CS 207 Digital Logic - Spring 2019
Quiz 1

Monday, Mar. 11, 2019

Write down your answer to the questions with detailed procedures. Feel free to refer to the lecture notes. Discussion is allowed as long as not disturbing to others.

SUSTech SID: _____

1. Obtain the 1's and 2's complements of the following binary numbers:
   (a) 00010000
   (b) 11011010
   (c) 10000101

Solution:

1' complement of 00010000 is 11101111. 2' complement of 00010000 is 11110000.

1' complement of 11011010 is 00100101. 2' complement of 11011010 is 00100110.

1' complement of 10000101 is 01111010. 2' complement of 10000101 is 01111011.

2. Simplify the following Boolean expressions to a minimum number of literals:
   (a) $(a+b+c')(a'b'+c)$
   (b) $a'b'c+ab'c+abc+a'bc$
   (c) $(a+c)(a'+b+c)(a'+b'+c)$

Solution:

$(a+b+c')(a'b'+c) = aa'b'+ac+ba'b'+bc+c'a'b'+c'c = ac+bc+a'b'c'$

$a'b'c+ab'c+abc+a'bc = b'c+bc = c$

$$\begin{aligned}(a+c)(a'+b+c)(a'+b'+c) &= (ab+ac+a'c+bc+c)(a'+b'+c)\\ &= (ab+c)(a'+b'+c) = abc+a'c+b'c+c\\ &= abc+c(a'+b'+1) = c\end{aligned}$$

3. Express the following Boolean expressions in sum-of-minterms and product-of-maxterms form:
   (a) $(b+c'd)(a'+cd')$
   (b) $(ad+b'c+bd')(b+d)$

Solution:

$$
\begin{aligned}
(b + c'd)(a' + cd') &= a'b + bcd' + a'c'd + 0 \\
&= a'b(c + c')(d + d') + (a + a')bcd' + a'(b + b')c'd \\
&= \sum(1, 4, 5, 6, 7, 14) = \prod(0, 2, 3, 8, 9, 10, 11, 12, 13, 15) \\
(ad + b'c + bd')(b + d) &= abd + bd' + ad + b'cd \\
&= ab(c + c')d + (a + a')b(c + c')d' + a(b + b')(c + c')d + (a + a')b'cd \\
&= \sum(3, 4, 6, 9, 11, 12, 13, 14, 15) = \prod(0, 1, 2, 5, 7, 8, 10)
\end{aligned}
$$

4. Simplify the following Boolean functions, using Karnaugh maps:
   (a) $F(A, B, C, D) = \sum(1, 5, 9, 12, 13, 15)$
   (b) $F(w, x, y, z) = \sum(0, 2, 3, 8, 10, 11)$
   (c) $F(A, B, C, D) = A'B'C'D' + B'CD' + AC'D' + A'BCD + BC'D$

Solution:

$F(A, B, C, D) = \sum(1, 5, 9, 12, 13, 15) = C'D + ABC' + ABD$

$F(w, x, y, z) = \sum(0, 2, 3, 8, 10, 11) = x'y + x'z'$

$F(A, B, C, D) = A'B'C'D' + B'CD' + AC'D' + A'BCD + BC'D = B'D' + ABC' + A'BD$

5. Implement Boolean function $F(A, B, C, D) = \sum(1, 5, 8, 9, 10, 11, 12, 13, 15)$ using the following two-level forms of logic
   (a) AND-OR
   (b) NAND-NAND
   (c) OR-AND
   (d) NOR-NOR

Solution:

$$
\begin{aligned}
F(A, B, C, D) &= C'D + AB' + AC' + AD \\
&= ((C'D)'(AB')'(AC')'(AD)')' \\
F(A, B, C, D) &= (A + D)(A + C')(B' + C' + D) \\
&= ((A + D)' + (A + C')' + (B' + C' + D)')'
\end{aligned}
$$