Solutions - Quiz 2

(October 10th @ 5:30 pm)

PROBLEM 1 (35 PTS)

- Complete the following table. Use the fewest number of bits in each case:

REPRESENTATION			
Decimal	**Sign-and-magnitude**	**1's complement**	**2's complement**
-11	11011	10100	10101
-32	1100000	1011111	100000
-4	1100	1011	100
30	011110	011110	011110

- Convert the following decimal number to its 2's complement representation: -14.25 (5 pts)

  $14.25 = 01110.01 \rightarrow -14.25 = 10001.11_2$

PROBLEM 2 (30 PTS)

- Perform the following operations in the 2's complement representation, i.e., provide the summands and the result in 2's complement representation. Use the minimum number of bits to represent both the summands and the result so that the overflow bit is 0.

✓ -11 + 16

n = 6 bits

$c_6 \oplus c_5 = 0$
No Overflow

	c_6=1	c_5=1	c_4=0	c_3=0	c_2=0	c_1=0	c_0=0
-11 =	1	1	0	1	0	1	+
16 =	0	1	0	0	0	0	
5 =	0	0	0	1	0	1	

$-11+16 = 5 \in [-2^5, 2^5-1] \rightarrow$ no overflow

✓ -30 - 14

n = 6 bits

$c_6 \oplus c_5 = 1$
Overflow!

	c_6=1	c_5=0	c_4=0	c_3=0	c_2=1	c_1=0	c_0=0
-30 =	1	0	0	0	1	0	+
-14 =	1	1	0	0	1	0	
-44 =	0	1	0	1	0	0	

$-30\ -14 = -44 \notin [-2^5, 2^5-1] \rightarrow$ overflow!

To avoid overflow:
n = 7 bits (sign-extension)

$c_7 \oplus c_6 = 0$
No Overflow

	c_7=1	c_6=1	c_5=0	c_4=0	c_3=0	c_2=1	c_1=0	c_0=0
-30 =	1	1	0	0	0	1	0	+
-14 =	1	1	1	0	0	1	0	
-44 =	1	0	1	0	1	0	0	

$-30\ -14 = -44 \in [-2^6, 2^6-1] \rightarrow$ no overflow

PROBLEM 3 (35 PTS)

- Complete the timing diagram of the circuit shown below: