Exercises with Sequential Logic

CS 64: Computer Organization and Design Logic

Lecture #15

Winter 2020

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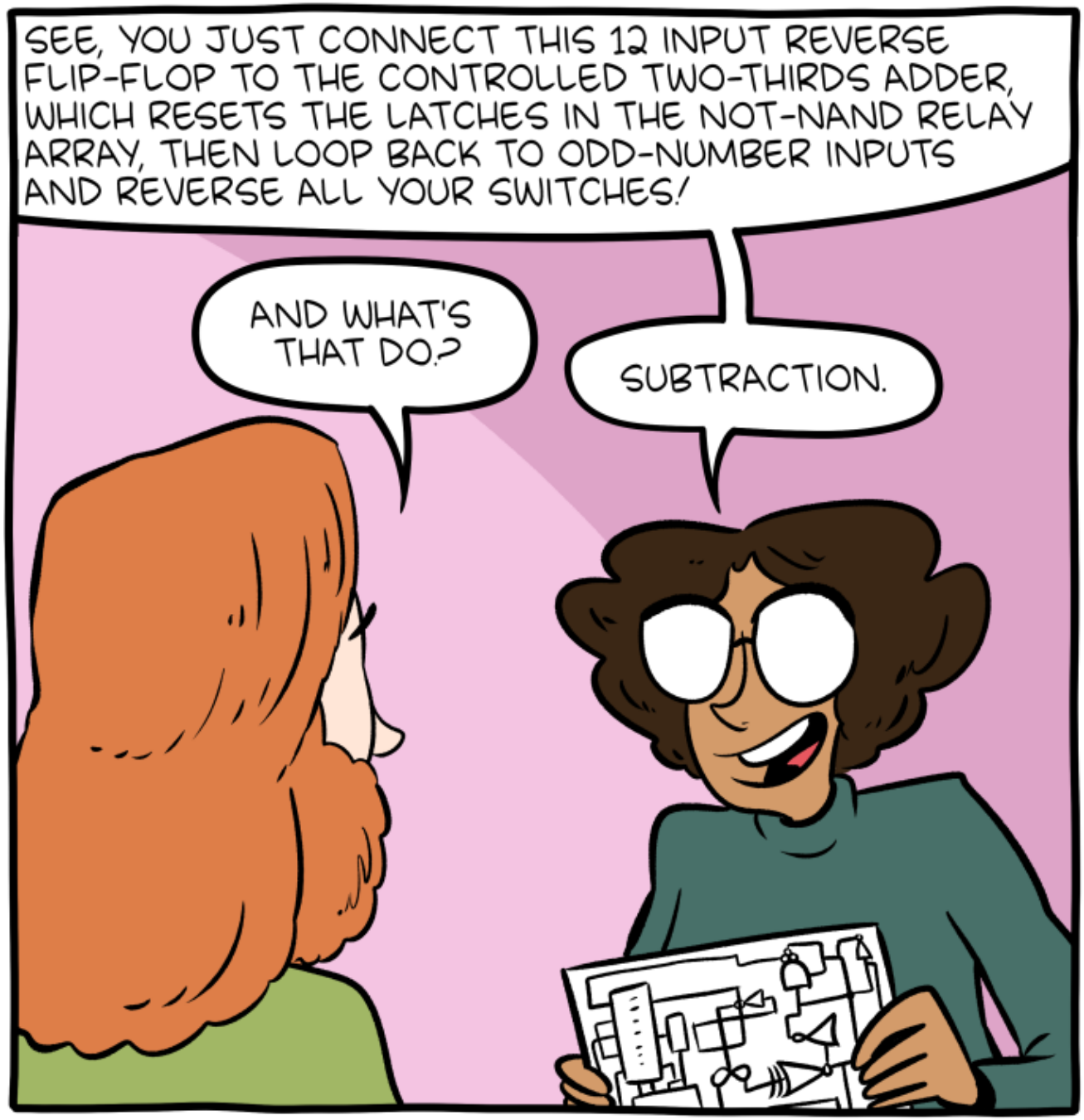
THIS IS WHAT LEARNING LOGIC GATES FEELS LIKE



