

**CSEE 4823 Advanced Logic Design**  
**Handout: Lecture #8**  
**9/30/11**

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**Ripple-Carry Adders (RCA)**

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## Basic Building Blocks: Half Adder (HA)

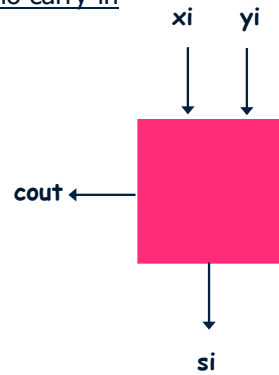
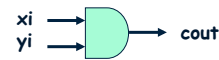
**Purpose:** add two 1-bit operands with no carry-in

$x_i$	$y_i$	$s_i$	$c_{out}$
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Truth Table

$$c_{out} = x_i y_i$$

$$s_i = x_i \text{ XOR } y_i$$



#3

## Basic Building Blocks: Full Adder (FA)

**Purpose:** add two 1-bit operands with carry-in

$c_{in}$	$x_i$	$y_i$	$s_i$	$c_{out}$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	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

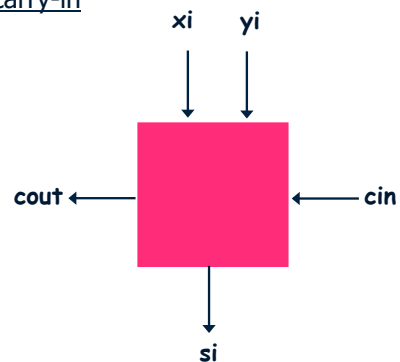
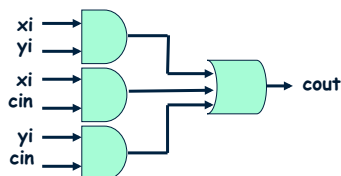
Truth Table

$$c_{out} = x_i y_i + x_i c_{in} + y_i c_{in}$$

= MAJORITY Function

$$s_i = x_i \text{ XOR } y_i \text{ XOR } c_{in}$$

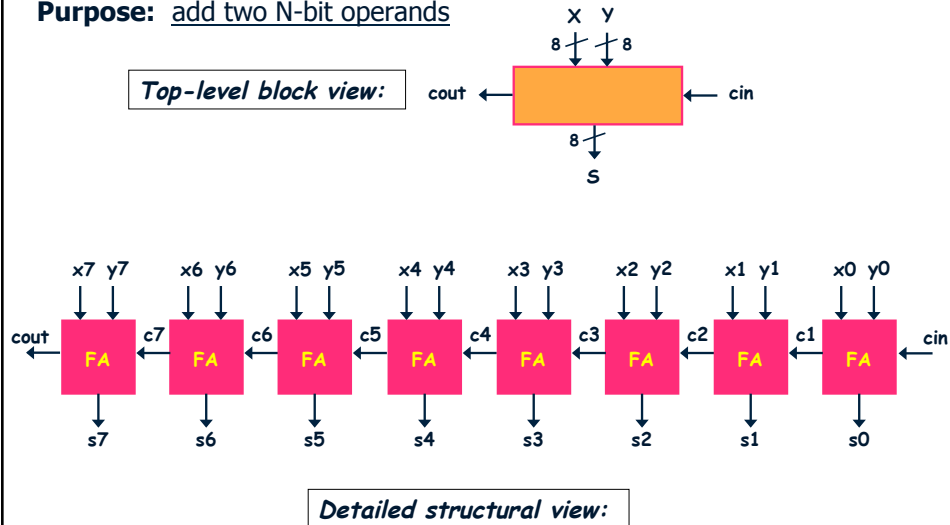
= ODD PARITY Function



#4

## Ripple-Carry Adder (RCA): 8-Bit Example

**Purpose:** add two N-bit operands



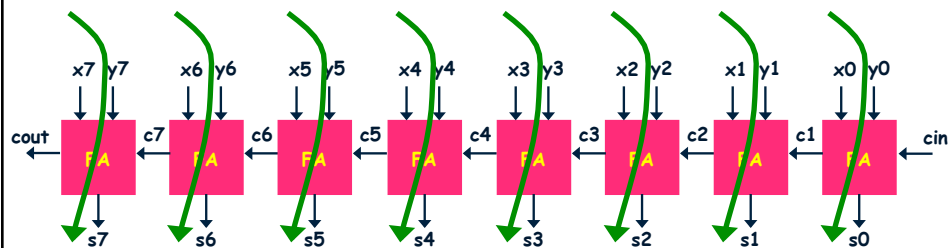
#5

## Ripple-Carry Adder (RCA): Simulations

**Example #1:** best-case = no carry chain (*all carries are 0*)

*Addition:*

$$\begin{array}{r} 00110010 = 49 \\ + 00000100 = 4 \\ \hline 00110110 = 53 \end{array}$$



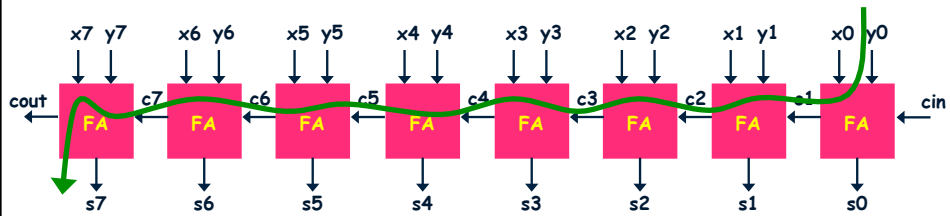
#6

## Ripple-Carry Adder (RCA): Simulations

**Example #2:** worst-case = longest carry chain (*all carries are 1*)

*Addition:*

$$\begin{array}{r} 00000001 = 1 \\ + 11111111 = -1 \text{ (2s Complement Representation)} \\ \hline 00000000 = 0 \end{array}$$



#7