ECE 3170 - Microcontroller Applications

Assignment #1 - Prerequisite Assessment

10pts, due Monday, Sept. 15, 2008

- Calculators are not allowed for the problems
- You must show all the intermediate steps to receive full credit.
- If additional space is needed, use the back of the page.
- This exam comprises about 5% of your final EE3170 grade.

1. One way to minimize logic function is to use CAD tools. Give 2 other methods of logic minimization.
   (\text{WinTs})
   (a) \underline{\text{K-Map}} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }}
   (b) \underline{\text{Boolean Algebra}} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }}

2. Give 3 methods of representing signed binary numbers.
   (\text{WinTs})
   (a) \underline{\text{1’s Complement}} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }}
   (b) \underline{\text{2’s Complement}} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }}
   (c) \underline{\text{Sign-Magnitude}} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }} \underline{\text{ }}

3. Fill in the truth table for a D flip-flop shown below

\begin{array}{c|c|c}
D & Q(t+1) \\
\hline
0 & 0 \\
1 & 1 \\
\end{array}

\begin{circuitikz}
\draw (0,0) to [short] (1,0) to [short] (1,1) to [short] (0,1) to cycle;
\node at (0.5,0) {D};
\node at (0.5,1) {Q};
\node at (1.5,0) {$\overline{Q}$};
\end{circuitikz}
4. Draw the schematic of a four-bit register with D-flip-flops.

**Number Representation** (10 points for each question below)

5. Write each of the following expressions as a decimal number. Show intermediate steps where necessary.

   (a) \[2D_{10} = 2 \times 16 + 13 = 45_{10}\]

   (b) \[ABE_{10} = 10 \times 16^2 + 11 \times 16 + 14 = 2750_{10}\]

6. Convert decimal -78 into an 8-bits

   (a) signed magnitude binary number
   \[78_{10} = 64 + 8 + 4 + 2 = 01001110_2\]
   \[-78_{10} = 11001110_2\]

   (b) 2’s complement binary number
   2’s complement binary number for +78 is 01001110
   2’s complement binary number for -78 is 10110001 + 1 = 10110010

7. Give the decimal equivalent of binary number 11001101 if it represents

   (a) a unsigned binary number
   \[2^7 + 2^6 + 2^3 + 2^2 + 1 = 128 + 64 + 8 + 4 + 1 = 205_{10}\]

   (b) a signed magnitude binary number
   \[-(2^6 + 2^3 + 2^2 + 1) = -(64 + 8 + 4 + 1) = -77_{10}\]

   (c) a 2’s complement binary number
   Complement each bit: 00110010
   Add 1: 00110011
   Decimal equivalent: -51_{10}
Perform the following arithmetic operations. For binary numbers, assume two’s complement representation. Show all the intermediate steps.

(a) \(01101110_2 (6_{10}) + 00111110_2 (62_{10}) = 10101100 (172_{10})\)

(b) \(11100101_2 (-27_{10}) - 01110011_2 (113_{10}) = 11100101 (-27_{10}) + 10001101 (115_{10}) = 101110010 (-132_{10})\)

**Combinational Logic**

(10 Points)

Draw a logic diagram (using gates) of a binary half adder. Show all the inputs and outputs. Fill out the truth table of the circuit.

\[S = X_1 \oplus X_2\]
\[C = X_1 \cdot X_2\]

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Carry</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1 X2</td>
<td>Carry</td>
<td>Sum</td>
<td></td>
</tr>
<tr>
<td>0 0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>0 1</td>
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<td>1 0</td>
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**Synchronous Sequential Logic Design**

(10 Points)

Draw the state transition diagram for a finite state machine which will recognize (i.e. output a logical one) when the single input completes the sequence 10011. Use a Moore FSM (i.e. one which has outputs associated with the state and independent of the inputs).

\[F = \bar{X}_1 X_1\]
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\[R_1 = 0\]
\[R_2 = X_1\]
\[R_3 = \bar{X}_1\]
\[R_4 = \bar{X}_1 \bar{X}_1\]
\[R_5 = X_1 \bar{X}_1\]
\[R_6 = X_1 \bar{X}_1\]

\[S = 0\]
\[S = 1\]
\[S = 1\]
\[S = 0\]
\[S = 2\]
\[S = 2\]
\[S = 1\]
PreRequisite Class (You can’t get this one wrong unless you don't fill it out.)

(a) Year and Semester you took EE 2171 (or its equivalent): ____________________.

(b) Instructor: ____________________.

(c) Textbook: ____________________.

(d) What topic from EE 2171 was/is the most confusing for you?