1's complement and 2's complement

■ We would explain Binary Arithmetic operations before explaining 1's and 2's complement, there are four arithmetic operations as in a decimal system:

1- Addition

The 4 basic rules for adding binary digits (bits) are as follows:

$0 + 0 = 0$

$0 + 1 = 1$

$1 + 0 = 1$

$1 + 1 = 0 \quad with \quad carry \quad 1$

Example: $11001 + 10011 = 101100_2$

2- Subtraction

The four basic rules for subtracting bits as follows:

$0 - 0 = 0$

$1 - 0 = 1$

$1 - 1 = 0$

$0 - 1 = 10 - 1 = 1 \quad with \quad borrow \quad of 1$

Example: $11101 - 10110 = 00111_2$

3- Multiplication

The four basic rules for multiplying bits are as follows:

$0 * 0 = 0$

$0 * 1 = 0$

$1 * 0 = 0$

$1 * 1 = 1$

Example: $111 * 101 = 100011_2$

4- Binary division

The rules for division by binary bits is as follows:

$0 \div 1 = 0$
$1 \div 1 = 1 \quad where \quad division \quad by \quad zero \quad is \quad not \quad permitted$

Example: $110 \div 10 = 10_2$

■ 1's complement:

- Subtraction of a number from another one can be achieved by adding the 1's complement of the subtrahend to the minuend.

- A form of signed binary in which negative numbers are created by complementing all bits.
- Subtraction of binary numbers using the 1's complement method can be achieved by addition.
- 1- Subtraction of smaller number from larger number as the following steps:

  Step1:The 1's complement of a binary number can be obtained by changing all 1s to 0s and all 0s to 1s on the (subtrahend).

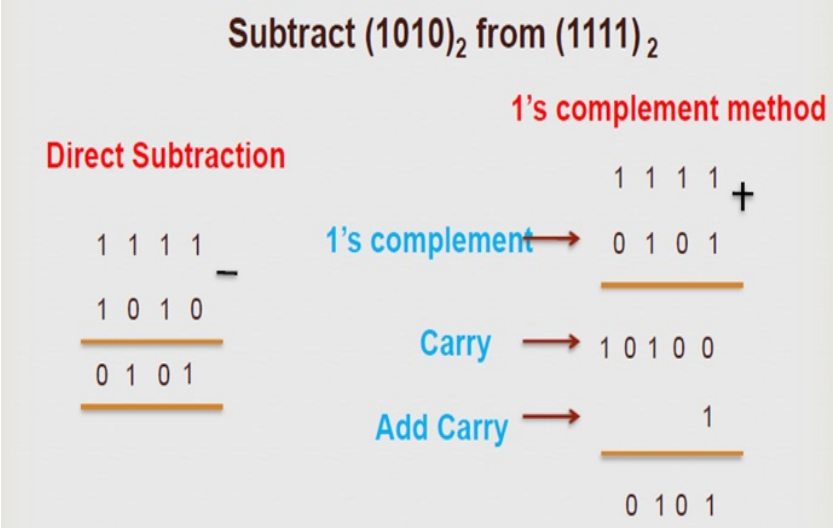
  Step2: Add the result from step 1 to the larger number (minuend), the result is positive number.

  Step3: Carry will be generated after the addition which is called End-round carry.

  Step4: Remove the carry and add it to the result. This carry is called end-around-carry.

  Example:

  $subtract \quad (1010)_2 \quad from \quad (1111)_2 \quad using \quad 1's complement$



- 2- Subtraction a larger number from the smaller number as the following steps:

  Step1: Determine the 1's complement of the larger number (Subtrahend).

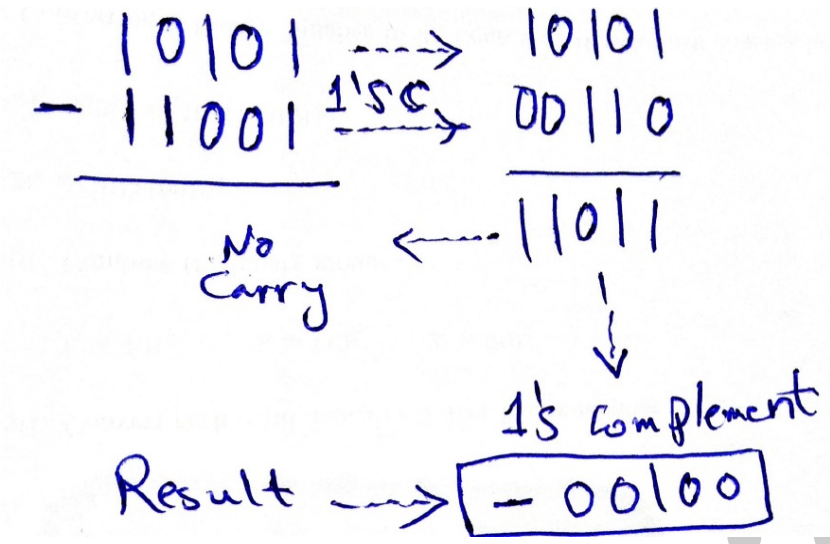
  Step2: Add 1's complement to the smaller number (minuend).

