Sequential Circuit Analysis

ECE 2372 | Modern Digital System Design | Texas Tech University

Lecture Overview

Signal Tracing

Timing Charts

Mealy versus Moore Machines

Signal Tracing

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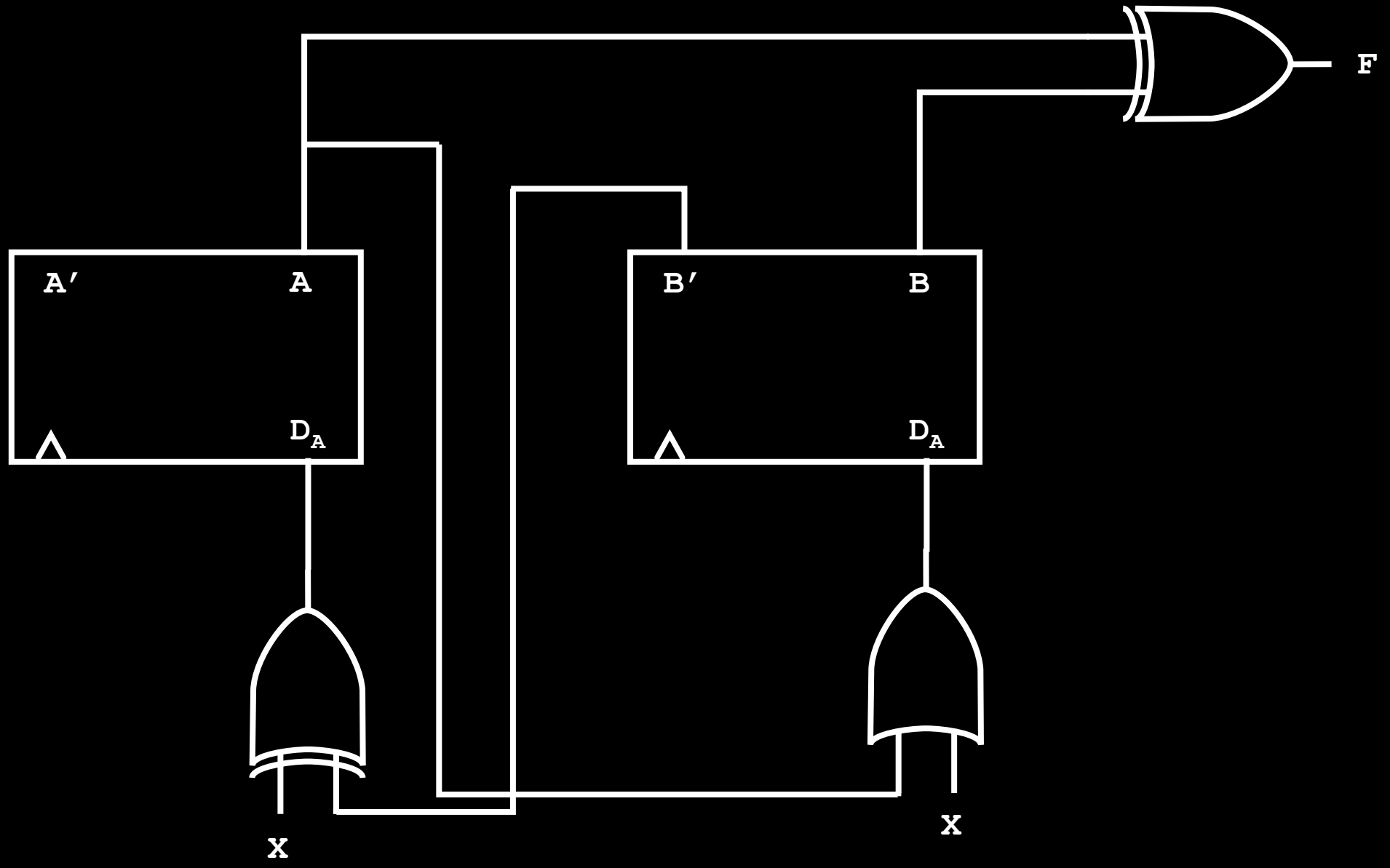
Signal Tracing

- Analyze clocked sequential circuits to find the output sequence resulting from a given input sequence by tracing 0 and 1 signals through the circuit.

We've already been doing this.

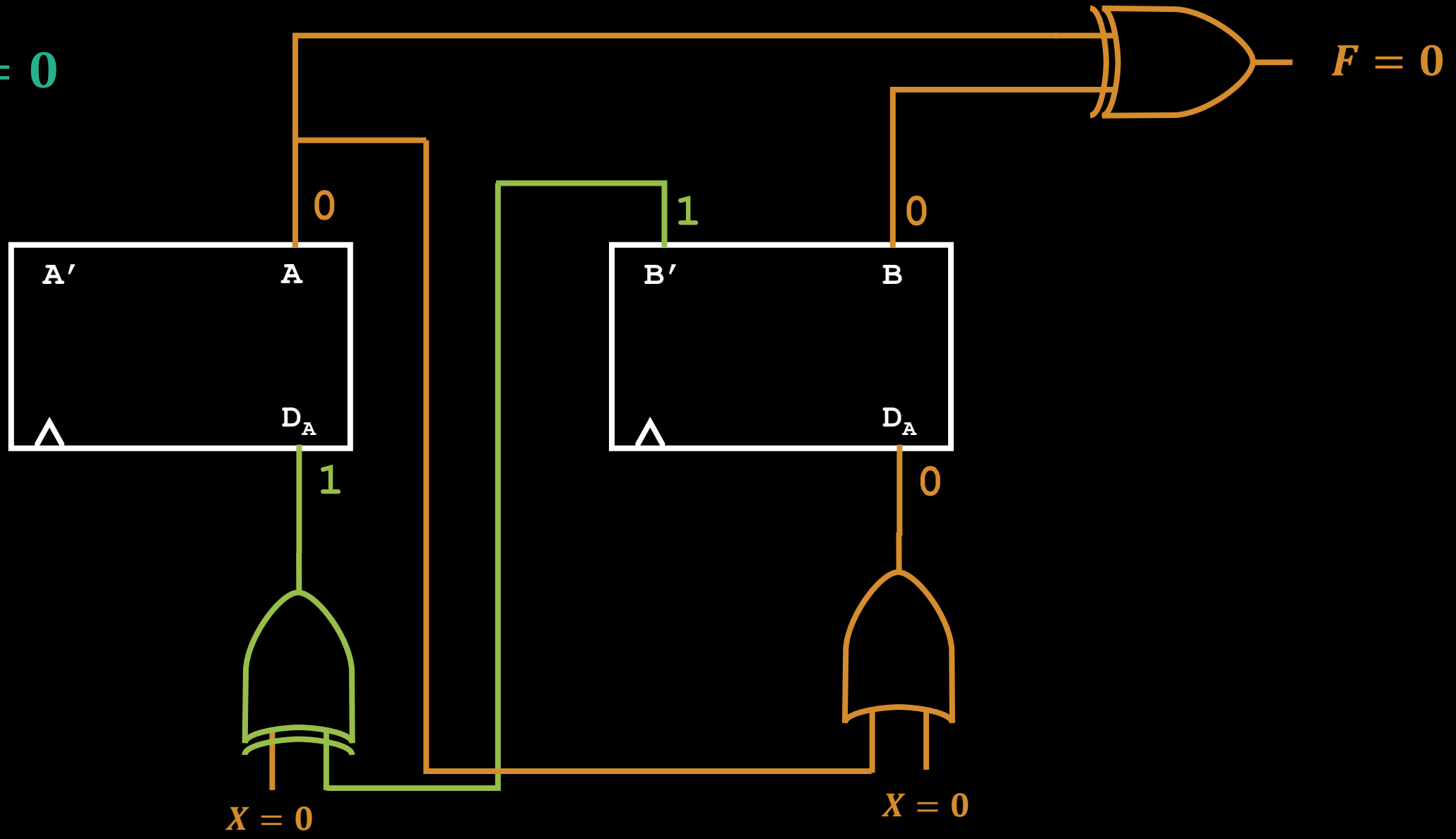
Signal Tracing: Procedure

1. Assume an initial state of the flip-flops.
   - Assume at rest (Q = 0) unless otherwise specified.
2. For the first input in the given sequence, determine the circuit outputs and flip-flop inputs.
3. Determine the new set of flip-flop states after the next active clock edge.
4. Determine the outputs that correspond to the new states.
5. Repeat 2, 3, and 4 for each input in the given sequence.


