Assignment #2

Assuming 8-bit binary values including the sign bit, give the a) signed magnitude, b) 1s complement, and c) 2s complement values for each of the following decimal numbers:

1. -37
2. +16

The following 8-bit binary values include the sign bit, give the decimal value assuming the following value is a) signed magnitude, b) 1s complement, and c) 2s complement.

3. 10100101
4. 01011010

Perform the following subtractions using 2s complement addition with 8-bit binary values including the sign bit:

5. 37-16
6. 16-37
7. -37-16

Solutions to Assignment #2

1. -37

converting decimal magnitude to binary

37/2 = 18 remainder = 1 (LSB)
18/2 = 9 remainder = 0
9/2 = 4 remainder = 1
4/2 = 2 remainder = 0
2/2 = 1 remainder = 0
1/2 = 0 remainder = 1 (MSB)

$+37_{10} = 00100101_2$ (note sign bit is 0 for positive 37)

$-37_{10} = 10100101_2$ (signed magnitude)
$-37_{10} = 11011010_2$ (1s complement)
$-37_{10} = 11011011_2$ (2s complement)

2. +16

converting decimal magnitude to binary

16/2 = 8 remainder = 0 (LSB)
8/2 = 4 remainder = 0
4/2 = 2 remainder = 0
2/2 = 1 remainder = 0
1/2 = 0 remainder = 1 (MSB)

$+16_{10} = 00010000_2$ (since the number is positive there is nothing left to do)

$+16_{10} = 00010000_2$ (signed magnitude)
$+16_{10} = 00010000_2$ (1s complement)
$+16_{10} = 00010000_2$ (2s complement)

3. 10100101

signed magnitude: invert SB and convert to decimal

$00100101_2 = 1\times2^5 + 0\times2^4 + 0\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0$
$= 32 + 4 + 1 = 37_{10}$

10100101 (signed magnitude) = -37_{10}

1s complement: invert all bits and convert to decimal

$01011010_2 = 1\times2^6 + 0\times2^5 + 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 0\times2^0$
$= 64 + 16 + 8 + 2 = 90_{10}$

10100101 (1s complement) = -90_{10}

2s complement: invert all bits and add 1, then convert to decimal

$01011011_2 = 1\times2^6 + 0\times2^5 + 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0$
$= 64 + 16 + 8 + 2 + 1 = 91_{10}$

10100101 (2s complement) = -91_{10}

4. 01011010

the number is positive (SB=0) so we only need to convert to decimal

$01011010_2 = 1\times2^6 + 0\times2^5 + 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 0\times2^0$
$= 64 + 16 + 8 + 2 = 90_{10}$

01011010 (signed magnitude) = $+90_{10}$
01011010 (1s complement) = $+90_{10}$
01011010 (2s complement) = $+90_{10}$

For problems 5-7, we first obtain the 8-bit positive binary values for +37 and +16

+37 = 00100101
+16 = 00010000

Next obtain the 2s complement for the negative numbers

-37 = 11011011
-16 = 11110000

5. 37-16 (= 21)

```
 111000000 carry
  37   00100101
 -16   11110000
 100010101
```

↑SB=0 therefore positive number we only need to convert to decimal

$00010101_2 = 21_{10}$

6. 16-37 (= -21)

```
 000100000 carry
  16   00010000
 -37   11011011
 011101011
```

↑SB=1 therefore negative number perform 2s complement transformation & convert to decimal

2s complement of 11101011 is 00010101 = 21_{10}

$11101011_2 = -21_{10}$

7. -37-16 (= -53)

```
 111100000 carry
 -37   11011011
 -16   11110000
 111001011
```

↑SB=1 therefore negative number perform 2s complement transformation & convert to decimal

2s complement of 11001011 is 00110101 = 53_{10}

$11001011_2 = -53_{10}$