Arithmetic Operation.

Arithmatic operation in a computer are done using binary number. and not decimal number, and these take place in its arithmatic unit.

Binary Arithmatic.

The arithmatic rules for Addition Subtraction, multiplication and Division. of Binary numbers is

Addition	Subtraction.
1) 0+0 =0	0-0 =0
2) 0+1 =1	1-0 =1
3) 1+0 =1	1-1 =0
4) 1+1 =10, carry =1	10-1 =1

Multiplication.	Division.
1 0x0 =0	
2 0x1 =0	
3 1x0 =0	
4 1x1 =1	

Binary Addition :- Two binary number can be added in the same way a two decimal numbers are added. ~~The additti~~

Example — 1010 and 1111

MSB C=1 C=1 C=1 LSB

1 1 1 1 → 15

1 0 1 0 10

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step 1 → The least significant bits are add ,
i.e 0+1=1 with a carry 0

step-2 — The carry in the previous step is added to the next higher significant bits.
i.e. = 1+1=0 with a carry 1

Step-3 The carry in the above step is added to the next higher significant bit
i.e. 0+1~~+~~1=0 with a carry 1

step-4 · ~~The~~ preceding carry is added to the most significant bits. i.e. 1+1+1=1 . with carry =1

Binary Subtraction :- Binary Subtraction is also carried out in the same way as decimal number are subtracted. ~~The subtraction is carried out from the least significant bits and Proceds to the~~

Case -1 MSB LSB

$$\begin{array}{r} 1101 \\ 1001 \\ \hline 10000100 \end{array} \qquad \begin{array}{r} 13 \\ 9 \\ \hline 4 \end{array}$$

step- the LSB in the first column are 1 and 1 hence, the difference is 1-1=0

step-2 — In the second column, the subtraction is performed as 0-0=0

step- 3 In the Third column, the difference is given by 1-0=1

Step 4 ⇒ In the 4th column (MSB), the difference is given by 1-1=0

case - 2

$$\begin{array}{r} 1001 \\ 0111 \\ \hline 0010 \end{array} \qquad \begin{array}{r} \text{Decimal} \\ 9 \\ 7 \\ \hline 2 \end{array}$$

multiply the following binary number system

(a) 1011 and 1101

(b) 100110 and 1001

(c) 1.01 and 10.1

$$\begin{array}{r} 1011 \\ \times\ 1101 \\ \hline c=1\quad 1011 \\ c=1\quad 0000\times \\ c=1\ \ c=1\quad 1011\times\times \\ 1011\times\times\times \\ \hline \text{carry} \rightarrow 10001111 \end{array}$$

Ans

sign

→ Addition in 2's complement system:-

Addition can be explained with four possible cases. (I) when both the numbers are possitive. (II) when augend is a positive and adend is negative. (III) when augend is negative and addend is positive. (IV) when both the number are negative.

Case - I Two positive number

		16	8	4	2	1
+29 →	0 0 0	1	1	1	0	1
+19 →	0 0 0	1	0	0	1	0
48	0 0 1	1	0	0	0	0

Ans.

sign

32 16

Case-3 positive addend number and negative augend number.

Consider to addition of -47 and +29

	32	16	8 4 2 1	
-47 → ~~take~~	0 0 1 0	1 1 1 1	ons's complement
	1 1 0 1	0 0 0 0	
		+1	
	1 1 0 1	0 0 0 1	— 2's complement

+29 0 0 0 1 1 1 0 1

-18

sign bit → 1 1 1 0 1 1 1 0

0 0 1 0 0 0 1

+1

− → 1 0 0 1 0 0 1 0 -18 Ans

Case-4 Two negative numbers.

Consider the addition of -32 and -44

	32	16	8	4	2 1
-32 →	0 0 1 0	0	0	0	0
	1 1 0 1	1	1	1	1 1's comp
				+1	
	1 1 1 0	0	0	0	0 2's complement

-44 → 0 0 1 0 1 1 0 0

1 1 0 1 0 0 1 1 → 1's complement

+1

-44 1 1 0 1 0 1 0 0

-32 1 1 1 0 0 0 0 0

~~-76~~ 1 1 0 1 1 0 1 0 0

~~+1~~

1 1 0 0 1 0 1 1

+1

64+8+4

-76

→ 1 1 0 0 1 1 0 0

9's complement

The 9's complement of a decimal number can be found by subtracting each digit in the number from 9's complement of decimal digits 0 to 9 is shown.

Decimal digit	9's complement
0	9
1	8
2	7
3	6
4	5
5	4
6	3
7	2
8	1
9	0

Example. find the 9's complement of each of the following number.

(a) 19 (b) 146 (c) 469 (d) 4397

(a)
$$\begin{array}{r} 99 \\ -19 \\ \hline 80 \end{array}$$
9's complement of 19

b)
$$\begin{array}{r} 999 \\ 146 \\ \hline 853 \end{array}$$
→ 9's complement of 146

c)
$$\begin{array}{r} 999 \\ 469 \\ \hline 530 \end{array}$$
→ 9's complement of 469

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$$\begin{array}{r} 9999 \\ 4397 \\ \hline 5602 \end{array} \longrightarrow \text{9's complement of } 4397$$

Subtraction of 9's complement

$$\begin{array}{r} 99 \\ -06 \\ \hline 93 \end{array}$$

Example. 18 − 06

$$\begin{array}{r} 18 \\ -6 \\ \hline 12 \end{array}$$

(a) $\begin{array}{r} 18 \\ +93 \\ \hline 111 \\ +1 \\ \hline 12 \end{array} \rightarrow$ Ans

