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HW 10: Sum of Products and Karnaugh Maps (CS220-03)

For problems 1 through 3, write the (a) complete Sum of Products expression and (b) Sum of Products Minterm form expression equivalent to the logic in the truth table provided.

1)

A	B	X
0	0	1
0	1	0
1	0	1
1	1	1

X(A,B) = sum{0,2,3} =

$\overline{A}\overline{B} + A\overline{B} + AB$

2)

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

X(A,B,C) = sum{0,2,3,5,6,7} =

$\overline{A}\overline{B}\overline{C} + \overline{A}\overline{B}C + \overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$

3)

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

X(A,B,C) = sum{1,2,4,5,6,7} =

$\overline{A}\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\overline{C} + A\overline{B}C + AB\overline{C} + ABC$

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For problems 4 through 5, complete the truth table to be equivalent to the Sum of Products minterm form expression provided.

4) $X(A,B,C) = \sum_m\{0, 1, 3, 4, 6, 7\}$

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

5) $X(A,B,C,D) = \sum_m\{1, 3, 5, 7, 10, 11, 13, 14, 15\}$

A	B	C	D	X
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

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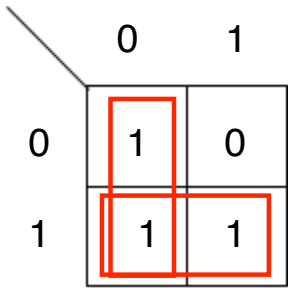
For the following logical functions (6 through 12), use the Karnaugh map and 1s looping to find a simplified equivalent Boolean expression

6)

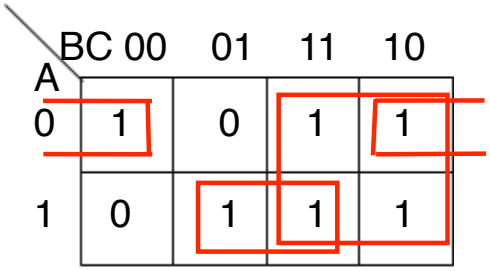
A	B	X
0	0	1
0	1	0
1	0	1
1	1	1



$x(A,B) = \overline{B} + A$

7)

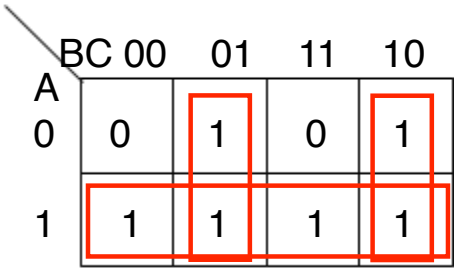
A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



$X(A,B,C) = \overline{AC} + AC + B$

8)

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1



$X(A,B,C) = A + \overline{BC} + B\overline{C}$

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9)

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

A \ BC	00	01	11	10
0	1	1	1	0
1	1	1	1	0

$X(A,B,C) = \overline{B} + BC$

10)

A	B	C	D	X
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

AB \ CD	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	1
10	0	0	1	1

$X(A,B,C,D) = \overline{A}D + ABD + AC$

11)

A	B	C	D	X
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

AB \ CD	00	01	11	10
00	0	1	0	0
01	1	1	0	1
11	1	1	0	1
10	0	1	0	0

$X(A,B,C,D) = B\overline{C} + \overline{BC}D + B\overline{C}$

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11) 'X' as output means that input minterm is impossible

A	B	C	D	Z
0	0	0	0	1
0	0	0	1	0
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1

A	B	C	D	Z
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	X
1	1	1	0	X
1	1	1	1	1

AB \ CD	00	01	11	10
00	1	0	0	X
01	0	0	1	1
11	1	X	1	X
10	1	0	0	0

$$X(A,B,C,D) = \overline{A}\overline{C}\overline{D} + AB + BC$$

12) Z(A,B,C,D) outputs a 1 for all prime 4-bit inputs. All multiples of 4 (including zero) and minterms 6, 10, and 14 are impossible.

AB \ CD	00	01	11	10
00	X	1	1	1
01	X	1	1	X
11	1	1	X	1
10	1	1	1	X

6 = 0110
10= 1010
14= 1111
0 = 0000
4 = 0100
8 = 0110

X(A,B,C,D) = n/a
since everything cancels out