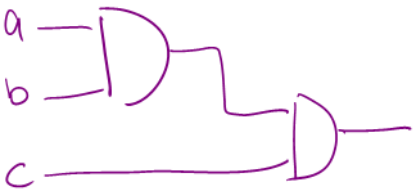
Warm up!

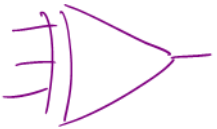
Can I ~~build~~ make an *n*-input AND from 2-input AND gates?

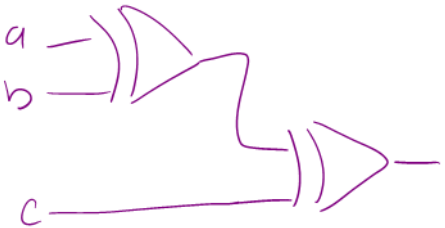
n = 3



Warm up!

What about XOR gates?





Adder, Clocks

CS 2130: Computer Systems and Organization 1

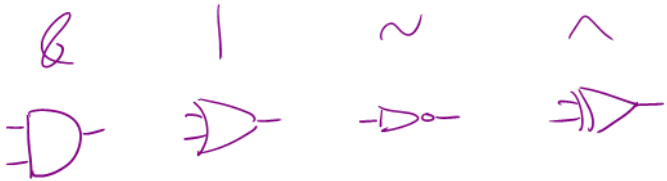
September 9, 2022

Announcements

- Quiz 2 out at 5pm, due Monday at 8am
- Homework 1 due Monday
- New Location! **Gilmer 301** on Monday It's official!

Review

- Transistors
- Information modeled by voltage through wires (1 vs 0)
- Gates



- Examples of AND, NOT gates
- Multi-bit values: representing integers
  - Signed and unsigned
- Floating point

How to do the work of multi-bit?