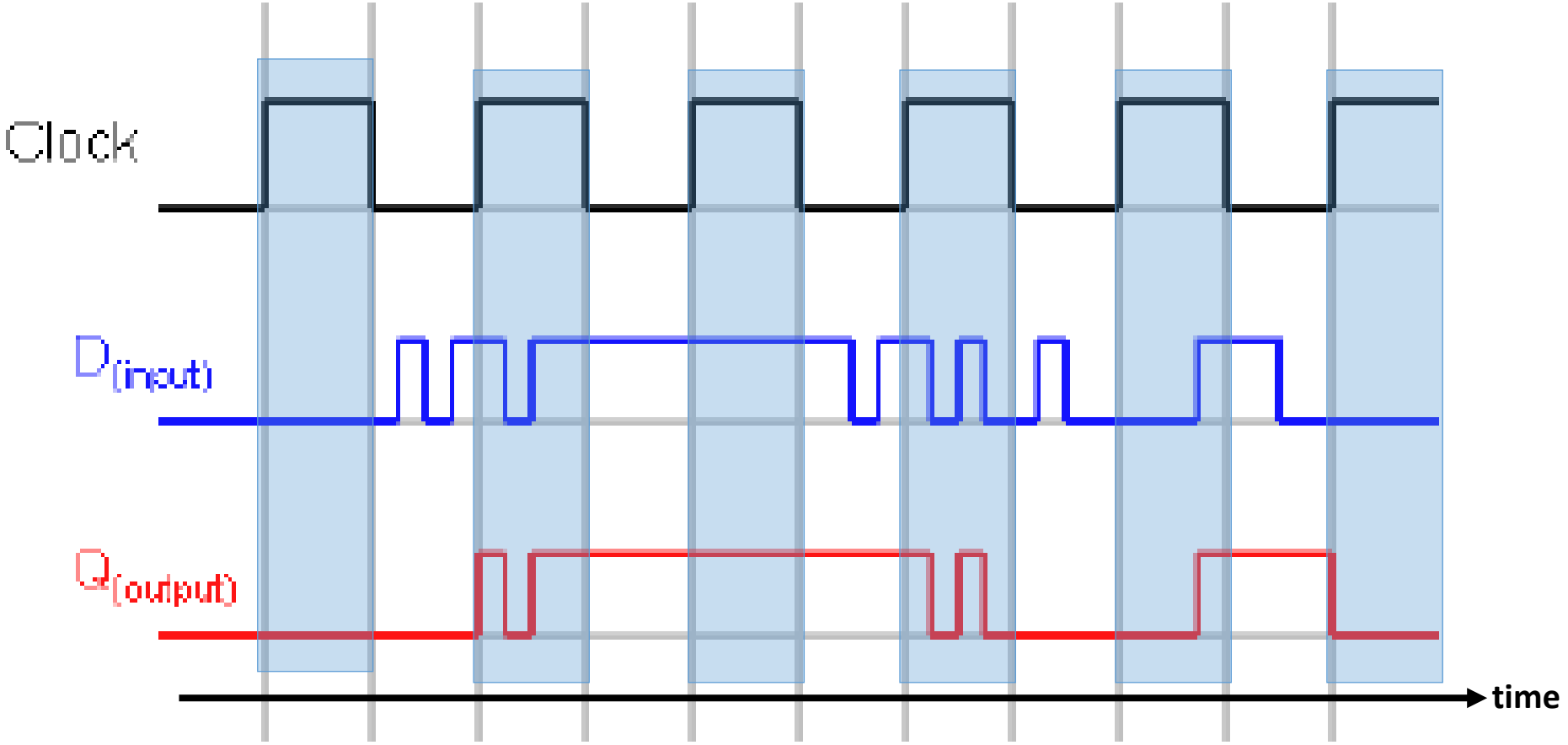
Administrative

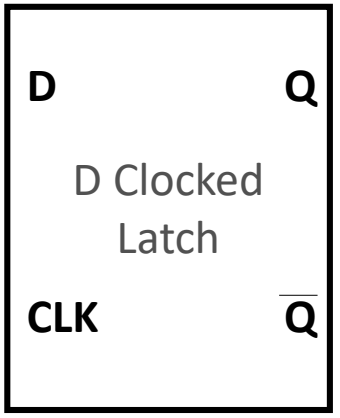
- Lab 8 will be posted today

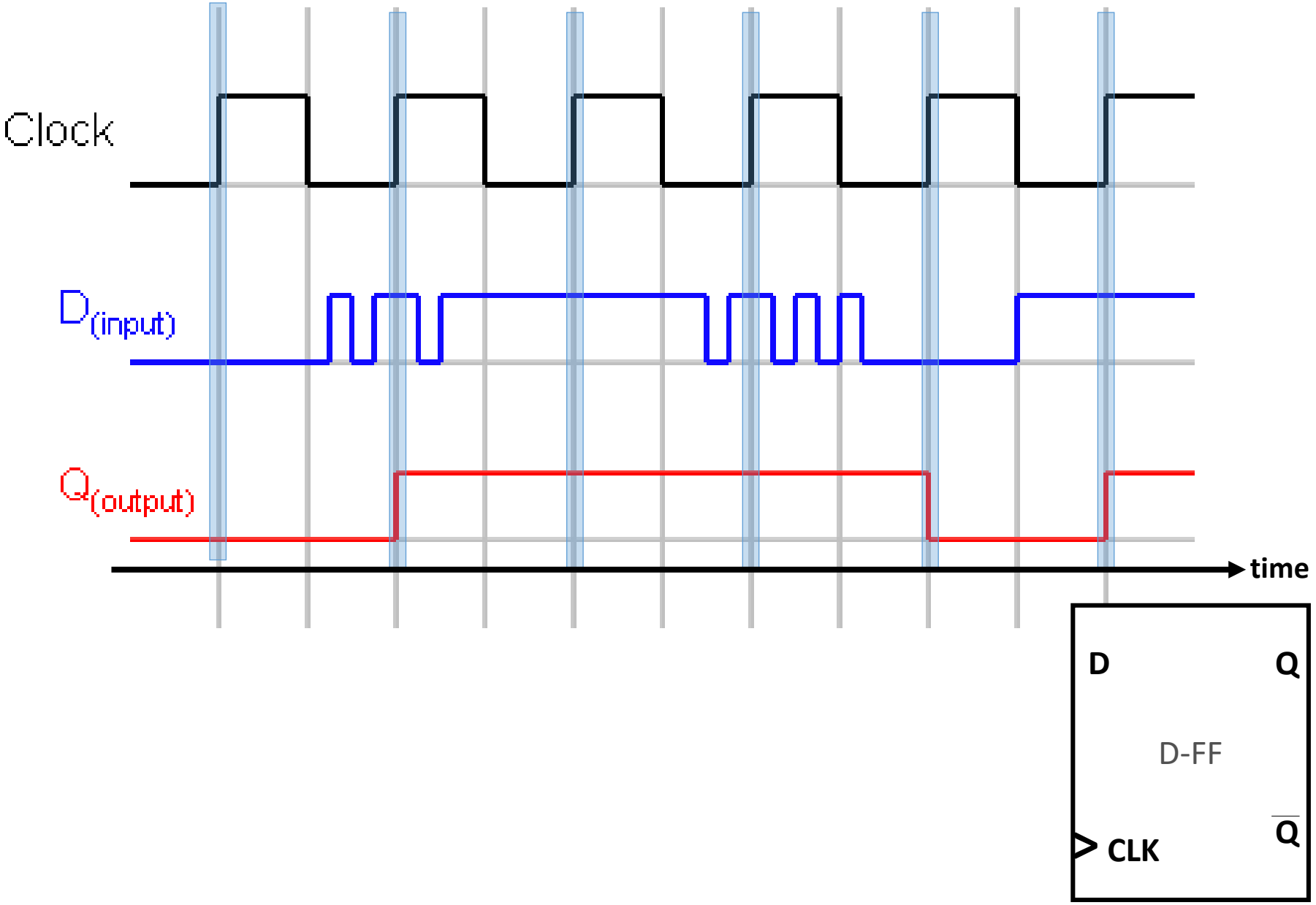
- Final Exam Info:
  - **Tuesday, March 17th at 7:30 PM** in this classroom
    - Arrive 10 mins early – randomized seating…
  - Cumulative Exam
  - Study guide/example Qs will be issued by this weekend
  - More details to follow

