③ Multiplication of binary numbers.

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$
$$1 \times 0 = 0$$
$$1 \times 1 = 1$$

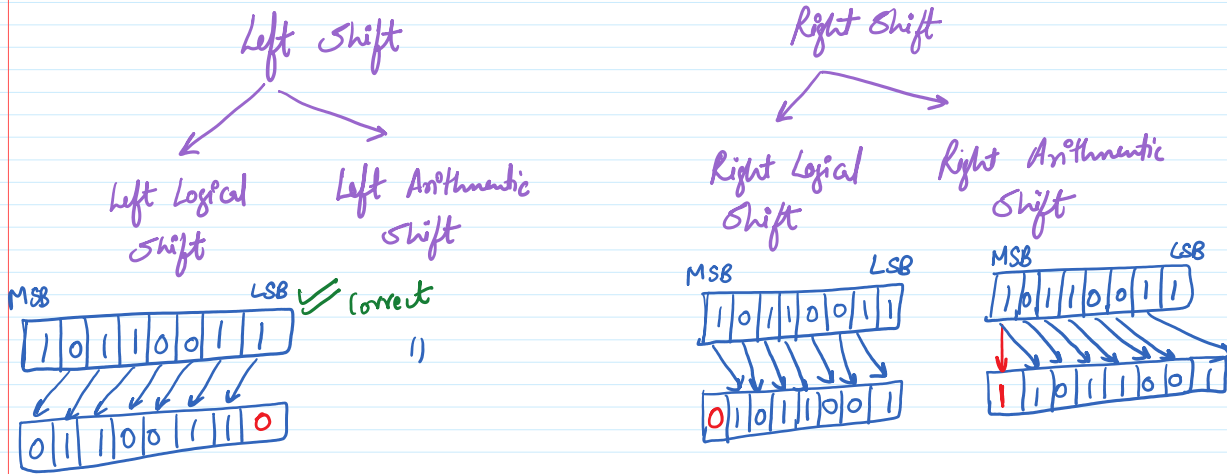ⓐ $1010 \times 101 =$

$$
\begin{array}{r}
1010 \\
\times\ 101 \\
\hline
1010 \\
0000 \\
\hline
01010 \\
1010 \\
\hline
110010 \\
\end{array}
$$

$\leftarrow$ 1st intermediate sum

ⓑ 1011.01×110.1

$$
\begin{array}{r}
1011.01 \\
\times\ 110.1 \\
\hline
101101 \\
000000 \\
\hline
010110l \\
01101 \\
\hline
111\,00001 \\
01101 \\
\hline
1001001.001 \\
\end{array}
$$

$\leftarrow$ Answer

Bit Manipulation operations

Left Shift

- Left Logical Shift
- Left Arithmetic Shift

Right Shift

- Right Logical Shift
- Right Arithmetic Shift

MSB | 1 0 1 1 0 0 1 1 | LSB ✓ Correct))

| 0 1 1 0 0 1 1 0 |

MSB | 1 0 1 1 0 0 1 1 | LSB

| 0 1 0 1 1 0 0 1 |

MSB | 1 0 1 1 0 0 1 1 | LSB

| 1 1 0 1 1 0 0 1 |

Uses of left arithmetic shift and right arithmetic shift in multiplication and division.
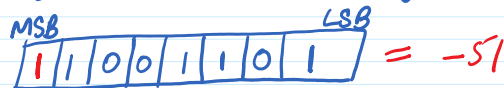
Shifting i bits to the right $\Longleftrightarrow Q(i,j) = P(i,j) \div 2^i$

Shifting i bits to the left $\Longleftrightarrow Q(i,j) = P(i,j) \times 2^i$

Example :—

Q:— What is $\overbrace{10011010}^{-102} \div 2$?

Ans:— Here i is 1. (2^i)

So, by Right arithmetic shifting 1 bit.

MSB | 1 1 0 0 1 1 0 1 | LSB = −51

Q: What is $\overbrace{00110010}^{50} \times \underset{2^2}{④}$?

Ans: Here i is 2. (2^i)

So, left arithmetic shifting 2 bits.

MSB | 1 1 0 0 1 0 0 0 | LSB = 200

> Note:— The numbers here are signed 2's complements.