CPE100: Digital Logic Design I

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K-Map Examples

Chapter 2.7

Example 1: 3 Input

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

Example 1: 3 Input

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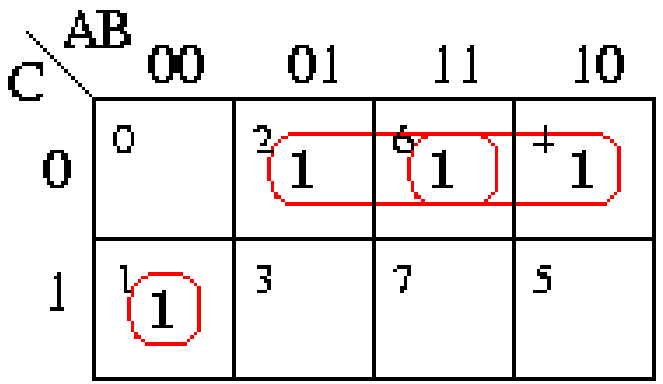
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0



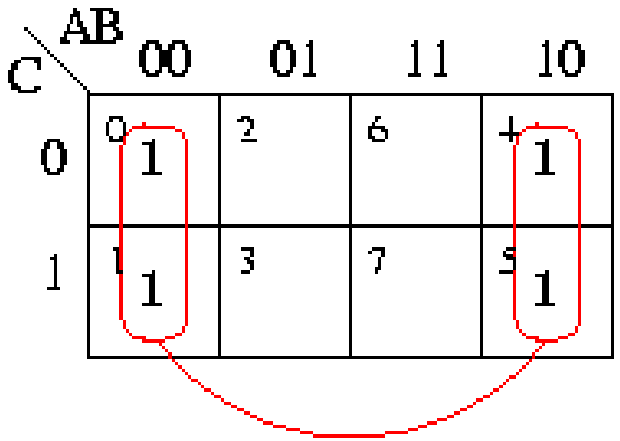
$$Y = \bar{A}\,\bar{B}C + B\,\bar{C} + A\,\bar{C}$$

Example 2: 3 Input

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

Example 2: 3 Input

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



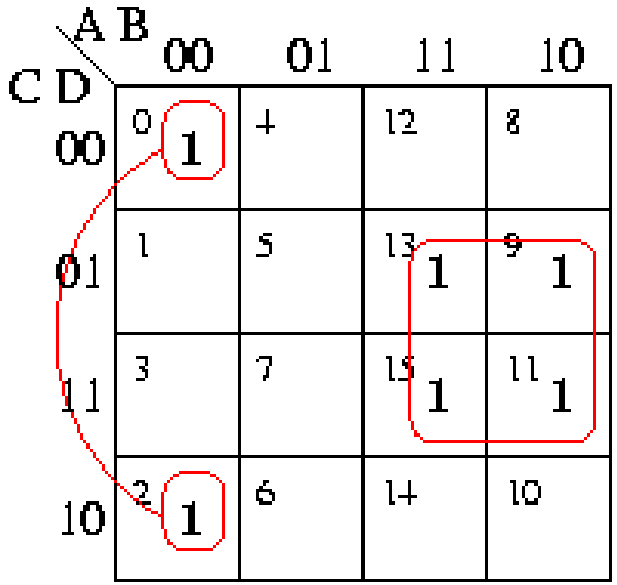
$$Y = \bar{B}$$

Example 3: 4 Input

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

Example 3: 4 Input

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1



$$Y = AD + \bar{A}\bar{B}\bar{D}$$

Example 4: Minterm Specification

- 4 variable (A,B,C,D) input
- $Y = \sum m(0,2,8,9,10,11)$
  - E.g.
  - $m8 = A\bar{B}\bar{C}\bar{D} = 1000$
  - $A = 1, B = 0, C = 0, D = 0$

