# **Binary Arithmetic**

We will be familiar with different arithmetic operations such as addition and subtraction in a digital system.

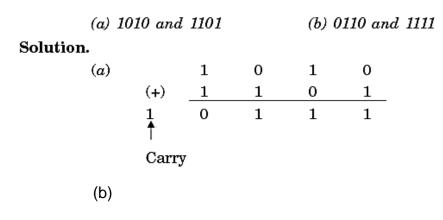
# **Binary Addition**

The rules of binary addition are

x	Y	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Addition is carried out from the LSB and it proceeds to higher significant bits.

**Ex)** Add the binary numbers:



# **Binary Subtraction**

It is possible to use the circuits designed for binary addition to perform binary subtraction. Only we have to change the problem of subtraction into an equivalent addition problem. This can be done by using of 1's and 2's complements.

# Complements

Complements are used in for simplifying the subtraction operation and representing signed numbers. There are two types of complements: The r's complement and the (r - 1)'s complement. When we deal with a binary system, the complements are 2's and 1's complements.

# (r-1) 's Complement

In binary system, the 1<sup>st</sup> complements can be obtained by replacing ones with zeros and zeros with ones.

The 1's complement of (10110)<sub>2</sub> is 01001

Or we can use the general formula to find the (r-1) 's Complement:

 $(r^n - r^{-m})_{10} - N$ , Where

r: Radix

n: Number of digits in the integer part

m: Number of digits in the fractional part

N: Number

Ex) Find the 9's complement of (23450)<sub>10</sub>

$$(r^n - r^{-m})_{10} - N$$

 $(10^5 - 10^0)_{10} - 23450 = 76549$ 

Ex) Find The 7's complement of (2350)8

$$(r^n - r^{-m})_{10} - N$$

$$= (8^4 - 8^0)_{10} - (2350)_8$$

$$= (4095)_{10} - (2350)_8$$

 $= (4095)_{10} - (1256)_{10} = (2839)_{10} = (5427)_8$ 

Ex) Find The 15's complement of (A3E4)<sub>16</sub>

 $(r^{n} - r^{-m})_{10} - N$ =  $(16^{4} - 16^{0})_{10} - (A3E4)_{16}$ =  $(65535)_{10} - (A3E4)_{16}$ =  $(65535)_{10} - (41956)_{10} = (23579)_{10} = (5C1B)_{16}$ 

Ex) Find The 1's complement of (0.1011)<sub>2</sub>

#### r's Complement

In binary system, the 2<sup>nd</sup> complements can be obtained by replacing ones with zeros and zeros with ones and then adding one to the final number.

Ex) Find the 2's complement of (10110)<sub>2</sub>

 $(10110)_2 - 2$ 's  $\rightarrow 01001 + \frac{1}{01010}$ 

Or the r's complement of *N number* is given as

 $(r^{n})_{10} - N$ , Where

r: Radix

n: Number of digits in the integer part

N: Number

Ex) Find the 10's complement of (23450)10

$$(r^n)_{10} - N$$

 $(10^5)_{10} - (23450)_{10} = (76550)_{10}$ 

Ex) Find the 10's complement of (23.324)<sub>10</sub>

$$(r^n)_{10} - N$$

 $(10^2)_{10} - (23.324)_{10} = (76.676)_{10}$ 

Ex) Find The 8's complement of (376)<sub>8</sub>

$$(r^{n})_{10} - N$$

$$= (8^{3})_{10} - (376)_{8}$$

$$= (512)_{10} - (376)_{8}$$

$$= (512)_{10} - (254)_{10} = (258)_{10} = (402)_{8}$$
**Ex)** Find The 16's complement of (4A30)\_{16}  

$$(r^{n})_{10} - N$$

$$= (16^{4})_{10} - (4A30)_{16}$$

$$= (65536)_{10} - (18992)_{10} = (46544)_{10} = (B5D0)_{16}$$
**F**

Ex) Find The 2's complement of (0.1011)<sub>2</sub>