(b) $\begin{array}{r} 39 \\ -23 \\ \hline 16 \end{array}$ $\begin{array}{r} 99 \\ -23 \\ \hline 76 \end{array}$ $\begin{array}{r} 39 \\ +76 \\ \hline \boxed{1}15 \\ +1 \\ \hline 16 \end{array} \rightarrow$ Ans

(c) $\begin{array}{r} 34 \\ -49 \\ \hline -15 \end{array}$ $\begin{array}{r} 34 \\ +50 \\ \hline 84 \end{array}$ — 9's complement

$\begin{array}{r} 99 \\ 84 \\ \hline -15 \end{array}$ Ans — 9's complemnt of 84

$$\begin{array}{r} 49 \\ -84 \\ \hline -35 \end{array}$$

$\begin{array}{r} 99 \\ -84 \\ \hline 15 \end{array}$

$\begin{array}{r} 49 \\ +15 \\ \hline 64 \end{array}$ — 9's complement of 84

−35 9's complement of 64.

② 10's Complement — The 10's complement of Decimal number is equal to 9's complement +1

Example (a) 9, (b) 46, (c) 739

$\begin{array}{r} 9 \\ -9 \\ \hline 0 \\ +1 \\ \hline 1 \end{array}$ — 9's complement of 9

1 10's complement of 9

(b)

$$\begin{array}{r} 46 \\ 99 \\ \hline 53 \end{array}$$ — 9's complement of 46

$$\begin{array}{r} +1 \\ \hline 54 \end{array}$$ — 10's complement of 46

$$\begin{array}{r} 739 \\ -999 \\ \hline \cancel{88} \\ 260 \end{array}$$ — 9's complement of 739

$$\begin{array}{r} +1 \\ \hline 261 \end{array}$$ 10's complement of 739

Subtract the following decimal number.

Ex— (a) 9−4 (b) 20−09, (c) 69−32, (d) 347 − 265

Regular Subtraction. 10's complement Subtraction

(a)

$$\begin{array}{r} 9 \\ -4 \\ \hline 5 \end{array}$$

$$\begin{array}{r} 9 \\ +5 \\ \hline 15 \end{array}$$ — 10's complement of 4

drop carry

(b)

$$\begin{array}{r} 20 \\ -9 \\ \hline 11 \end{array}$$

$$\begin{array}{r} 20 \\ +91 \\ \hline 111 \end{array}$$ → 10's complement

Ans

drop carry

$$\begin{array}{r} 99 \\ -32 \\ \hline 67 \\ +1 \\ \hline 68 \end{array}$$

(c)

$$\begin{array}{r} 69 \\ -32 \\ \hline 37 \end{array}$$

$$\begin{array}{r} 69 \\ +68 \\ \hline 137 \end{array}$$ → 10's complement — Ans.

drop carry

(d)

$$\begin{array}{r} 999 \\ 265 \\ \hline 734 \\ +1 \end{array}$$

$$\begin{array}{r} 347 \\ -265 \\ \hline \cancel{94} \\ 82 \end{array}$$

$$\begin{array}{r} 347 \\ 735 \\ \hline 1082 \end{array}$$

082 Ans

~~BCD~~ Binary coded decimal (BCD)

↳ Binary coded decimal (BCD) number is a combination of four binary digits that represent decimal number. and It is also called as 8421 code:

↳ The 8421 is a type of binary coded decimal. It has 4 bits and represent the decimal digits 0 to 9.

↳ To express any decimal number in BCD each decimal digit should be replaced by the appropriate four bit code.

Decimal	Binary	BCD code.
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	0001, 0000
11	1011	0001 0001
12	1100	0001 0010
13	1101	0001 0011
14	1110	0001 0100
15	1111	0001 0101

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BCD   ## BCD Arithmatic.

BCD is a numerical code. Many application Require Arithmatic operations. Adition is the most important of these because the other 3 operation, which is subtraction, multiplication and division can be done using addition.

↳ The rules for addition of two BCD numbers

↳ • Add the two numbers using the rules for binary addition.

↳ • If four-bit sum is equal to or less than 9, it is a valid BCD number.

↳ If a four bit sum is greater than 9, or if a carry-out of group is generated it is an invalid result :

↳ Add 6 $(0110)_2$ to the four bit sum in order to skip the six invalid states and return to BCD.
if a carry results when 6 is added, add the carry to the next four bit group.

Ex. Add the following BCD number

(a) 1001 and 0100   (b) 00011001 and 00010100

Solution

1001

1001
0100
1101 → invalid BCD number. $(13)_{10}$
+0110 → Add 6
$\underbrace{0001}_{1}\ \underbrace{0011}_{3}$

~~10 + 3 =~~

$(13)_{10}$ Ans

(b)

  0 0 0 1 1 0 0 1
+ 0 0 0 1 0 1 0 0
  0 0 1 0 1 1 0 1 → Right group is invalide.

~~0010~~ +0110 Add 6

$\underbrace{0011}_{3}\ \underbrace{0011}_{3}$ – Valide BCD number.

$(33)_{10}$ Ans

⇒ BCD Subtraction ⇒

206 − 147

206 → 0010 0000 0110
− 147 → − 0001 0100 0111

$\underbrace{0000}_{0}\ \underbrace{1011}_{\text{invalid } 11}\ \underbrace{1111}_{15 \text{ invali}}$

0110   −0110

$\underbrace{0101}_{5}\ \underbrace{1001}_{9}$

(0000, 0101. 1001) BCD.

0

59 Ans.