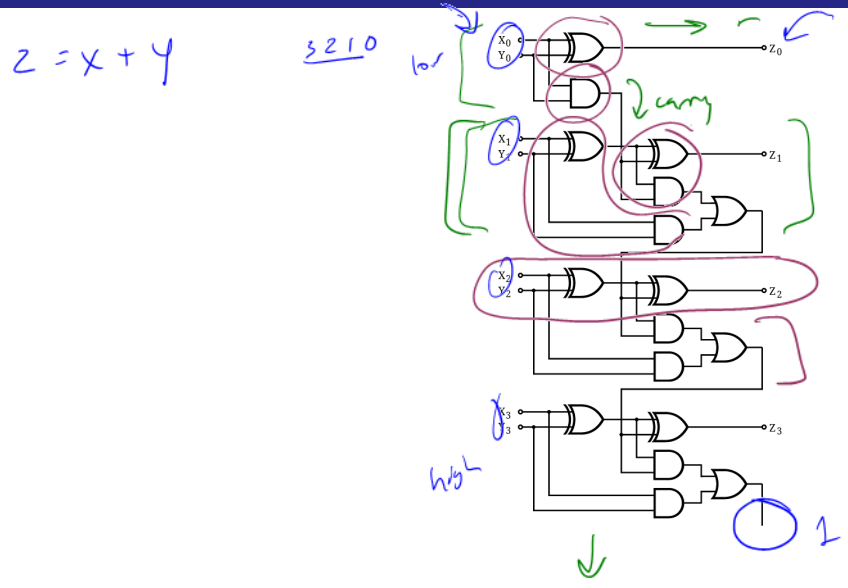
Clocks, Registers, Other Hardware

CS 2130: Computer Systems and Organization 1
September 12, 2025

Announcements

- Quiz 2 out later today, due Sunday at 11:59pm
- Homework 1 due Monday
- Homework 2 available Monday