Example 4: Minterm Specification

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  - E.g.
  - $m8 = A\bar{B}\bar{C}\bar{D} = 1000$
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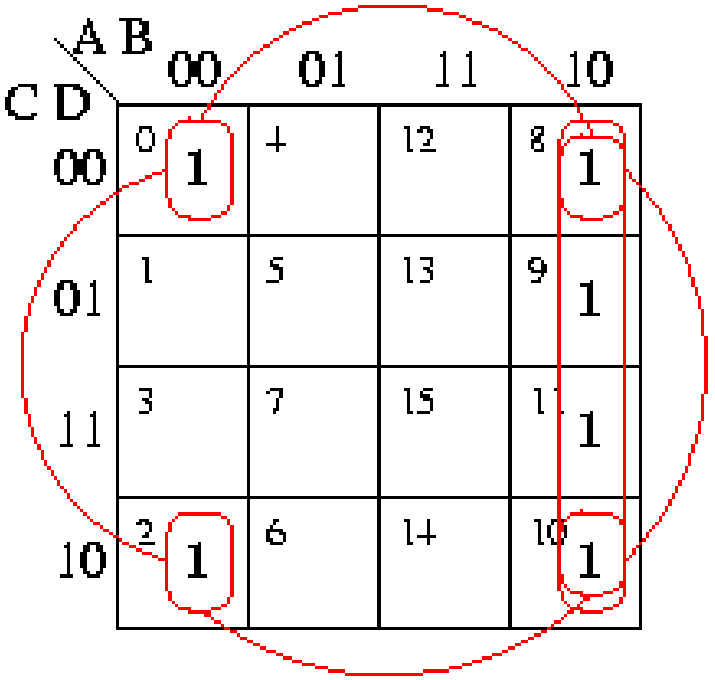

$Y = \bar{B}\bar{D} + A\bar{B}$

Example 5: Minterm Specification

- 4 variable (A,B,C,D) input
- $Y = \sum m(1,3,6,9,11,12,13)$

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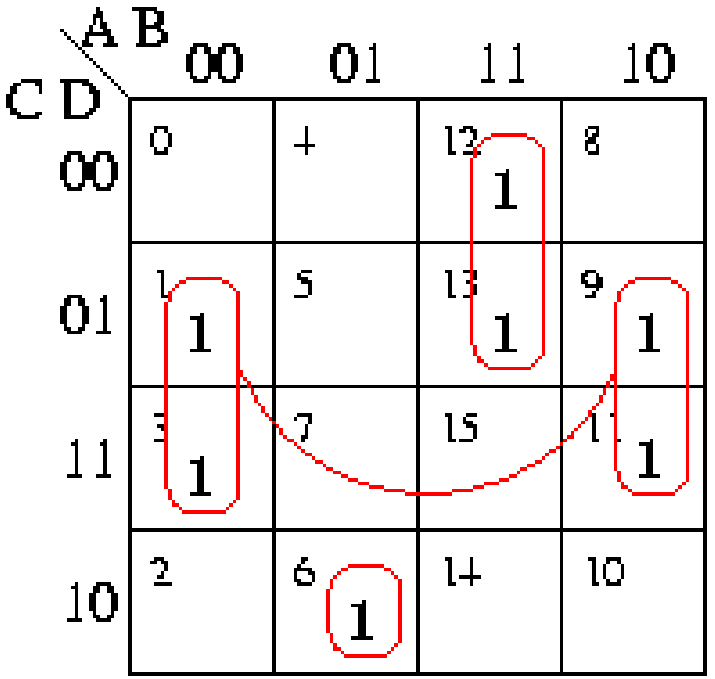
- $Y = \sum m(1,3,6,9,11,12,13)$



