

# Solutions - Quiz 2

(October 11<sup>th</sup> @ 5:30 pm)

## PROBLEM 1 (40 PTS)

- Complete the following table:

REPRESENTATION			
Decimal	Sign-and-magnitude	1's complement	2's complement
5	0101	0101	0101
-8	11000	10111	1000
-4	1100	1011	100
-9	11001	10110	10111

- Convert the following decimal number to its 2's complement representation: -9.25 (5 pts)

$$+9.25 = 01001.01_2 \rightarrow -9.25 = 10110.11_2$$

## PROBLEM 2 (20 PTS)

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

$$\checkmark -15 - 9$$

n = 5 bits

 $c_5 \oplus c_4 = 1$   
 Overflow!

 $\begin{array}{ccccccc} \text{Carry} & 1 & 0 & 1 & 1 & 1 & 0 \\ \text{Summand} & 1 & 0 & 0 & 0 & 1 & + \\ & 1 & 0 & 1 & 1 & 1 & \\ \hline & 0 & 1 & 0 & 0 & 0 & \end{array}$ 

$$-15 = 1\ 0\ 0\ 0\ 1\ +$$

$$-9 = 1\ 0\ 1\ 1\ 1$$

$$-24 = 0\ 1\ 0\ 0\ 0$$

$$-15 - 9 = -24 \notin [-2^4, 2^4-1] \rightarrow \text{overflow!}$$

To avoid overflow:

n = 6 bits (sign-extension)

 $c_7 \oplus c_6 = 0$   
 No Overflow

 $\begin{array}{ccccccc} \text{Carry} & 1 & 1 & 0 & 1 & 1 & 0 \\ \text{Summand} & 1 & 1 & 0 & 0 & 0 & 1 & + \\ & 1 & 1 & 0 & 1 & 1 & 1 & \\ \hline & 1 & 0 & 1 & 0 & 0 & 0 & \end{array}$ 

$$-15 = 1\ 1\ 0\ 0\ 0\ 1\ +$$

$$-9 = 1\ 1\ 0\ 1\ 1\ 1$$

$$-24 = 1\ 0\ 1\ 0\ 0\ 0$$

$$-15 - 9 = -24 \in [-2^5, 2^5-1] \rightarrow \text{no overflow}$$

## PROBLEM 3 (40 PTS)

- Complete the timing diagram of the circuit shown below:  $y = y_3y_2y_1y_0$ ,  $x = x_1x_0$

