

EE 200- Digital Logic Circuit Design

3.8 Exclusive-OR Function

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Introduction

- What is XOR function?
- What is the symbol for XOR?



Lecture Outline

- 1 Exclusive-OR Function
 - Odd Function
 - Parity Generation and Checking

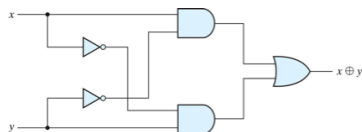


Exclusive-OR Function

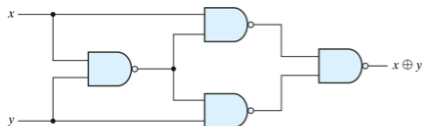
- XOR: $x \oplus y = xy' + x'y$
- XNOR: $(x \oplus y)' = xy + x'y'$
- XOR identities:
 - $x \oplus 0 = x$
 - $x \oplus 1 = x'$
 - $x \oplus x = 0$
 - $x \oplus x' = 1$
 - $x \oplus y' = x' \oplus y = (x \oplus y)'$
 - $x \oplus y = y \oplus x$
 - $(x \oplus y) \oplus z = x \oplus (y \oplus z) = x \oplus y \oplus z$



Exclusive-OR Function



Exclusive-OR with AND-OR-NOT gates



Exclusive-OR with NAND gates

- $(x' + y')x + (x' + y')y = xy' + x'y = x \oplus y$



Odd Function

- $A \oplus B \oplus C$
 $= (AB' + A'B)C' + (AB + A'B')C$
 $= AB'C' + A'BC' + ABC + A'B'C$
 $= \sum(1, 2, 4, 7)$
- True if odd number of 1's.
- n-variable XOR is the logical sum of the $2^n/2$ minterms whose binary numerical value have an odd number of ones.



Odd Function

		BC		B	
		00	01	11	10
A	0	m_0	m_1	m_3	m_2
	1	m_4	m_5	m_7	m_6
		C			

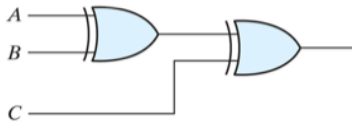
Odd function $F = A \oplus B \oplus C$

		BC		B	
		00	01	11	10
A	0	m_0	m_1	m_3	m_2
	1	m_4	m_5	m_7	m_6
		C			

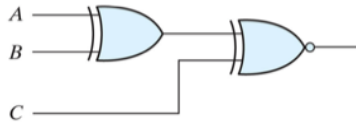
Even function $F = (A \oplus B \oplus C)'$



Odd Function



(a) 3-input odd function



(b) 3-input even function



Odd Function

		CD		C	
		00	01	11	10
A	AB	m_0	m_1	m_3	m_2
	00		1		1
	01	1		1	
	11	m_{12}	m_{13}	m_{15}	m_{14}
10	m_6	m_4	m_{11}	m_{10}	
		D			

Odd function $F = A \oplus B \oplus C \oplus D$

		CD		C	
		00	01	11	10
A	AB	m_0	m_1	m_3	m_2
	00	1		1	
	01		1		1
	11	1	m_{13}	1	m_{14}
10	m_6	m_4	m_{11}	m_{10}	
		D			

Even function $F = (A \oplus B \oplus C \oplus D)'$



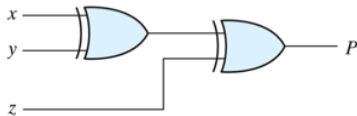
Parity Generation and Checking

Even-Parity-Generator Truth Table

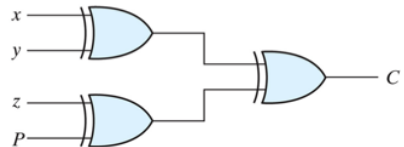
Three-Bit Message			Parity Bit
<i>x</i>	<i>y</i>	<i>z</i>	<i>P</i>
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



TParity Generation and Checking



(a) 3-bit even parity generator



(b) 4-bit even parity checker



Parity Generation and Checking

Even-Parity-Checker Truth Table

Four Bits Received				Parity Error Check
x	y	z	P	C
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0



Summary

- 1 Exclusive-OR Function
 - Odd Function
 - Parity Generation and Checking