  Step3: We will get No carry.

  Step4: The result will be negative number, to get the result in true form, take the 1's complement of the result and put assign –ve sign to the answer.

  Example:

  $subtract \quad (11001)_2 \quad from \quad (10101)_2 \quad using \quad 1's complement$



■ 2's complement:
The subtraction can be done using 2's complement.

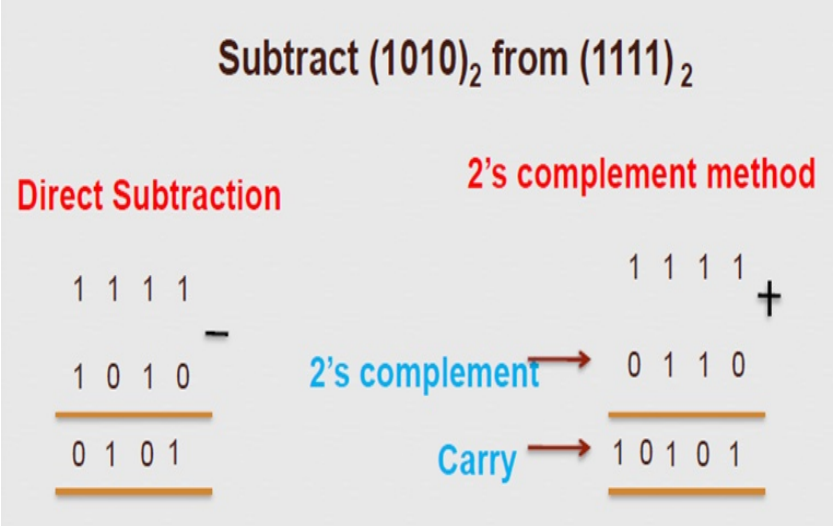
- 1- Subtraction of smaller number from larger number as the following steps:
  Step1:determine the 2's complement of smaller number (subtrahend).

  Step2: Add 2's complement to the larger number (minuend).

  Step3: discard the carry generated. Always a carry is generated in this case.

  Example:

  $subtract \quad (1010)_2 \quad from \quad (1111)_2 \quad using \quad 2's complement$



- 2- Subtraction a larger number from the smaller number as the following steps:

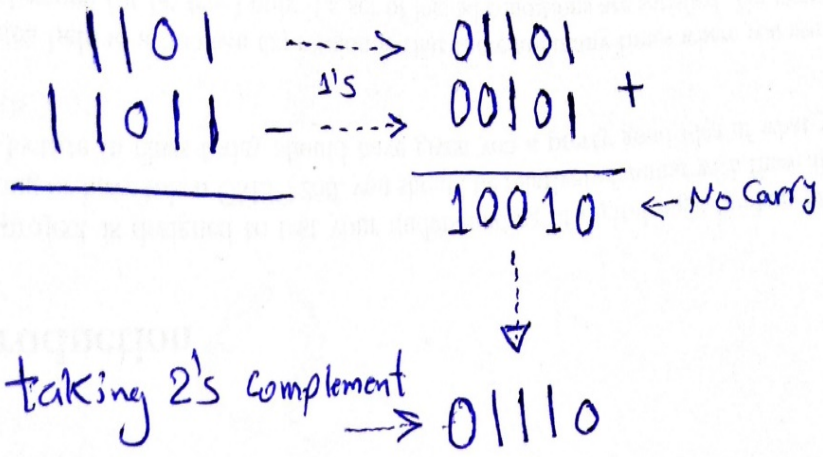
  Step1: Specify the 2's complement of larger number (subtrahend).

  Step2: Add 2's complement to the smaller number (minuend).

  Step3: To get the answer in the true form, take 2's complement and assign negative sign to the answer, no carry is generated in this method.

  Example:

  $subtract \quad (1101)_2 \quad from \quad (11011)_2 \quad using \quad 2'scomplement$



■ 9's complement:

- 9's complement of a decimal number can be obtained by subtracting it from 9.