F
A′
A
D_A
B′
B
D_A
X
X

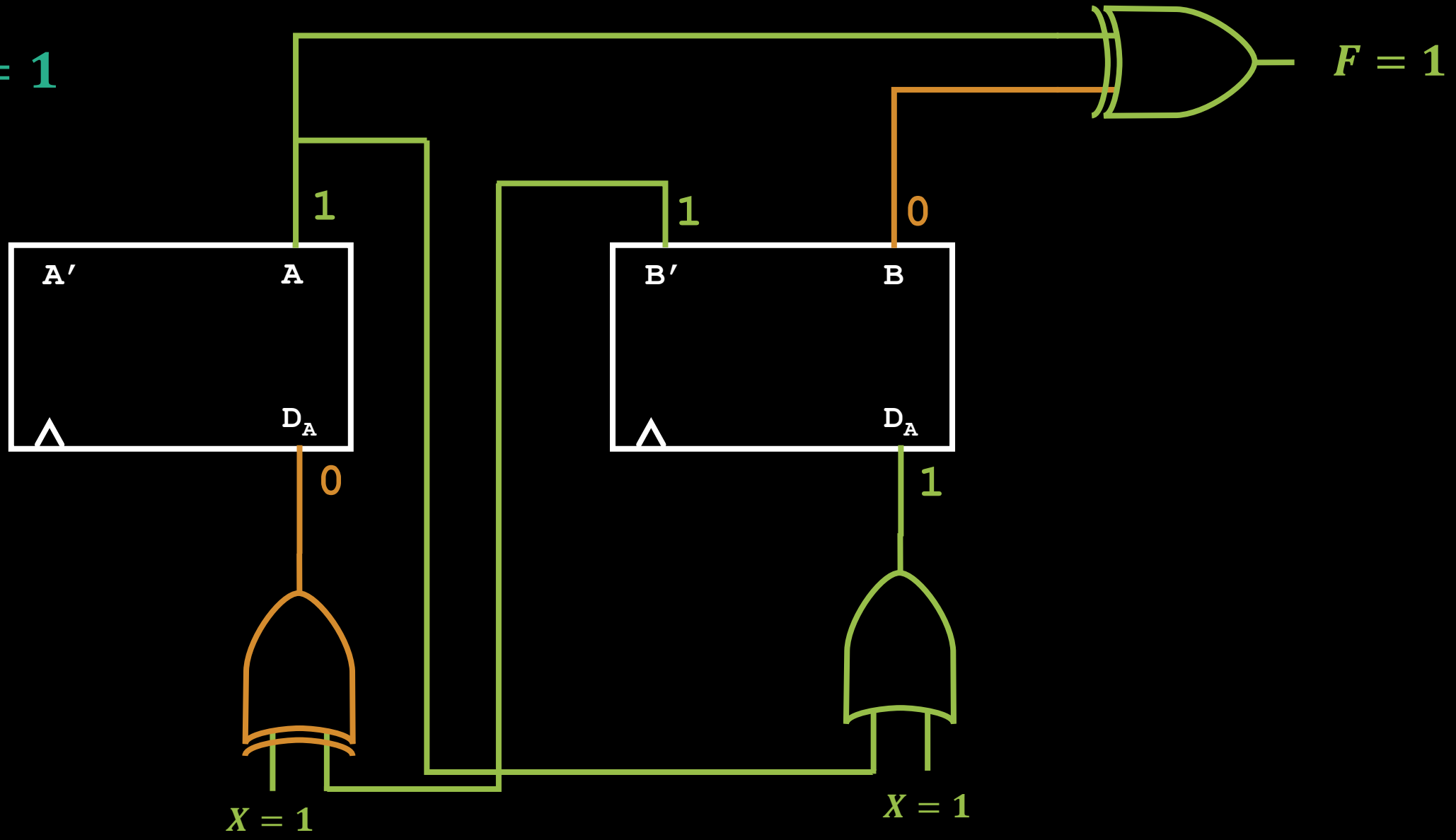
$X = \{0, 1, 1, 0, 1\}$

$Cycle = 0$



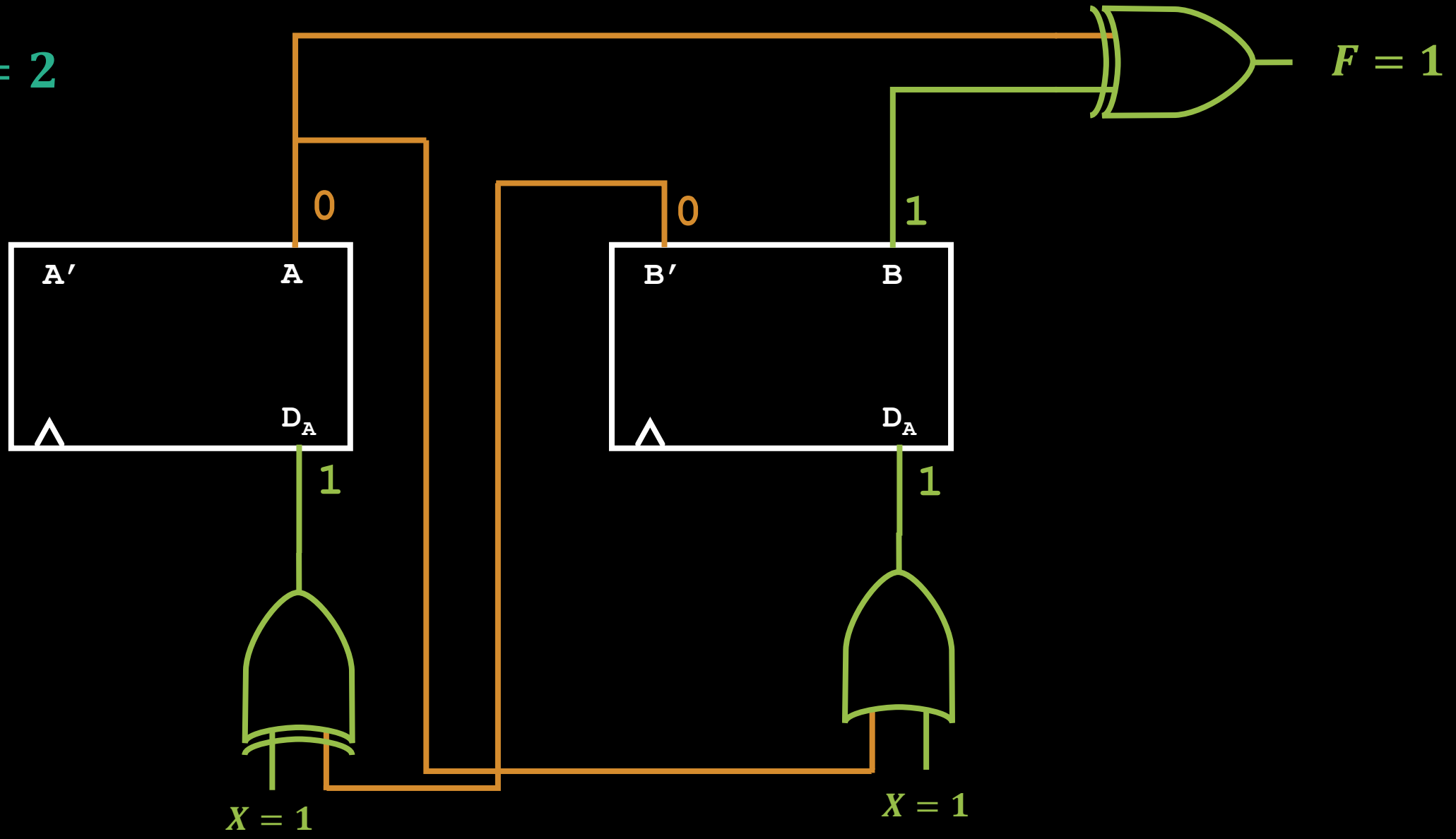
$X = \{1, 1, 0, 1\}$

$Cycle = 1$



