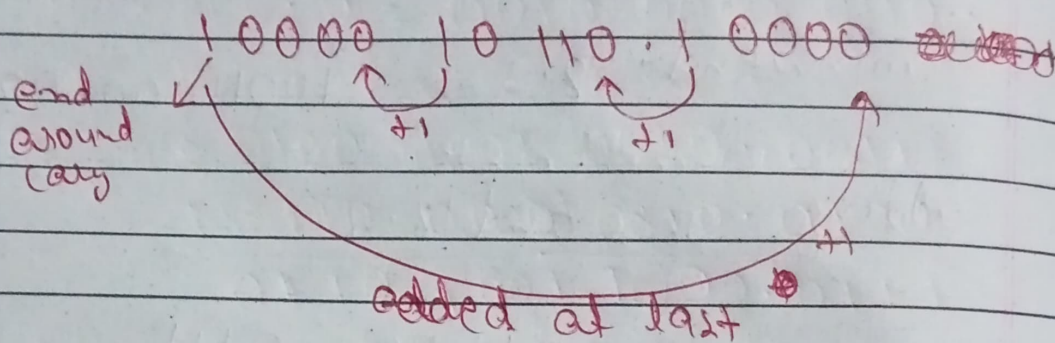
1010 10000 . 1010
+ 0110 0110 0110
10000 10110 10000

These extra carry will shifted to new bit.

So, result is

$$00010111.0001 \Rightarrow 17.1$$

Q2,



Q. $10.2 - 02.1$ (in 10's complement)

→ Surplus = 02.1

9's complement of 2.1 is 97.9 which is,

$$10010111.1001$$

10.2 in BCD is 00010000.0010

now,

$$\begin{array}{r} 10010111.1001 \\ + 00010000.0010 \\ \hline 10100111.1011 \\ + 0110 \quad \cdot 0100 \end{array}$$

discard (100000111.1000)

$$\begin{array}{r} 00001000.0001 \\ \hline \end{array}$$

$\Rightarrow 8180.1$

Q. $206.4 - 507.6$

$\rightarrow S = 507.6$ 9's co = 492.3

~~$m = 206.4 = 0100 1001 0010.0011$~~

$m = 206.4 = 0010 0000 0110.0100$

$$\begin{array}{r}
 0100 \ 1001 \ 0010.0011 \\
 0010 \ 0000 \ 0110.0100 \\
 \hline
 0110 \ 1001 \ 1000.0111 \\
 6 \quad 9 \quad 8 \quad . \quad 7
 \end{array}$$

It is (-ve) as, no end carry.

9's complement of 698.7 is 301.2

10's " " " 698.7 is 301.3

\rightarrow Rules of 10's Complement sub -

- Convert 10's complement of Surplus hand. add it to Minus hand using BCD addition.

- If result is invalid BCD, make it valid by adding 6 to invalid digits.

- Shift carry to next bits.

- If end around carry is there then discard it, and if no there then result is negative. now consider 10's complement to get result final.

→ Excess-3 code :-

It is a sequence code.

In excess 3 code we add 3 to each digit of BCD code

Ex- BCD 12

excess 3 for 12 is

$$\begin{array}{r} 12 \\ + 3 \\ \hline 15 \end{array} \rightarrow 01000101$$

So, 15 is excess 3 code of 12.

No.	BCD	Ex-3
0	0000	0011 (3)
1	0001	0100 (4)
14	00010100	01000111 (17)