Multi-bit Mux

Our first multi-bit example: mux

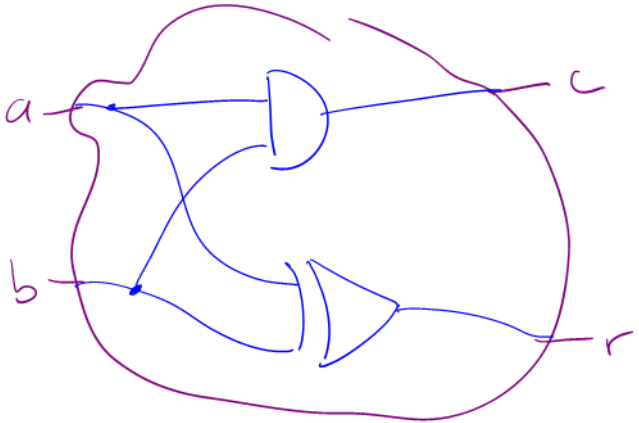
Adder

10_2

Add 2 1-bit numbers: a, b

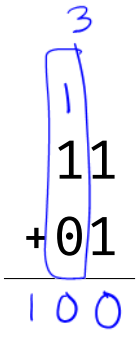
```
  a
+ b
---
 --
 c r
```

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



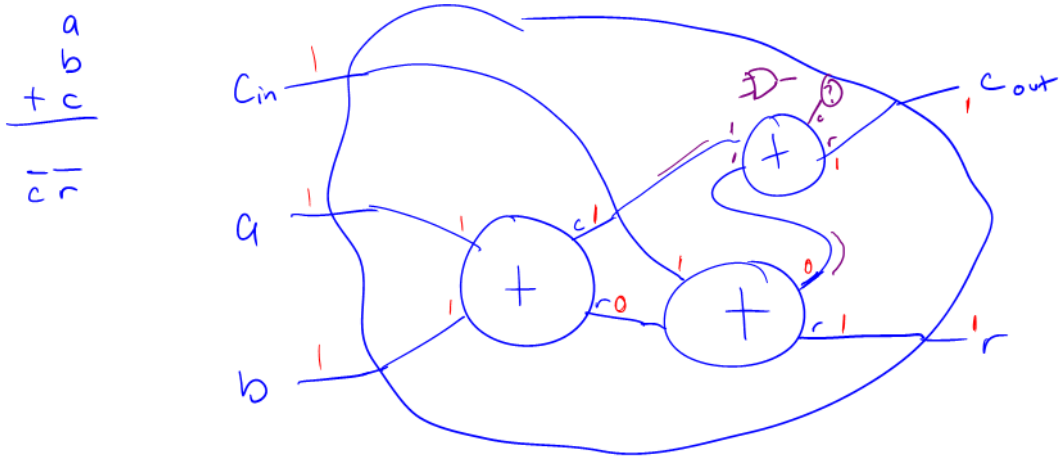
Adder

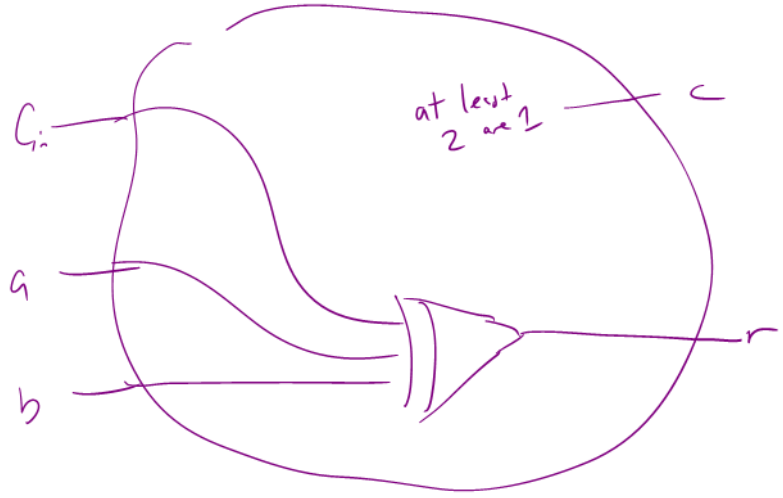
What is missing? Consider:



