

# Karnaugh Maps

ELEC 311

Digital Logic and Circuits

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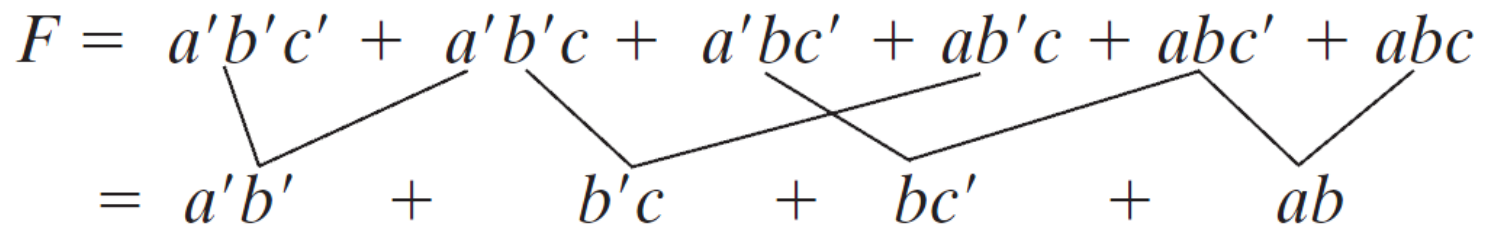
*Images Courtesy of Cengage Learning*



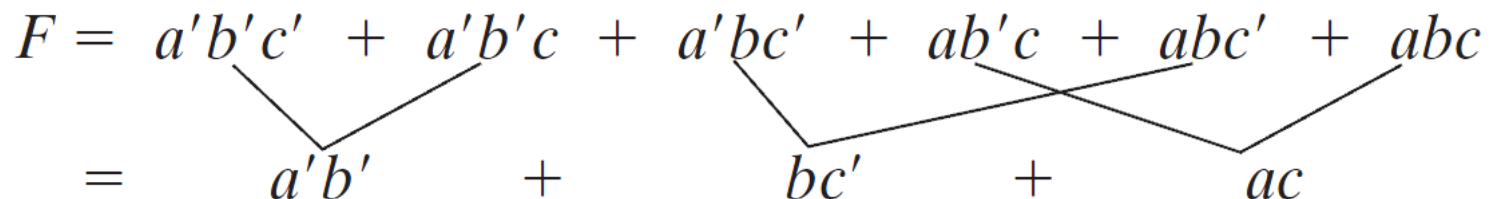
# Minimum Switching Functions

Find a minimum sum-of-products expression for

$$F(a, b, c) = \Sigma m(0, 1, 2, 5, 6, 7)$$

$$\begin{aligned} F &= a'b'c' + a'b'c + a'bc' + ab'c + abc' + abc \\ &= a'b' + b'c + bc' + ab \end{aligned}$$


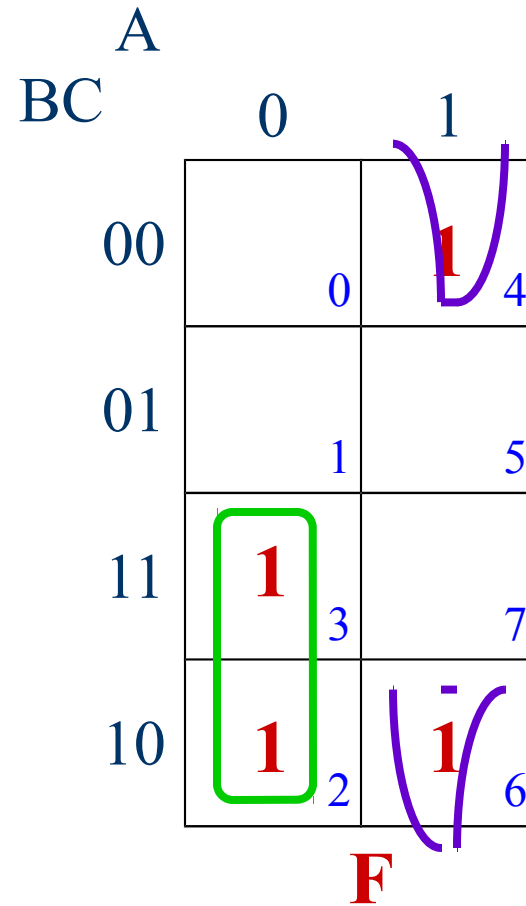
None of the terms in the above expression can be eliminated by consensus. However, combining terms in a different way leads directly to a minimum sum of products:

