Arithmetic Operation

Contents

- Binary Arithmetic
- Hexadecimal Arithmetic
- Octal Arithmetic

Binary Arithmetic

Binary Addition

The four basic rules for adding binary digits (bits) are as follows:

$0 + 0 = 0$ Sum of 0 with a carry of 0

$0 + 1 = 1$ Sum of 1 with a carry of 0

$1 + 0 = 1$ Sum of 1 with a carry of 0

$1 + 1 = 10$ Sum of 0 with a carry of 1

Carry bits

$1 + 0 + 0 = 01$ Sum of 1 with a carry of 0

$1 + 1 + 0 = 10$ Sum of 0 with a carry of 1

$1 + 0 + 1 = 10$ Sum of 0 with a carry of 1

$1 + 1 + 1 = 11$ Sum of 1 with a carry of 1

Carry   Carry

```
    1 ←  1 ←
    0    1    1
  + 0    0    1
  ___  ___  ___
    1  └ 0  └ 0
```

MCQ

What is the sum of binary number 10110 and 11011?

(a) 010001

(b)111001

(c) 110001

(d) 101011

Binary Subtraction

The four basic rules for subtracting bits are as follows:

$$0 - 0 = 0$$
$$1 - 1 = 0$$
$$1 - 0 = 1$$
$$10 - 1 = 1 \qquad 0 - 1 \text{ with a borrow of } 1$$

Left column:
When a 1 is borrowed,
a 0 is left, so $0 - 0 = 0$.

Middle column:
Borrow 1 from next column
to the left, making a 10 in
this column, then $10 - 1 = 1$.

$$\begin{array}{r} 101 \\ -0\ 11 \\ \hline 0\ 10 \end{array}$$

Right column:
$1 - 1 = 0$

MCQ

What will be the result value after Subtracting two binary number 11011 and 10110.

(a) 10001

(b) 01101

(c) 00101

(d) 00010

Binary Multiplication

The four basic rules for multiplying bits are as follows:

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

```
              11
           ×  11
Partial  {    11
products { + 11
           1001
```

MCQ

What will be the result value after multiplying two binary number 1011 and 101.

(a) 111011

(b) 011101

(C)111001

(d)110111

Hexadecimal Addition

$$2B_{16}$$
$$+ \ 84_{16}$$
$$\overline{\mathbf{AF}_{16}}$$

right column: $B_{16} + 4_{16} = 11_{10} + 4_{10} = 15_{10} = F_{16}$

left column: $2_{16} + 8_{16} = 2_{10} + 8_{10} = 10_{10} = A_{16}$

$$DF_{16}$$
$$+ \ AC_{16}$$
$$\overline{\mathbf{18B}_{16}}$$

right column: $F_{16} + C_{16} = 15_{10} + 12_{10} = 27_{10}$

$27_{10} - 16_{10} = 11_{10} = B_{16}$ with a 1 carry

left column: $D_{16} + A_{16} + 1_{16} = 13_{10} + 10_{10} + 1_{10} = 24_{10}$

$24_{10} - 16_{10} = 8_{10} = 8_{16}$ with a 1 carry

MCQ

Determine addition of two hexadecimal number 2689 and 5437.

(a) 7AB0

(b) 7AC0

(C) 7ABF

(d) 7BCF

Hexadecimal Subtraction

Octal Number addition and subtraction

- It is less frequently used as compare to hexadecimal in computer and microprocessor.

The **octal** number system is composed of eight digits, which are

0, 1, 2, 3, 4, 5, 6, 7

To count above 7, begin another column and start over:

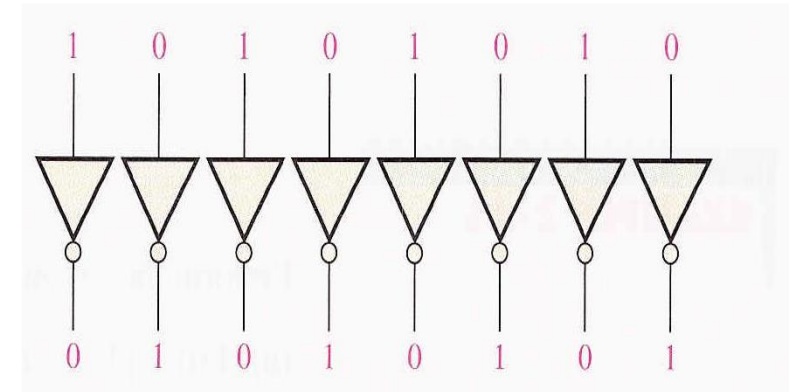10, 11, 12, 13, 14, 15, 16, 17, 20, 21, . . .

