



## FACULTY OF ENGINEERING & TECHNOLOGY

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# NUMBER SYSTEM

## Binary Addition:

The counting of numbers in any system is a form of addition since successive numbers, while counting, are obtained by adding 1. In decimal number system, the successive addition is obtained as follows:

$$0 + 1 = 1$$

$$1 + 1 = 2$$

$$2 + 1 = 3$$

$$3 + 1 = 4$$

...

....

$$8 + 1 = 9$$

$$9 + 1 = 10$$

i.e. the sum is zero but have a carry to the next position.

In the similar fashion if this rule is applied to the binary system the binary addition may be illustrated as follows:

$$0 + 1 = 1$$

$$1 + 1 = 10$$

i.e. sum is zero and carry is 1.

Example : Perform the following binary additions.

(i)  $110111 + 11010$  (ii)  $101101.101 + 101011.011$

Solution:

(i) Carry 1 1 1 1 1 0

1 1 0 1 1 1

0 1 1 0 1 0

**1 0 1 0 0 0 1**

(ii) Carry 1 0 1 1 1 1 1 1 1

1 0 1 1 0 1 . 1 0 1

1 0 1 0 1 1 . 0 1 1

**1 0 1 1 0 0 1 . 0 0 0**

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## Binary Subtraction:

Half – subtractor table can be used for subtraction. when 1 is subtracted from 0, a 1 is to be borrowed from the next adjacent higher position.

a	b	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Example : Perform the following binary operations.

(i)  $1101101 - 1100111$  (ii)  $11011.01 - 10101.11$

Solution:

$$\begin{array}{r} \text{(i) Borrow } 0000110 \\ 1101101 \\ 1100111 \\ \hline 0000110 \end{array}$$

$$\begin{array}{r} \text{(ii) Borrow } 010110 \\ 11011.01 \\ 10101.11 \\ \hline 00101.10 \end{array}$$

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## Binary Multiplication:

The process of multiplication of binary numbers is similar to that of decimal multiplication.

Steps of multiplication of two binary numbers:

Step 1: Multiplier is checked from the right hand side. If LSB is 1 the multiplicand is copied as the first partial product. If LSB is zero, then zeros are entered as the first partial product.

Step 2: Next bit (left to the previous bit) of the multiplier is examined, if it is 1 the multiplicand is copied as the next partial product after shifting left this partial product by one bit. If it is zero then enter zeros as the next partial product after shifting it left by one bit.

Step 3: Repeat step 2 till all bits in the multiplier have been considered.

Step 4: The final product is obtained by adding all the partial products.

Example: Multiply 10101 by 10011.

Solution:

Multiplicand	1 0 1 0 1
Multiplier	1 0 0 1 1
Partial products	1 0 1 0 1 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 1
Product	1 1 0 0 0 1 1 1 1



Q1. Perform the following binary additions.

- (i)  $11010111 + 1011010$
- (ii)  $10111101.101 + 10101001.011$
- (iii)  $100101101.101 + 10010110.01$
- (iv)  $111010110.1101 + 10111011.0101$

Q2. Perform the following binary subtraction.

- (i)  $11010011 - 1010010$
- (ii)  $10100101.101 - 10111001.001$
- (iii)  $100101011.001 - 10100110.01$
- (iv)  $110010110.1001 - 10100011.0111$

Q3. Solve the following:

- (i)  $(11011)_2 \times (101)_2 = (?)_2$
- (ii)  $(110010)_2 \times (1011)_2 = (?)_2$
- (iii)  $(1101.011)_2 \times (101.01)_2 = (?)_2$

