



جامعة كلكامش كلية الهندسة

م.م جنات طارق

النظام الرقمي
Lecture 2

Arithmetic Operations

1-Addition

The following tables illustrate the rules of addition in Binary, Octal and hexadecimal.

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

Figure 1 Binary addition rules.

Example: Add $(0011010)_2$ to $(0001100)_2$?

Answer:

$$\begin{array}{r} 11 \quad \leftarrow \text{Carry} \\ 0011010 \\ + 0001100 \\ \hline 0100110 \end{array}$$

Example: Find the result of $(11010.1101)_2 + (111101.111)_2$?

Answer:

$$\begin{array}{r} 1111111 \\ 011010.1101 \\ + 111101.1110 \\ \hline 1011000.1011 \end{array}$$

← Carry

2-Subtraction

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

Figure2 Binary subtraction rules

Example: Find the results of $(0011010)_2 - (001100)_2$?

Answer:

$$\begin{array}{r} & 10 & 10 \\ & \uparrow & \uparrow \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ - & & & & & & \\ \hline & 0 & 0 & 1 & 1 & 1 & 0 \end{array}$$

Diagram illustrating the subtraction of binary numbers. The top row shows the result of the subtraction with '10' above the first two digits. Blue arrows labeled 'borrow' point from the third column to the first and second columns. Blue arrows labeled 'new value' point to the digits in the result row.

Example: Find the results of $(110.1101)_2 - (11.1011)_2$?

Answer:

$$\begin{array}{r} & 10 & 10 & 10 \\ & \uparrow & \uparrow & \uparrow \\ 0 & 0 & 1 & 1 & 0 & . & 1 & 1 & 0 & 1 \\ - & & & & & & & & & \\ \hline & 0 & 1 & 1 & . & 1 & 0 & 1 & 1 \end{array}$$

Diagram illustrating the subtraction of binary numbers with a decimal point. The top row shows the result of the subtraction with '10' above the first three digits and another '10' above the fourth digit. Blue arrows labeled 'borrow' point from the fourth column to the first three columns. Blue arrows labeled 'new value' point to the digits in the result row.

3-Multiplication

In this section we will discuss the multiplication rules only in binary numbers.

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

Figure 3 Binary multiplication rules

Example: Find the results of $(10011)_2 \times (0101)_2$?

Answer:

$$\begin{array}{r} 10011 \\ \times 0101 \\ \hline 10011 \\ 00000 \\ 1001100 \\ 00000000 \\ \hline 01011111 \end{array}$$

Example: Find the results of $(100.111)_2 \times (010.11)_2$?

Answer:

$$\begin{array}{r} 100.111 \\ 010.11 \\ \hline 100111 \\ 1001110 \\ 0000000 \\ 100111000 \\ 000000000 \\ \hline 01101.01101 \end{array}$$

4-Division

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

Example: Find the results of $(11011)_2 \div (11)_2$?

Answer:

$$\begin{array}{r} 1001 \\ \hline 11 \overline{)11011} \\ -11 \\ \hline 00 \\ -00 \\ \hline 01 \\ -00 \\ \hline 11 \\ -11 \\ \hline 00 \end{array}$$

Example: Find the results of $(101011.10)_2 \div (110)_2$?

Answer:

$$\begin{array}{r} 111.01 \\ \hline 110 \quad \boxed{101011.10} \\ - 110 \\ \hline 1001 \\ - 110 \\ \hline 0111 \\ - 110 \\ \hline 0011 \\ - 110 \\ \hline 000 \\ \hline 110 \\ - 110 \\ \hline 000 \end{array}$$

The diagram shows the division of the binary number 101011.10 by 110 . The quotient is 111.01 . The process is as follows:

- 1. The first step shows 1010 being compared with 110 . The result of the subtraction is 1001 .
- 2. The next step shows 1001 being compared with 110 . The result of the subtraction is 0111 .
- 3. The next step shows 0111 being compared with 110 . The result of the subtraction is 0011 .
- 4. The next step shows 0011 being compared with 110 . The result of the subtraction is 000 .
- 5. The final step shows 000 being compared with 110 . The result of the subtraction is 110 .

Blue arrows point from the first three subtraction steps to the right, indicating the current step of the division process.