Assignment 4

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Assignment #4

Problem 1:

a) 28 + 91

28:

28%2 = 14 r0
14%2 = 7 r0
7%2 = 3 r1
3%2 = 1 r1
1%2 = 0 r1

28 = 00011100

91:

91%2 = 45 r1
45%2 = 22 r1
22%2 = 11 r0
11%2 = 5 r1
5%2 = 2 r1
2%2 = 1 r0
1%2 = 0 r1

91 = 01011011

=> 00011100 => 28
+ 01011011 => 91
01110111   119

01110111 ✓
= 119 ✓

b) 102 - 75

102:

102%2 = 51 r0
51%2 = 25 r1
25%2 = 12 r1
12%2 = 6 r0
6%2 = 3 r0
3%2 = 1 r1
1%2 = 0 r1
=> 102 = 01100110

-75: First, we will convert (+75) to binary.

75%2 = 37 r1
37%2 = 18 r1
18%2 = 9 r0
9%2 = 4 r1
4%2 = 2 r0
2%2 = 1 r0
1%2 = 0 r1

01001011 = (+75)
-> Flip and add 1:
10110101 = -75 ✓

01100110
+ 10110101
1 00011011 => overflow!

$\underbrace{00011011}_{8\text{-bits}}$

c) 12×-5

12:

$12\%2=0$
$6\%2=0$
$3\%2=1$
$1\%2=1$

$\Rightarrow 12 = 00001100$

5:

$5\%2=2$ r1
$2\%2=1$ r0
$1\%2=0$ r1

$00000101=5$

$\Rightarrow -5 \Rightarrow 11111011$

12x-5: We know the answer is -60 so, first, we will do the operation 12x5

12=00001100
5=00000101 ⇒

```
        00001100
        00000101
        --------
        00001100
       000000000
      0000110000
     00000000000
    000000000000
   0000000000000
  00000000000000
 000000000000000
----------------
0000000000111100 = 60
```

So, we get 0111100 = 60 ⇒ Change this to -60,

1000011 add 1.
⇒ 1000100 = -60

$$\begin{array}{r} 12 \\ \times -5 \\ \hline -60 \end{array}$$

#

c) 10 = 01010
240 = 01111000

```
         1100
01010 | 01111000
        01010
         01010
          01010
        ------
        000000
```

R=0

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Problem 2:

(n=5)

A=-12
B=-10

A:

12%2 = 6 r 0
6%2 = 3 r 0
3%2 = 1 r 1
1%2 = 0 r 1

=> 01100 = $(+12)_{10}$

Flip => 10011 add 1 to end
=> 10100 = -12

B:

+10%2 = 5 r 0
5%2 = 2 r 1
2%2 = 1 r 0
1%2 = 0 r 1

=> $(+10)_{10}$ = 01010

=> Flip => 10101
add 1 => 10110 => $(-10)_{10}$

a) A+B = (-12) + (-10)

=>
```
   10100
 + 10110
 -------
 1 01010
```

b) A-B = (-12) - (-10)

=>
```
   10100
 - 10110
 -------
   10000
```
Need to borrow.

c) $-A + B = -(-12) + (-10) \Rightarrow (-10) - (-12)$

$$\begin{array}{r} 10110 \\ -\ 10100 \\ \hline 00010 \end{array} \qquad \begin{array}{r} -10 \\ +12 \\ \hline 2 \end{array}$$

d) $-A + B = -(-12) - (-10) = 12 + 10$

$12 = 01100$
$10 = 01010$

$$\Rightarrow \begin{array}{r} 01100 \\ 01010 \\ \hline 10110 \end{array} \qquad \begin{array}{r} 12 \\ +10 \\ \hline 22 \end{array}$$

Question 4:

a) Arithmetic Shift: the bits that are shifted out of their ends are discarded.

Logical Shift: Zero's are shifted in to replace discarded bits

Rotational Shift: the bits are rotated as if the left and right ends of the register were joined.

b) 1) Arithmetic shift left might cause an overflow.
2) To Preserve MSB of a binary string.

c) Using arethmetic shift right for signed #'s.

ex: 1000 = -8 => shift right
=> 10100 = -12
↑
must add

We must add a "1" in the MSB to keep the # a signed value (-). This results in a totally different value.