Ripple-Carry Adder



Ripple-Carry Adder

$z = x - y$

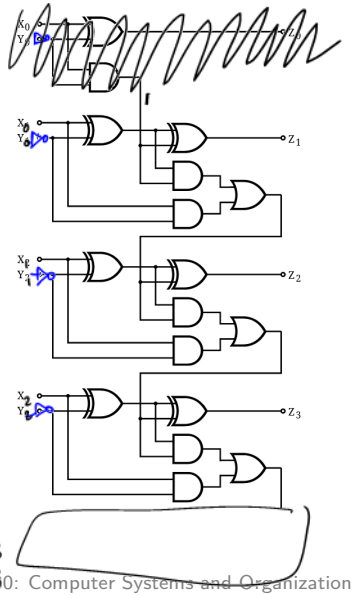
$z = x + (-y)$

$\uparrow$

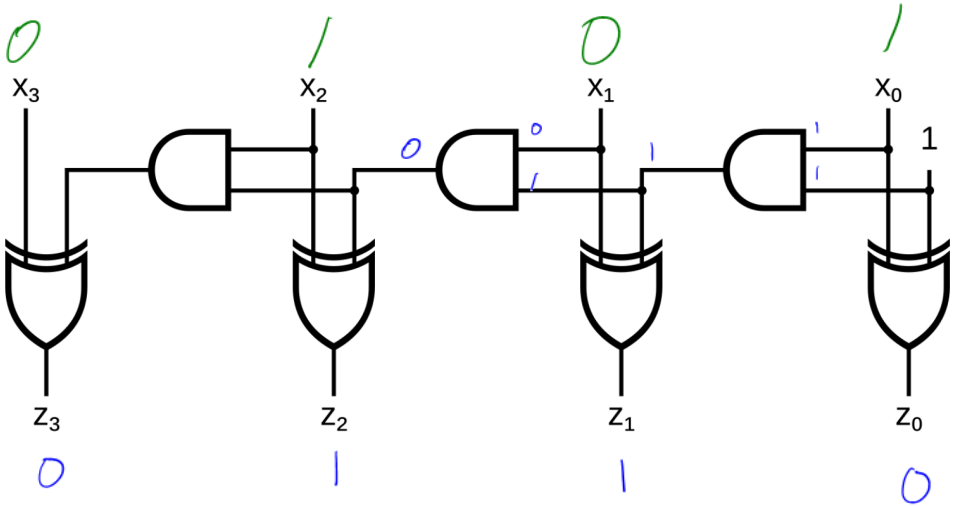
$\sim$

$+1$

$z = x + (\sim y) + 1$



What does this circuit do?



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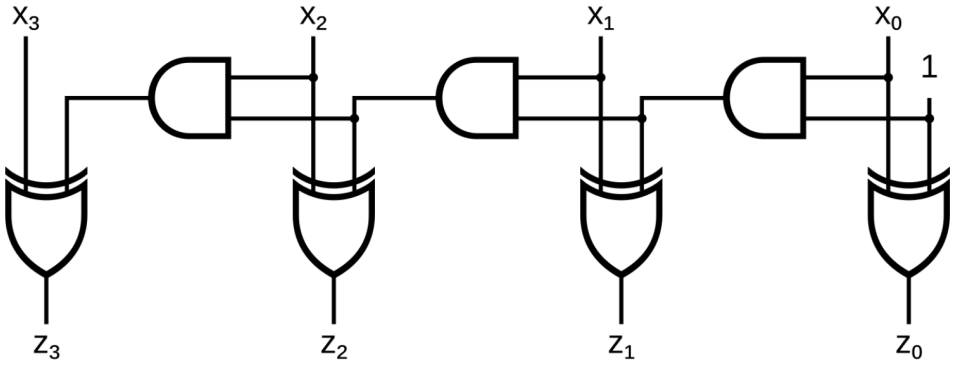
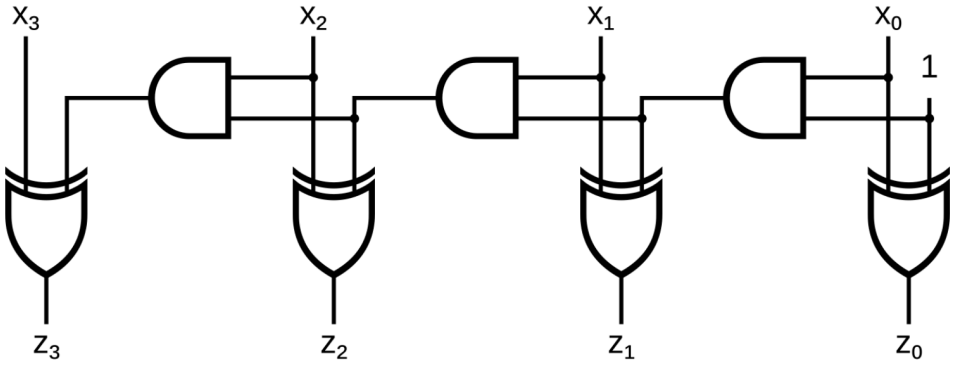
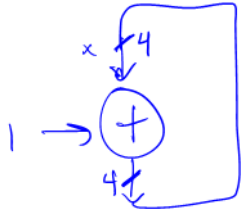