  Example:
  Find the 9's complement of the following numbers: 6, 212, 7905

  $9 - 7 = 3$
  $999 - 212 = 787$
  $9999 - 7905 = 2094$

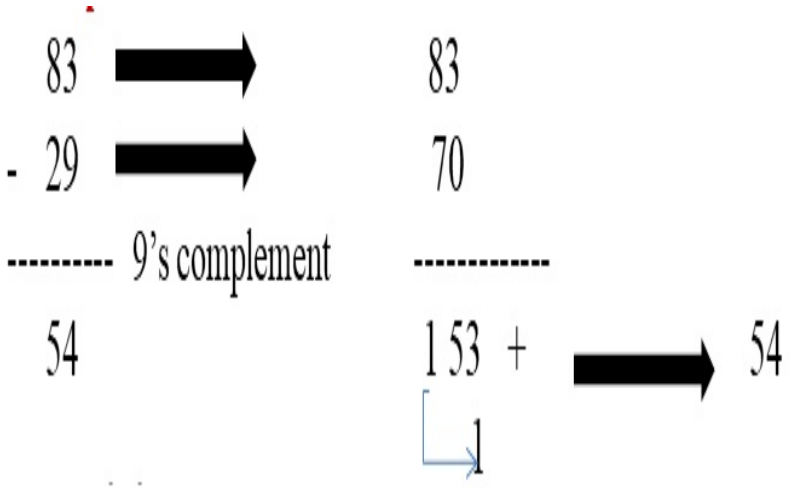
- 1- Subtraction of smaller number from larger number as the following steps:

  Step1: produce 9's complement of subtrahend.

  Step2: Adding the result of step 1 with Minuend.

  Step3: There will be carry that can be added to the result, this is called (End Around Carry).

  Example:



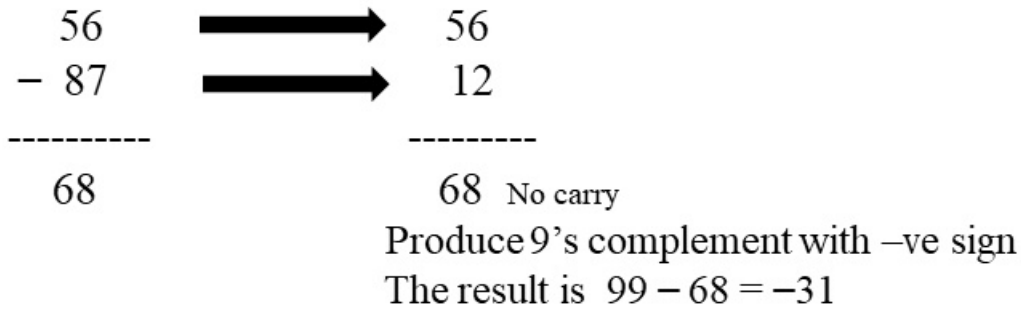
- 2- Subtraction a larger number from the smaller number as the following steps:

  Step1: produce 9's complement of Subtrahend.

  Step2: Add the produced result from Step 1 to Minuend.

  Step3: There is no carry in the produced result, so change the result to 9's complement and putting –Ve sign.

Example:
Perform the following subtraction using 9's complement



■ 10's complement:

- 10's complement of a decimal number can be obtained by obtaining 9's Plus 1.

  Example:

  Find the 10's complement of the following numbers: 26,360

  $99-26=73 \qquad 73+1= \quad 74 \quad is \quad the \quad 10's \quad complement \quad of \quad 26$

  $999-360=639 \qquad 639+1= \quad 640 \quad is \quad the \quad 10's \quad complement \quad of \quad 26$

- 1- Subtraction using 10's complement method of smaller number from larger number.

Example:

83
− 25

⟹

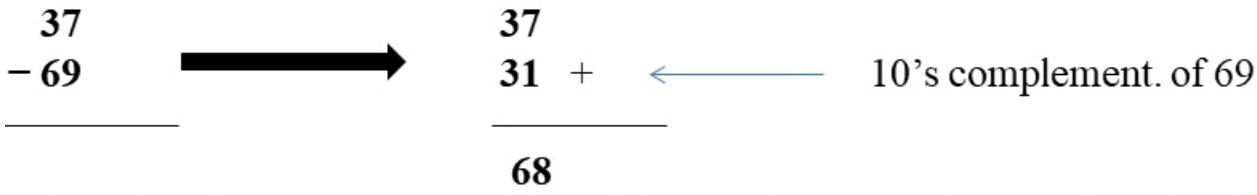
83
+ 75 ← **10's complement**

carry discard → 1 58

Here the carry is generated, then we discard it, the reaming value is true answer a positive number (+ve).

- 2- Subtraction using 10's complement method of larger number from smaller number.

Example:



Here there is no carry, so taking 10's complement of the result to obtain the final r
–ve sign
The answer is -32