Last (Family) Name: ________________
First (Given) Name: ________________
Student ID: ________________

Instructor (circle one): Thomas Kaminski, Yu Hen Hu

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University of Wisconsin - Madison

ECE/Comp. Sci. 352 – Digital System Fundamentals

Quiz # 1
Thursday, September 28, 2000 Duration: 75 minutes

• Closed Book in-class Examination
• Enter answers in the box given.
• No calculator or hand-held, laptop computers allowed.

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<thead>
<tr>
<th>PROBLEM</th>
<th>POINTS</th>
<th>SCORE</th>
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<td>TOTAL</td>
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1. (30 points) base conversion, arithmetics, binary code

(a) (6 points) Convert the following decimal number to radix 5 representation

\[(23.44)_{10} = (\underline{\hspace{6cm}})_{5}.
\]

(b) (6 points) Convert \(11.33_8\) to \((A)_{16}\).

\[A = (\underline{\hspace{6cm}})_{16}.
\]

(c) (6 points) Find the radix \(r\) that satisfies the following equation:

\[(16)_{r} \times (19)_{r} = (28.A)_{r}\]

Answer: \(r = \underline{\hspace{6cm}}\)
(d) (6 points) Perform the following arithmetic operations with the specified radices:

\[(AA)_{16} \times (BB)_{16} = (\_\_\_\_\_\_)_{16}\]

(e) (6 points) BCD Code

The result of a BCD addition is 4578. It is known that carries occurred from the positions of digit 7 and digit 5. What were the binary values of the sums before the correction including the value of the carry?

Answer: \_\_\_\_\_\_.

2. (20 points) Boolean Algebra

(a) (5 points) Find the dual expression of the following Boolean identity:

\[ XY + \overline{X}Z + YZ = XY + \overline{X}Z \]

Answer: 

(b) (5 points) Find the complement of the following Boolean expression

\[ AB + \overline{A} \cdot \overline{B} \]

The result must be in SOP format.

Answer: 

(c) (5 points) Simplify the following Boolean function into POS (product of sum) format using minimum number of literals:

\[ f(a, b, c) = \prod(2, 4, 6) \]

Answer: \[ f(a, b, c) = \]

(d) (5 points) Give the Karnaugh map of the Boolean function below:

\[ g(w, x, y, z) = (\overline{w} + y + z)(w + \overline{x} + \overline{y})(x + \overline{z}) \]

\[
\begin{array}{c|cccc}
  \text{wx} & 00 & 01 & 11 & 10 \\
  \hline
  00 & & & & \\
  01 & & & & \\
  11 & & & & \\
  10 & & & & \\
\end{array}
\]
3. (15 points)

(a) (7 points) The following is a Boolean conditional statement. Determine whether this statement is TRUE or FALSE. If it is deemed as a TRUE statement, give a concise explanation. If it is deemed as a FALSE statement, give a counter example. **Answer alone without explanation or a counter example will not receive ANY credit.**

If $A \cdot B = 1$, then $\overline{AD} + \overline{BD} + A\overline{B\overline{D}} + \overline{B} \cdot \overline{C} + A\overline{C} \cdot \overline{D} = \overline{D}$.

**Answer:** (circle one) **TRUE  FALSE**

**Explanation:**

(b) (8 points) Denote $A$, $B$ to be known Boolean variables and $f(A, B)$ an unknown Boolean function. Solve for **ALL distinct** solutions of the following Boolean equation

$$(A + B) \cdot f(A, B) = B$$

Give your answer(s) in the *product of maxterm* format. Hint: A truth table may help.

**Answer:** $f(A, B) =$

\[ \Box \]
4. (15 points) Boolean expressions

(a) (10 points) Find the sum-of-minterm format of the boolean function

\[ F(A, B, C, D) = (A + B)(\overline{A} + C)(B + D) \]

**Answer:** \[ F(A, B, C, D) = \Sigma( \quad ) \]

(b) (5 points) Implement

\[ g(w, x, y, z) = (w \cdot \overline{y} + x)(\overline{x} + \overline{w}z) + wxy \]

using AND, OR, and NOT logic gates. Assume that the complements of these four Boolean variables have been made available. Do not simplify or modify above Boolean function.
(a) (10 points) If $\overline{a} \overline{b} \overline{c}$ and $\overline{a} \cdot \overline{c} \cdot \overline{d}$ are both in the set of essential prime implicants (EPI) of a certain Boolean function $f(a, b, c, d)$. Which of the following product term(s) definitely can NOT be a prime implicant (PI) of $f(a, b, c, d)$ (Place an X in the X box)? Explain each answer (the one you mark with X) briefly. No grade will be given without explanation. Hint: Use a Karnaugh map.

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<tr>
<th>Product Term</th>
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<th>Brief Explanations</th>
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<tr>
<td>$\overline{b} \overline{c} \overline{d}$</td>
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More space for explanations:
(b) (10 points) Simplify the following Boolean function with don’t care terms into SOP (sum of product) format using minimum number of literals:

\[ f(w, x, y, z) = \sum m(2, 3, 4, 5, 6, 8, 11), \quad d(w, x, y, z) = \sum m(7, 9, 14) \]

Answer: \( f(w, x, y, z) = \)