Lecture Outline

- Exercises with Sequential Logic

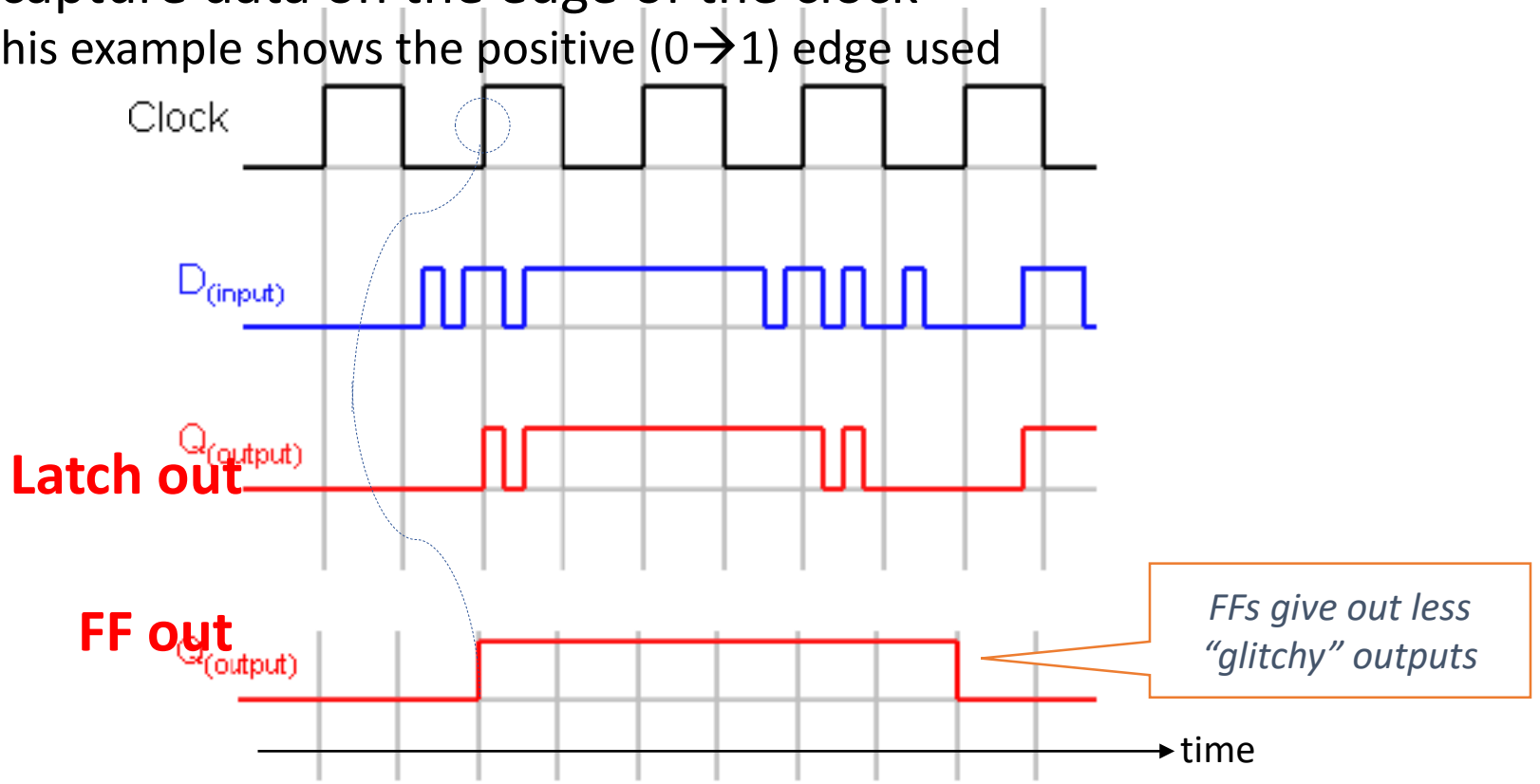

Clock
D (input)
Q (output)
time


D
Q
D Clocked Latch
CLK
Q

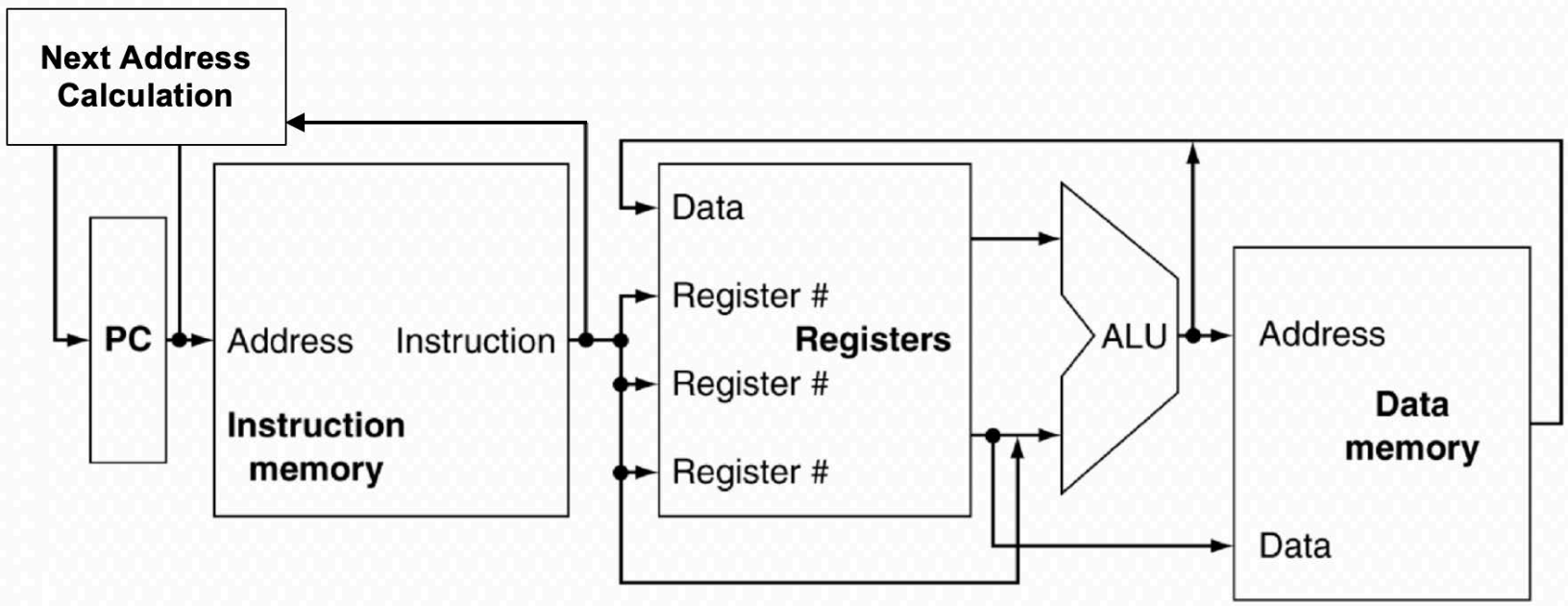

Clock
D(input)
Q(output)
time
D
Q
D-FF
CLK
Q

Latches vs. FFs

- Latches capture data on an entire 1 or 0 of the clock
- FFs capture data on the edge of the clock
  - This example shows the positive (0→1) edge used

