Computer Arithmetic

(A) Binary Addition — Direct ✓

(B) Binary Subtraction
- Direct ✓
- 1's Complement ✓
- 2's Complement ✓

} → Details

(C) Binary Multiplication → Direct

(d) Binary Division → Direct

Binary Multiplication (+ve Number)

* Same as decimal Multiplication

Rules to multiply Binary Number

Case	A x B	Multiplication
1	0 x 0	0
2	0 x 1	0
3	1 x 0	0
4	1 x 1	1

} AND Gate

Ex

$$
\begin{array}{r}
1\ 0\ 1 \\
\times\ 1\ 1 \\
\hline
1\ 0\ 1 \\
+\ 1\ 0\ 1\ x \\
\hline
(1\ 1\ 1\ 1)_2
\end{array}
$$

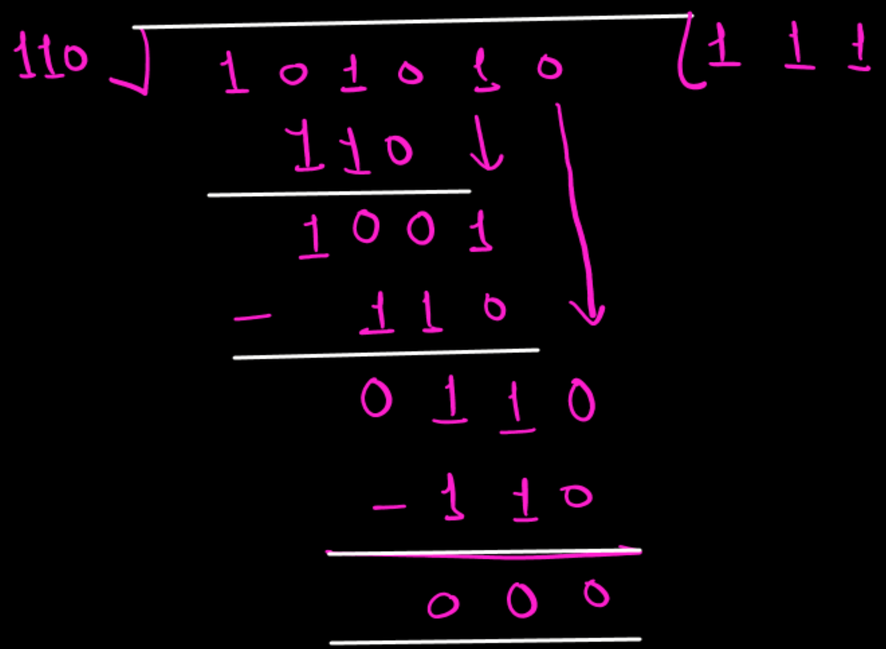
Ex

$$
\begin{array}{r}
0\ 0\ 1\ 1\ 0\ 1\ 0 \\
\times\ \ 1\ 1\ 0\ 0 \\
\hline
0\ 0\ 0\ 0\ 0\ 0\ 0 \\
0\ 0\ 0\ 0\ 0\ 0\ 0\ x \\
0\ 0\ 1\ 1\ 0\ 1\ 0\ x\ x \\
+\ 0\ 0\ 1\ 1\ 0\ 1\ 0\ x\ x\ x \\
\hline
0\ 1\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 0 \\
\hline
\end{array}
$$

Binary Division

* Similar to Decimal Devision
  - Long division Method

$$\frac{101010}{110} \longrightarrow$$



1's Complement to Store Signed Number

	Binary (+ve)	1s Comp	
0	0 000	1 1 1 1	(-0)
1	0 001	1 1 1 0	(-1)
2	0 010	1 1 0 1	(-2)
3	0 011	1 1 0 0	(-3)
4	0 100	1 0 1 1	(-4)
5	0 101	1 0 1 0	(-5)
6	0 110	1 0 0 1	(-6)
7	0 111	1 0 0 0	(-7)

(1) → (-ve number)

+ve Number
↳ as it is

-ve → +ve number ? (1's Complement लेकर)

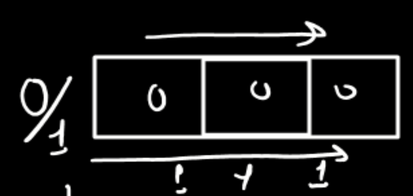
Range $(-2^{n-1}-1)$ to $+(2^{n-1}-1)$

Signed Number

4 bits
- 1 bit – Sign
- 3 bits → Number

Sign bit = 1 (-ve)
= 0 (+ve)

4 bit – sign
↳ 3 bits → $2^3 = 8$



↳ 8 +ve 0-7
8 -ve -(0 to 7)

– 7 to +7

2's Complement Method → Store -ve number

4 bits

$(5)_{10} \rightarrow (0101)_2 \rightarrow$ 2's Complement

↳ 1's Comp : 1010

2's Comp : + 1

$(1011)_2 \rightarrow (-5)_{10}$

$(4)_{10} \rightarrow (0100)_2$

↳ 2's Complement → (1's Comp + 1)

$\Rightarrow$ 1011

+ 1

$(1100)_2 \rightarrow (-4)_{10}$

Number	Binary (+ve)		2's Complement (-ve)
0	0 000	0	0 000
1	0 001	-1	1 111
2	0 010	-2	1 110
3	0 011	-3	1 101
4	0 100	-4	1 100
5	0 101	-5	1 011
6	0 110	-6	1 010
7	0 111	-7	1 001
8	—	-8	1 000

Sign

Sign

7 number

Range

↳ (−8 to +7)

↓

$-(2^{n-1})$ to $(2^{n-1}-1)$

2's Complement is a weightage Code

$(1\ 1\ 0\ 1)_2$

Sign ↳ 2's Complement

$2^3\ 2^2\ 2^1\ 2^0$
$1\ 1\ 0\ 1 =$

8 4 2 1
1 1 0 1
$= (13)_{10}$

$-2^3\ \ 2^2\ \ 2^1\ \ 2^0$
$1\ \ 1\ \ 0\ \ 1$

$= -8 + 4 + 1$
$-8 + 5$
$= (-3)_{10}$

Ex $(1\ 0\ 1\ 1\ 0)_2$ ← 2's Complement form

sign

-16 8 4 2 1
1 0 1 1 0

$\Rightarrow -16 + 4 + 2$
$-16 + 6$
$= (-10)_{10}$

$(1100)_2$ ← 2's Complement Convert to decimal

Sign

-2^3	2^2	2^1	2^0
1	1	0	0

$\Rightarrow -2^3 + 2^2$

$= -8 + 4 = (-4)_{10}$

16	8	4	2	1
1	0	0	1	0

Ex Represent (−18) in 2's Complement form

$(18)_{10} \longrightarrow (10010)_2 \longrightarrow$ 2's Comp

$$\begin{array}{r} 01101 \\ +\quad 1 \\ \hline (11110)_2 \end{array}$$

$= (-18)_{10}$