Homework Assignment #5 - SOLUTIONS

Assigned Thursday, February 24, 2005
Due Thursday, March 3, 2005

(Note – Solutions are posted on the course web site after the due date)

1. (10 pts) Do problem 5.1 in the Brown & Vranesic textbook.

(a) 478
(b) 743
(c) 2025
(d) 41567
(e) 61680

2. (15 pts) Do problem 5.3 in the Brown & Vranesic textbook.

(a) 478
(b) –281
(c) –2

3. (15 pts) Do problem 5.5 in the Brown & Vranesic textbook.

In these problems, you are dealing with 8-bit two's complement numbers. The result must also be an 8-bit two's complement number. Therefore, we discard any carry out bit or borrow out bit of the most significant bit.

```
(a)     00110110              54
       +01000101             +69
      ---------------        ----
        01111011             123

(b)     01110101             117
       +11011110             -34
      ---------------        ----
        01010011              83

(c)     11011111           (-33)
       +10111000          +(-72)
      ---------------        ----
        10010111            -105

(d)     00110110              54
       -00101011             -43
      ---------------        ----
        00001011              11

(e)     01110101           (117)
       -11010110          -(-42)
      ---------------        ----
        10011111           (159)
```

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(f)      11010011              (-45)
        -11101100             -(-20)
       ---------------          ----
         11100111              (-25)
```

Arithmetic overflow occurs in example e; note that the pattern 10011111 represents –97 rather than +159.

4. (15 pts) Do problem 5.7 in the Brown & Vranesic textbook.

In the circuit of Figure 5.5b, we have:

$$
\begin{aligned}
s_i &= (x_i \oplus y_i) \oplus c_i \\
&= x_i \oplus y_i \oplus c_i \\
c_{i+1} &= (x_i \oplus y_i) \oplus c_i + x_i y_i \\
&= (\bar{x}_i y_i + x_i \bar{y}_i) c_i + x_i y_i \\
&= \bar{x}_i y_i c_i + x_i \bar{y}_i c_i + x_i y_i \\
&= y_i c_i + x_i c_i + x_i y_i
\end{aligned}
$$

The expressions for s_i and c_{i+1} are the same as those derived in Figure 5.4b.

5. (15 pts) Fill in the unknown x's in the following equations. Assume all numbers are unsigned.

xxx_{10}	**$= xxxxxx1101_2$**	**$= 12x_{16}$**	**$= 4xx_8$**
xxx_{10}	**$= xxxxxxxxxx_2$**	**$= x6x_{16}$**	**$= 142_8$**
511_{10}	**$= xxxxxxxxxx_2$**	**$= xFx_{16}$**	**$= x7x_8$**
$2xx_{10}$	**$= 0x0x0x0x0x_2$**	**$= x0x_{16}$**	**$= xx0_8$**
456_{10}	**$= xxx100xxxx_2$**	**$= xxx_{16}$**	**$= xx0_8$**

301_{10}	$= 0100101101_2$	$= 12D_{16}$	$= 455_8$
98_{10}	$= 0001100010_2$	$= 062_{16}$	$= 142_8$
511_{10}	$= 0111111111_2$	$= 1FF_{16}$	$= 777_8$
256_{10}	$= 0100000000_2$	$= 100_{16}$	$= 400_8$
456_{10}	$= 0111001000_2$	$= 1C8_{16}$	$= 710_8$

6. (15 pts) Take the binary number B = 10101001.
(a) If B is an unsigned number, what is its decimal value?
(b) If B is a signed-magnitude number, what is its decimal value?
(c) If B is an 8-bit, two's complement number, what is its decimal value?
(d) Assume B is an 8-bit, two's complement number. Extend B to 16 bits; that is, write its equivalent value as a 16 bit two's complement number.
(e) If B is an 8-bit, two's complement number, write –B as an 8-bit, two's complement number.

(a) B = 128+0+32+0+8+0+0+1 = 169_{10}
(b) B = -(32+0+8+0+0+1) = -41_{10}
(c) B = -128+0+32+0+8+0+0+1 = -87_{10}
(d) B = 1111 1111 1010 1001 (i.e., just extend the sign bit to the left)
(e) To negate B, flip all the bits and add 1: -B = 01010111

7. (15 pts) Consider the decimal number -63. Express this number as a 9-bit two's complement binary number, a 9-bit one's complement number, and a 9-bit signed magnitude number.

+63 = 0 0011 1111

As a 9-bit two's complement binary number (just flip all the bits and add 1):
-63 = 1 1100 0001

As a 9-bit one's complement number (just flip all the bits):
-63 = 1 1100 0000

As a 9-bit signed magnitude number:
-63 = 1 0011 1111