$$Y = AB\bar{C} + \bar{B}D + \bar{A}BC\bar{D}$$

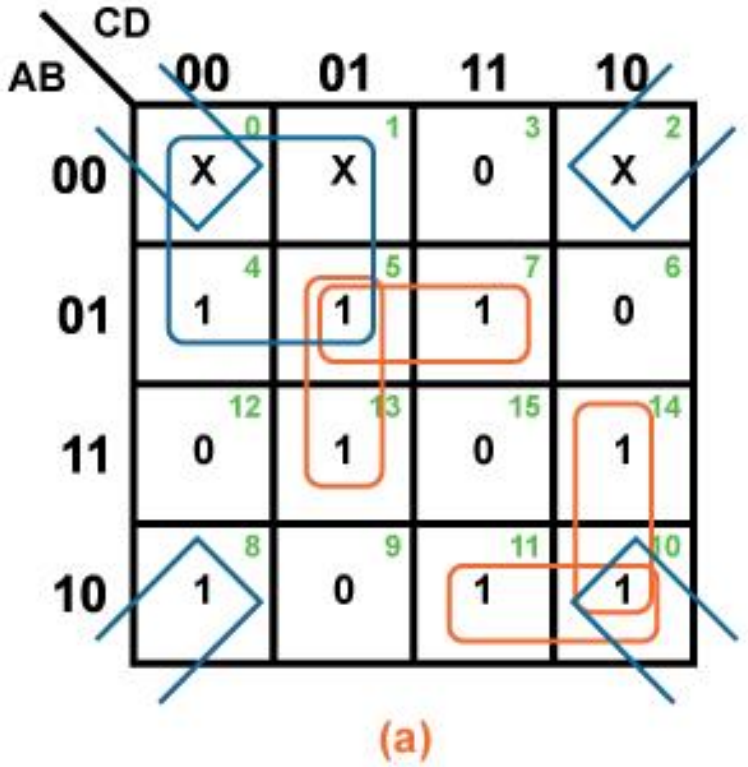
Example 6: Don't Cares

- 4 variable (A,B,C,D) input

- $Y = \sum m(4,5,7,8,10,11,13,14) + \sum d(0,1,2)$
  - d term indicates do not care

Example 6: Don't Cares

- 4 variable (A,B,C,D) input
- $Y = \sum m(4,5,7,8,10,11,13,14) + \sum d(0,1,2)$
  - d term indicates do not care



$$Y = \bar{B}\bar{D} + \bar{A}\bar{C} + B\bar{C}D + \bar{A}BD + AC\bar{D} + A\bar{B}C$$

Note: AB and CD are switched in this K-map

Example 7: Maxterm Specification

- 4 variable (A,B,C,D) input

- Maxterm expression for POS form
- $Y = \prod M(3,6,9,12,15) + \sum d(0,1,2)$

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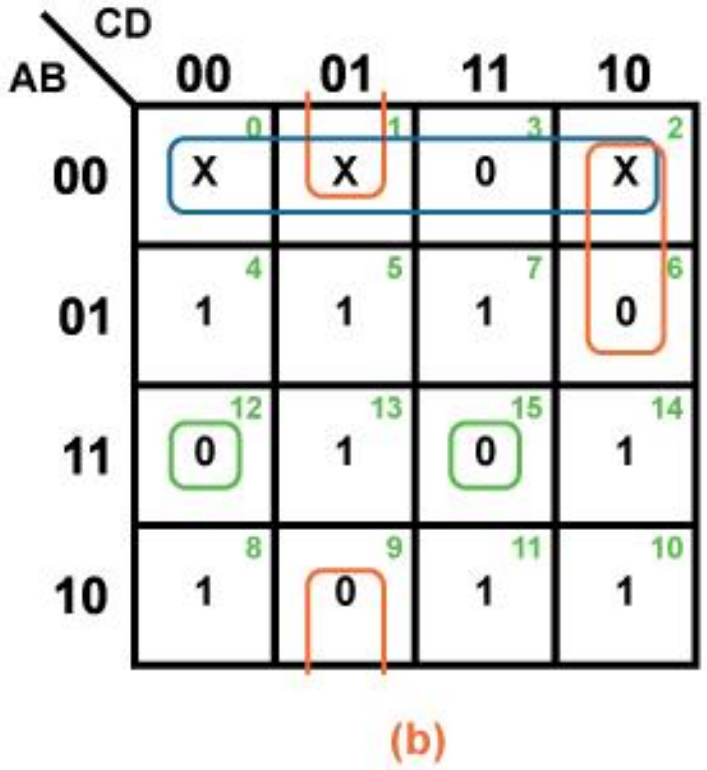
- 4 variable (A,B,C,D) input
- Maxterm expression for POS form
- $Y = \prod M(3,6,9,12,15) + \sum d(0,1,2)$



$$Y = (A + B)(B + C + \bar{D})(A + \bar{C} + D)(\bar{A} + \bar{B} + C + D)(\bar{A} + \bar{B} + \bar{C} + \bar{D})$$

Note: AB and CD are switched in this K-map

Example 8: Equation Specification

- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

- Note this is a 4-input problem
- Use expansion to find canonical minterms or
- Create full truth table

- Ex:
  - ABC → 1110 and 1111 (D can be either 0 or 1)
  - AC → 1010, 1011, 1110, and 1111
    - 1st and 3rd bits turned on

Example 8: Equation Specification

- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

A	B	C	D	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

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- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

A	B	C	D	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	1
1	1	1	1	1

Example 8: Equation Specification

- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

A	B	C	D	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	1
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	1
1	1	1	1	1

Example 8: Equation Specification

- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

A	B	C	D	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	1
1	0	0	0	
1	0	0	1	
1	0	1	0	1
1	0	1	1	1
1	1	0	0	
1	1	0	1	
1	1	1	0	1
1	1	1	1	1

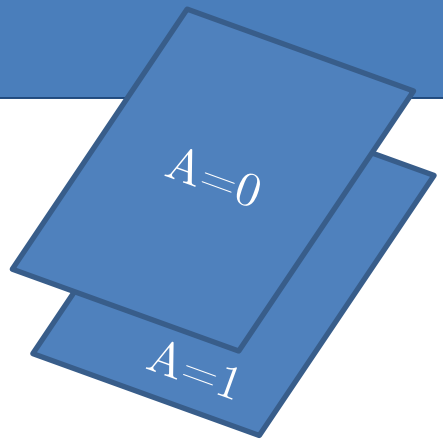
Example 8: Equation Specification

- Use a K-map to simplify the following equation
- $Y = ABC + BCD + AC + BC$

- Normal simplification
  - $Y = AC + BC$

A	B	C	D	Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	1
0	1	1	1	1
1	0	0	0	
1	0	0	1	
1	0	1	0	1
1	0	1	1	1
1	1	0	0	
1	1	0	1	
1	1	1	0	1
1	1	1	1	1

Example 9: 5 Input



- 5-input function (A,B,C,D,E)
  - Create two 4-input K-maps and "stack"

A = 0

DE \ BC	00	01	11	10
00	0	4	12	8
01	1	5	13	9
11	3	7	15	11
10	2	6	14	10

A = 1

DE \ BC	00	01	11	10
00	16	20	28	24
01	17	21	29	25
11	19	23	31	27
10	18	22	30	26

  - Draw bubbles within 4x4 and in between stack (above or below)
    - E.g. cell 5 and 21 → B'CD'E

Example 9: 5 Input

- $Y = \sum m(0,1,2,3,8,9,16,17,20,21,24,25,28,29,30,31)$

Example 9: 5 Input

- $Y = \sum m(0,1,2,3,8,9,16,17,20,21,24,25,28,29,30,31)$

A = 0

DE \ BC	00	01	11	10
00	1	4	12	1
01	1	5	13	1
11	1	7	15	11
10	1	6	14	10

A = 1

DE \ BC	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	19	23	1	27
10	18	22	1	26

  - Be sure to check “above/below”
- Y=AD’+ A’B’C’ + ABC + C’D’