

Binary Arithmetic

Binary arithmetic is essential part of all the digital computers and many other digital system.

Binary Addition

It is a key for binary subtraction, multiplication, division. There are four rules of binary addition.

Case	A	+	B	Sum	Carry
1	0	+	0	0	0
2	0	+	1	1	0
3	1	+	0	1	0
4	1	+	1	0	1

In fourth case, a binary addition is creating a sum of (1 + 1 = 10) i.e. 0 is written in the given column and a carry of 1 over to the next column.

Example – Addition

$$\begin{array}{r} 0011010 + 0011100 = 00100110 \\ \begin{array}{r} 11 \text{ carry} \\ 0011010 = 26_{10} \\ + 0001100 = 12_{10} \\ \hline 0100110 = 38_{10} \end{array} \end{array}$$

Binary Subtraction

Subtraction and Borrow, these two words will be used very frequently for the binary subtraction. There are four rules of binary subtraction.

Case	A	-	B	Subtract	Borrow
1	0	-	0	0	0
2	1	-	0	1	0
3	1	-	1	0	0
4	0	-	1	0	1

Example – Subtraction

$$\begin{array}{r} 0011010 - 0011100 = 0001110 \\ \begin{array}{r} 11 \text{ borrow} \\ 00\cancel{1}1010 = 26_{10} \\ - 0001100 = 12_{10} \\ \hline 0001110 = 14_{10} \end{array} \end{array}$$

Binary Multiplication

Binary multiplication is similar to decimal multiplication. It is simpler than decimal multiplication because only 0s and 1s are involved. There are four rules of binary multiplication.

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

Example – Multiplication

Example:

$$0011010 \times 001100 = 100111000$$

$$\begin{array}{r} 0011010 = 26_{10} \\ \times 0001100 = 12_{10} \\ \hline 0000000 \\ 0000000 \\ 0011010 \\ 0011010 \\ \hline 0100111000 = 312_{10} \end{array}$$

Binary Division

Binary division is similar to decimal division. It is called as the long division procedure.

There are four rules of binary division.

Input A	Input B	Sum (S) A+B	Carry (C)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Example – Division

$$101010 / 000110 = 000111$$

$$\begin{array}{r} 111 = 7_{10} \\ 000110 \overline{) 101010} = 42_{10} \\ \underline{-110} = 6_{10} \\ 1001 \\ \underline{-110} \\ 110 \\ \underline{-110} \\ 0 \end{array}$$

MCQs

1. What is the addition of the binary numbers 11011011010 and 010100101?

- a) 0111001000
- b) 1100110110
- c) 11101111111
- d) 10011010011

Answer: c

Explanation: The rules for Binary Addition are :

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 0 \text{ (Carry 1)}$$

$$\begin{array}{r} 1 \\ 11011011010 \\ + 00010100101 \\ \hline 11101111111 \end{array}$$

2. Perform binary addition: 101101 + 011011 = ?

- a) 011010
- b) 1010100
- c) 101110
- d) 1001000

Answer: d

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

Therefore, the addition of $101101 + 011011 = 1001000$.

3. Perform binary subtraction: $101111 - 010101 = ?$

a) 100100

b) 010101

c) 011010

d) 011001

Answer: c

Explanation: The rules for Binary Subtraction are :

$$0 - 0 = 0$$

$$0 - 1 = 1 \text{ (Borrow 1)}$$

$$1 - 0 = 1$$

$$1 - 1 = 0$$

$$\begin{array}{r} 1\ 0\ 1\ 1\ 1\ 1 \\ -\ 0\ 1\ 0\ 1\ 0\ 1 \\ \hline 0\ 1\ 1\ 0\ 1\ 0 \end{array}$$

Therefore, The subtraction of $101111 - 010101 = 011010$.

4. Perform multiplication of the binary numbers: $01001 \times 01011 = ?$

a) 001100011

b) 110011100

c) 010100110

d) 101010111

Answer: a

Explanation: The rules for binary multiplication are:

$$0 * 0 = 0$$

$$0 * 1 = 0$$

$$1 * 0 = 0$$

$$1 * 1 = 1$$

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

$$\begin{array}{r}
 01001000 \\
 00000000 \\
 \hline
 001100011
 \end{array}$$

Therefore, $01001 \times 01011 = 001100011$.

5. On multiplication of (10.10) and (01.01), we get _____
- a) 101.0010
 - b) 0010.101
 - c) 011.0010
 - d) 110.0011

Answer: c

$$\begin{array}{r}
 10.10 \\
 \times 01.01 \\
 \hline
 1010 \\
 00000 \\
 101000 \\
 0000000 \\
 \hline
 011.0010
 \end{array}$$

Therefore, $10.10 \times 01.01 = 011.0010$.

6. Divide the binary numbers: $111101 \div 1001$ and find the remainder.
- a) 0010
 - b) 1010
 - c) 1100
 - d) 0111

Answer: d

Explanation: Binary Division is accomplished using long division method.

$$\begin{array}{r}
 1001 \overline{) 111101} \quad (11 \\
 \underline{1001} \\
 01100 \\
 \underline{1001} \\
 0111
 \end{array}$$

Therefore, the remainder of $111101 \div 1001 = 0111$.

7. Divide the binary number (011010000) by (0101) and find the quotient.
- a) 100011
 - b) 101001
 - c) 110010
 - d) 010001

Answer: b

Explanation:

$$\begin{array}{r} 0101 \overline{) 0110100000} \quad (010111 \\ \underline{0000} \\ 01101 \\ \underline{00101} \\ 0100000 \\ \underline{0000000} \\ 10000 \\ \underline{00101} \\ 010110 \\ \underline{000101} \\ 100010 \\ \underline{000101} \\ 111010 \\ \underline{000101} \\ 10101 \\ \underline{00101} \\ 10000 \end{array}$$

Therefore, the quotient of 011