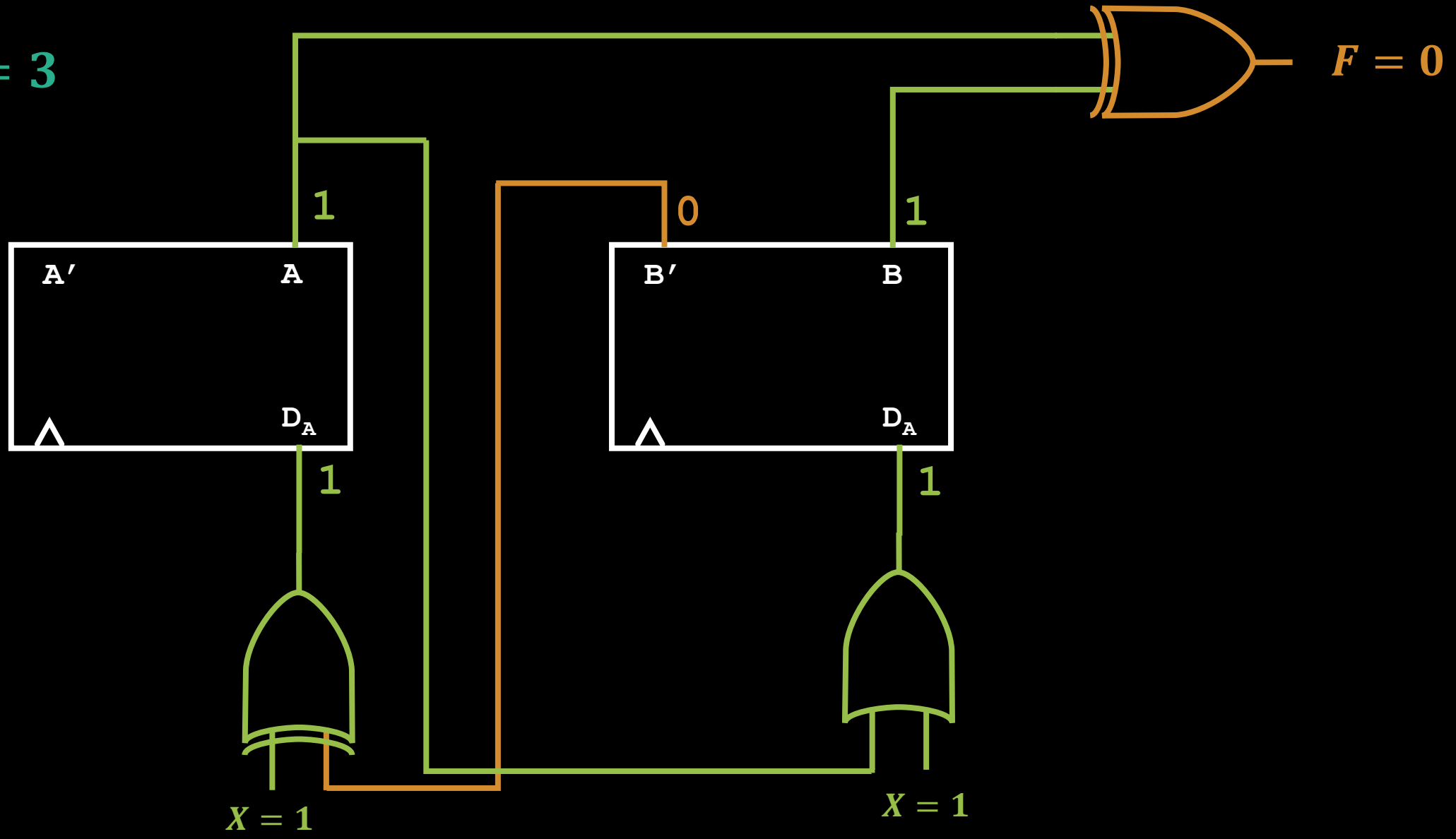
$X = \{1, 0, 1\}$

$Cycle = 2$



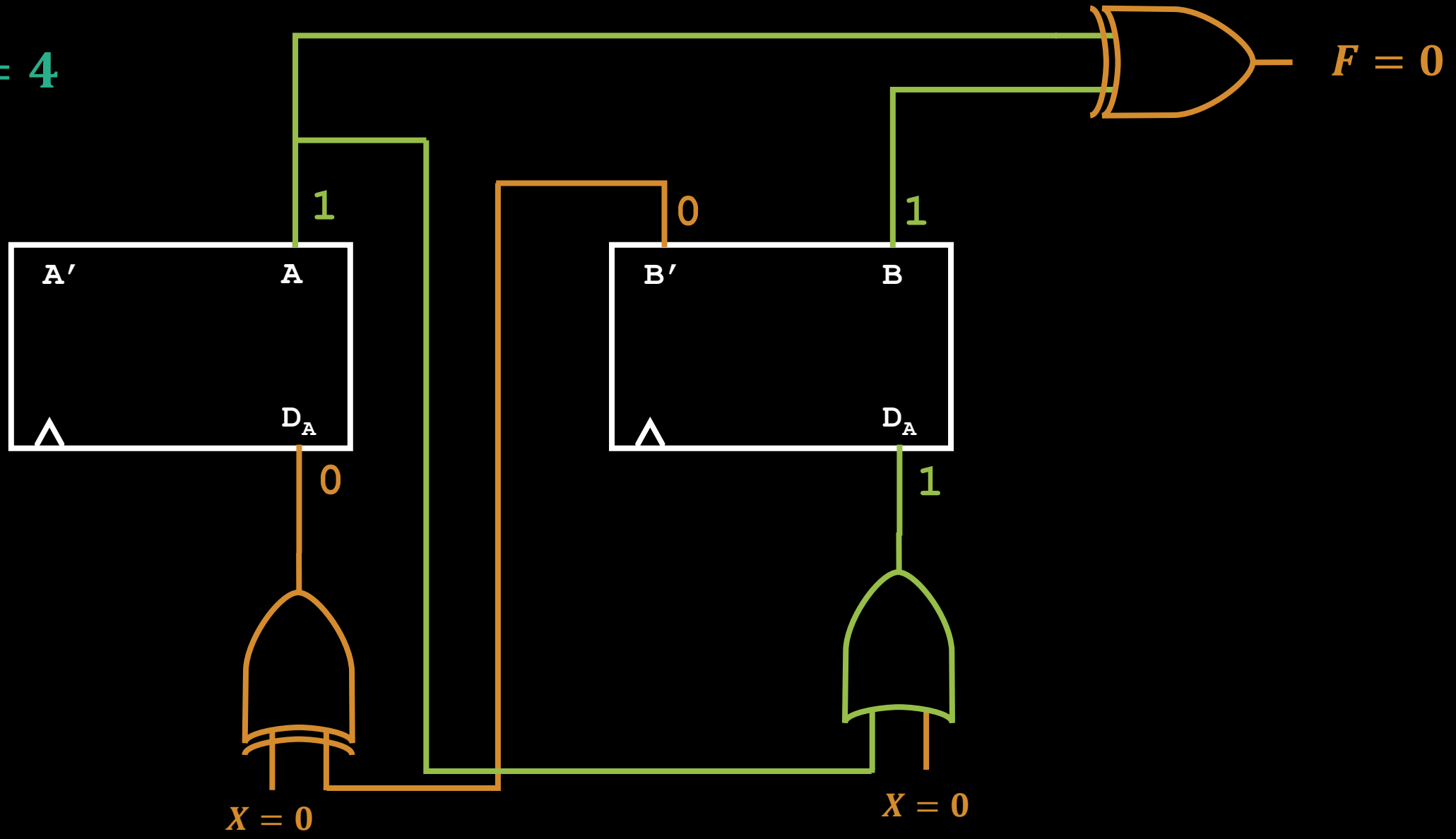
$X = \{1, 0, 1\}$

$Cycle = 3$



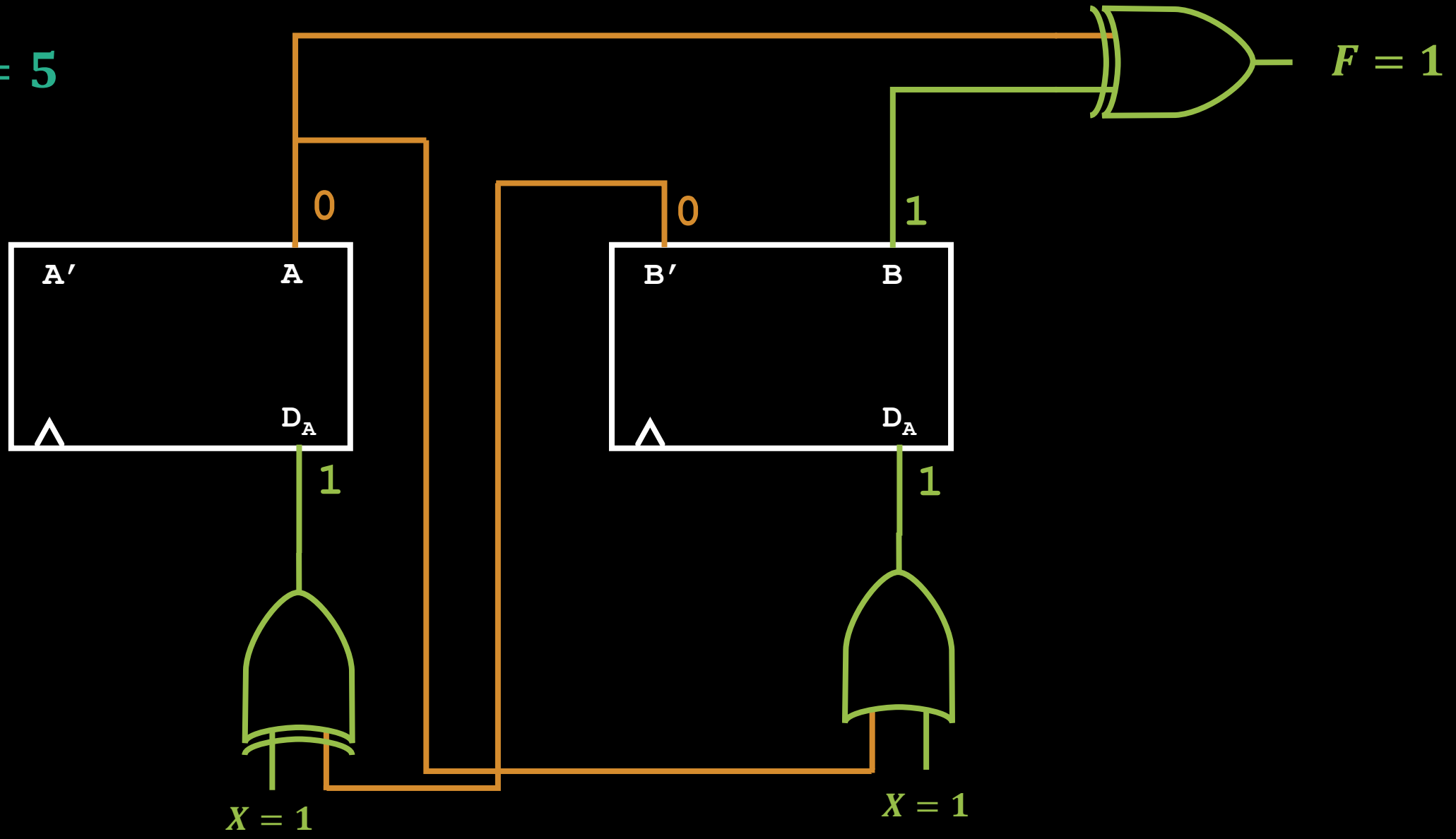
$X = \{0, 1\}$

$Cycle = 4$



$X = \{1\}$

$Cycle = 5$



What questions do you have?

EXAM Question: Signal Tracing

For the sequential circuit shown on the next slide, what will the output be at the end of the input sequence?

