DIGITAL SYSTEMS AND MICROPROCESSORS (ELE2002M)

LECTURE 3 - GATE LEVEL MINIMIZATION (CONT…)

Instructor:

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CD\AB	00	01	11	10
00	1	1	1	1
01				
11				
10	1	1	1	1

F=D’

Implement the following function in both NAND and NOR form
[Hint: for NOR form implement the F']

F(A,B,C,D) = (4,5,6,7,9,13,15)

CD\AB	00	01	11	10
00		1		
01		1	1	1
11		1	1	
10		1		

Implement the following function in both NAND and NOR form
[Hint: for NOR form implement the F']

F(A,B,C,D) = (4,5,6,7,9,13,15)

CD\AB	00	01	11	10
00	0	1	0	0
01	0	1	1	1
11	0	1	1	0
10	0	1	0	0

Other Two-Level Implementations

- Wired AND (Also called AND-OR-Invert)

- Wired OR (Also called OR-AND-Invert)

AND-OR-Invert Implementation

$F = (AB+CD+E)'$

OR-AND-Invert Implementation

$F = [\,(A+B)(C+D)E)]'$

Homework Exercise

Implement $F' = x'y + xy' + z$ using

1. AND-NOR and NAND-AND (using AND-OR-Invert)

2. OR-NAND and NOR-OR (using OR-AND-Invert)

Exclusive-OR Function

- The exclusive-OR (XOR) is represented by the symbol $\oplus$
- The exclusive-OR of 2 variables (x,y) is equal to 1 only if x = 1 OR y=1 (but not both)
- Similarly XNOR of 2 variables (x,y) is equal to 1 only if x = 0 OR y = 0 (but not both)

a **xor** 0 = a

a **xor** 1 = a'

a **xor** a = 0

a **xor** a' = 1

a **xor** b' = a' **xor** b = (a **xor** b)'

a **xor** b =b **xor** a

(a **xor** b) **xor** c = a **xor** (b **xor** c) = a **xor** b **xor** c

Odd function

- For a 2 variable odd function only 1 variable must be equal to 1
- A multiple-variable exclusive-OR function is defined as an **odd function**
- Generally, if the minterms of a function consist of only odd number of 1s it is an odd function
- An n-variable exclusive-OR function is an odd function defined as the logical sum of $2^n/2$ minterms whose binary numerical values have an odd number of 1's

Parity Generation and Checking

Reading Assignment

Combinational Logic

- Combinational logic (CL) consists of input variables, logic gates and output variables.
- CL reacts to the values of signals at their inputs and produce a value of output signal.
- For n-input variables, there are 2n possible binary input combinations.

Analysis Procedure

Reading Section 4.3

Design Procedure

Reading Assignment Section 4.4

Binary Adder

- The half adder
  - The half adder is a circuit for adding two single bit numbers
  - Develop a truth table and Boolean expressions for the half adder

A	B	S	C
0	0		
0	1		
1	0		
1	1		

S and C are the Sum and Carry

Half adder

- The sum is XOR operation and the carry an AND:

A	B	S	C
0	0		
0	1		
1	0		
1	1