2- Subtraction:-

The direct method of subtraction throught in elementary schools uses the borrow concept. This method, works well when people perform subtraction with paper and pencil. However, when subtraction is implemented with digital H/w, the method is less efficient than the method that uses complements.

The subtraction of two n-digit numbers M-N can be done as follows:-

1- If we use (r-1)'s complement [1's, 9's, 7's, 15's]:-

a) For M-N, if $M \geq N$, the sum produce an end carry which can be added to the sum and this is referred to as an end around carry.

b) For M-N, if $M < N$, the sum does not produce an end carry and to obtain the answer in a familier form, take the (r-1)'s complement of the sum and place a negative sign infront.

2- If we use (r)'s complement [2's, 10's, 8's, 16's]:-

a) For M-N, if $M \geq N$, the sum produce an end carry which can be discarded

b) For M-N, if $M < N$, the sum does not produce an end carry and to obtain the answer in familier form, take the r's complement of the sum and place a negative sign infront.

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Ex: Subtract the following binary number by use 1's and 2's Complement :-

a) $(1010100)_2 - (1000011)_2$ b) $(1000011)_2 - (1010100)_2$

Solution:-

use 1's complement

a) $(1010100)_2 - (1000011)$

```
         1010100
      ┌─ 1000011 -
      │  -------
      │  1010100
1's comp.
      └→ 0111100 +
        --------
        10010000
    cy  └────→ 1 +
        --------
result = (0010001)_2
```

use 2's complement

```
          1010100
      ┌── 1000011 -
      │   -------
      │   1010100
2's comp.
      └→  0111101 +
          -------
         10010001
     del. ↑

result = (0010001)_2
```

b) $(1000011)_2 - (1010100)_2$

use 1's complement

```
         1000011
      ┌─ 1010100 -
      │  -------
      │  1000011
1's comp.
      └→ 0101011 +
         -------
      ┌─ 1101110
1's comp.
      └→ 0010001
add(-)
      └→ -(0010001)_2

result = -(0010001)_2
```

use 2's complement

```
          1000011
      ┌── 1010100 -
      │   -------
2's comp. 1000011
      └→  0101100 +
          -------
      ┌── 1101111
2's comp.
      └→  0010001
add(-)
      └→  -(0010001)_2

result = -(0010001)_2
```

Ex:- Using 9's and 10's complement subtracte:-

a) $(72532)_{10} - (3250)_{10} =$ b) $(3250)_{10} - (72532)_{10}$

Solution:-

a) $(72532)_{10} - (3250)_{10}$

9's complement

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$$\begin{array}{r} 72532 \\ 03250- \\ \hline \end{array}$$

9's comp.

$$\begin{array}{r} 72532 \\ 96749+ \\ \hline 169281 \\ 1+ \\ \hline (69282)_{10} \end{array}$$

cy

result = $(69282)_{10}$

10's complement

نساوي المراتب

$$\begin{array}{r} 72532 \\ 03250- \\ \hline \end{array}$$

10's comp

$$\begin{array}{r} 72532 \\ 96750+ \\ \hline \cancel{1}69282 \end{array}$$

يهمل cy

result = $(69282)_{10}$

b) $(3250)_{10} - (72532)_{10}$

9's complement

نساوي المراتب

$$\begin{array}{r} 03250 \\ 72532- \\ \hline \end{array}$$

9's comp

$$\begin{array}{r} 03250 \\ 27467+ \\ \hline 30717 \end{array}$$

9's comp. → 69282

add(−) → $-(69282)_{10}$

result = $-(69282)_{10}$

10's complement

نساوي المراتب

$$\begin{array}{r} 03250 \\ 72532- \\ \hline \end{array}$$

10's comp.

$$\begin{array}{r} 03250 \\ 27468+ \\ \hline 30718 \end{array}$$

10's comp → (69282)

add(−) → $-(69282)_{10}$

result = $-(69282)_{10}$

Ex:- Subtract the following octal number by use 7's and 8's complement:-

a) $(256)_8 - (341)_8$

Solution:-

7's complement

```
          256
        ┌ 341 -
7's comp│ ─────
        │ 256
        └→436 +
          ─────
        ┌ 715
7's comp└→063
add(-)  └→ -(63)8
```

result $= -(63)_8$

8's complement

```
          256
          341 -
          ─────
          256
          437 +
          ─────
        ┌ 715
8's comp└→063
add(-)  └→ -(63)8
```

result $= -(63)_8$

Ex:- Subtract the following hexadecimal number by use 15's and 16's complement:-

a) $(592)_{16} - (3A5)_{16}$

Solution:-

15's complement

```
          592
        ┌ 3A5 -
15's    │ ─────
comp    │ 592
        └→C5A +
          ─────
        ┌ 1 1EC
        └──→  1 +
          ─────
```

result $= (1ED)_{16}$

16's complement

```
          592
          3A5 -
          ─────
          592
          C5B +
          ─────
    cy  ~~1~~ 1ED
```

result $= (1ED)_{16}$

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Ex:- Subtract the following number by use 1's and 2's complement:-

a) $(-3)_{10} + (4)_{10}$ b) $(-3)_{10} + (-4)_{10}$

Solution:-

a) $(-3)_{10} + (4)_{10}$

1's Complement

```
                    -3
binary :- بدون       4 +
                   -----
                    011
                    100
                   -----
1's comp. [illegible]  100
                    100 +
                   -----
cy                 1 000
                       1 +
                   -----
result = (001)₂
```

2's complement

```
                   -3
binary :- بدون      4 +
                  -----
                  011
                  100
                  -----
2's comp.         101
                  100
                  -----
cy               X 001
result = (001)₂
```

b) $(-3)_{10} + (-4)_{10}$

1's Complement

```
                 -3
[illegible]      -4 +
                 -----
                 0011
                 0100
                 -----
                 1100
1's comp.        1000
                 -----
                1 0111
                     1 +
                 -----
                 1000
1'st comp =      0111
result = -(111)
```

2's Complement

```
                 -3
                 -4 +
                 -----
                 0011
                 0100
                 -----
                 1101
                 1100
                 -----
نهمل            1 1001
2's comp =       0111
result = -(111)
```

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H.W: Find the following:-

a) $(1001001)_2-(101110)_2$ using 1's & 2's complement.

b) $(341)_8-(256)_8$ using 7's & 8's complement.

c) $(9F1B)_{16}-(4A36)_{16}$ using 15's & 16's complement.

d) $(-18)_{10}+(-37)_{10}$ using 1's & 2's complement.