CSE460: VLSI Design

Lecture 8: Logic Function Synthesis using k-map

Review: Logic Function Synthesis using k-map

- The Karnaugh map (or k-map) is an **alternative to the truth-table** form for representing a function
- The map consists of cells that correspond to the rows of the truth table

x_1	x_2	
0	0	m_0
0	1	m_1
1	0	m_2
1	1	m_3

x_2 \ x_1	0	1
0	m_0	m_2
1	m_1	m_3

x_1	x_2	x_3	
0	0	0	m_0
0	0	1	m_1
0	1	0	m_2
0	1	1	m_3
1	0	0	m_4
1	0	1	m_5
1	1	0	m_6
1	1	1	m_7

x_3 \ $x_1 x_2$	00	01	11	10
0	m_0	m_2	m_6	m_4
1	m_1	m_3	m_7	m_5

$x_3 x_4$ \ $x_1 x_2$	00	01	11	10
00	m_0	m_4	m_{12}	m_8
01	m_1	m_5	m_{13}	m_9
11	m_3	m_7	m_{15}	m_{11}
10	m_2	m_6	m_{14}	m_{10}

Logic Function Synthesis (SOP) using k-map

Consider a logic function, Y = f(A,B)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

- **Minterm (SOP)** - Group 2^n no. of 1 and skip 0. n = 0,1,2,3…. (Make groups larger as possible)
- Grouping can be square/rectangle shaped or along row/column (Not along diagonal). Groups can be overlapped.
- The inputs which are <u>varying</u> in a group, can be <u>omitted</u>. The others (**fixed**) can be written as **product** form. **Invert** the variables which are fixed with the value **0**.
- Don't cares (d) can be used 0/1 as per convenience.

K-map:

A \ B	**0**	**1**
0		
1		

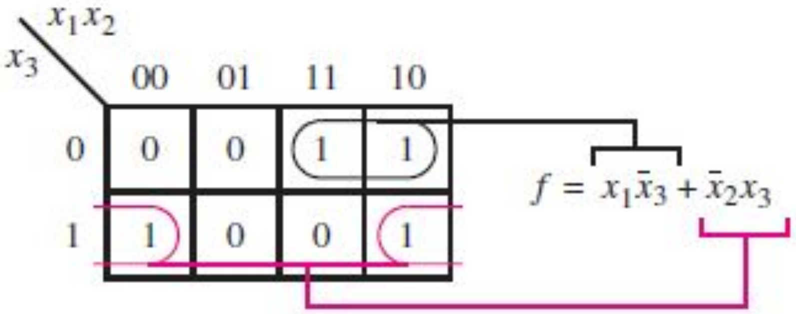
A omitted.
B fixed with 1.
Y = B

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

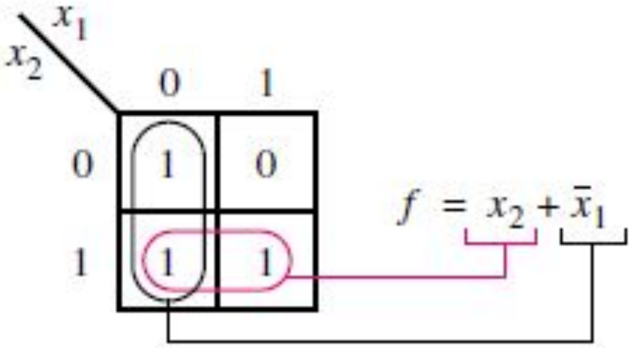
Y = B’

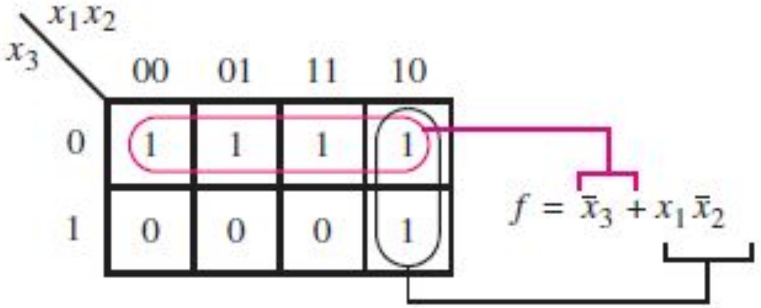
Logic Function Synthesis (SOP) using k-map