Increment Circuit



Building a Counter



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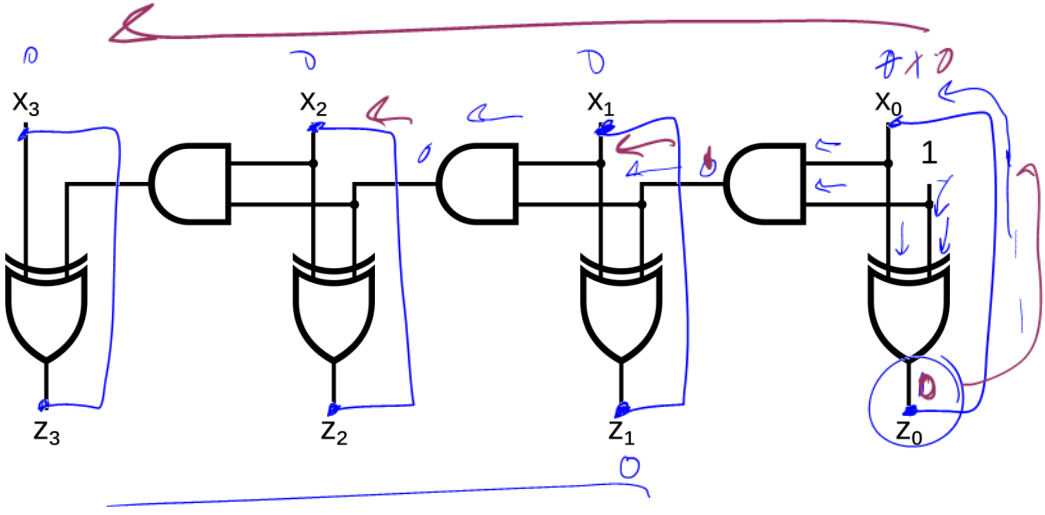
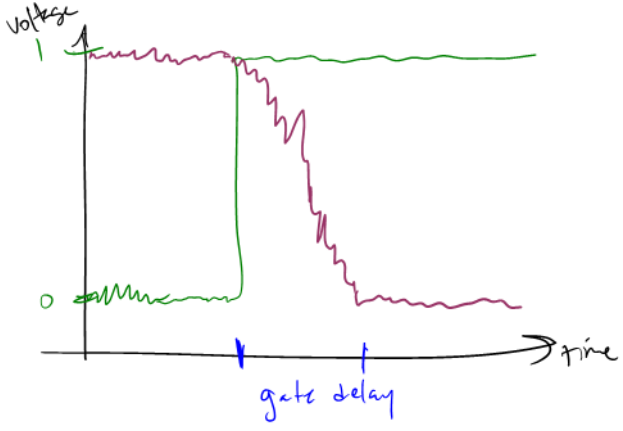
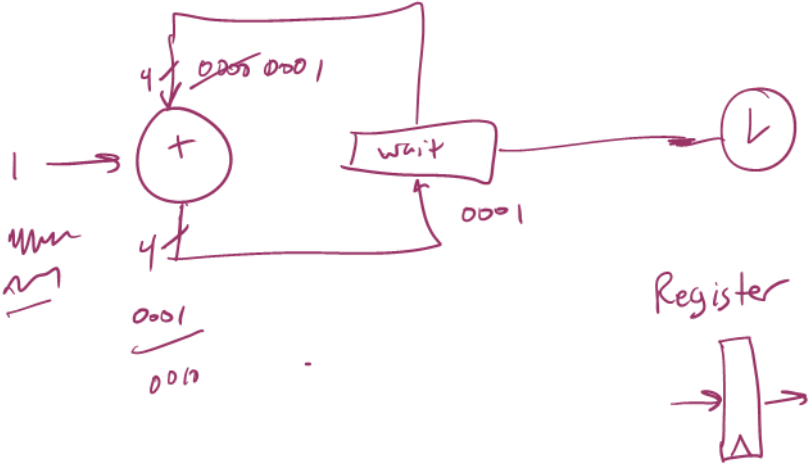


