PHYS 231 Dec. 4, 2024

Last Class!

Reminders:

- Lab notebook due at the end of your lab tomorrow. L01 → 11:50
  L02 → 15:50

  See Nov. 22 entry on course website for expectations.

- Final Exam is Thurs. Dec. 12
  19:00 – 21:30
  EME 1202

  Practice finals (+ sol'ns) are on the course website. See Oct. 7 entry for more details.

You can bring a formula sheet to the final. One 8.5" x 11" (letter-sized) sheet of paper with anything written on it.

You can bring a calculator. Anything that can go online or wirelessly communicate with other devices is fine. Graphing calculators are fine.

Today: Application of digital logic gates.

→ Adding binary numbers.

Want to add together a pair of bits

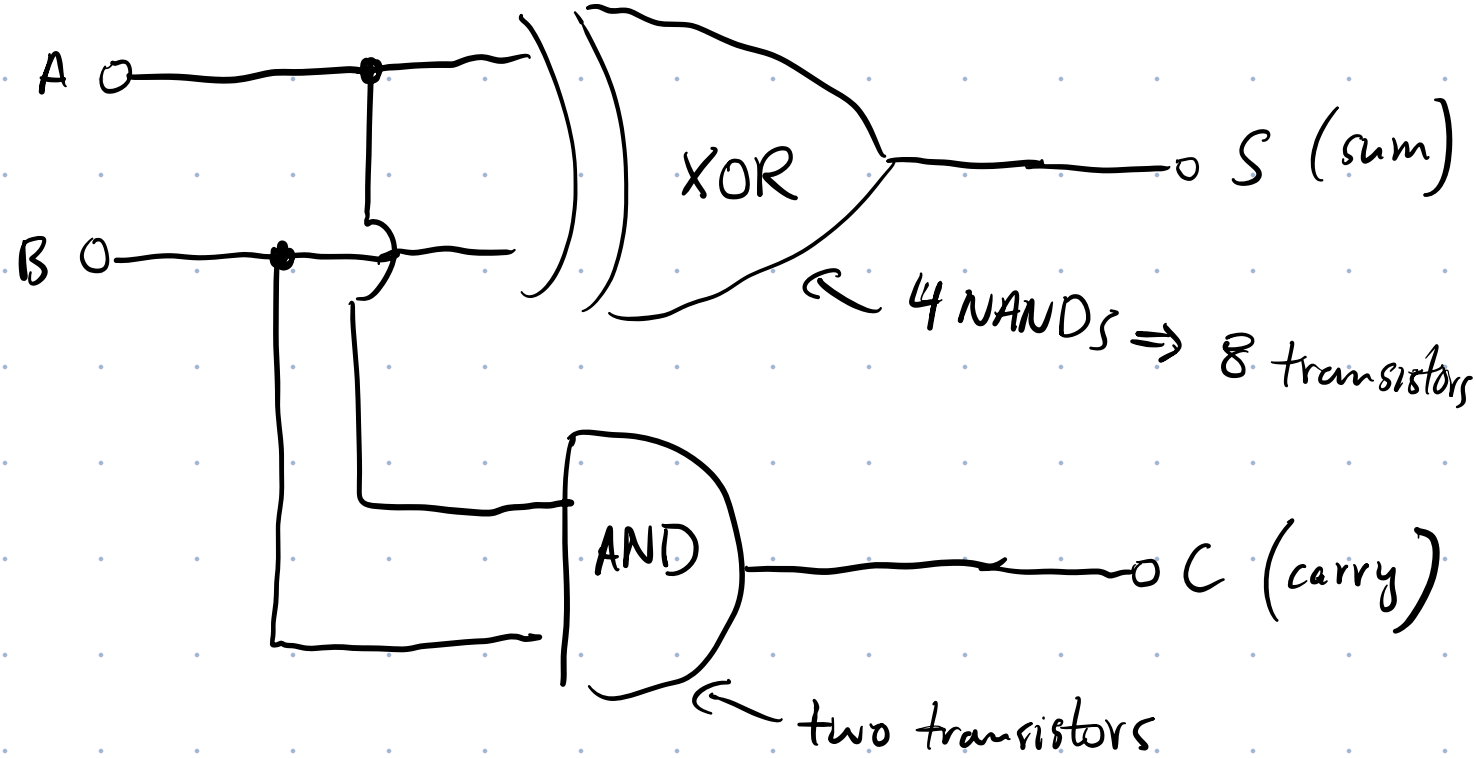
$0 + 0 = 00$
$0 + 1 = 01$
$1 + 0 = 01$
$1 + 1 = 10$

Our bit adder will require two inputs & two outputs.