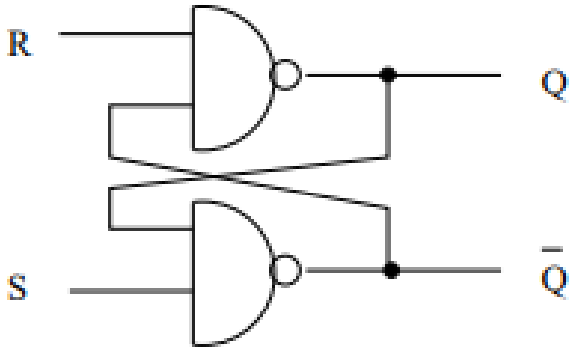


Simplified CPU Block Diagram



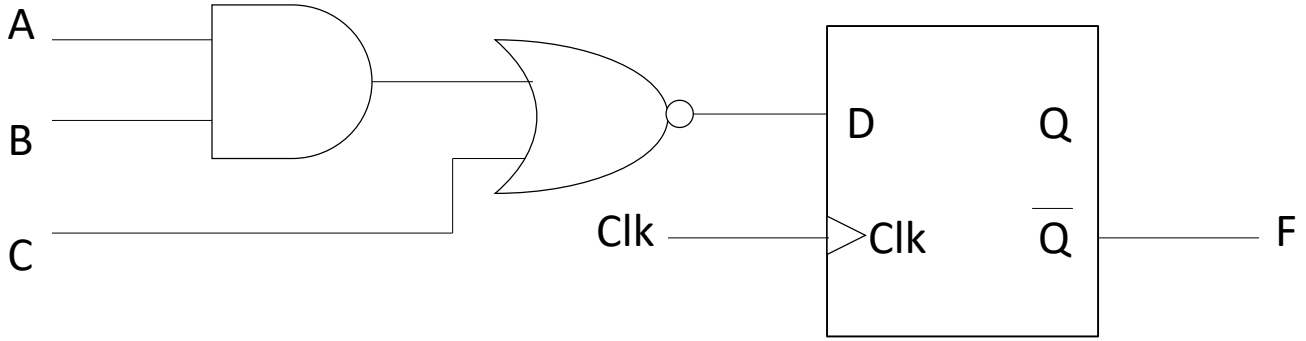
Class Exercise 1

The figure below shows an RS latch made out of NAND gates (rather than NOR gates). How do Q and $\overline{Q}$ depend on the RS inputs? i.e. verify that the circuit can indeed be used as a RS latch.



Exercise 2

Given waveforms for A, B, C, and Clk (see blackboard), determine the output waveform for F



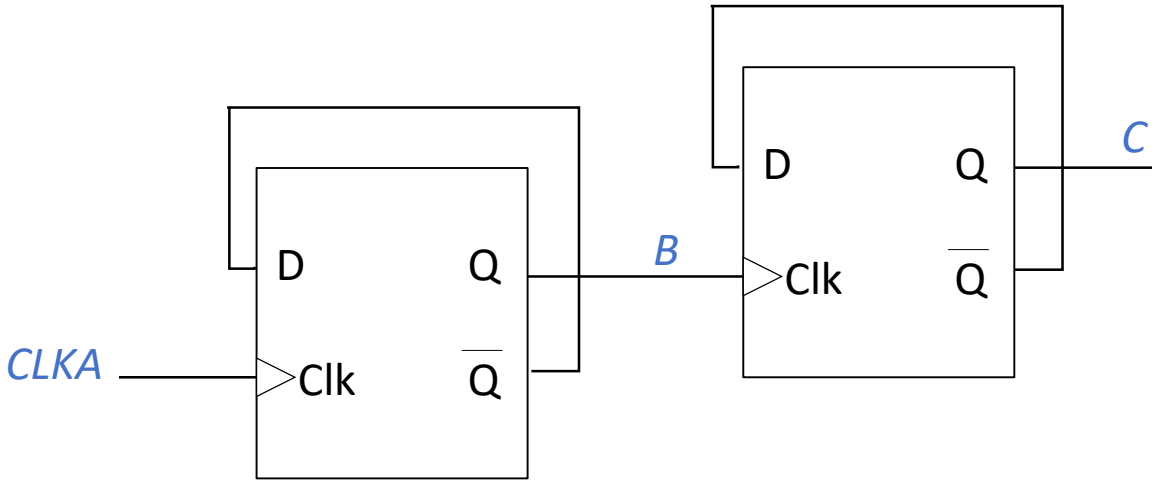
Exercise 3

- Let's design a 3-bit counter using D-FFs and logic gates.
- What's needed:
  - This counts 000 → 001 → 010 → … → 111 → 000
    - i.e. from 0 to 7 and then loops again to 0, etc…
- Draw the T.T. based on this description
  - How many inputs? How many outputs?
  - Figure out what the "next states" look like based on "current states"
- Draw K-Maps and find optimal output functions