Gate Delay

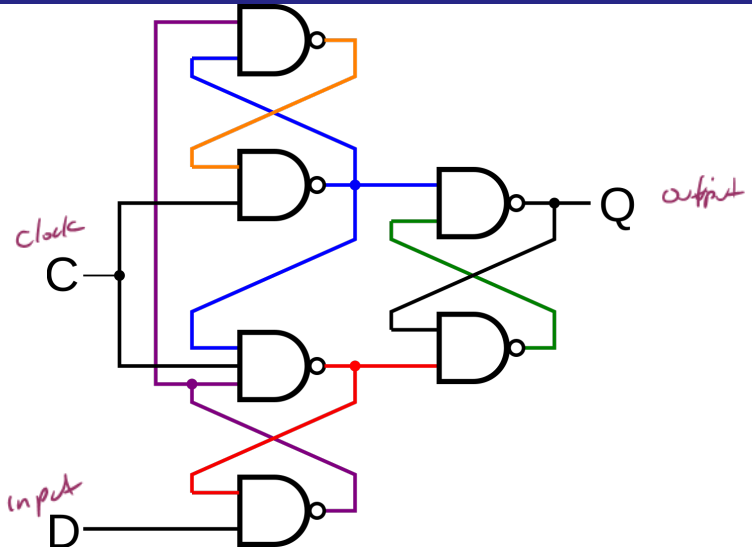
What happens when I change my input?



Building a Counter - Waiting



1-bit Register Circuit



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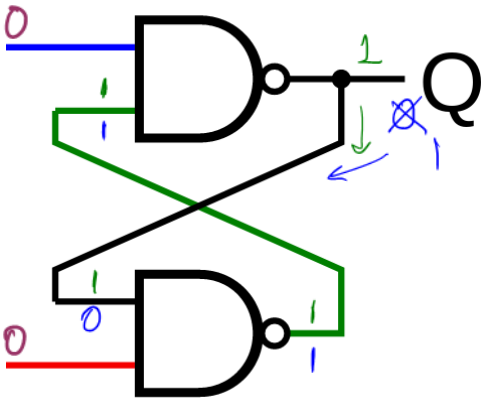

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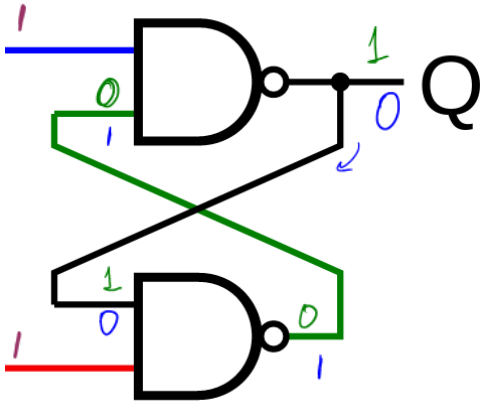
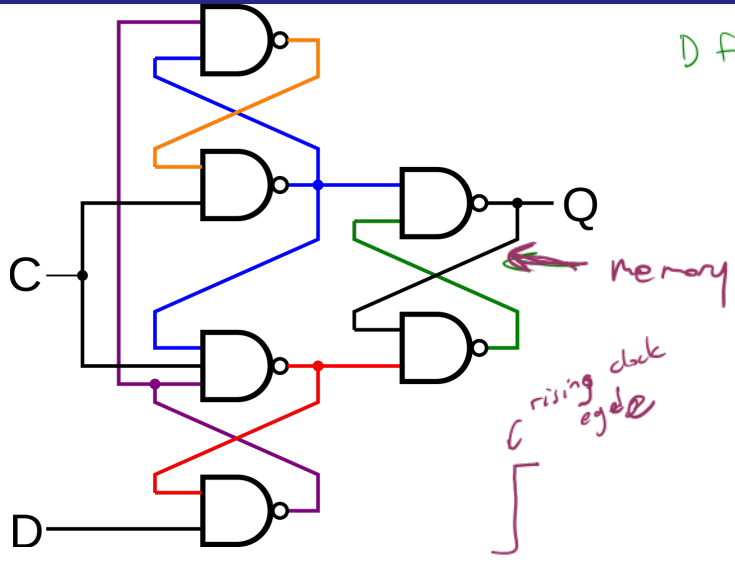
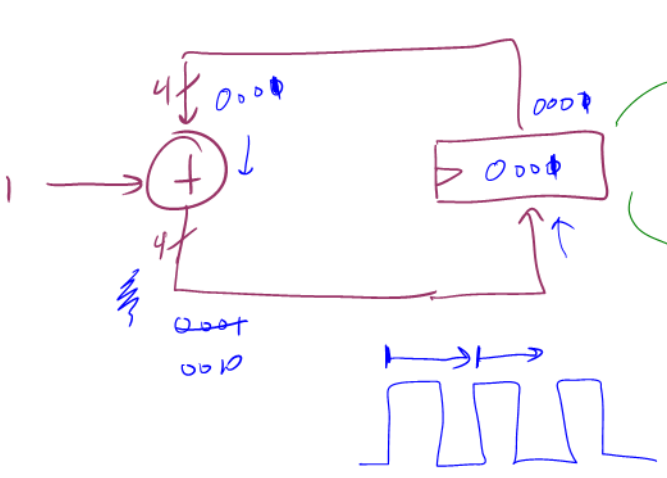
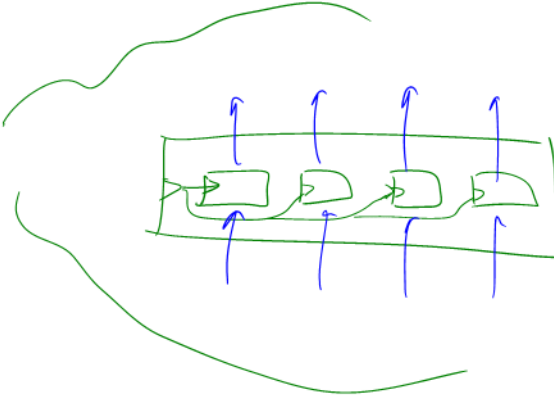