"truth table" for bit adder

A	B	output	
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0
		(C) AND	(S) XOR

Consider the following circuit!



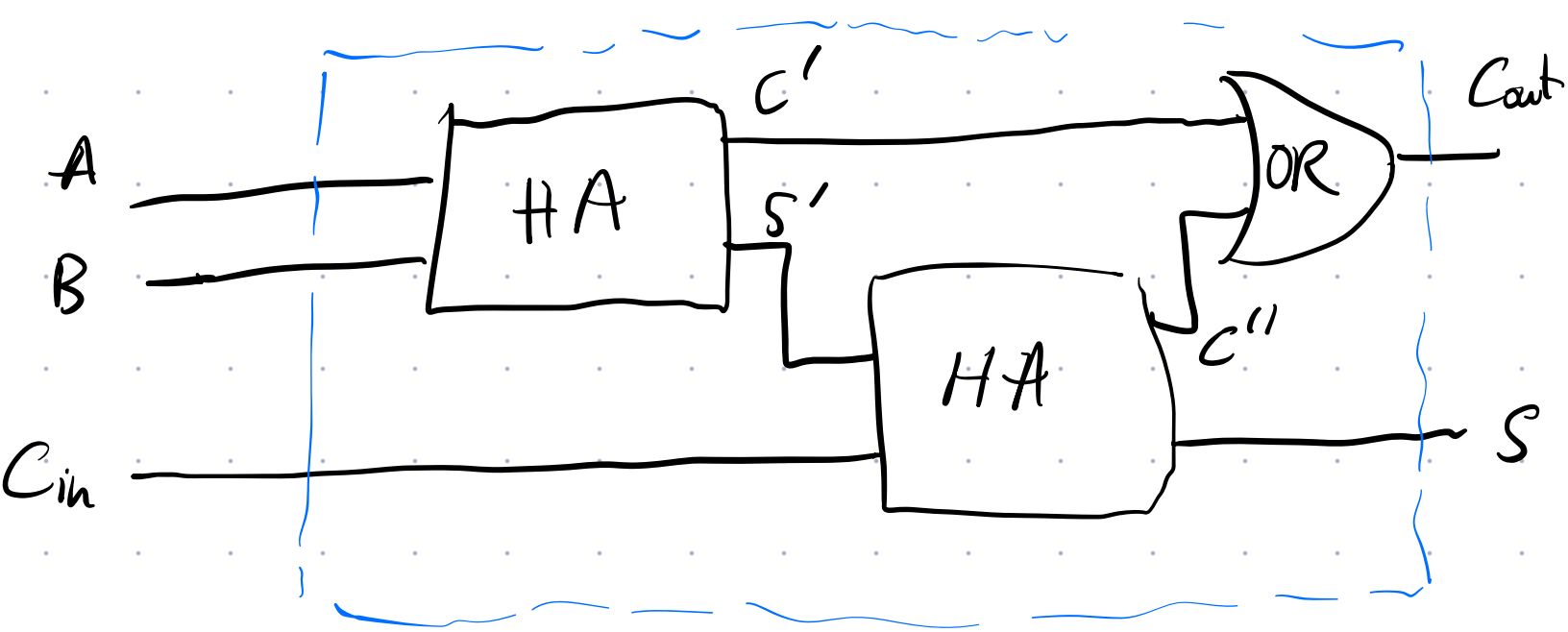
This circuit is called the "half adder"

10 transistors.

