Solutions - Quiz 2

(October 4th @ 5:30 pm)

PROBLEM 1 (35 PTS)

▪ Complete the following table. Use the <u>fewest</u> number of bits in each case:

REPRESENTATION			
Decimal	**Sign-and-magnitude**	**1's complement**	**2's complement**
−21	110101	101010	101011
−16	110000	101111	10000
−31	111111	100000	100001
32	0100000	0100000	0100000

▪ Convert the following decimal number to its 2's complement representation: −17.375 (5 pts)

$17.375 = 010001.011_2 \rightarrow -17.375 = 101110.101_2$

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.

✓ −17 + 32

n = 7 bits
$c_7 \oplus c_6 = 0$
No Overflow

$c_7=1$ $c_6=1$ $c_5=0$ $c_4=0$ $c_3=0$ $c_2=0$ $c_1=0$ $c_0=0$

```
 -17 = 1 1 0 1 1 1 1 +
  32 = 0 1 0 0 0 0 0
 ─────────────────────
  15 = 0 0 0 1 1 1 1
```

$-17 + 32 = 15 \in [-2^6, 2^6-1] \rightarrow$ no overflow

✓ −31 −15

n = 6 bits
$c_6 \oplus c_5 = 1$
Overflow!

$c_6=1$ $c_5=0$ $c_4=0$ $c_3=0$ $c_2=1$ $c_1=0$ $c_0=0$

```
 -31 = 1 0 0 0 0 1 +
 -15 = 1 1 0 0 0 1
 ─────────────────
 -46 = 0 1 0 0 1 0
```

$-31 -15 = -46 \notin [-2^5, 2^5-1] \rightarrow$ overflow!

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

$c_7 \oplus c_6 = 0$
No Overflow

$c_7=1$ $c_6=1$ $c_5=0$ $c_4=0$ $c_3=0$ $c_2=0$ $c_1=1$ $c_0=0$

```
 -31 = 1 1 0 0 0 0 1 +
 -15 = 1 1 1 0 0 0 1
 ─────────────────────
 -46 = 1 0 1 0 0 1 0
```

$-31 -15 = -46 \in [-2^6, 2^6-1] \rightarrow$ no overflow

PROBLEM 3 (35 PTS)

▪ Complete the timing diagram of the circuit shown below:

z=0 when P=0000