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


# Karnaugh Map

<i>A</i>	<i>B</i>	<i>C</i>	<i>F</i>
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

$$F(A,B,C) = \Sigma m(2,3,4,6)$$



# Four-Variable Karnaugh Map

AB					
CD		00	01	11	10
00		0	4	12	8
01		1	5	13	9
11		3	7	15	11
10		2	6	14	10

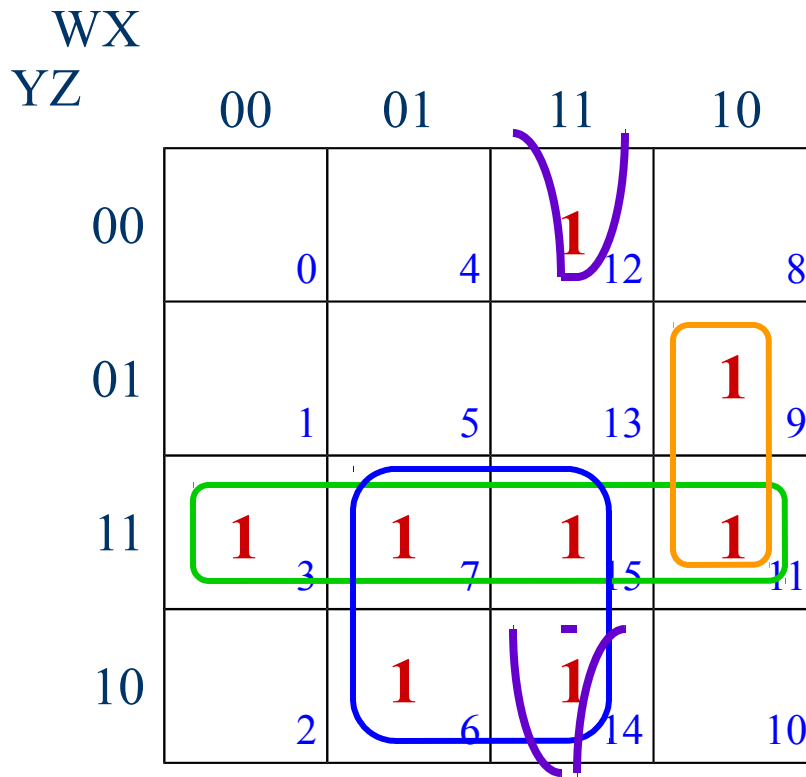
# Terminology

- ◆ Minterm
- ◆ Implicant
- ◆ Cover
- ◆ Prime Implicant
- ◆ Essential Prime Implicant
- ◆ Secondary Prime Implicant
- ◆ Minimal Sum

# Methodology

- ◆ Minimal Sum
  - Essential Prime Implicants
  - Secondary Prime Implicants
  - Minimal Cover

# Example



$$F = (YZ) + (XY) + (WX'Z) + (WXZ')$$

$$F(W,X,Y,Z) = \Sigma m(3,6,7,9,11,12,14,15)$$

# Don't Cares

		x1x2 x3x4			
		00	01	11	10
00		1	1	X	1
01		1		X	1
11		1	1	X	X
10		1		X	X

$$B = x2' + (x3'x4') + (x3x4)$$

$$B(x1,x2,x3,x4) = \Sigma m (0,1,2,3,4,7,8,9) + \Sigma d(10-15)$$



# Summary

- ◆ Minimizing Switching Functions
- ◆ Karnaugh Maps
  - Three-Variable
  - Four-Variable
  - Don't Cares