1-bit Register Circuit

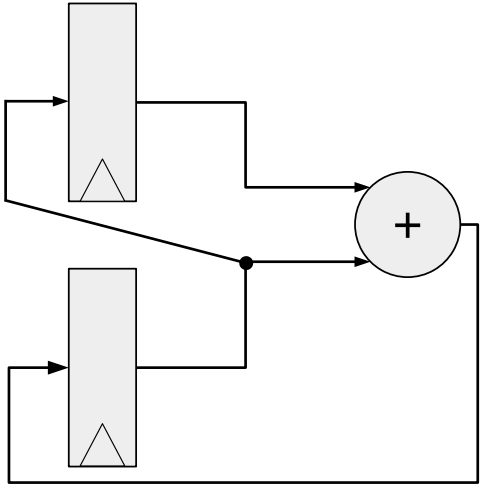


Building a Counter

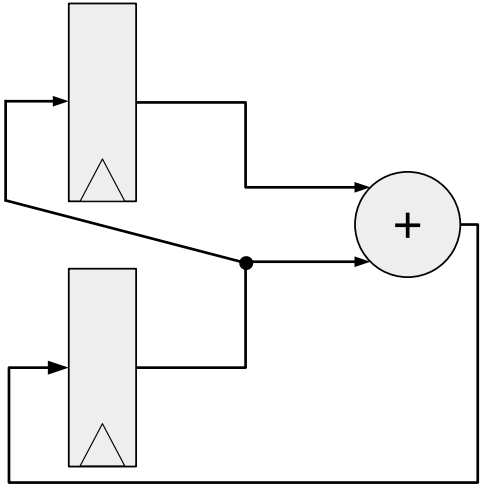




Another Circuit



Another Circuit



Common Model in Computers

Code to Build Circuits from Gates

Write code to build circuits from gates

- Gates we *already* know: `&`, `|`, `^`, `~`
- Operations we can build from gates: `+`, `-`
- Others we can build:

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- Gates we *already* know: `&`, `|`, `^`, `~`
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- Others we can build:
- Ternary operator: `?` `:`

Equals

Equals: `=`

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

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- 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