

# What's a Minterm?

- Otherwise known as a *standard product*
- Possible AND combinations of  $n$  variables
- Example? For two variables  $a$  and  $b$ :

a	b	minterm	
0	0	$a'b'$	$m_0$
0	1	$a'b$	$m_1$
1	0	$ab'$	$m_2$
1	1	$ab$	$m_3$

# What's a Maxterm?

- Otherwise known as a *standard sum*
- Possible OR combinations of  $n$  variables
- Example? For two variables  $a$  and  $b$ :

a	b	Maxterm	
1	1	$a' + b'$	$M_3$
1	0	$a' + b$	$M_2$
0	1	$a + b'$	$M_1$
0	0	$a + b$	$M_0$

# Minterms & Functions

- Given a truth table, a function can be put into algebraic form by OR-ing all of the minterms that have a 1 in the result column
- Example?  $F = (ab') + (a'b)$

a	b	minterm		F
0	0	$a'b'$	$m_0$	0
0	1	$a'b$	$m_1$	1
1	0	$ab'$	$m_2$	1
1	1	$ab$	$m_3$	0

- ANY Boolean function can expressed this way

# Maxterms & Functions

- Given a truth table, a function can be put into algebraic form by AND-ing all of the **maxterms** that have a 0 in the result column
- Example?  $F = (a+b)(a'+b')$

a	b	minterm		maxterm		F
0	0	$a'b'$	$m_0$	$a+b$	$M_0$	0
0	1	$a'b$	$m_1$	$a+b'$	$M_1$	1
1	0	$ab'$	$m_2$	$a'+b$	$M_2$	1
1	1	$ab$	$m_3$	$a'+b'$	$M_3$	0

- ANY Boolean function can expressed this way

## **Canonical Form**

- Boolean functions expressed algebraically as either...
  - A sum of minterms
  - A product of maxterms

## Canonical Form $\rightarrow$ Complements

- The Complement for Sum of Minterms is...
  - ...the sum of minterms missing from the original function
  - Two-variable example (4 minterms)?

$$F = \sum(0, 2) \quad \text{so} \quad F' = \sum(1, 3)$$

- Converting to a Product of Maxterms?
  - Remember that any minterm is the complement of its corresponding maxterm (e.g.  $m'_0 = M_0$ )
  - So, using the example above:

$$F = \sum(0, 2) \quad \text{so} \quad F' = \sum(1, 3) \quad \text{so} \quad (F')' = \prod(1, 3)$$



# Canonical Form - Examples

a	b	c	minterm		F
0	0	0	a'b'c'	m <sub>0</sub>	0
0	0	1	a'b'c	m <sub>1</sub>	1
0	1	0	a'bc'	m <sub>2</sub>	0
0	1	1	a'bc	m <sub>3</sub>	0
1	0	0	ab'c'	m <sub>4</sub>	1
1	0	1	ab'c	m <sub>5</sub>	1
1	1	0	abc'	m <sub>6</sub>	0
1	1	1	abc	m <sub>7</sub>	0

Sum of Minterms?  $F = m_1 + m_4 + m_5 = \Sigma(1, 4, 5)$

Product of Maxterms?  $F = M_0 \cdot M_2 \cdot M_3 \cdot M_6 \cdot M_7 = \Pi(0, 2, 3, 6, 7)$

**Table 2.3**  
*Minterms and Maxterms for Three Binary Variables*

$x$	$y$	$z$	Minterms		Maxterms	
			Term	Designation	Term	Designation
0	0	0	$x'y'z'$	$m_0$	$x + y + z$	$M_0$
0	0	1	$x'y'z$	$m_1$	$x + y + z'$	$M_1$
0	1	0	$x'yz'$	$m_2$	$x + y' + z$	$M_2$
0	1	1	$x'yz$	$m_3$	$x + y' + z'$	$M_3$
1	0	0	$xy'z'$	$m_4$	$x' + y + z$	$M_4$
1	0	1	$xy'z$	$m_5$	$x' + y + z'$	$M_5$
1	1	0	$xyz'$	$m_6$	$x' + y' + z$	$M_6$
1	1	1	$xyz$	$m_7$	$x' + y' + z'$	$M_7$



**Table 2.4**  
*Functions of Three Variables*

$x$	$y$	$z$	Function $f_1$	Function $f_2$
0	0	0	0	0
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$f_1 = x'y'z + xy'z' + xyz = m_1 + m_4 + m_7$$

$$f_1' = x'y'z' + x'yz' + x'yz + xy'z + xyz'$$

$$\begin{aligned} f_1 &= (x + y + z)(x + y' + z)(x' + y + z')(x' + y' + z) \\ &= M_0 \cdot M_2 \cdot M_3 \cdot M_5 \cdot M_6 \end{aligned}$$

$$f_2 = x'yz + xy'z + xyz' + xyz = m_3 + m_5 + m_6 + m_7$$

$$\begin{aligned} f_2 &= (x + y + z)(x + y + z')(x + y' + z)(x' + y + z) \\ &= M_0 M_1 M_2 M_4 \end{aligned}$$