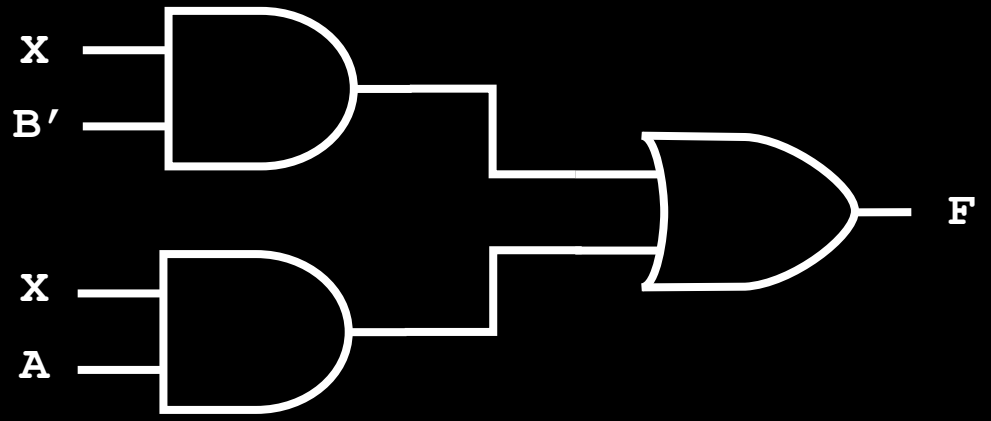
$A.\ \ F = 0$

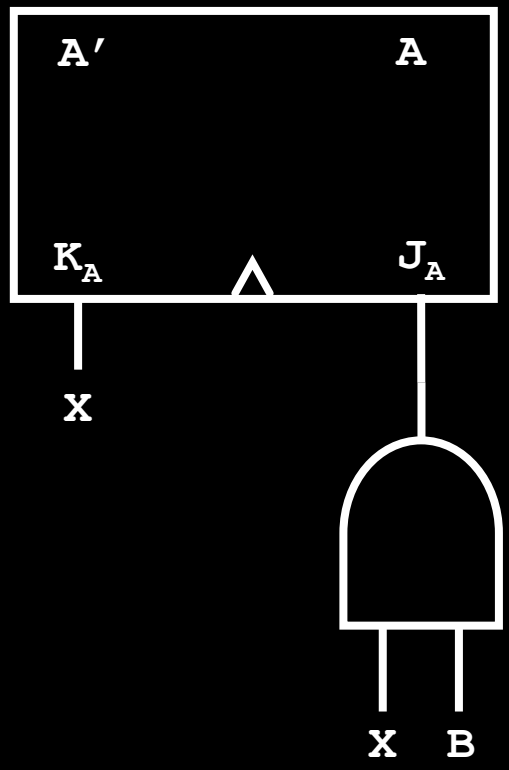
$B.\ \ F = 1$

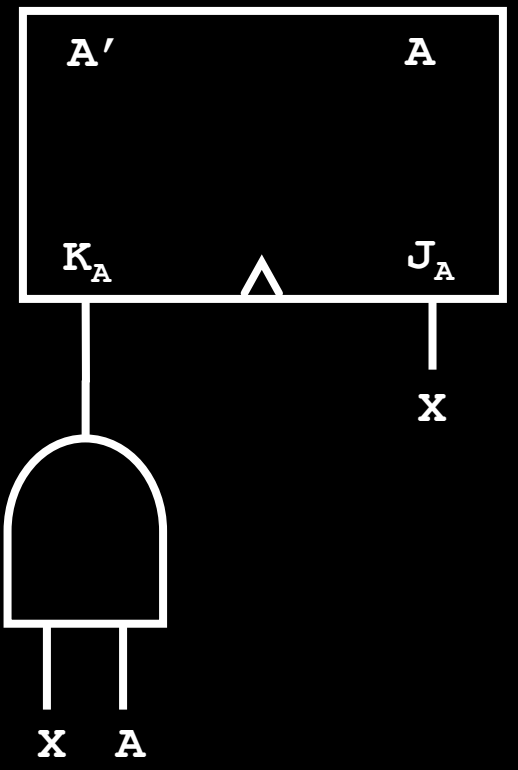
$A.\ F = 0$

$B.\ F = 1$

$X = \{1, 0, 1, 0, 1\}$



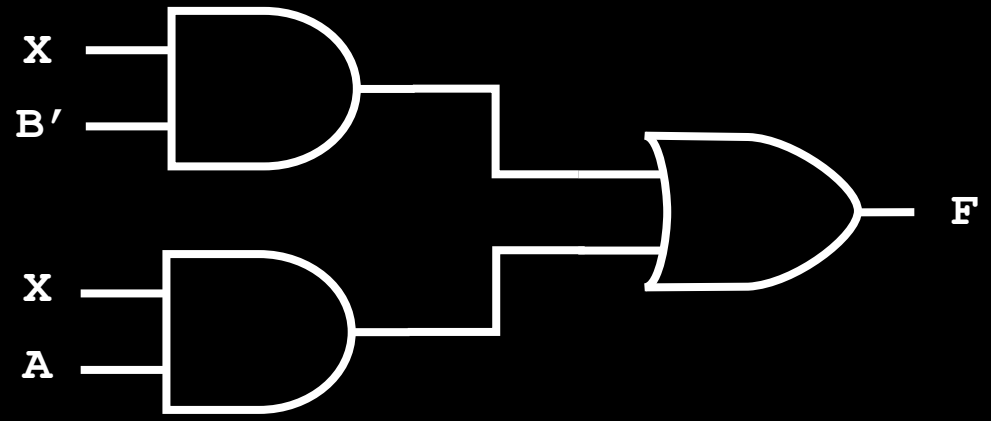


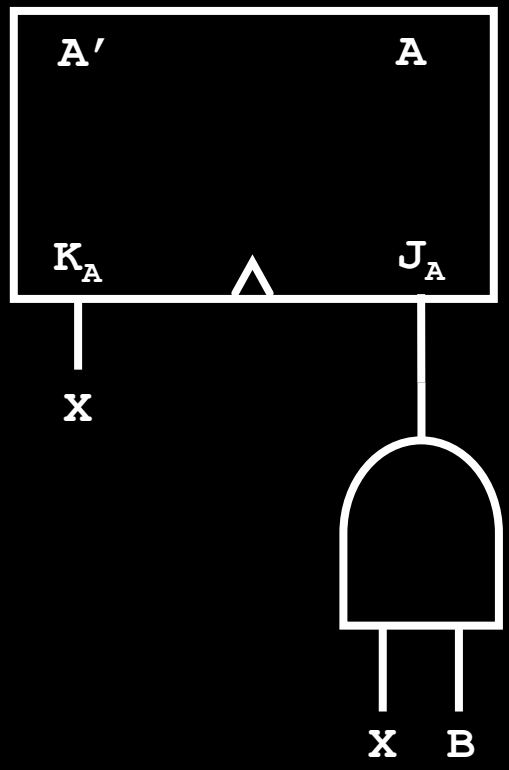


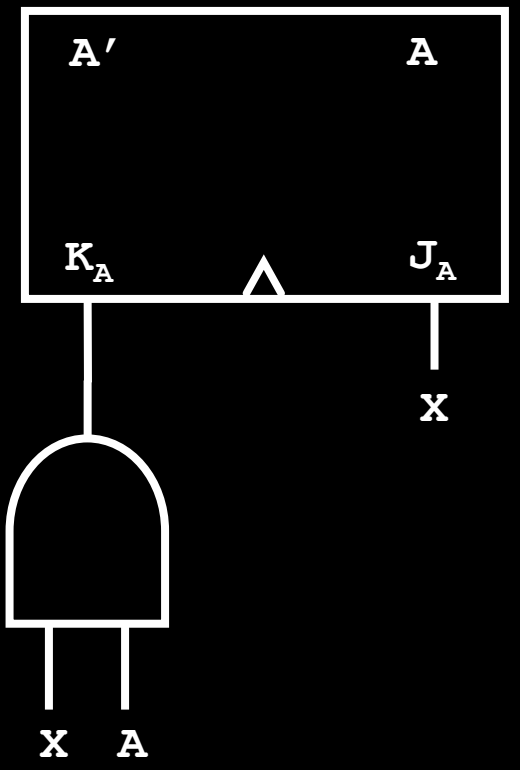
~~*A.* $F = 0$~~

B. $F = 1$

