

Clocks, Registers, Other Hardware

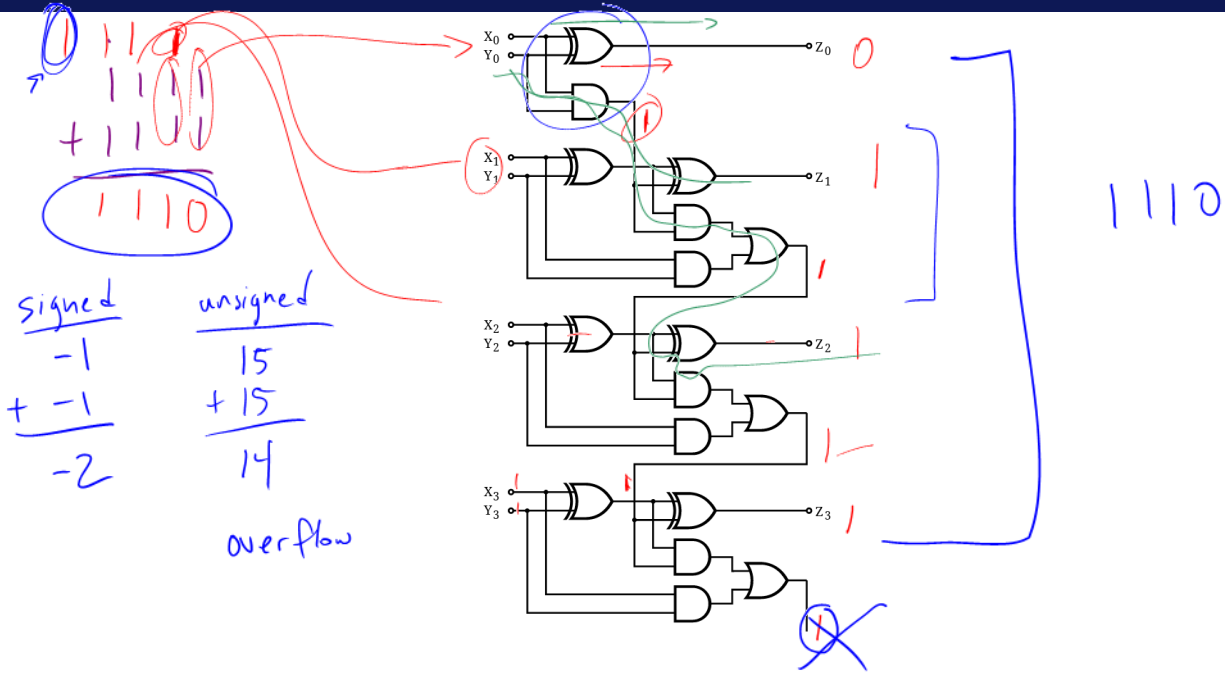
CS 2130: Computer Systems and Organization 1