3-input Adder

Add 3 1-bit numbers: a, b, c




C_i
g
b
at least
2 are 1
c
r

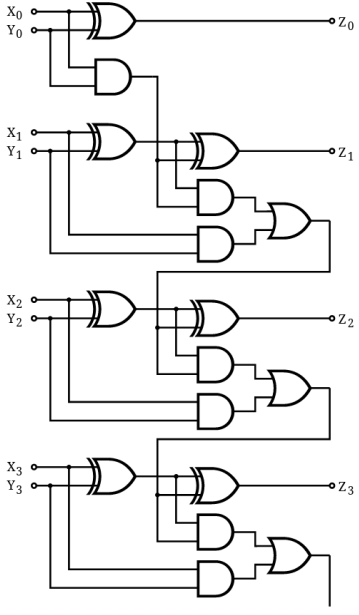
Ripple-Carry Adder

$x_3\ x_2\ x_1\ x_0$

$y_3\ y_2\ y_1\ y_0$

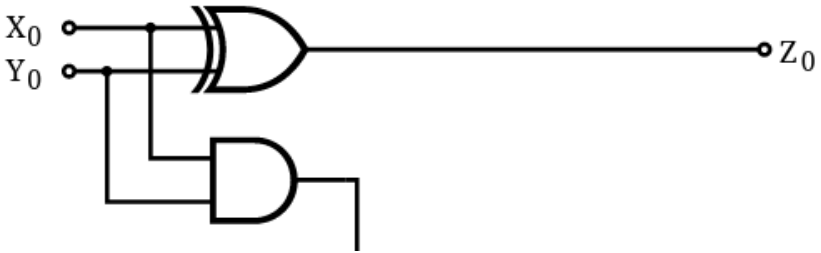
$x - y$

$\equiv$

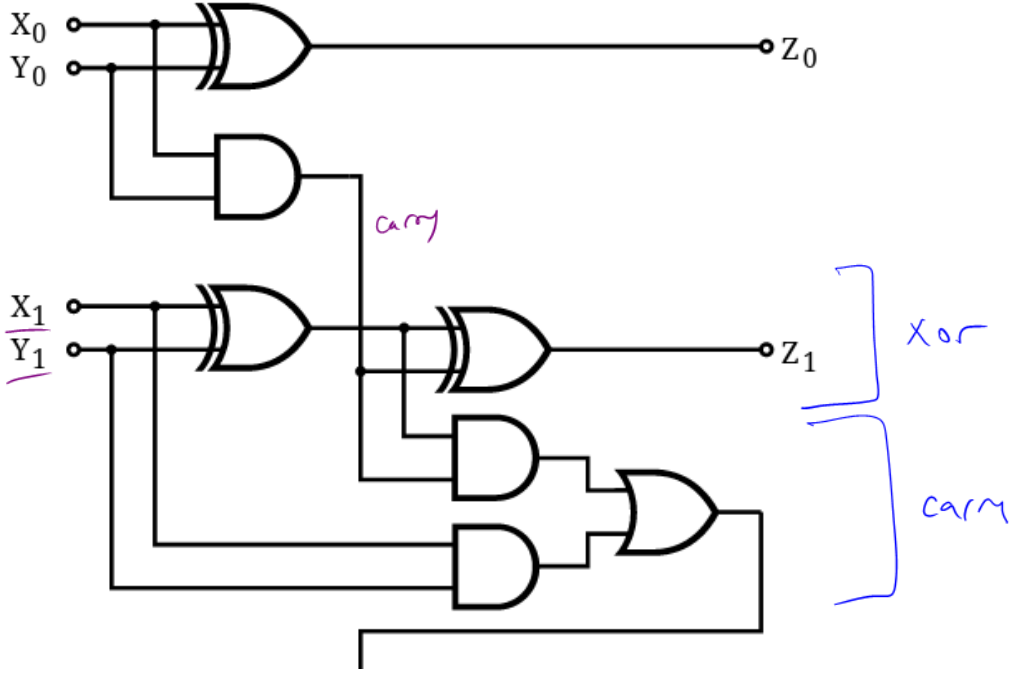


$z_3\ z_2\ z_1\ z_0$

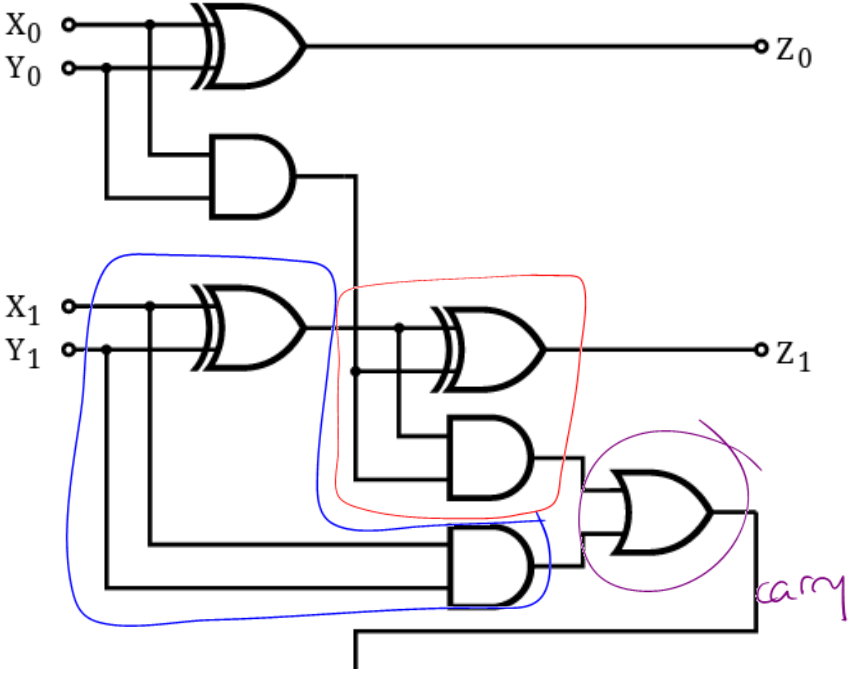
Ripple-Carry Adder



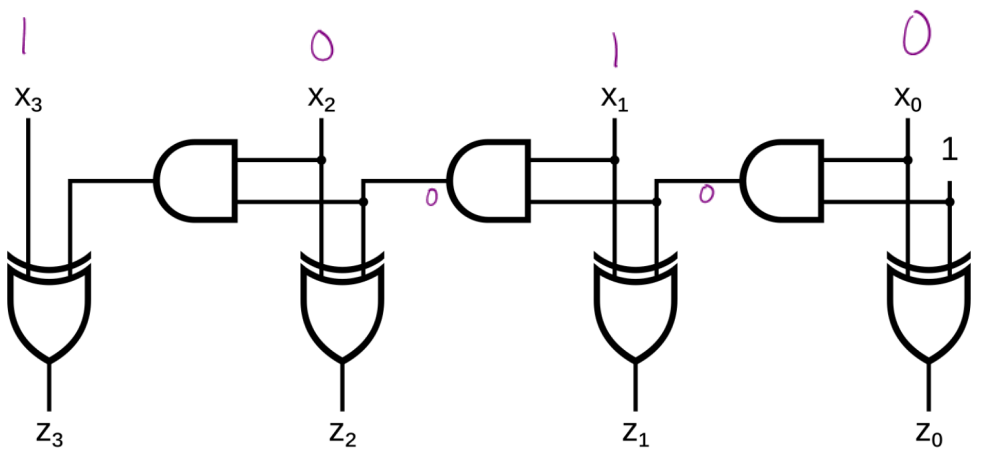
