Lecture 6

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Revision Quiz (Poll 1)

- 1's complement of 1011101 is _____

    a) 0101110
    b) 1001101
    c) 0100010
    d) 1100101

Revision Quiz (Poll 2)

- 2's complement of 11001011 is _____

    a) 01010111
    b) 11010100
    c) 00110101
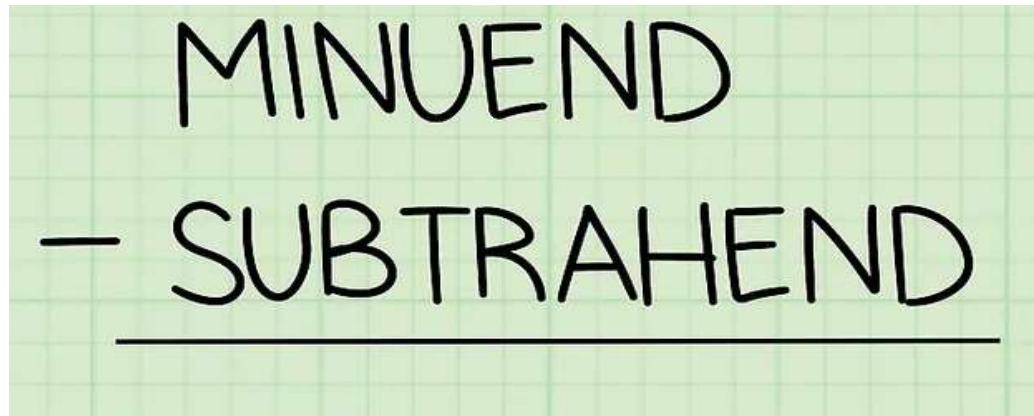   d) 11100010

Subtraction by Addition of r's Compliment

Subtraction can carried by means of addition of complimented number.

Add minuend M to the compliment of subtrahend N

M-N = M + r's compliment of N

If M ≥ N sum will produce end carry which is discarded -> positive result

If M ≤ N sum will not produce end carry to obtain result take r's compliment of sum again -> Negative result

Perform 1010100 – 1000011 using 2's compliment

2's compliment of 1000011 is 0111101

$$
\begin{array}{r}
1\,111 \\
1010100 \\
+\,0111101 \\
\hline
10010001 \\
\hline
\end{array}
$$

Discard carry positive result

00100001

Perform 1000011 - 1010100 using 2's compliment

2's compliment of 1010100 is 0101100

$$1111$$

$$1000011$$

$$+\,0101100$$

$$\overline{1101111}$$

No end carry Negative result

Take $2's\,comp\lim ent\,of\,1101111$

Final result $\quad 0010001$

Subtraction by Addition of (r-1)'s Compliment

Subtraction can carried by means of addition of complimented number.

Add minuend M to the compliment of subtrahend N

M-N = M + (r-1)'s compliment of N

If M ≥ N sum will produce end carry which is added in result -> positive result

If M ≤ N sum will not produce end carry to obtain result take (r-1)'s compliment of sum again -> Negative result

Perform 1010100 – 1000011 using 1's compliment

1's compliment of 1000011 is 0111100

$$
\begin{array}{r}
1\,1\,1\,1 \\
1\,0\,1\,0\,1\,0\,0 \\
+\;0\,1\,1\,1\,1\,0\,0 \\
\hline
1\,0\,0\,1\,0\,0\,0\,0 \\
\hline
+\qquad\qquad 1 \\
\hline
0\,0\,1\,0\,0\,0\,1 \\
\hline
\end{array}
$$

Add carry positive result

0010001

Perform 1000011 - 1010100 using 1's compliment

1's compliment of 1010100 is 0101011

$$
\begin{array}{r}
11 \\
1000011 \\
+\,0101011 \\
\hline
1101110 \\
\hline
\end{array}
$$

No end carry Negative result

Take 1's comp lim ent of 0010001

Final result 0010001

Using 10's compliment 72532 – 03250

9's compliment of 03250 = 99999 – 03250 = 96749

10's compliment of 3250 = 96479 + 1 = 96750

72532 + 10's compliment of 3250 = 72532 + 96750

$$= 169282$$

End carry exits positive result

Discard the carry final result = 69282

- **<u>Using 10's compliment 3250 - 72532</u>**
- 9's compliment of 72532 = 99999 – 72532 = 27467
- 10's compliment of 72532 = 27467 + 1 = 27468
- 3250 + 10's compliment of 72532 = 03250 + 27468
- $\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ = 30718

- No end carry result in negative
- Take 10's compliment of 30718
- 9's compliment of 30718= 99999 – 30718 = 69281
- 10's compliment of 30718 = 69281 + 1 = 69282

- Final result -69282

Subtraction by Addition of Compliment

Find Subtraction of 342 and 614 using 8's complement method

8's complement of a number is 1 added to it's 7's complement number.
7's complement of 614 is

```
    7   7   7
-   6   1   4
_____
    1   6   3
```

Now add 1 : 163 + 1 = 164

```
        1
    3   4   2
+   1   6   4
_____
    5   2   6
```

Here there is no carry, answer is - (8's complement of the sum obtained)

8's complement of a number is 1 added to it's 7's complement number.
7's complement of 526 is

```
    7  7  7
-   5  2  6
_____
    2  5  1
```

Now add 1 : 251 + 1 = 252
So answer is -252

Find Subtraction of B06 and C7C using 16's complement method

16's complement of a number is 1 added to it's 15's complement number.
15's complement of C7C is

```
      F   F   F
  -   C   7   C
  _____

      3   8   3
```

Now add 1 : 383 + 1 = 384

```
      B   0   6
  +   3   8   4
  _____

      E   8   A
```

Here there is no carry, answer is - (15's complement of the sum obtained)

15's complement of a number is obtained by subtracting all bits from FFF.
15's complement of E89 is

```
    F  F  F
 -  E  8  9
   _____

    1  7  6
```

So answer is -176

Practice Question

Addition is performed with 1's compliment representation of signed number

```
  +3       0011             +4       0100             +5       0101
+ +4     + 0100           + -7     + 1000           + -5     + 1010
─────    ──────           ─────    ──────           ─────    ──────
  +7       0111             -3       1100             -0       1111


  -2       1101             +6       0110             -0       1111
+ -5     + 1010           + -3     + 1100           + -0     + 1111
─────    ───────          ─────    ───────          ─────    ───────
  -7      10111             +3      10010             -0      11110
         +     1                   +     1                   +     1
         ───────                   ───────                   ───────
           1000                      0011                      1111
```

Practice Question

Addition is performed with 2's compliment representation of signed number

Carry our of the sign bit is discarded and negative result automatically stores in 2's compliment format

$$
\begin{array}{rl}
+\ 6 & 00000110 \\
+13 & 00001101 \\
\hline
+19 & 00010011
\end{array}
\qquad
\begin{array}{rl}
-\ 6 & 11111010 \\
+13 & 00001101 \\
\hline
+\ 7 & 00000111
\end{array}
$$

$$
\begin{array}{rl}
+\ 6 & 00000110 \\
-13 & 11110011 \\
\hline
-\ 7 & 11111001
\end{array}
\qquad
\begin{array}{rl}
-\ 6 & 11111010 \\
-13 & 11110011 \\
\hline
-19 & 11101101
\end{array}
$$