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Arithmatic operation: → Addition, Subtraction

1- Addition:-

① Binary Addition:-

The basic rules of binary addition are as follows:-

1. $0+0=0$
2. $0+1=1$
3. $1+0=1$
4. $1+1=0$ with a carry of 1 to the next most significant bit.
5. $1+1+1=1$ with a carry of 1 to the next most significant bit.

Ex:- Add the following binary numbers:-

a) $11+11$ b) $100+10$ c) $111+11$ d) $110+100$

Solution:-

a) $11+11=(110)_2$

$$\begin{array}{r} {\scriptstyle 1\ \ } \\ 11 \\ 11 \\ \hline (110)_2 \end{array} +$$

b) $100+10=(110)_2$

حامل (carry)

$$\begin{array}{r} 100 \\ 010 \\ \hline (110)_2 \end{array} +$$

c) $111+11=(1010)_2$

$$\begin{array}{r} {\scriptstyle 1\ 1\ \ } \\ 111 \\ 011 \\ \hline (1010)_2 \end{array}$$

حامل (carry)

d) $110+100=(1010)_2$

$$\begin{array}{r} 110 \\ 100 \\ \hline (1010)_2 \end{array}$$

(b) Octal Addition:- 1) If the sum result ≥ 8, subtract 8 and carry 1

Ex:- Add the following numbers:-

a) $(57)_8 + (432)_8$ b) $(4163)_8 + (7520)_8$

Solution:- a) $(57)_8 + (432)_8 = (511)_8$

Start → ① ①
0 57
432 +
$(511)_8$

b) $(4163)_8 + (7520)_8 = (13703)_8$

①
4163
7520 +
$(13703)_8$

(c) Hexadecimal Addition:- 1) A=10, B=11, C=12, D=13, E=14, F=15
2) IF the sum result ≥ 16, Subtract 16 and Carry 1

Ex:- Add the following numbers:-

a) $(58)_{16} + (4B)_{16}$ b) $(2A58)_{16} + (71D0)_{16}$

Solution:- a) $(58)_{16} + (4B)_{16} = (A3)_{16}$

①
58
4B +
$(A3)_{16}$

b) $(2A58)_{16} + (71D0)_{16} = (9C28)_{16}$

①
(2A58)
(71D0) +
$(9C28)_{16}$

(H.w):- Add the following numbers:-

a) $(110101)_2 + (11001)_2$

b) $(175214)_8 + (152405)_8$

c) $(4F1A5)_{16} + (B85D5)_{16}$

- Complements:—

Complement are used in digital computer for simplifying the subtraction operation and for logical manipulation. There are two types of complements for each base-r system: The first is referred to as the r's complement and the second as the (r-1)'s complement.

1- Binary Number Complements:-

In the binary number system we have the 1's and 2's complements.

The 1's complement of a binary number is obtained by replacing 0s with 1s and 1s with 0s.

$0 \longrightarrow 1$
$1 \longrightarrow 0$

For example, the 1's complement of $(10010110)_2$ is $(01101001)_2$

The 2's complement of a binary number is obtained by adding '1' to it's 1's complement. or right to left copy bits through 1st logic 1, then invert.

2's Complement = 1's Complement + 1

For example, the 2's complement of $(10010110)_2$ is $(01101010)_2$

Ex:— Find the 1's complement of the following numbers:-

a) $(1011000)_2$ b) $(01011 01)_2$

Solution:- a) 1011000
↓↓↓↓↓↓↓ 1's complement
$(0100111)_2$

b) 0101101
↓↓↓↓↓↓↓ 1's complement
$(1010010)_2$

Ex:- Find the 2's complement of the following numbers:-

a) $(10110101100)_2$ b) $(11011010011)_2$

Solution:- a) $(10110101100)_2$

First method 2's = 1's + 1

1st complement = 01001010011 (carries ① ①)

2's complement = $(01001010100)_2$ (1 +)

Second method:- 1's complement | unchange

10110101100

01001010100

b) $(11011010011)_2$

First method = 2's = 1's + 1

1's Complement = 00100101100

2's complement = (00100101101) (1 +)

Second method:- 1's complement | unchange

11011010011

$(00100101101)_2$

2- Decimal numbers Complements:-

In the Decimal number system we have the 9's and 10's Complements.