$X = \{1, 0, 1, 0, 1\}$





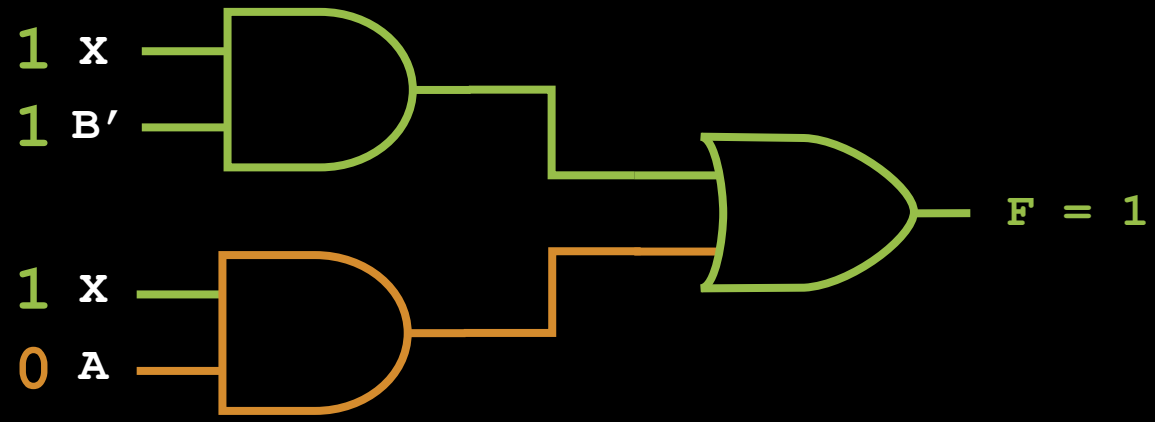


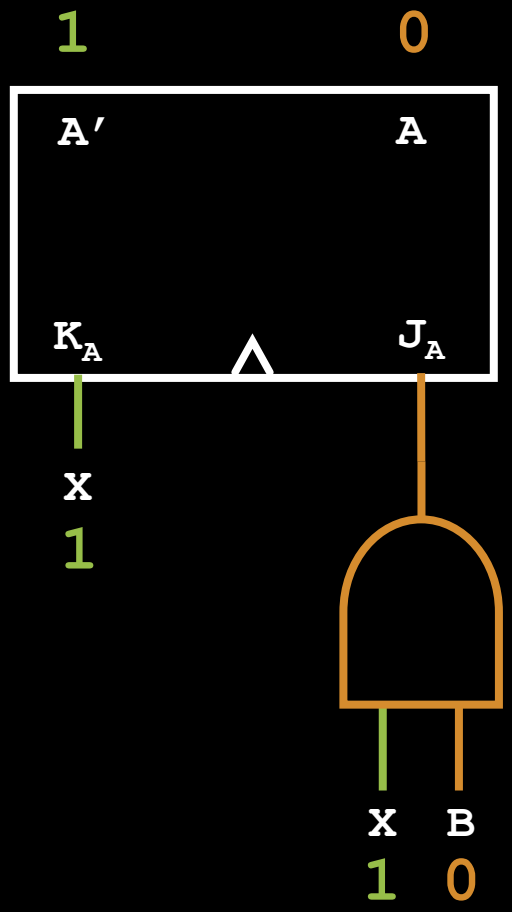
~~A. $F = 0$~~

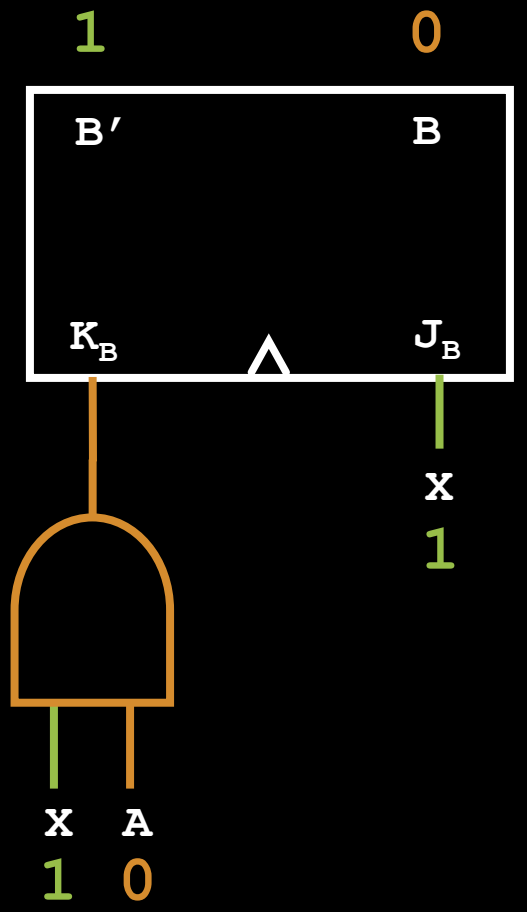
B. $F = 1$

$X = \{1, 0, 1, 0, 1\}$

$\boldsymbol{Cycle = 0}$





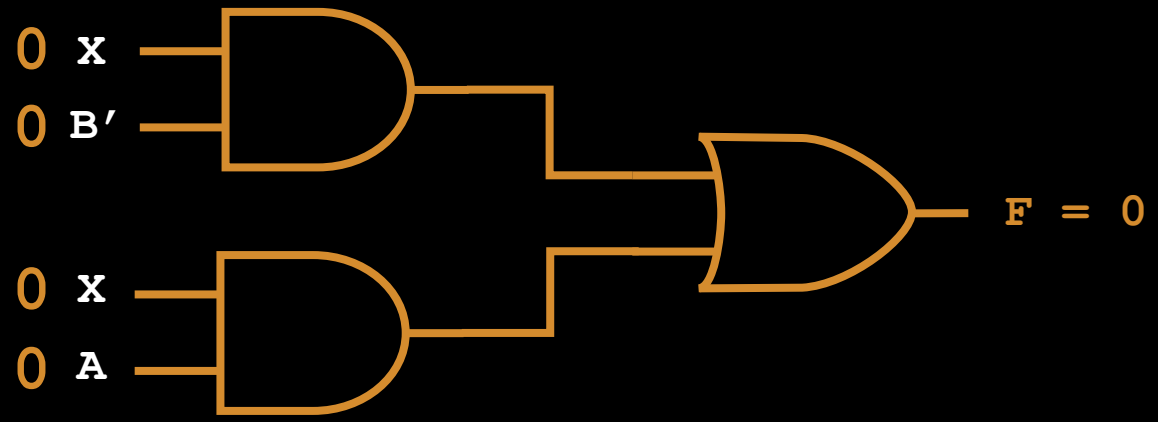


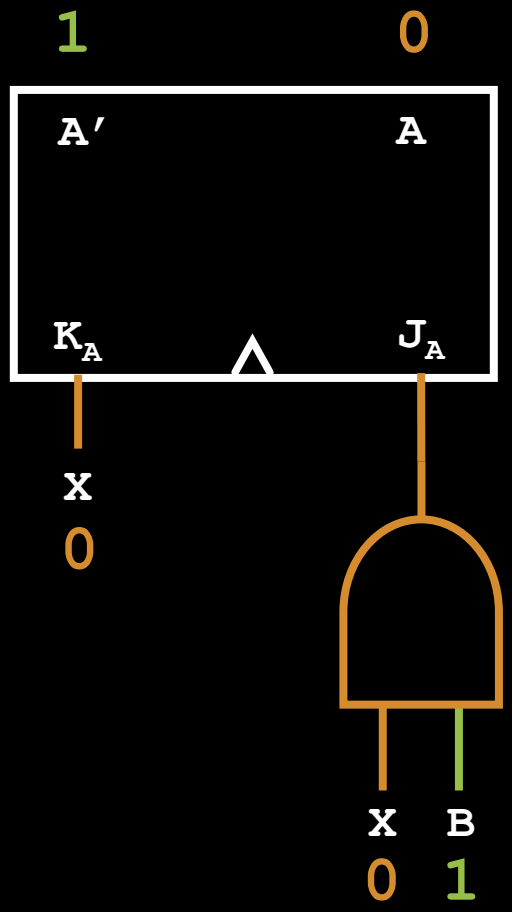
~~A. $F = 0$~~

