Problem 1 (20 points):

In each case, create a switch level implementation for F using n-type and p-type transistors. Assume that both the inputs and their complements are available. Your design should contain no shorts and no floats.

a) \( F = \overline{A}B + A\overline{B} \)

b) \( F = A + \overline{B}CD \)
Problem 2 (30 Points):

Implement the following logical expressions using a gate level design. Use mixed logic for the design procedure. In each case, state the number of transistors used for the design.

a) $F = \overline{AB(C + AD)}$, implement using NAND gates and NOT gates

b) $F = (X + Y)WZ$, implement using NOR gates and NOT gates

$4 \times 4T + 4 \times 2T = 24T$

$3 \times 4T + 4 \times 2T = 20T$
Problem 3 (30)

Use a Karnaugh map to find the simplest SOP expression for each of the following expressions.

a) \( F(A,B,C,D) = \Sigma m(0,1,3,5,7,9,11,12,14) \)

\[
\begin{array}{c|c|c|c|c}
& 00 & 01 & 11 & 10 \\
\hline
00 & \text{1} & \text{1} & \text{1} & \text{1} \\
01 & \text{1} & \text{1} & \text{1} & \text{1} \\
11 & \text{1} & \text{1} & \text{1} & \text{1} \\
10 & \text{1} & \text{1} & \text{1} & \text{1} \\
\end{array}
\]

Prime Implicant | Essential?
--- | ---
\( \overline{BC} \) | \( Y \)
\( \overline{AC} \) | \( Y \)
\( \overline{AB} \) | \( N \)

Simplified SOP: \( \overline{BC} + \overline{AC} \)

b) \( F(A,B,C,D) = \Sigma m(1,3,4,5,6,7,9,11,12,13,14,15) \)

\[
\begin{array}{c|c|c|c|c}
& 00 & 01 & 11 & 10 \\
\hline
00 & \text{1} & \text{1} & \text{1} & \text{1} \\
01 & \text{1} & \text{1} & \text{1} & \text{1} \\
11 & \text{1} & \text{1} & \text{1} & \text{1} \\
10 & \text{1} & \text{1} & \text{1} & \text{1} \\
\end{array}
\]

Prime Implicant | Essential?
--- | ---
\( B \) | \( Y \)
\( \overline{AB} \) | \( Y \)

Simplified SOP: \( B \lor \overline{AB} \)
c) \( F(A,B,C,D) = \Sigma m(2,3,7,10) \)

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<tr>
<th>AB</th>
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Prime Implicant

- \( \overline{A} \overline{B} \overline{C} \)
- \( BCD \)
- \( \overline{A} \overline{C} \overline{D} \)

Essential?

- \( Y \)
- \( N \)
- \( Y \)

Simplified SOP:

\( \overline{A} \overline{B} \overline{C} + A \overline{C} \overline{D} \)
Problem 4 (21 Points):

Perform the following conversions:

\[
\begin{align*}
110101_2 &= \frac{53}{32 + 16 + 4 + 1} \\
01101010_2 &= \frac{35}{3} \\
7C_{16} &= \text{011111000100}_2 \\
35F_{16} &= \frac{863}{10} \\
184_{10} &= \text{10110000}_2 \\
110110.101_2 &= \frac{36.4}{8} \\
110110.101_2 &= \frac{546.25}{10}
\end{align*}
\]
Problem 1 (20 points):

In each case, create a switch level implementation for $F$ using n-type and p-type transistors. Assume that both the inputs and their complements are available. Your design should contain no shorts and no floats.

a) $F = \overline{ABC}$

b) $F = AB(C + \overline{D})$

(a) $F = \overline{A} + \overline{B} + C$

(b) $F = AB \overline{C} \overline{D}$
Problem 2 (30 Points):

Implement the following logical expressions using a gate level design. Use mixed logic for the design procedure. In each case, state the number of transistors used for the design.

a) $F = A + B(C + AD)$, implement using NAND gates and NOT gates

b) $F = \overline{XY} + WZ$, implement using NOR gates and NOT gates

\[
\begin{align*}
\text{a) } & \quad 4 \times 4T + 7 \times 2T = 30T \\
\text{b) } & \quad 3 \times 4T + 4 \times 2T = 20T
\end{align*}
\]
Problem 3 (30)

Use a Karnaugh map to find the simplest SOP expression for each of the following expressions.

a) \( F(A,B,C,D) = \Sigma m(0,1,2,3,9,11,12,14) \)

\[
\begin{array}{cccc}
\text{CD} & 00 & 01 & 11 & 10 \\
\hline
\text{AB} & 00 & \circ & \circ & \circ \\
 & 01 & \circ & \circ & \\
 & 11 & \circ & \\
 & 10 & \circ & \\
\end{array}
\]

Prime Implicant | Essential?
---|---
\( \overline{BD} \) | \( \checkmark \)
\( \overline{AB} \) | \( \checkmark \)
\( \overline{A} \) | 
\( \overline{B} \) | 

Simplified SOP: \( F = \overline{B}D + \overline{A} \overline{B} \)

b) \( F(A,B,C,D) = \Sigma m(1,3,4,5,6,7,9,11,12,13,14,15) \)

\[
\begin{array}{cccc}
\text{CD} & 00 & 01 & 11 & 10 \\
\hline
\text{AB} & 00 & \circ & \circ & \circ \\
 & 01 & \circ & \circ & \\
 & 11 & \circ & \\
 & 10 & \circ & \\
\end{array}
\]

Prime Implicant | Essential?
---|---
\( D \) | \( \checkmark \)
\( B \) | \( \checkmark \)

Simplified SOP: \( F = D + B \)
c) \( F(A, B, C, D) = \Sigma m(2, 3, 7, 10) \)

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<tr>
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Prime Implicant

<table>
<thead>
<tr>
<th>Prime Implicant</th>
<th>Essential?</th>
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<tr>
<td>( \overline{A}BC )</td>
<td>( N )</td>
</tr>
<tr>
<td>( \overline{A}CD )</td>
<td>( Y )</td>
</tr>
<tr>
<td>( \overline{B}CD )</td>
<td>( Y )</td>
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</tbody>
</table>

Simplified SOP: \( F = \overline{A}CD + \overline{B}CD \)
Problem 4 (21 Points):

Perform the following conversions:

\[ 101101_2 = \frac{45}{10} \]

\[ 110111_2 = 37 \]

\[ 7B_{16} = 0111\ 1011\ 0011 \]

\[ 35F_{16} = 863 \]

\[ 143_{10} = 10001\ 111 \]

\[ 111110,101_2 = 3E.A_{16} \]

\[ 111110,101_2 = 62.625_{10} \]

\[ 32 \]

\[ 8 \]

\[ 4 \]

\[ 2 \]

\[ 6.2 \]

\[ 32 \]

\[ 16 \]

\[ 8 \]

\[ 4 \]

\[ 2 \]

\[ 6.25 \]

\[ 0.125 \]

\[ \frac{5}{15} \]

\[ \frac{-8}{7} \]

\[ \frac{-4}{3} \]

\[ \frac{-2}{1} \]