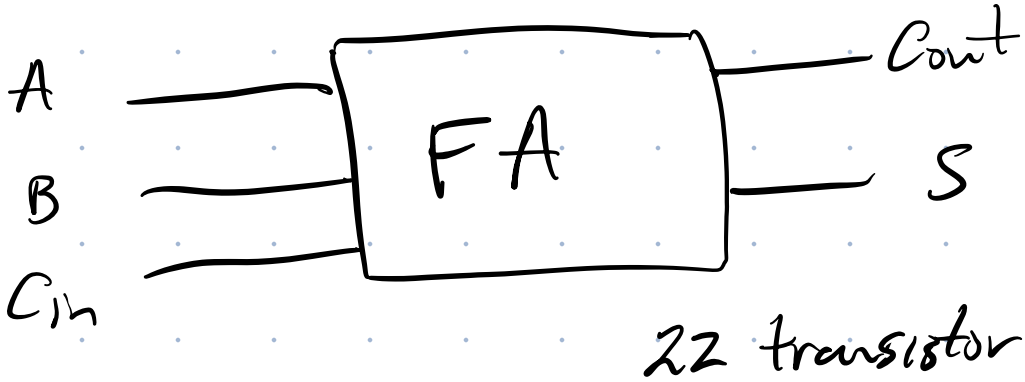
How can we add sequences of longer bits?

Eg.
$$\begin{array}{r} {\scriptstyle 1\,1\,1} \\ 1001 \\ +\ 1111 \\ \hline 11000 \end{array}$$

To add a longer string of bits, require an additional input to handle the possibility of a carry forward from a previous operation.

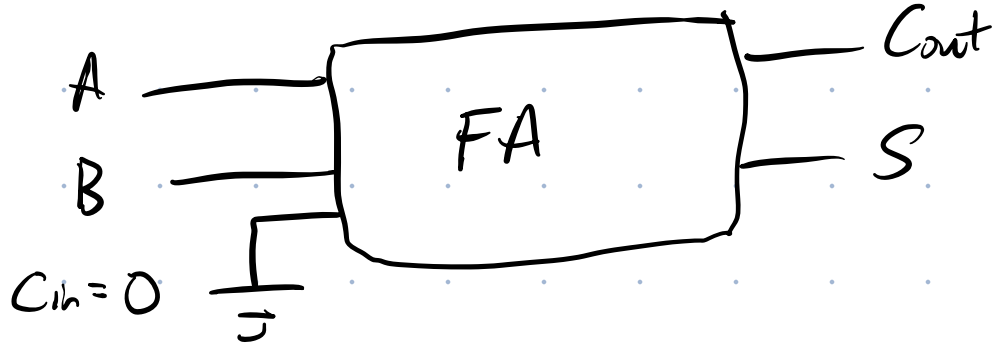


Full Adder



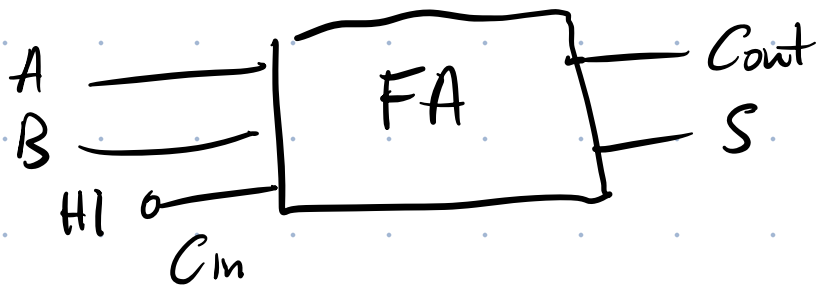
22 transistor circuit.

Verify that full adder correctly sums 2 bits



A	B	C_{in}	C'	S'	C''	S	Cout	S	decimal equiv.
0	0	0	0	0	0	0	0	0	0
0	1	0	0	1	0	1	0	1	1
1	0	0	0	1	0	1	0	1	1
1	1	0	1	0	0	0	1	0	2

