EECS 281: Homework #5 Due: Tuesday, October 26, 2004

Name: ___________________________ Email: ___________________________

0. Practice, study (do not hand in) Wakerly problems (solutions at www.wakerly.com): 4.13(a) and 4.13(b).

1a. Apply T13 & T4 to the expression \( \overline{a} \overline{b} \) resulting in:

1b. Apply T13 & T4 to the expression \( a \lor \overline{b} \lor \overline{c} \) resulting in:

1c. Apply T8 to the expression \( (a \lor b)(a \lor \overline{b}) \) resulting in (note: same as saying: \( (a + b)(a + \overline{b}) \)):

1d. Apply T8 to the expression \( (a \lor b)(a \lor \overline{b})(\overline{a} \lor b) \) resulting in:

1e. Given the minterms \( \sum_{abc}(1,2,4,7) \), write the DNF (i.e. SOP) expression:

1f. Give the maxterms of 1e: ___________________________

1g. Give the CNF (i.e. POS) expression of 1f (read Wakerly page 208):

1h. Draw the logic gate schematic of 1g:

2a. Give the truth table, minterms, and Maxterms for the following function \( f(a,b,c) = \overline{ab} \lor \overline{ac} \lor \overline{a} \):

<table>
<thead>
<tr>
<th>a b c</th>
<th>( \overline{ab} )</th>
<th>ac</th>
<th>( \overline{ab} \lor ac )</th>
<th>( \overline{ac} \lor \overline{a} )</th>
<th>( \overline{a} )</th>
<th>minterms</th>
<th>maxterms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 0 1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0 1 0</td>
<td></td>
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<tr>
<td>0 1 1</td>
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<tr>
<td>1 0 0</td>
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<tr>
<td>1 0 1</td>
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<tr>
<td>1 1 0</td>
<td></td>
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<tr>
<td>1 1 1</td>
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</tbody>
</table>

2b. Using boolean algebra (Wakerly page 199 Table 4-2, page 201, Table 4-3), give the DNF (i.e. SOP):

2b. Applying theorem T13’ on \( \overline{ab} \lor \overline{ac} \lor \overline{a} \), we now have __________________________

2b. Applying theorem T13, we now have __________________________

2b. Applying theorem T4, we now have __________________________

2b. Applying theorem T8’, we now have __________________________
2b. Factor out $\bar{a}$ and applying theorem T2, we now have _________________

2bbb. Applying theorem T1', we now have _________________
(note: Does 2bbb match the truth table of 2a?)

2c. Give the n-cubes for part 2bbb: _________________

2d. Give the minterms (i.e. 0-cubes or ON-set) for part 2bbb: _________________

2e. Did 2d match your truth table of 2a? __

2f. Fill in the k-map from 2bbb, showing circles of only the terms of 2bbb:

<table>
<thead>
<tr>
<th></th>
<th>$\bar{b}\bar{c}$</th>
<th>$bc$</th>
<th>$bc$</th>
<th>$\bar{b}\bar{c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{a}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2g. Give the optimal minimal SOP of 2f: _________________

2h. Give the Maxterms (i.e. OFF-set) from part 2d: _________________

2i. Give the CNF of 2h (i.e. canonical product, POS, see Wakerly, page 208): _________________

3a. Show by circling in the k-map each term in function $f(a, b, c) = \bar{a}\bar{b} \lor bc \lor ac \lor ab \lor \bar{c}\bar{b}$:

<table>
<thead>
<tr>
<th></th>
<th>$\bar{b}\bar{c}$</th>
<th>$bc$</th>
<th>$bc$</th>
<th>$\bar{b}\bar{c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{a}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td></td>
<td></td>
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</tbody>
</table>

3b. Show the optimal minimal circling in the k-map of 3a (Wakerly, page 223, Fig. 4-27, Fig. 4-29):

<table>
<thead>
<tr>
<th></th>
<th>$\bar{b}\bar{c}$</th>
<th>$bc$</th>
<th>$bc$</th>
<th>$\bar{b}\bar{c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{a}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3c. Give the Minimal SOP of the k-map: _________________

3d. Give the CNF (i.e POS) of 3c: _________________
4a Show by circling in the k-map each term in function \( f(a, b, c, d) = \overline{a} \overline{b} \overline{c} \lor \overline{b}c \lor bcd; \)

\[
\begin{array}{cccc}
\overline{a}b & \overline{b} & ab & \overline{a}b \\
\overline{a}b & \overline{b} & ab & \overline{a}b \\
ab & \overline{b} & ab & \overline{a}b \\
\overline{a}b & \overline{b} & ab & \overline{a}b \\
\end{array}
\]

4b Show the optimal minimal circling in the k-map of 4a:

\[
\begin{array}{cccc}
\overline{c}d & \overline{cd} & cd & \overline{cd} \\
\overline{a}b & \overline{b} & ab & \overline{a}b \\
\overline{a}b & \overline{b} & ab & \overline{a}b \\
ab & \overline{b} & ab & \overline{a}b \\
\end{array}
\]

4c. Give the Minimal SOP of the k-map: ____________________________

4d. Give the CNF (i.e POS) of 4c: ____________________________

4e. Give the minterms of the k-map in 4a: ____________________________

4f. Group the minterms of 4e by the number of 1’s:

4g. Do the Quine-McCluskey Algorithm in 4f.
5a Show the optimal k-map for $\sum_{a,b,c,d}(1, 2, 3, 5, 7)$:

\[
\begin{array}{cccc}
\bar{a}\bar{b} & \bar{c} & \bar{d} & \bar{c}\bar{d} & \bar{c}d & cd & \bar{c}d \\
\bar{a}b & & & & & & \\
ab & & & & & & \\
ab & & & & & & \\
ab & & & & & & \\
\end{array}
\]

5b. Give the Minimal SOP of the k-map: 

5c. Given the don’t cares (10,11,12,13,14,15), show the optimal k-map:

\[
\begin{array}{cccc}
\bar{a}\bar{b} & \bar{c} & \bar{d} & \bar{c}\bar{d} & \bar{c}d & cd & \bar{c}d \\
\bar{a}b & & & & & & \\
ab & & & & & & \\
ab & & & & & & \\
ab & & & & & & \\
\end{array}
\]

5d. Give the Minimal SOP of the k-map: 

5e. Do the Quine-McCluskey Algorithm of 5a only (not 5c):
6. A programmer as written the following C code fragment:
   
   ```c
   f=0;
   if (a & b) {
       if (c) { f=1; }
   } else if (b | c) { f=1; }
   ```

6a. Give the truth table for the variable f (assume that a, b, c are boolean values only):

6b. Give the optimal k-map of 6a.

```
   b\bar{c} | b c  | b\bar{c}  \\-------------------------
   \bar{a} | 0 0  | 1 1       \\
   a      | 0 1  | 0 1       
```

6c. Give the optimal minimum SOP:

6d. Re-write as optimal C code: