

EE 200- Digital Logic Circuit Design

3.3 Four-Variable K-Map

Dr. Muhammad Mahmoud

جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals



September 29, 2013



Introduction

- What is the order of minterms in three-variable K-maps?
- Can anyone guess the order of minterms in four-variable K-maps?



Lecture Outline

- 1 The Map Method
 - Four-Variable K-Map
 - Prime Implicants
 - Five(or more)-Variable Maps



Four-Variable K-Map

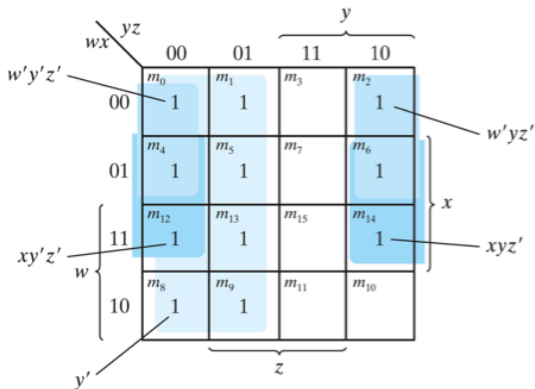
m_0	m_1	m_3	m_2
m_4	m_5	m_7	m_6
m_{12}	m_{13}	m_{15}	m_{14}
m_8	m_9	m_{11}	m_{10}

		y			
		00	01	11	10
wx	yz	m_0	m_1	m_3	m_2
	00	$w'x'y'z'$	$w'x'y'z$	$w'x'yz$	$w'x'yz'$
01	m_4	m_5	m_7	m_6	
	$w'xy'z'$	$w'xy'z$	$w'xyz$	$w'xyz'$	
11	m_{12}	m_{13}	m_{15}	m_{14}	
	$wxy'z'$	$wxy'z$	$wxyz$	$wxyz'$	
10	m_8	m_9	m_{11}	m_{10}	
	$wx'y'z'$	$wx'y'z$	$wx'yz$	$wx'yz'$	
		z			



Four-Variable K-Map

- $F(w, x, y, z) = \sum(0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14)$



- $F = y' + w'z' + xz'$

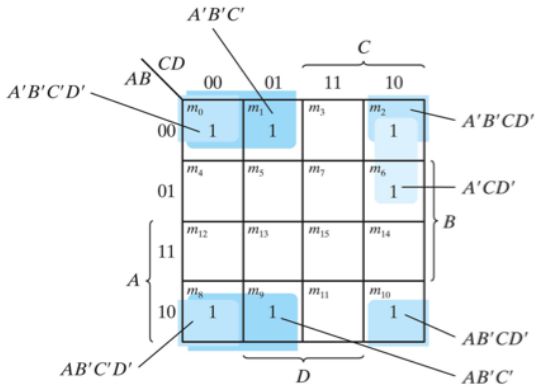


Four-Variable K-Map

- $F = A'B'C' + B'CD' + A'BCD' + AB'C'$
- 1st term $A'B'C' = A'B'C' \boxed{D} + A'B'C' \boxed{D'}$
- 2nd term $B'CD' = \boxed{A}B'CD' + \boxed{A'}B'CD'$
- 3rd term $A'BCD'$
- 4th term $AB'C' = AB'C' \boxed{D} + AB'C' \boxed{D'}$



Four-Variable K-Map



- $F = B'D' + B'C' + A'CD'$



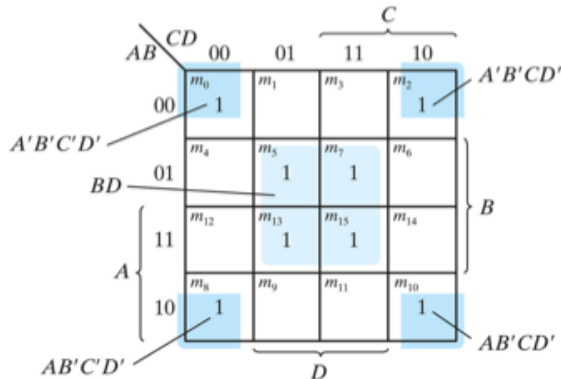
Prime Implicants

- A prime implicant is a product term obtained by combining the maximum possible number of adjacent squares in the map.
- The prime implicants of a function can be obtained from the map by combining all possible maximum numbers of squares.
- Prime Implicant:
 - 1 that is not adjacent to any other 1's.
 - Two adjacent 1's that are not in a group of four adjacent 1's.
 - Four adjacent 1's that are not in a group of eight adjacent 1's.
- Essential Prime Implicant: is the only prime implicant minterm(s).



Prime Implicants

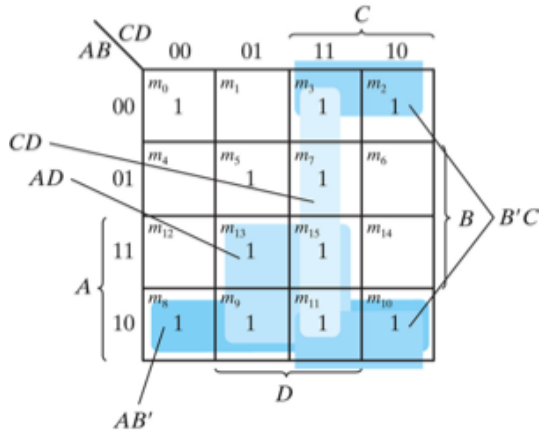
- $F(A, B, C, D) = \sum(0, 2, 3, 5, 7, 8, 9, 10, 11, 13, 15)$



- Essential prime implicant BD and $B'D'$



Prime Implicants





Prime Implicants

- $F = BD + B'D' + CD + AD$
- $= BD + B'D' + CD + AB'$
- $= BD + B'D' + B'C + AD$
- $= BD + B'D' + B'C + AB'$



Five(or more)-Variable Maps

- With five-variable maps we need 32 squares.
- With six-variable maps we need 64 squares.
- very complicated and will not be covered.



Summary

- 1 The Map Method
 - Four-Variable K-Map
 - Prime Implicants
 - Five(or more)-Variable Maps



Next Lecture

- Product-of-Sums Simplification
- Don't-Care Conditions.
- NAND and NOR Implementation.