Digital Logic Evaluation Expressions

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These slides show how to evaluate digital logic expressions via truth tables

Digital Logic Evaluation – Expressions

- Truth tables can be used to evaluate complex digital logic expressions
  - Process:
    1. Determine the total number of unique inputs (n)
    2. Create a table with n columns
    3. Populate the columns with the enumerated binary values for n bits (2^n rows)

       00

       01

       10

       11
    4. Determine the precedence of the operations
    5. Working from highest to lowest precedence
       - Create a new column
       - Evaluate just one logical statement at a time – using the previous column values

Digital Logic Evaluation – Expressions

- The order of operations for digital logic are
  - NOT >> AND >> XOR >> XNOR >> OR

- The associativity of digital logic expressions are all left to right

Digital Logic Evaluation – Expressions

- Example 1 – step 1/2/3

a and b and c

3 input signals
N = 3 columns
2^N = 8 rows

a	b	c
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Digital Logic Evaluation – Expressions

- Example 1 – step 4/5

(a and b) and c

Same precedence
Operate L → R

a	b	c	a and b (x)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Digital Logic Evaluation – Expressions

- Example 1 – step 4/5 cont'd

(a and b) and c

x and c

a and b and c

a	b	c	a and b (x)	x and c
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	1	0
1	1	1	1	1

Digital Logic Evaluation – Expressions

- Example 2 – step 1/2/3

a or b and $\overline{c}$

3 input signals
N = 3 columns
2^N = 8 rows

a	b	c
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Digital Logic Evaluation – Expressions

- Example 2 – step 4/5

a or b and $(\overline{c})$

Precedence
NOT → AND → OR

a	b	c	not c (x)
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

Digital Logic Evaluation – Expressions

- Example 2 – step 4/5 cont'd

a or b and $\overline{c}$

a or (b and x)

Precedence
NOT → AND → OR

a	b	c	not c (x)	b and x (y)
0	0	0	1	0
0	0	1	0	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	0
1	0	1	0	0
1	1	0	1	1
1	1	1	0	0

Digital Logic Evaluation – Expressions

- Example 2 – step 4/5 cont'd

a or b and $\overline{c}$

a or y

a or b and $\overline{c}$

Precedence
NOT → AND → OR

a	b	c	not c (x)	b and x (y)	a or y
0	0	0	1	0	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	0	0	0
1	0	0	1	0	1
1	0	1	0	0	1
1	1	0	1	1	1
1	1	1	0	0	1

Digital Logic Evaluation – Expressions

- Example 3 – step 1/2/3/4/5

$ab \otimes \overline{c + d}$

4 input signals
N = 4 columns
2^N = 16 rows

Precedence
$(ab) \otimes (\overline{c + d})$

$ab \otimes \overline{c + d}$

a	b	c	d	ab (x)	c + d (y)	$\overline{y}$ (z)	x⊗z
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	0
0	0	1	1	0	1	0	0
0	1	0	0	0	0	1	1
0	1	0	1	0	1	0	0
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	0
1	0	0	0	0	0	1	1
1	0	0	1	0	1	0	0
1	0	1	0	0	1	0	0
1	0	1	1	0	1	0	0
1	1	0	0	1	0	1	0
1	1	0	1	1	1	0	1
1	1	1	0	1	1	0	1
1	1	1	1	1	1	0	1