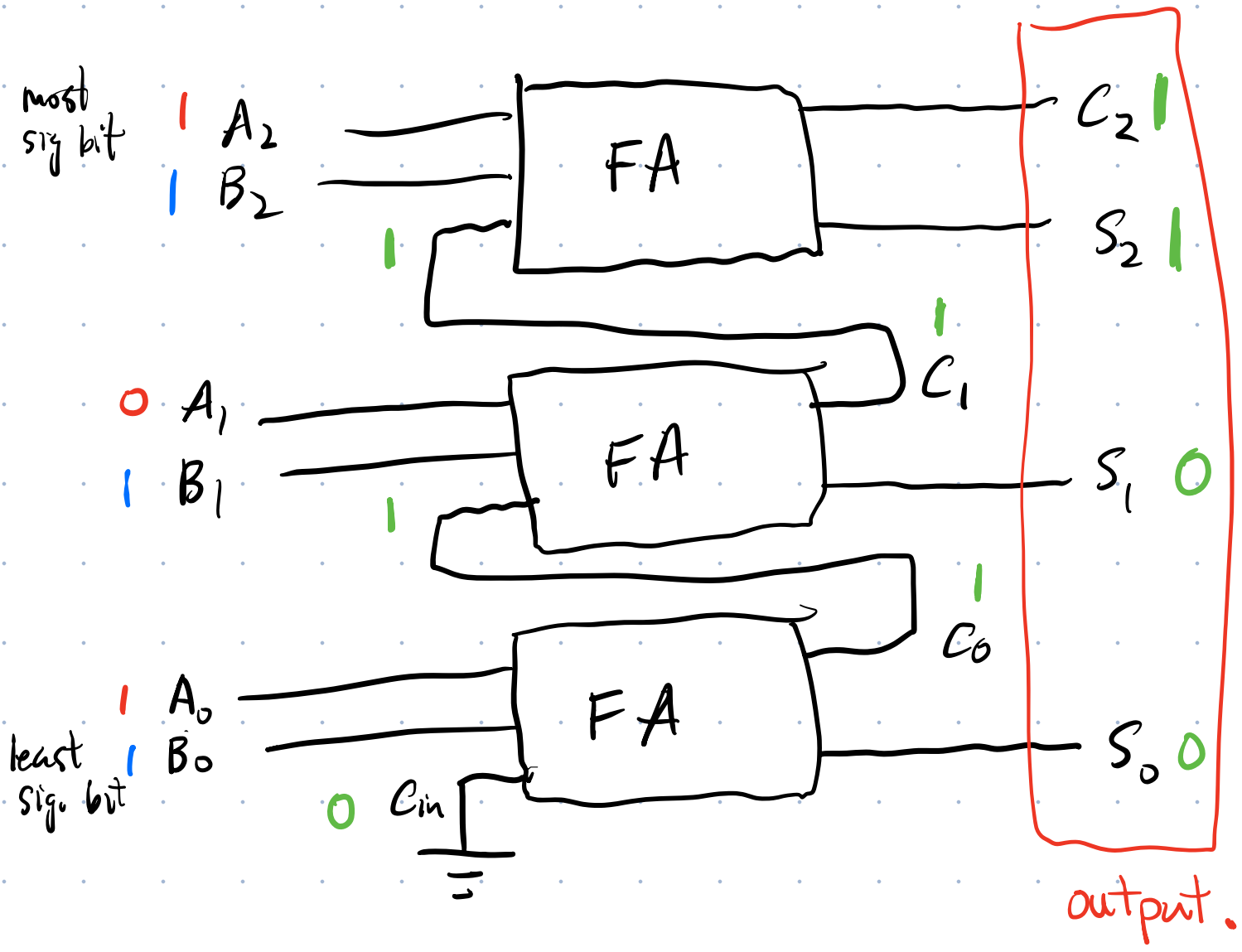
If $C_{in} = 1$, like adding $A + B + 1$



A	B	C_{in}	C'	S'	C''	S	Cout	S	decimal
0	0	1	0	0	0	1	0	1	1
0	1	1	0	1	1	0	1	0	2
1	0	1	0	1	1	0	1	0	2
1	1	1	1	0	0	1	1	1	3

Adding arbitrary lengths of bits...

→ Cascading Full Adders.



This cascade of full adders correctly sums pairs of 3-bit binary nos.

Circuit of 66 transistors!

Eg. $A = 101$, $B = 111$

$$A + B = 101 + 111 = 1100$$

(carries: 1 1)

0	0000
1	0001
2	0010
3	0011
4	0100
5	0101 A
6	0110
7	0111 B
8	1000
9	1001
10	1010
11	1011
12	1100 A+B