

Computer Arithmetic

Introduction:

Data is manipulated by using the arithmetic instructions in digital computers. Data is manipulated to produce results necessary to give solution for the computation problems. The Addition, subtraction, multiplication and division are the four basic arithmetic operations. All other operations can be derive by using these four operations.

- To execute arithmetic operations there is a separate section called arithmetic processing unit in central processing unit. The arithmetic instructions are performed generally on binary or decimal data. Fixed-point numbers are used to represent integers or fractions
- Fixed-point addition is the simplest arithmetic operation.
- If we want to solve a problem then we use a sequence of well-defined steps. These steps are collectively called algorithm. To solve various problems we give algorithms.
- In order to solve the computational problems, arithmetic instructions are used in digital computers that manipulate data. These instructions perform arithmetic calculations.

Addition and Subtraction :

The algorithms for addition and subtraction are derived from the table and can be stated as follows (the words parentheses should be used for the subtraction algorithm)

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

Here are some examples of binary addition.

• $10001 + 11101 = 101110$:

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

• $101101 + 11001 = 1000110$:

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

• $1011001 + 111010 = 10010011$:

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

• $1110 + 1111 = 11101$:

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

• $10111 + 110101 = 1001100$:

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

• $11011 + 1001010 = 1100101$:

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

Binary Subtraction :-

Work the columns right to left subtracting in each column. If you must subtract a one from a zero, you need to “borrow” from the left, just as in decimal 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

Here are some examples of binary subtraction.

- $1011011 - 10010 = 1001001$:
- $1010110 - 101010 = 101100$:
- $1000101 - 101100 = 11001$:

$$\begin{array}{r}
 1011011 \\
 - 10010 \\
 \hline
 1001001
 \end{array}$$

$$\begin{array}{r}
 00 \\
 \times 11 \\
 1010110 \\
 - 101010 \\
 \hline
 101100
 \end{array}$$

$$\begin{array}{r}
 011 \\
 \times 11 \\
 101101 \\
 - 101100 \\
 \hline
 11001
 \end{array}$$

- $100010110 - 1111010 = 10011100$:

$$\begin{array}{r}
 01111 \\
 \times 1111 \\
 10001110 \\
 - 1111010 \\
 \hline
 10011100
 \end{array}$$

- $101101 - 100111 = 110$:

$$\begin{array}{r}
 01 \\
 \times 11 \\
 101101 \\
 - 100111 \\
 \hline
 110
 \end{array}$$