February 3, 2023

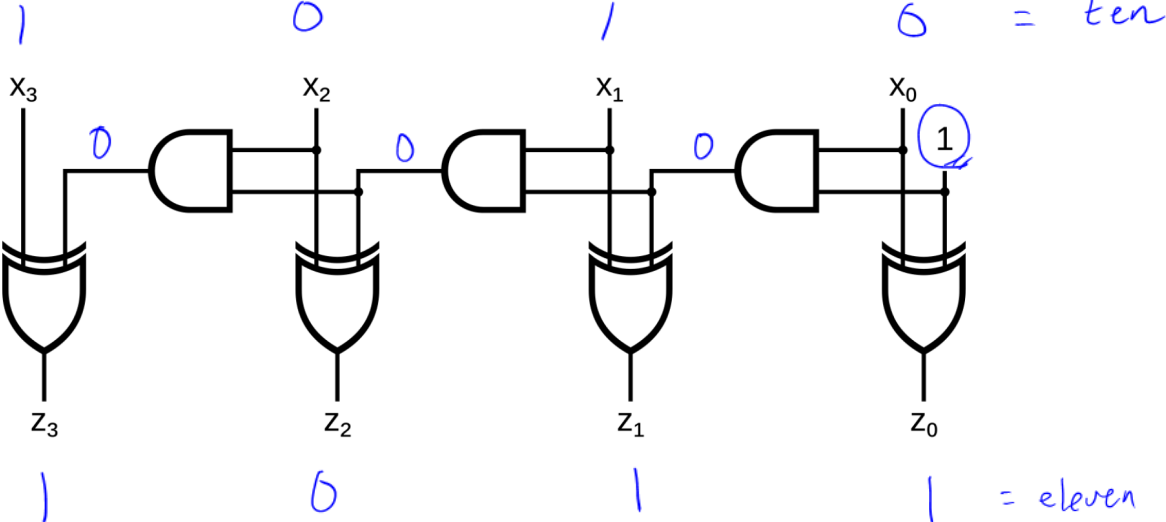
Announcements

- Quiz 2 out later today, due Sunday at 11:59pm
- Please join our Discord server
- Homework 1 due Monday
- Homework 2 available Monday

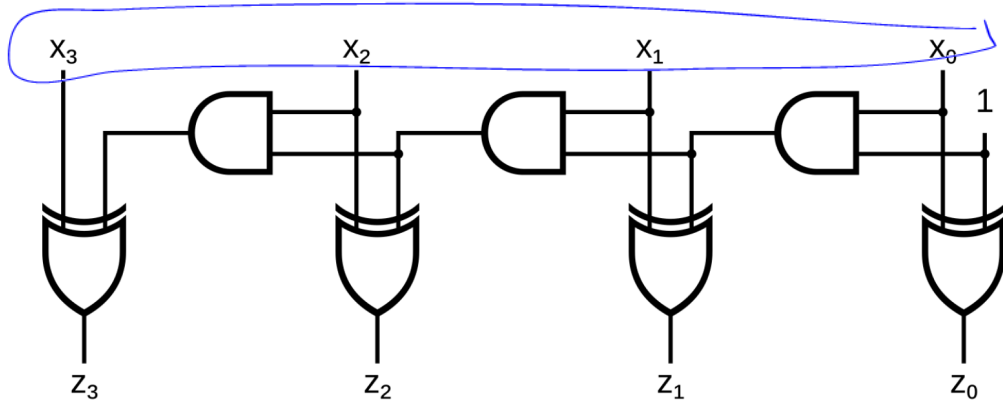
Ripple-Carry Adder



What does this circuit do?

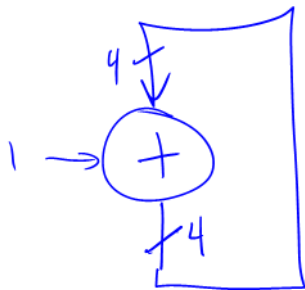


Increment Circuit



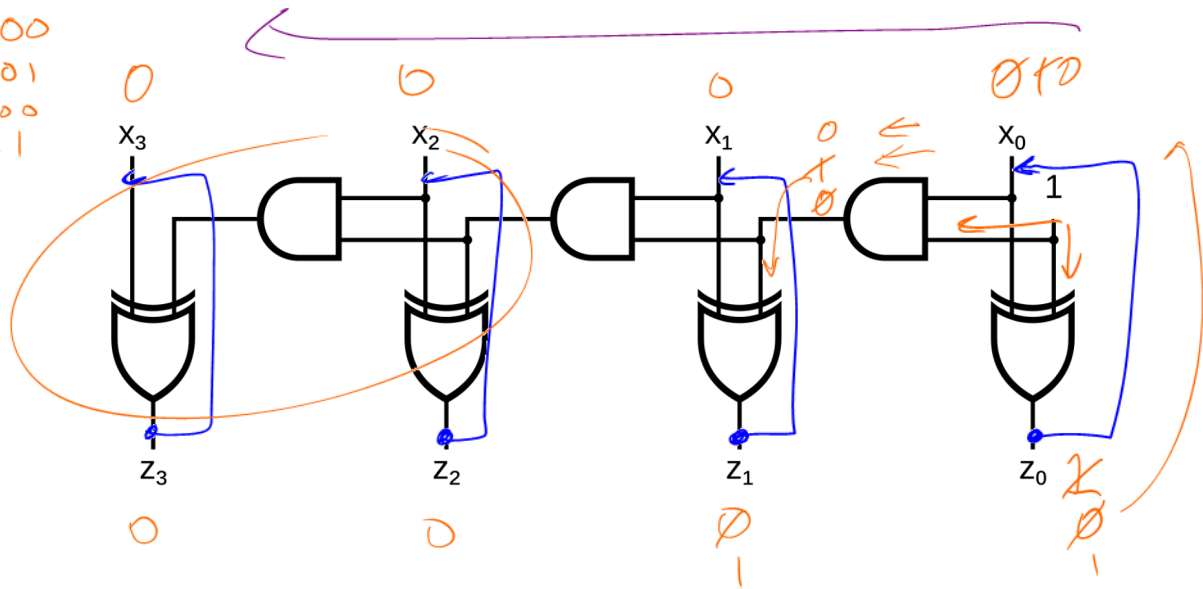
Building a Counter

want



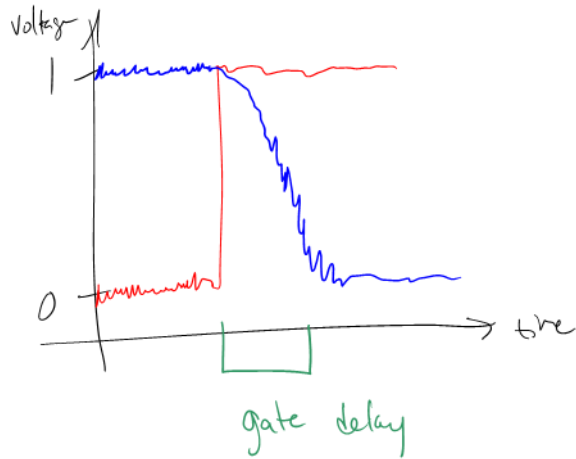
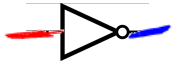
Building a Counter

0000
0001
0010
0011

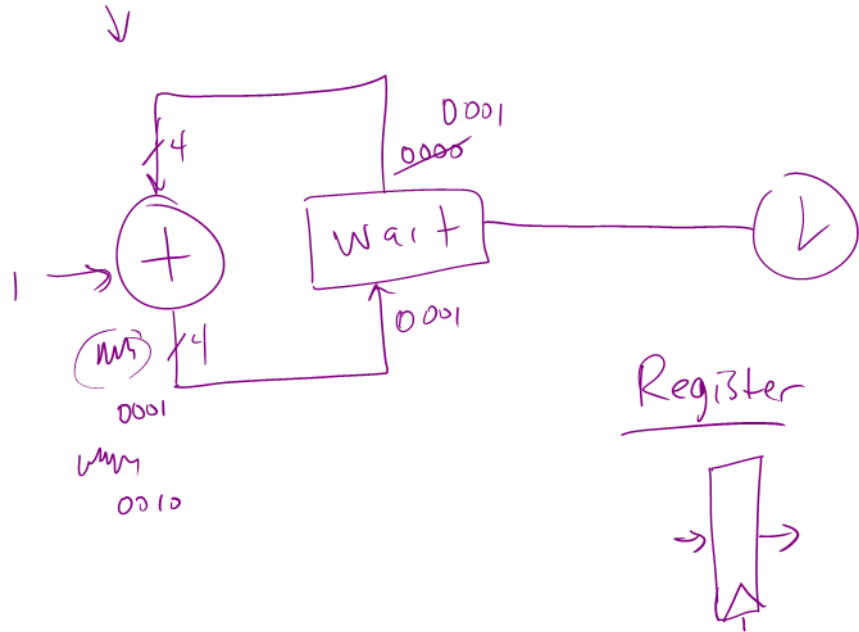


Gate Delay

What happens when I change my input?