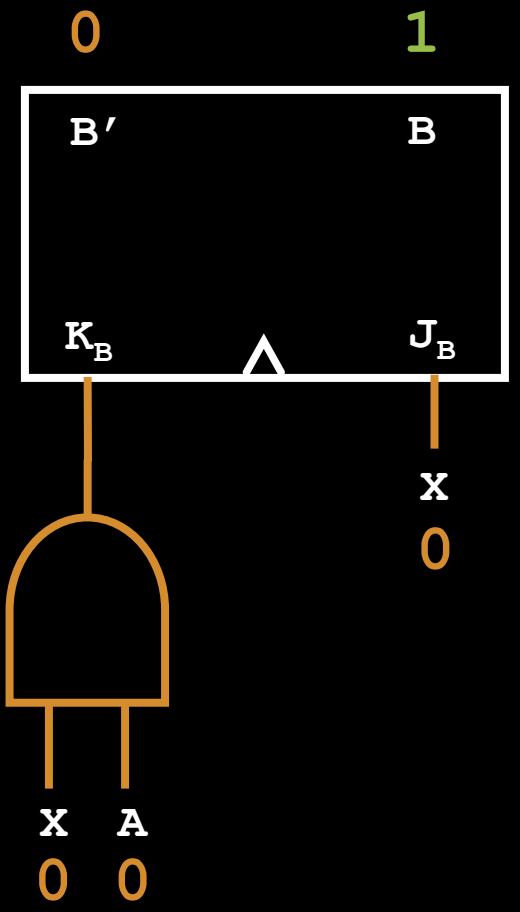
B. $F = 1$

$X = \{0, 1, 0, 1\}$

$\boldsymbol{Cycle = 1}$





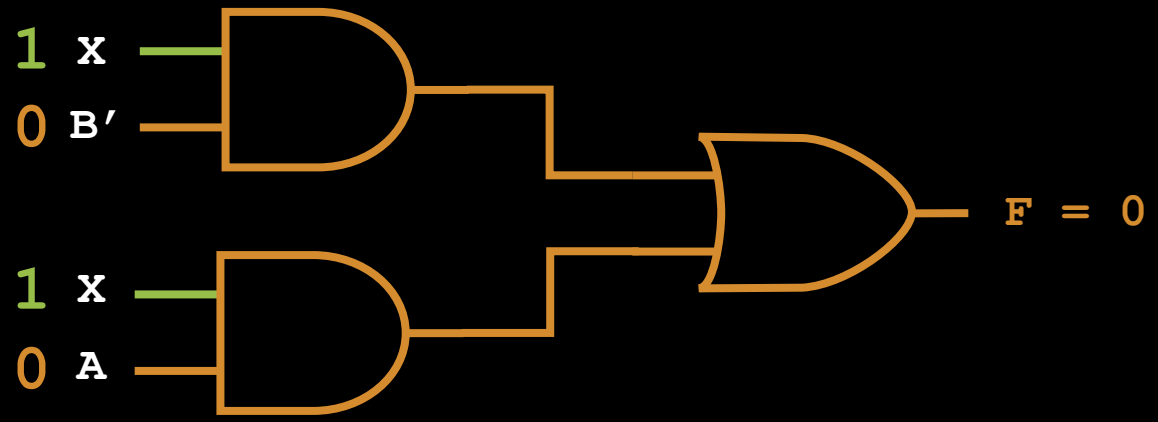


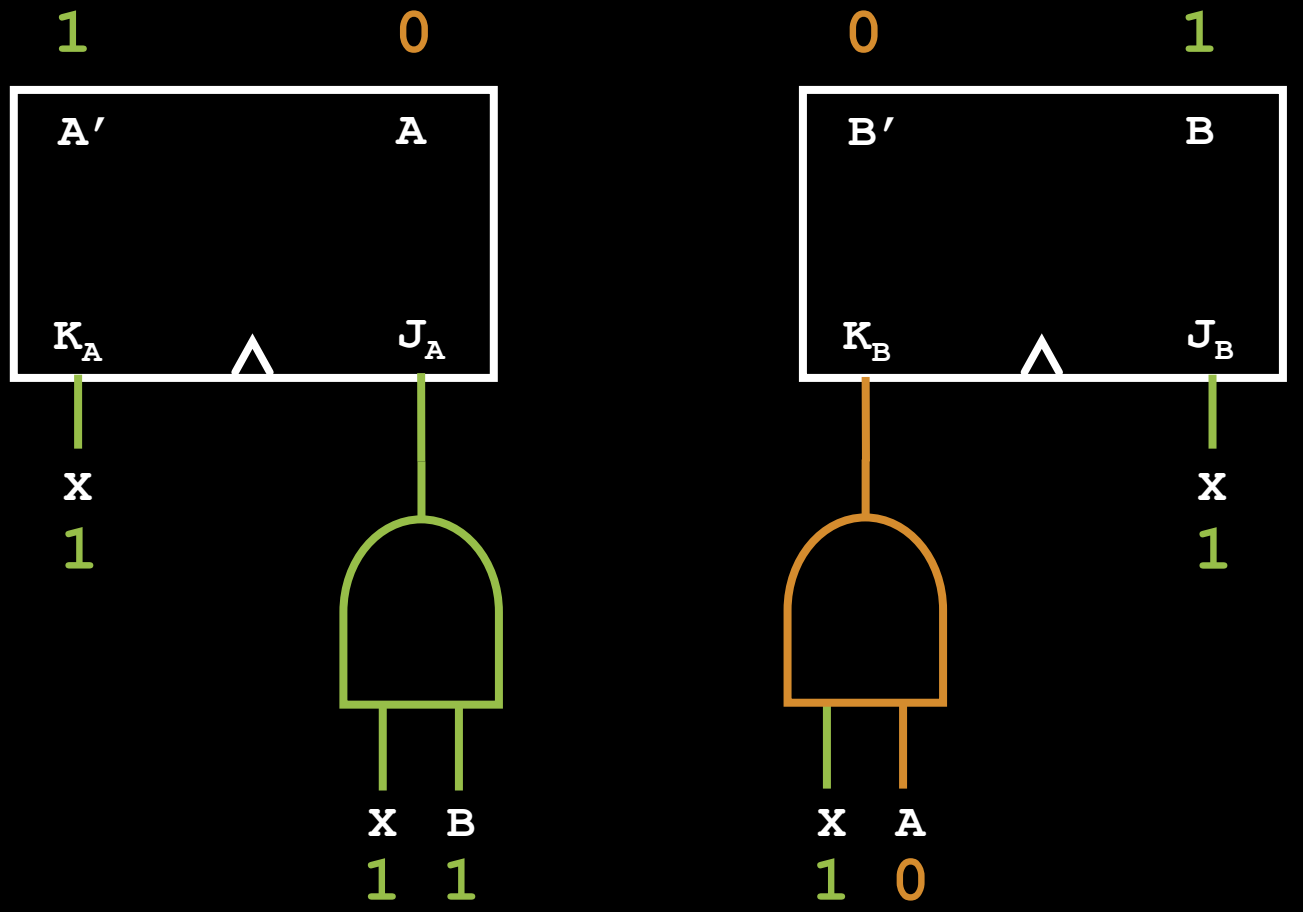
~~A. $F = 0$~~

B. $F = 1$

$X = \{1, 0, 1\}$

$Cycle = 2$



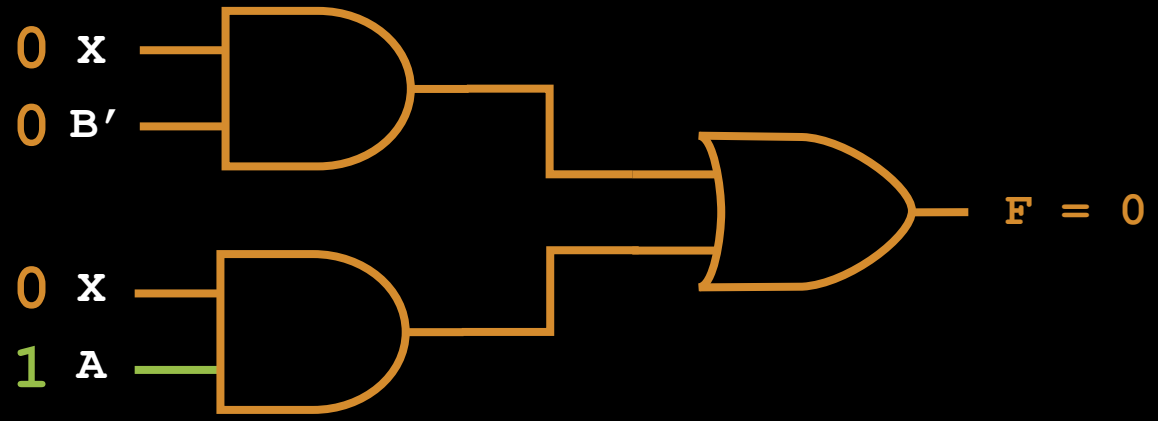


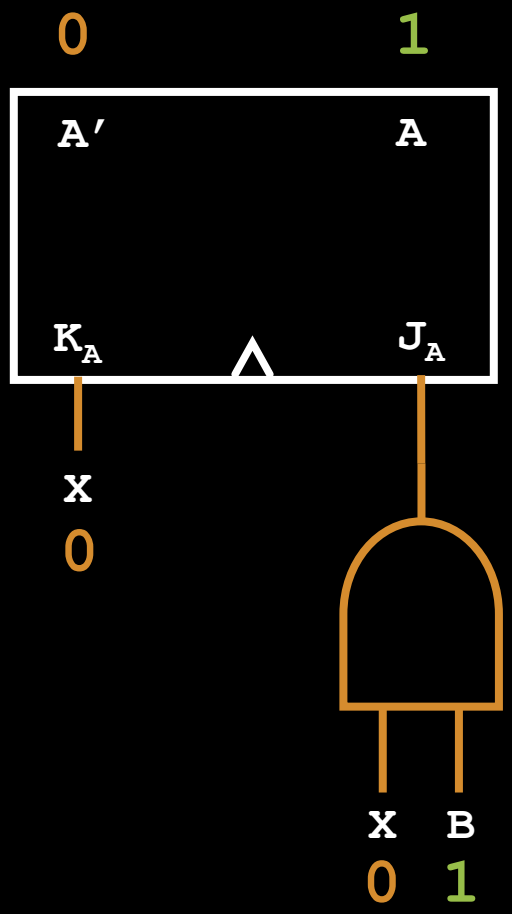
~~A. $F = 0$~~

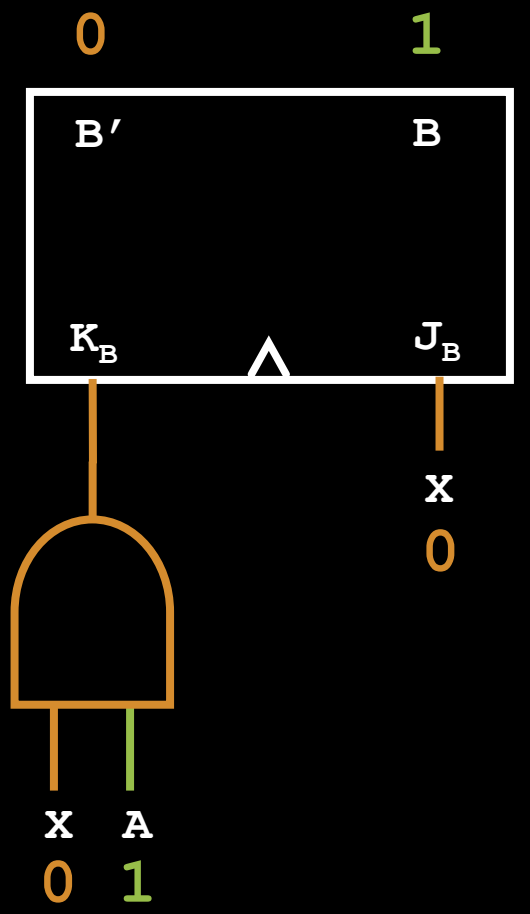
