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Signed Numbers:

There are two types of signed number : positive number & negative number . To represent sign of binary number an extra bit is used at the extreme left of the number. This extra bit is known as the sign bit. The sign bit is 0 or 1. By convention, a 0 bit is used for the positive numbers and a 1 bit is used for negative numbers.

e.g + 6 is represented by 0110
- 6 is represented by 1110

1's Complement Representation: In 1's complement represent of negative number, first write binary equivalent of positive number & then 1's complement to it. In 1's complement 0 converted into 1 & 1 converted into 0.

Example. The 1's complement of the number - 6 is obtained as:

- Binary equivalent of + 6 is =0110
- 1's complement of 0110 = 1001 = -6
- Hence 1's complement of - 6 =1001

2's Complement Representation: In 2's complement represent of negative number, first write binary equivalent of positive number & then 1's complement to it & adding 1 to the least significant bit position.

Example. The 2's complement of the number - 6 is obtained as:

- Binary equivalent of + 6 is =0110
- 1's complement of 0110 = 1001 = -6
- Hence 2's complement of - 6 =1001

+1

=1010

Addition/Subtraction of Signed Numbers in 2's Complement Representation:

The subtraction of two positive numbers means the addition of a negative number to the positive number. During the addition of two signed numbers,

- if MSB of the result is 0, then the answer is positive.
- if MSB is 1, then the answer is negative (in 2's complement form).

(i) Addition of positive number with smaller negative number:

+15	01111	
– 9	10111	(10111 is the 2's complement of +9)
+ 6	1 00110	

There is an end around carry which is ignored. So the answer is correct as 00110 represents + 6.

(ii) **Addition of positive number with larger negative number:**

+ 9	01001	
–15	10001	(10001 is the 2's complement of +15)
– 6	11010	

There is no end around carry so the answer is negative which is verified by the MSB of the answer. The answer is correct as 11010 represents – 6.

(iii) Addition of two positive numbers:

+15	01111
+ 9	01001
+24	11000

The result 11000 is correct in unsigned binary numbers but incorrect in signed binary numbers as 11000 represents – 8 in 5 bit signed binary numbers. The correct answer could be obtained if 6 bit signed binary system was considered.

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+15    001111
+ 9    001001
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+24    011000
```

Now the answer is correct.

(iv) Addition of two negative numbers:

```
–15    10001      (10001 is the 2's complement of +15)
– 9    10111      (10111 is the 2's complement of +9)
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–24  1 01000
```

After ignoring the end around carry the answer 01000 is incorrect, as the maximum limit of 5 bit signed binary numbers is – 16 to +15. To get the correct answer each number should have been represented in 6 bits signed binary form as follows:

```
–15    110001      (110001 is the 2's complement of +15)
– 9    110111      (110111 is the 2's complement of +9)
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–24  1 101000
```

Now the answer is correct as after ignoring the end around carry 101000 represents –24 in signed binary form.

Note:

The overflow is said to have occurred in the above two examples as initially insufficient number of bits were used for representing the signed binary numbers. While working with 2's complement addition, one should ensure that the positive and negative number are expressed in 2's complement representation and the sum also lie within the specified range, otherwise wrong result will occur. However, in computers a special circuit is provided to detect any overflow condition and indicate the erroneous result.

NUMBER SYSTEM

Q1. Perform the following operations in 8-bit system using 2's complement method.
(i) – 49 – 26 (ii) 67 – 39 (iii) – 87 + 112 .

Q2. Explain the 1's and 2's complement representation of binary numbers.

Q3. Perform the following operations in 12-bit system using 2's complement method.
(i) – 149 – 126 (ii) 607 – 319 (iii) – 871 + 112 (iv) 312 – 540.