Solutions - Quiz 2
(October 9th @ 5:30 pm)

PROBLEM 1 (40 pts)
- Complete the following table:

<table>
<thead>
<tr>
<th>REPRESENTATION</th>
<th>Decimal</th>
<th>Sign-and-magnitude</th>
<th>1's complement</th>
<th>2's complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td>0101</td>
<td>0101</td>
<td>0101</td>
</tr>
<tr>
<td>-8</td>
<td></td>
<td>11000</td>
<td>10111</td>
<td>1000</td>
</tr>
<tr>
<td>-4</td>
<td></td>
<td>1100</td>
<td>1011</td>
<td>100</td>
</tr>
<tr>
<td>-9</td>
<td></td>
<td>11001</td>
<td>10110</td>
<td>10111</td>
</tr>
</tbody>
</table>

- 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 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.

\[ \begin{align*}
n & = 5 \text{ bits} \quad \text{n = 5 bits} \\
\text{Overflow!} & = 1 \ 0 \ 0 \ 0 \ 1 + \\
-15 & = 1 \ 0 \ 0 \ 0 \ 1 + \\
-9 & = 1 \ 0 \ 1 \ 1 \ 1
\end{align*} \]

\[ -15 - 9 = -24 \not\in [-2^4, 2^4-1] \rightarrow \text{overflow!} \]

To avoid overflow:

\[ \begin{align*}
\text{n = 6 bits (sign-extension)} \quad \text{n = 6 bits (sign-extension)} \\
\text{No Overflow} & = 1 \ 1 \ 0 \ 0 \ 0 \ 1 + \\
-15 & = 1 \ 1 \ 0 \ 0 \ 0 \ 1 + \\
-9 & = 1 \ 1 \ 0 \ 1 \ 1 \ 1
\end{align*} \]

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

PROBLEM 3 (40 pts)
- Complete the timing diagram of the circuit shown below: \( y = y_3y_2y_1y_0, x = x_1x_0 \)

\[ \begin{align*}
\text{Unknown} \quad \text{Unknown} \\
\text{Unknown} \quad \text{Unknown}
\end{align*} \]