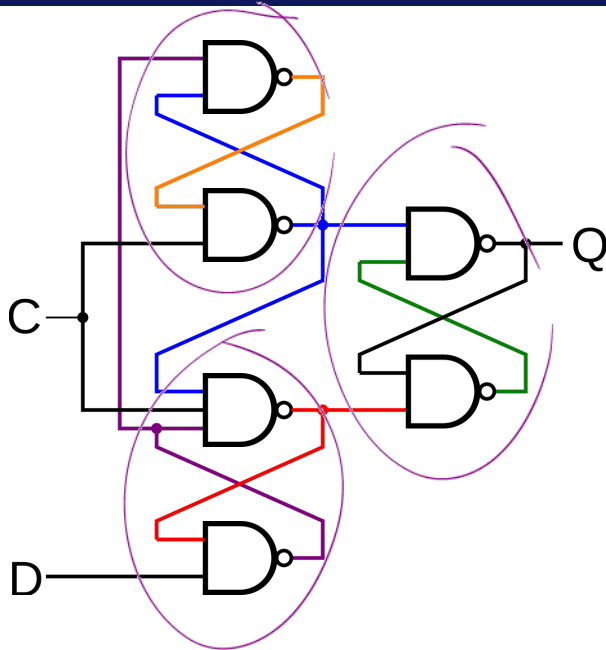
Building a Counter - Waiting



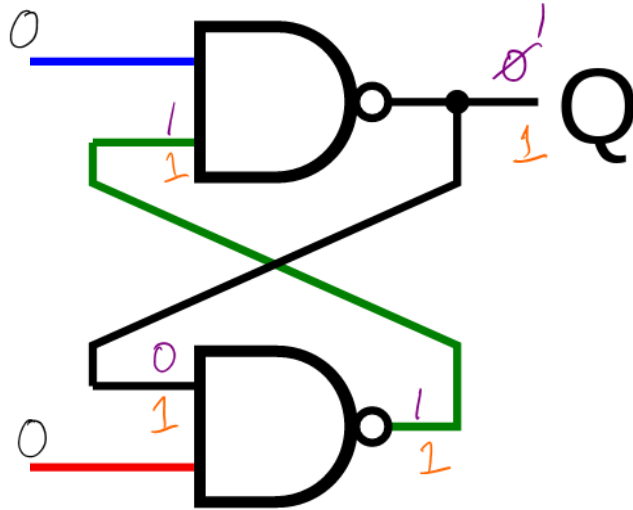
1-bit Register Circuit

NAND

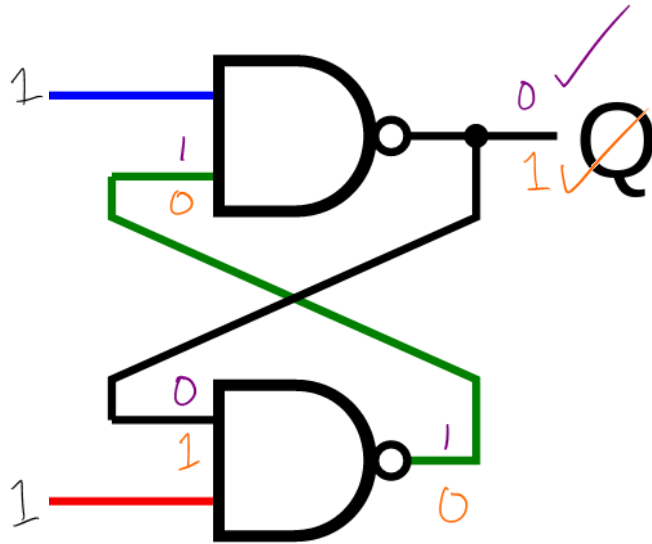
00	1
01	1
10	1
11	0



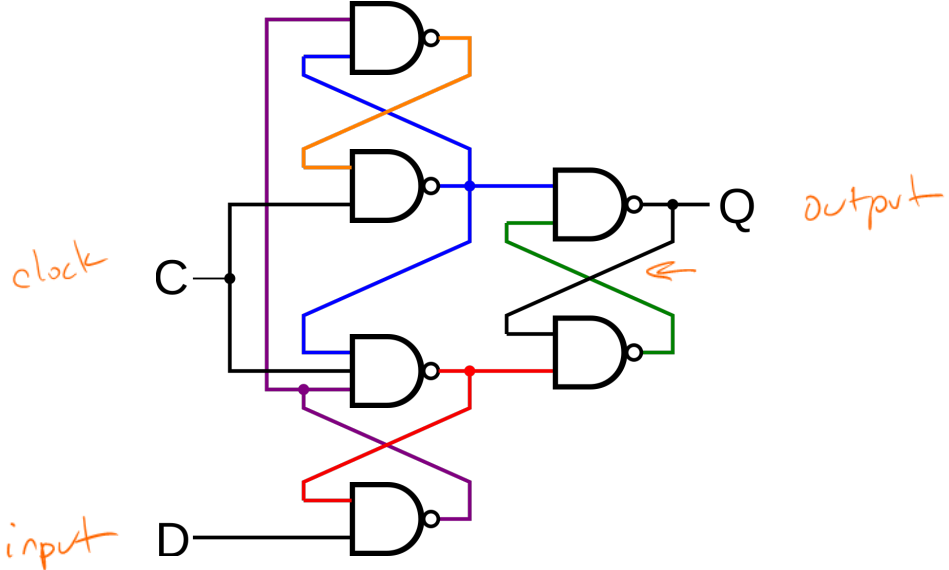
1-bit Register Circuit



1-bit Register Circuit

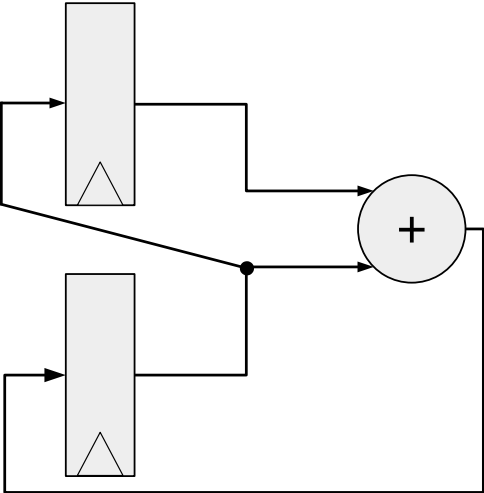


1-bit Register Circuit

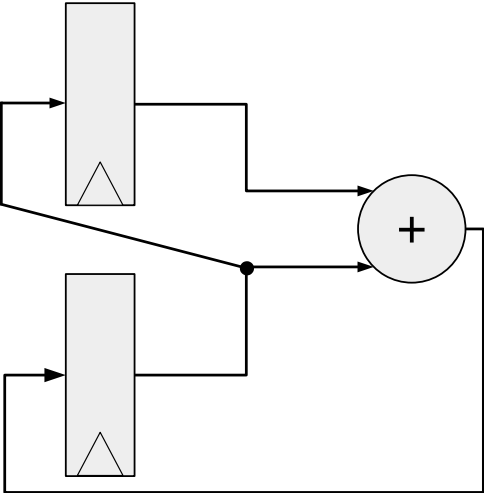


Building a Counter

Another Circuit



Another Circuit



Common Model in Computers

Code to Build Circuits from Gates

Write code to build circuits from gates

- Gates we *already* know: $\&$, $|$, \wedge , \sim
- Operations we can build from gates: $+$, $-$
- Others we can build:

Code to Build Circuits from Gates

Write code to build circuits from gates

- Gates we *already* know: $\&$, $|$, \wedge , \sim
- Operations we can build from gates: $+$, $-$
- Others we can build:
- Ternary operator: $?$ $:$

Equals

Equals: =

- Attach with a wire (i.e., connect things)
- Ex: $z = x * y$

Equals

Equals: =

- Attach with a wire (i.e., connect things)
- Ex: $z = x * y$
- What about the following?

$$x = 1$$

$$x = 0$$

Equals

Equals: =

- Attach with a wire (i.e., connect things)
- Ex: $z = x * y$
- What about the following?

$$x = 1$$

$$x = 0$$

- **Single assignment:** each variable can only be assigned a value once