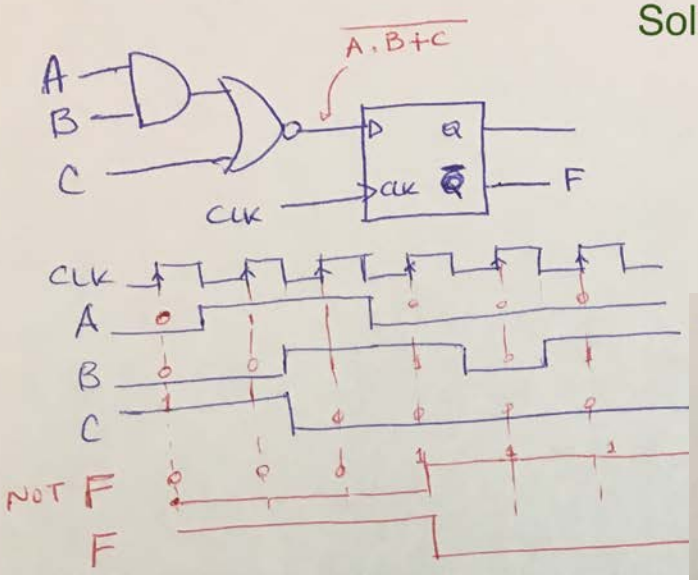
Exercise 4

- Draw the waveforms **B** and **C** for this digital circuit, given CLKA is a regular clock input.
  - Assume all inputs to the D-FFs are initially at 0.

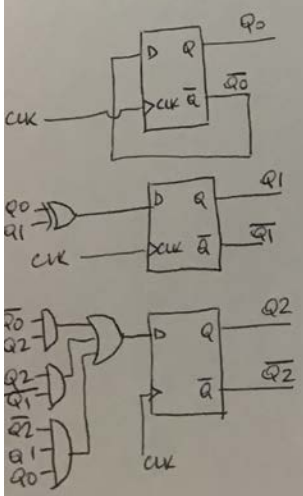
- What do you conclude about what this does?



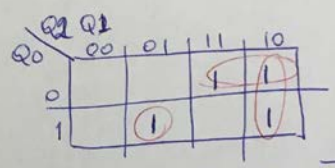
Solutions to Class Exercises 2 and 3 From Lecture 15



	Current state Q_2	Q_1	Q_0	Next state Q_2^*	Q_1^*	Q_0^*
0	0	0	0	0	0	1
1	0	0	1	0	1	0
2	0	1	0	0	1	1
3	0	1	1	1	0	0
4	1	0	0	1	0	1
5	1	0	1	1	1	0
6	1	1	0	1	1	1
7	1	1	1	0	0	0

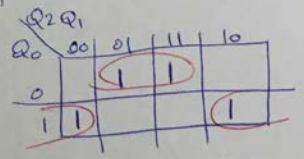


K-Map for Q_2^*



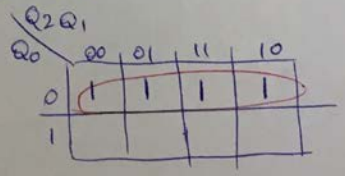
$$Q_2^* = Q_2.\overline{Q_0} + Q_2.\overline{Q_1} + \overline{Q_2}.Q_1.Q_0$$

for Q_1^*



$$Q_1^* = Q_1.\overline{Q_0} + \overline{Q_1}.Q_0 = Q_1 \oplus Q_0$$

for Q_0^*



$$Q_0^* = \overline{Q_0}$$

YOUR TO-DOs

- Lab 8

</LECTURE>