The 9's complement of a given decimal number is obtained by subtracting each digit from 9.

For example:- Find the 9's complement of $(2496)_{10}$

9999

2496 −

9's complement $(7503)_{10}$

The 10's Complement is obtained by adding '1' to the 9's complement.

10's complement = 9's complement + 1

For example: Find the 10's complement of $(2496)_{10}$

$$\begin{array}{rl} & 9999 \\ & 2496 \\ \hline 9\text{'s complement} \rightarrow & 7503 \\ & \quad\ 1 \ + \\ \hline 10\text{'s complement} & (7504)_{10} \end{array}$$

Ex:- Find the 9's and 10's complement of the following numbers:-

a) $(546700)_{10}$ b) $(012398)_{10}$

Solution:- a) $(546700)_{10}$

$$\begin{array}{rl} & 999999 \\ & 546700 - \\ \hline 9\text{'s Comp.} & (453299)_{10} \\ & \quad\ 1 + \\ \hline 10\text{'s comp.} & (453300)_{10} \end{array}$$

b) $(012398)_{10}$

$$\begin{array}{rl} & 999999 \\ & 012398 - \\ \hline 9\text{'s comp.} & (987601)_{10} \\ & \quad\ 1 + \\ \hline 10\text{'s comp.} & (987602)_{10} \end{array}$$

3- Octal number Complements:-

In the octal system, we have the 7's and 8's complements.

The 7's complement of a given octal number is obtaind by subtracting each octal digit from 7.

For example: the 7's complement of $(562)_8$ would be:-

$$\begin{array}{rl} & 777 \\ & 562 - \\ \hline 7\text{'s complement} & (215)_8 \end{array}$$

The 8's complement is obtained by adding '1' to the 7's complement.

8's complement = 7's complement +1

For example: the 8's complement of $(562)_8$ would by:-

$$\begin{array}{rl} & 777 \\ & 562 - \\ \hline 7\text{'s comp.} & (215)_8 \\ & \quad\ 1 + \\ \hline 8\text{'s comp.} & (216)_8 \end{array}$$

Ex:- Find the 7's and 8's complement for the following number :- $(6572)_8$

Solution :-

$$\begin{array}{r} 7\ 7\ 7\ 7 \\ 6\ 5\ 7\ 2 - \\ \hline (1\ 2\ 0\ 5)_8 \\ 1\ + \\ \hline (1\ 2\ 0\ 6)_8 \end{array}$$

7's complement

8's Complement.

4- Hexadecimal Number Complements:-

A=10 ; B=11 ; C=12
D=13 ; E=14 , F=15

The 15's and 16's complements are defined with respect to the hexa-decimal number system.

The 15's complement is obtained by subtracting each hex digit from 15. For example:- the 15's complement of $(3BF)_{16}$ would be

$$\begin{array}{r} 15\ 15\ 15 \\ 3\ B\ F - \\ \hline (C\ 4\ 0)_{16} \end{array}$$

The 16's complement is obtained by adding '1' to the 15's complement

> 16's Complement = 15's complement +1

For example: the 16's complement of $(2AE)_{16}$ would be

$$\begin{array}{r} 15\ 15\ 15 \\ 2\ A\ E - \\ \hline (D\ 5\ 1)_{16} \\ 1\ + \\ \hline (D\ 5\ 2)_{16} \end{array}$$

15's Complement

16's Complement

Ex:- Find the 15's and 16's complement of the following number:-

ABF8.

Solution:-

$$\begin{array}{r} 15\ 15\ 15\ 15 \\ A\ B\ F\ 8 - \\ \hline (5\ 4\ 0\ 7)_{16} \\ 1\ + \\ \hline (5\ 4\ 0\ 8)_{16} \end{array}$$

15's complement

16's complement