Ripple-Carry Adder



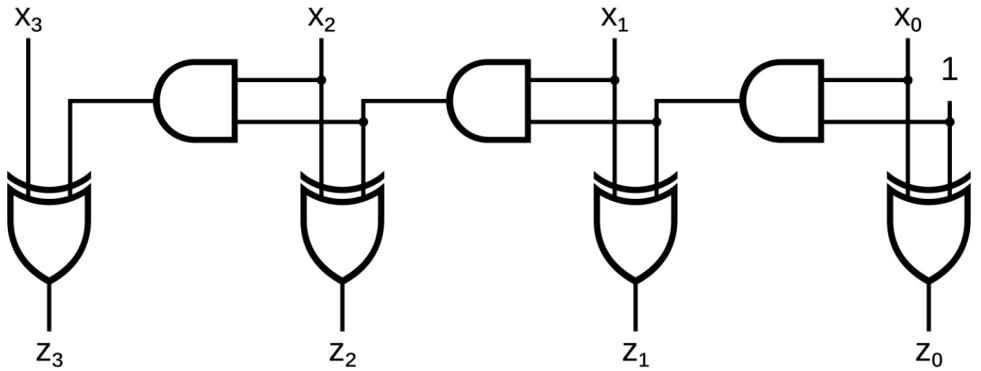
Ripple-Carry Adder



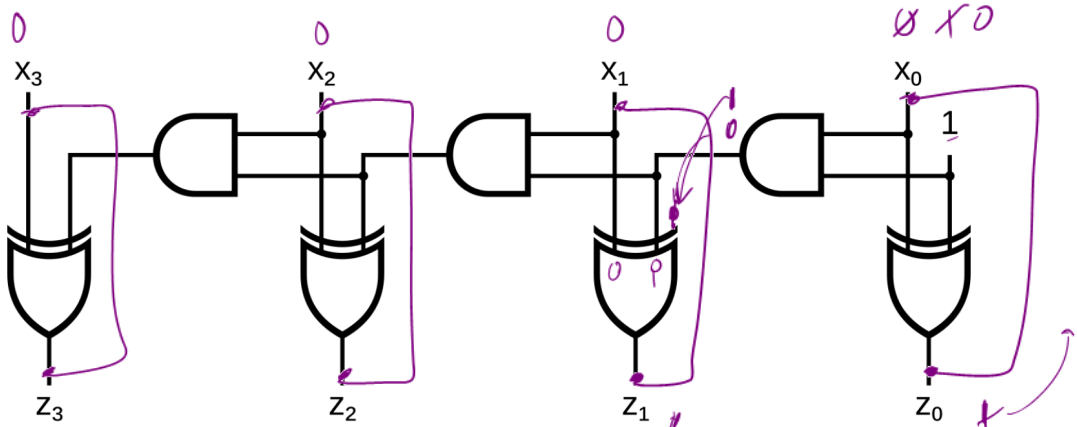
What does this circuit do?



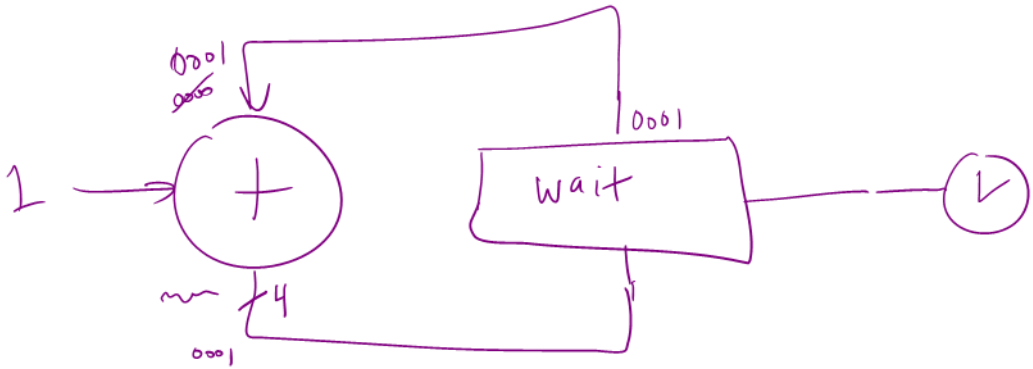
What does this circuit do?

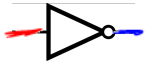
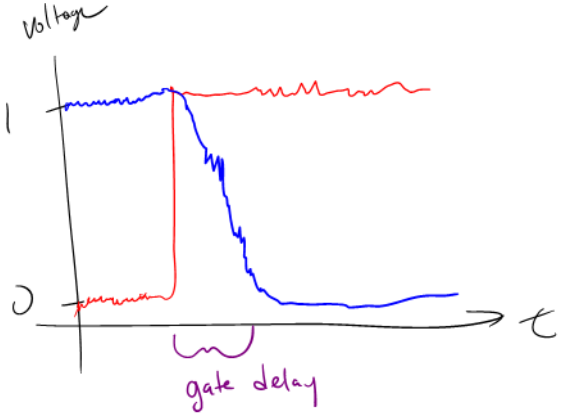


Increment Circuit



Building a Counter



Gate Delay

What happens when I change my input?