- Example-

Add 567 with 243.

1's and 2's complements of binary number

- It allows the representation of negative number.
- 2's complement arithmetic is commonly used in computer to handle negative number.
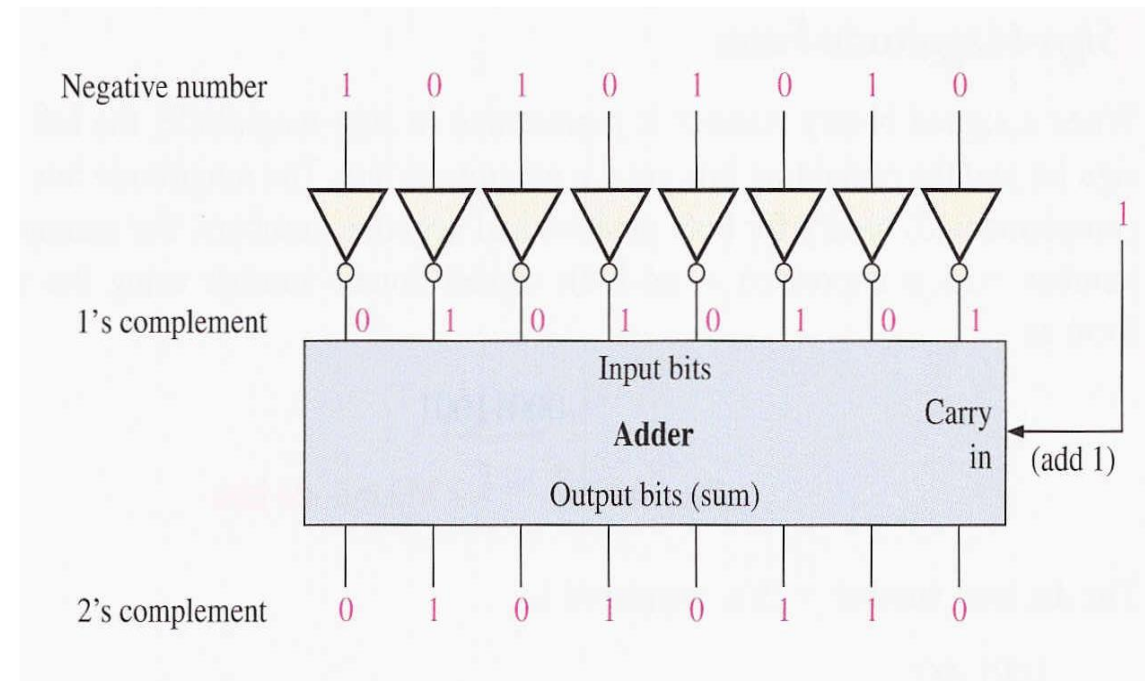
1's complements of binary number

1 0 1 1 0 0 1 0	Binary number
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	
0 1 0 0 1 1 0 1	1's complement

2's complements of binary number

$$2\text{'s complement} = (1\text{'s complement}) + 1$$

```
  10110010      Binary number
  01001101      1's complement
+        1      Add 1
  _____
  01001110      2's complement
```

Negative number   1 0 1 0 1 0 1 0

1's complement   0 1 0 1 0 1 0 1   1

Input bits

Adder   Carry
                                                   in   (add 1)

Output bits (sum)

2's complement   0 1 0 1 0 1 1 0

MCQ

Determine the 2's complement of 1101.11

(a) 0001.10

(b) 0010.01

(c) 1010.01

(d) 1101.01

Alternative method for finding 2's complement

1's complements
of original bits ⟶ $\rightarrow$ **01001000**

10111000   Binary number

2's complement

These bits stay the same.