- **Minterm (SOP)** - Group 2^n no. of 1 and no 0. n = 0,1,2,3…. (Make groups larger as possible)
- Grouping can be square/rectangle shaped or along row/column (Not along diagonal). Groups can be overlapped.
- The inputs which are varying in a group, can be omitted.
- Don’t cares (d) can be used 0/1 as per convenience.
- **Edges are connected.**



(a) The function of Figure 2.23





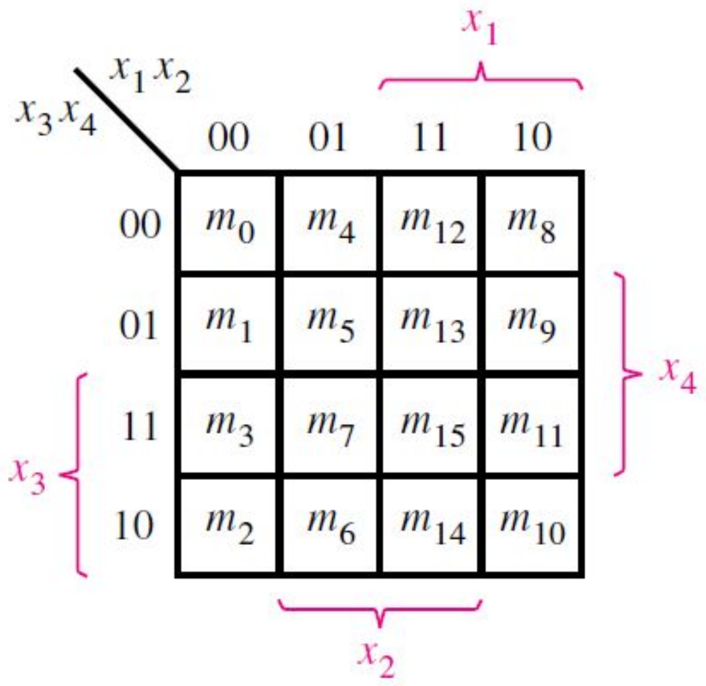
(b) The function of Figure 2.48

Logic Function Synthesis (SOP) using k-map

Consider the following function (where m= minterms, D = don’t cares):

$$f(x1, \ldots, x4) = \sum m(2, 4, 5, 6, 10) + D(12, 13, 14, 15)$$

x1	x2	x3	x4	Minterms
0	0	0	0	m0
0	0	0	1	m1
0	0	1	0	m2
0	0	1	1	m3
0	1	0	0	m4
0	1	0	1	m5
0	1	1	0	m6
0	1	1	1	m7
1	0	0	0	m8
1	0	0	1	m9
1	0	1	0	m10
1	0	1	1	m11
1	1	0	0	m12
1	1	0	1	m13
1	1	1	0	m14
1	1	1	1	m15



Logic Function Synthesis (SOP) using k-map

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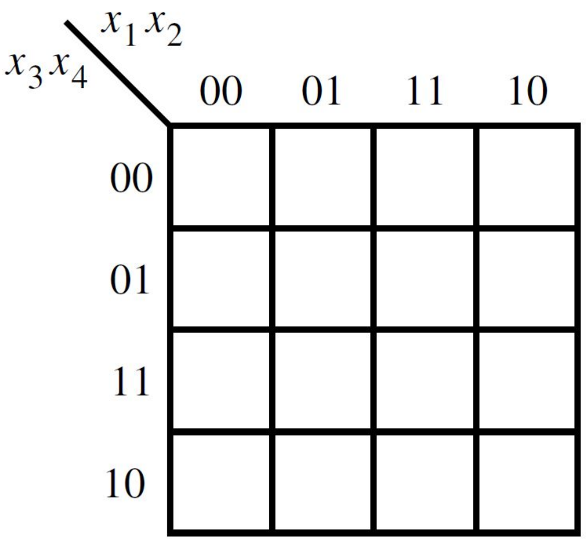

