ARITHEMATIC OPERATION ON BINARY NUMBERS

The arithmetic operations – addition, subtraction, multiplication & division, Performed on the binary numbers is called binary arithmetic.

In computer, the basic arithemetic operation Performed on the binary numbers is —

- Binary addition
- Binary Subtraction

1. Binary Addition:– Binary addition involves addition of two or more binary numbers.

Rule of Binary addition for two inputs.

Input1 (Augend)	Input 2 (Addend)	Sum	Carry
0	0	0	No carry
0	1	1	No Carry
1	0	1	No Carry
1	1	0	1

Rule of Binary addition for three input:-

Input 1	Input 2	Input 3	Sum	Carry
0	0	0	0	No carry
0	0	1	1	No carry
0	1	0	1	No Carry
0	1	1	0	1
1	0	0	1	No Carry
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Examples

Ex. Add 1001 & 1111. verify the answers with the help of decimal addition.

```
 1 1 1 1
   1 0 0 1
+  1 1 1 1
----------
 1 1 0 0 0
```

```
8 4 2 1
1 0 0 1 → 9
1 1 1 1 → 15
          --
          24
```

$(\overset{16}{1}\,\overset{8}{1}\,\overset{4}{0}\,\overset{2}{0}\,\overset{1}{0})_2 \rightarrow (24)_{10}$

Ex Add 1011 and 1100

```
  1 1
   1 0 1 1
+  1 1 0 0
----------
 1 0 1 1 1
```

Ex add 01101010, 00001000, 10000001 & 11111111.

```
       1
 1 1 1 1 1 1 1 1
   0 1 1 0 1 0 1 0
   0 0 0 0 1 0 0 0
   1 0 0 0 0 0 0 1
+  1 1 1 1 1 1 1 1
------------------
 1 1 1 1 1 0 0 1 0
```

2. Binary Subtraction: Binary subtraction involves subtracting of two binary numbers. (12)

Rules of Binary Subtraction ["where Input2 is subtracted from Input 1."

Input1 (Minuend)	Input2 (Subtrahend)	difference	Borrow
0	0	0	No borrow (0)
0	1	1	1
1	0	1	No borrow (0)
1	1	0	No borrow (0)

[example of any decimal number $\boxed{\begin{array}{r}31\\-12\\\hline 19\end{array}}$ here 1-2 was not possible so we take 1 borrow from 3 & 1 become 11 (eleven) & 3 become $(3-1=2)=2$. Similarly in binary. for example $\begin{array}{r}10\\-01\end{array}$ here 0-1 was not possible so we take 1 borrow from second column upper bit which is 1. so 0 become 10 or you can say 2 (in decimal) so $2-1=1$. $\boxed{\begin{array}{r}10\\-01\\\hline 1\end{array}}$ & 1 in first column from which we have take 1 borrow will become $(1-1=0)$ then (0-0=0) that's why $\begin{array}{r}10\\-01\\\hline 01\end{array}$

bit borrow

Ex

$$\begin{array}{r}1011\\-0110\\\hline 0101\end{array}\qquad \begin{array}{rr}1011 & \rightarrow 11\\0110 & \rightarrow -6\\\hline 0101 & 5\end{array}$$

Ex subtract 0111 from 1110

$$\begin{array}{r}1110\\-0111\\\hline 0111\end{array}\qquad \begin{array}{rr}1110 & 14\\0111 & -7\\\hline (0111)_2 & (7)_{10}\end{array}$$

Ex.

$$\begin{array}{rr}1001 & \rightarrow 9\\-0110 & -6\\\hline 0011 & 3\end{array}$$

Ex

$$\begin{array}{rr}1010 & 10\\-0101 & -5\\\hline & 5_{1010}\end{array}$$

③ **Binary Multiplication :-** Not necessary

Binary multiplication is similar to decimal multiplication. In binary, each partial product is either zero (multiplication by 0) or exactly same as the multiplicand (multiplication by 1).

Ex multiply 1001 by 1101

```
        1 0 0 1        multiplicand
        1 1 0 1        Multiplier
      ---------
        1 0 0 1        (I)   }
      0 0 0 0 x        (II)  }  Partial Product
    1 0 0 1 x x        (III) }
 + 1 0 0 1 x x x       (IV)  }
 ---------------
   1 1 1 0 1 0 1       } final Product
```

In a digital circuit, the multiplication operation is performed by repeated addition of all partial product to obtain the final product.

④ **Binary Division** – Binary division is obtained using the same procedure as decimal division.

Ex Divide 111 0101 by 1001.

```
                 1101   14         ← Quotient
Divisor  1001 ) 1110101            ← Dividend
 9             -1001    → 9
               ------
            11   1011   5
            -9   1001
               ------
             2    01001  4 → less then 11 so take 1001 → 9  1 also
                   1001  → 9
                  -----
                   0000
```