Reading 10

13.1 SR Latches

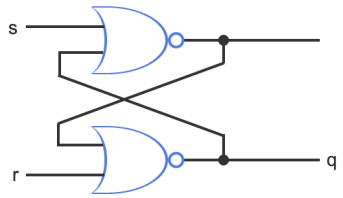
- A sequential circuit's output depends on the present and the past sequence of input values, which means the circuit stores at least one bit.

- In Contrast, a combinational circuit's output depends only on the present combination of input values.

- The simplist circuit for storing a bit is called a latch.
- An SR latch stores one bit, with an input s ("set") to set the latch to 1, an input r ("reset") to reset the latch to 0, and the stored bit appearing on output q.

- SR latch behavior:

s	r	q
0	0	Previously stored bit
0	1	0 ("Reset")
1	0	1 ("Set")
1	1	Unknown



- SR = 11 is problematic because it causes the latch to oscillate. Eventually the latch will settle to 0 or 1, but which is unknown. The latch only settles because of gate and wire delays.

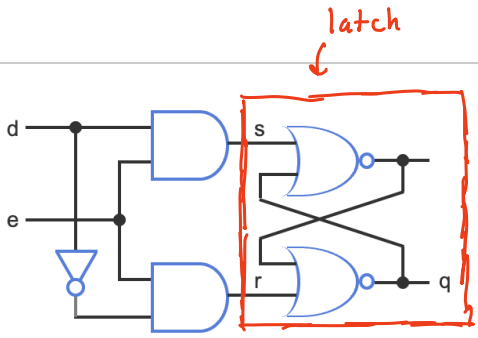
- SR latches are uncommon today.

13.2 Clocks, D flip-flops, and registers

- A D latch stores 1 bit, with input d ("data") having the bit to be stored, an input e ("enable") that when 1, enables storing the bit, and the stored bit appearing output q.

D Latch Behavior:

e	d	q
0	0	Previously stored bit (d is ignored)
0	1	Previously stored bit (d is ignored)
1	0	0 (d is stored)
1	1	1 (d is stored)



Clock

- Most digital circuits use an oscillating signal called a clock signal to control when to store bits.

- Instead of bits being stored while an enable signal is high, bits are stored only at a clock's rising edge: the instant a clock signal changes from 0 to 1.

- A clock cycle is the time between two rising edges; that time is called the clock period.
- Clock frequency is the number of cycles per second, or hertz (Hz)

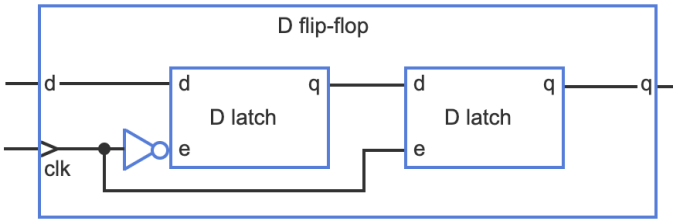
- A triangle indicates the clock input of a component.

D flip-flops

- A latch stores a new bit while an enable is 1.
  - ↳ A latch is level sensitive, storing when the enable input's "level" is high.

- In contrast, a flip-flop stores a new bit only at the instant of the clock input's rising edge.
- A flip-flop is edge-triggered.

- A flip flop implemented by 2 latches with the first latch's enable input inverted, has a main-secondary arrangement.
  - ↳ Other implementations exist.



Basic Register

- A register is a circuit that stores a group of bits.
  - ↳ On a rising clock edge, all bits are stored simultaneously.
- Storing bits in a register is called loading the register.