(2) Subtraction Operation:-

The direct method of subtraction taught in elementary schools uses the borrow concepts. This method works well when people perform subtraction with paper and pencil. However, when subtraction is implemented with digital, this method show less efficeint than the method that uses complements

Binary Numbers Complements:-

1's Complement: invert the binary representation for the number (1s become 0s and 0s become 1s).

2's Complement: Take 1s complement and add (1) to the result.

Ex:) 1's Complement of 1011000 is 0100111.
2's Complement of 110 1100 is 0010100

Decimal Numbers Complements:-

9's Complement:- it is obtained by subtract each digit from 9.

10's Complements - it is obtained by adding (1) to the 9's value.

Ex:-

9's Complement of 546700 is 453299

10's Complement of 246700 is 753300

Note:- Complements are used in digital computers for simplifying the subtraction operation.

Ex:) Subtract the following number by use 1's complement?

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

Sol:)

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

```
  1010100
  1000011 -
  -------
  (1)(1)(1)(1)
  0010100
```

1's complement → 1101100 +

rotate the carry → [1] 0010000

and adding → +

[0010001] ← the answer

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

```
  1000011
  1010100 -
  -------
     (1)(1)
  1000011
```

1's complement → 0101011 +

1101110

There is no carry therefore the answer is −

= −(1's complement for the result).

= −(1's complement of 1101110) = $-(0010001)_2$

The answer is:- $-(0010001)_2$

Ex:) Subtract the following binary by use 2's Complement?

a) $(1010100)_2 - (10001)_2$ b) $(1000011)_2 - (1010100)_2$

Sol.)

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

```
  1010100
  1000011 -
  -------
  1010100
2's → 0111101 +
  -------
  0010001
```

The carry is → 1 discard

```
  1000011
1's → 0111100
        1+
  -------
2's → 0111101
```

The answer is $(0010001)_2$

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

```
  1000011
  1010100 -
  -------
  1000011
2's → 0101100 +
  -------
  1101111
```

no carry

```
  1010100
1's → 0101011
        1+
  -------
2's → 0101100
```

The answer = -(2's complement of the result).

= -(2's complement of 1101111) = $-(0010001)_2$

The answer is $-(0010001)_2$

Ex:) Using 10's complement Subtract for $(72532)_{10} - (3250)_{10}$?

Sol:)

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

```
  72532
  03250 -
  -----
  72532
10's → 96750 +
  -----
Discard → 1 69282
```

```
  99999
  03250 -
  -----
9's → 96749
        1 +
  -----
10's → 96750
```

The answer is:- $(69282)_{10}$

Ex) Using 9's complement Subtract for $(3250)_{10} - (72532)_{10}$?

Sol:)

```
  03250
  72532 -
  -----
  03250
9's → 27467 +
  -----
no carry → 30717
```

```
  99999
  72532 -
  -----
9's → 27467
```

The answer is: $-(9\text{'s complement of } 30717) = -(69282)_{10}$

Ex) Using 1's complement to find $(-3)_{10} + (4)_{10}$?

Sol:) $-3 + 4$

$\downarrow$ $\downarrow$

011 100

```
  -011
   100+
  -----
   100
   100+
  -----
 1 000
   └──→1+
  -----
   001
```

```
   011
1's→100
```

The answer is $(1)_{10}$

Octal Numbers Complements:-

7's complement:- it is obtained by subtract each digit from 7.
8's Complement :- it is obtained by adding (1) to the 7's value.

Ex) Using 8's complement subtract for $(256)_8 - (341)_8$?

Sol:)

```
  256
  341 -
 -----
  256
8's → 437 +
 -----
no carry → 715
```

```
  7 77
  341 -
 -----
7's → 436
      1 +
 -----
8's → 437
```

The answer = (8's complement of 715)

$= -(063)_8$

```
  7 7 7
  7 1 5 -
 -------
7's → 0 6 2
      1 +
 -------
8's → 0 6 3
```

Hexadecimal Numbers Complements:-

15's Complement: it is obtained by subtract each digit from 15.
16's Complement: it is obtained by adding (1) to the 15's value.

Ex) Find $(592)_{16} - (3A5)_{16}$ using 16's complement?

Sol:)

```
   592
   3A5 -
 -------
   592
16's → C5B +
 -------
discard→ 1 1 E D
```

```
   F F F
   3 A 5 -
 -------
15's → C 5 A
       1 +
 -------
16's → C 5 B
```

The answer is:- $(1ED)_{16}$

Ex) Find $(3A5)_{16} - (592)_{16}$ by using 15's complement?

Sol:)

```
   3A5
   592 -
  -----
   3A5

   FFF
   592 -
  -----
   A6D
```

15's → A6D

15's → A6D+

no carry → E12

The answer is $(1ED)_{16}$

H.W: Find the following:-

1) $(1001001)_2 - (101110)_2$ using 1's and 2's comp.

2) $(43C)_{16} - (32B)_{16}$ using 15's and 16's comp.

3) $(316)_8 - (451)_8$ using 7's and 8's comp.

4) Add: $(3F8)_{16}$ and $(5B3)_{16}$

5) Find the complement of $(A9B)_{16}$ using 15's comp.

6) Find the complement of $(346)_8$ using 8's comp.