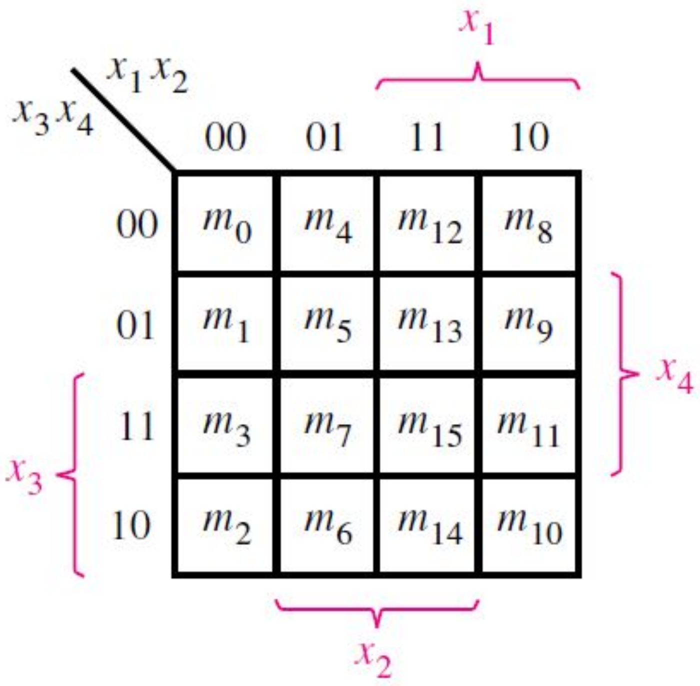

Logic Function Synthesis (SOP) using k-map

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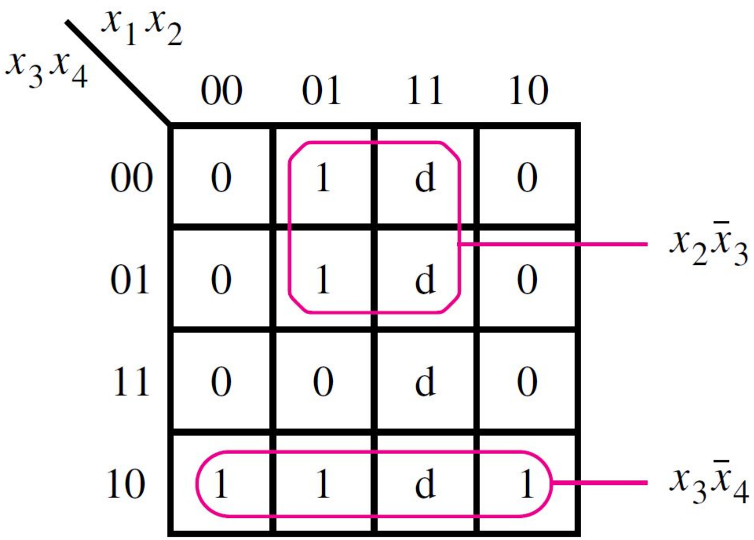

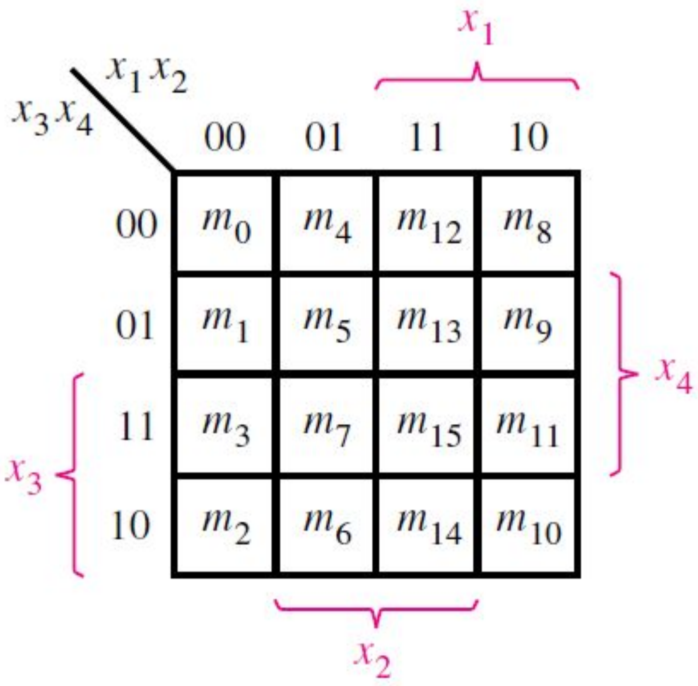

Logic Function Synthesis (SOP) using k-map

Consider the following function (where m= minterms, D = don’t cares):

$$f(x1, . . . , x4) = \sum m(2, 4, 5, 6, 10) + D(12, 13, 14, 15)$$

x_3x_4 \ x_1x_2	00	01	11	10
00	0	1	d	0
01	0	1	d	0
11	0	0	d	0
10	1	1	d	1

$$f = x_2\overline{x}_3 + x_3\overline{x}_4$$