B. $F = 1$

$X = \{0, 1\}$

$Cycle = 3$





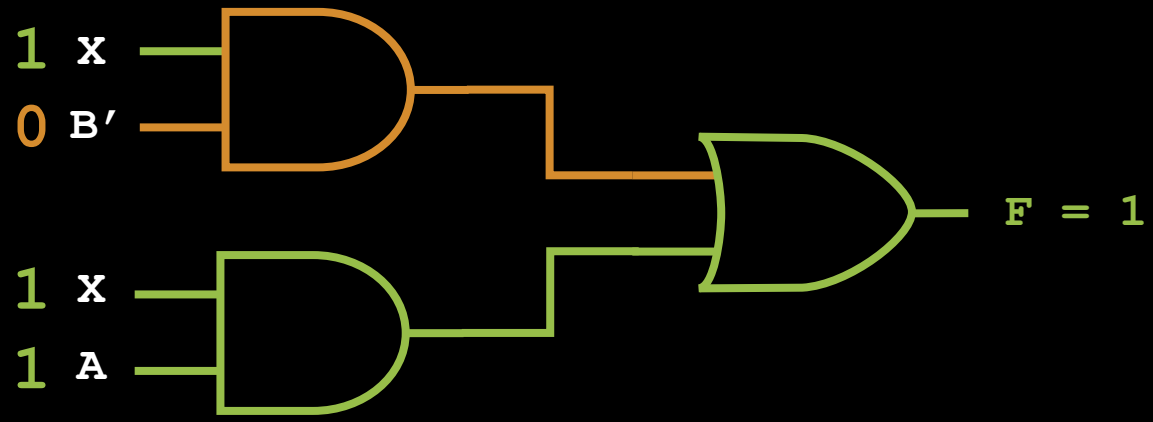


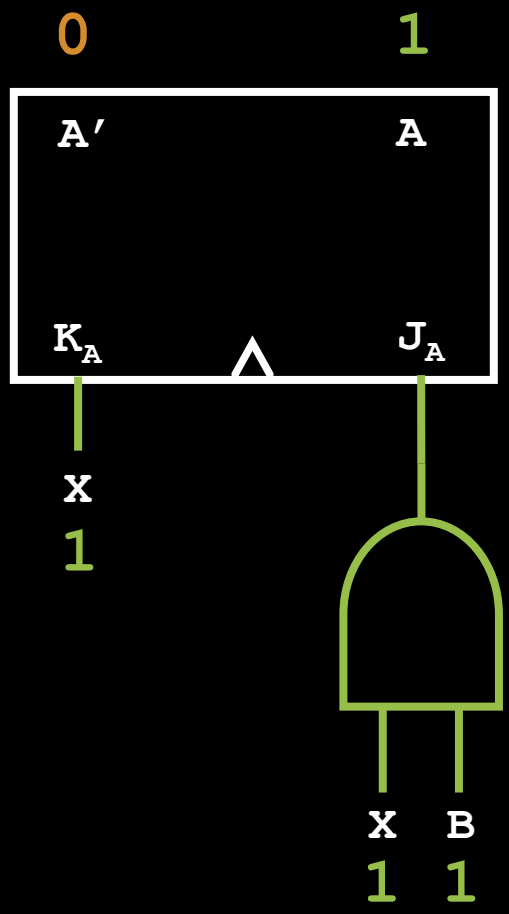
~~A. $F = 0$~~

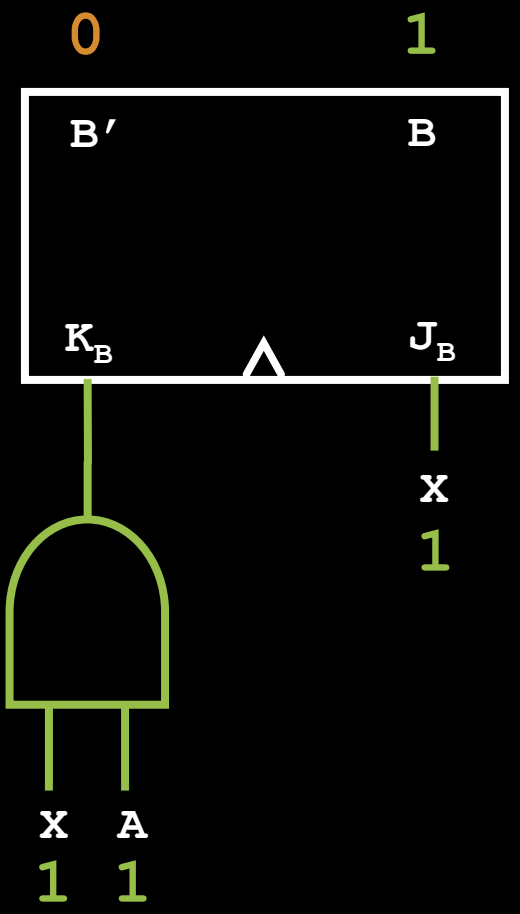
B. $F = 1$

$X = \{1\}$

$Cycle = 4$







Timing Charts

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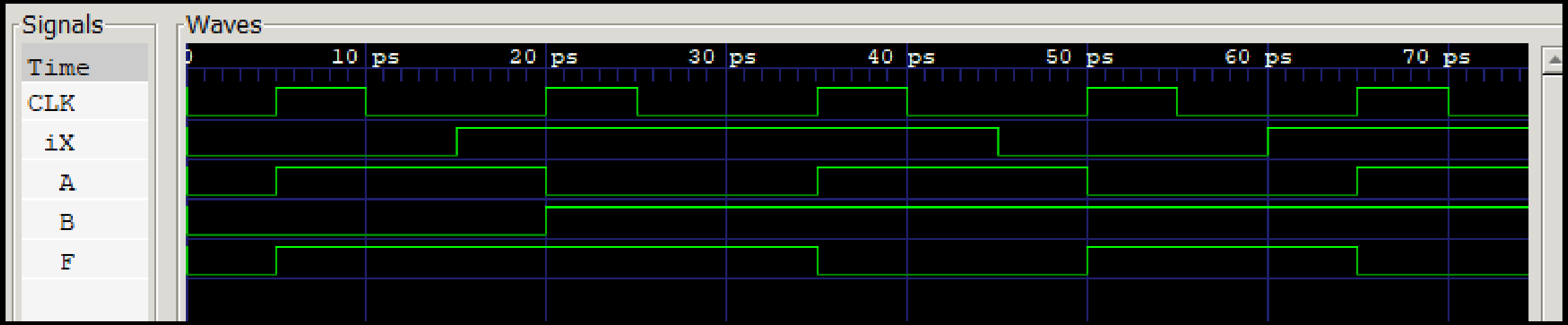
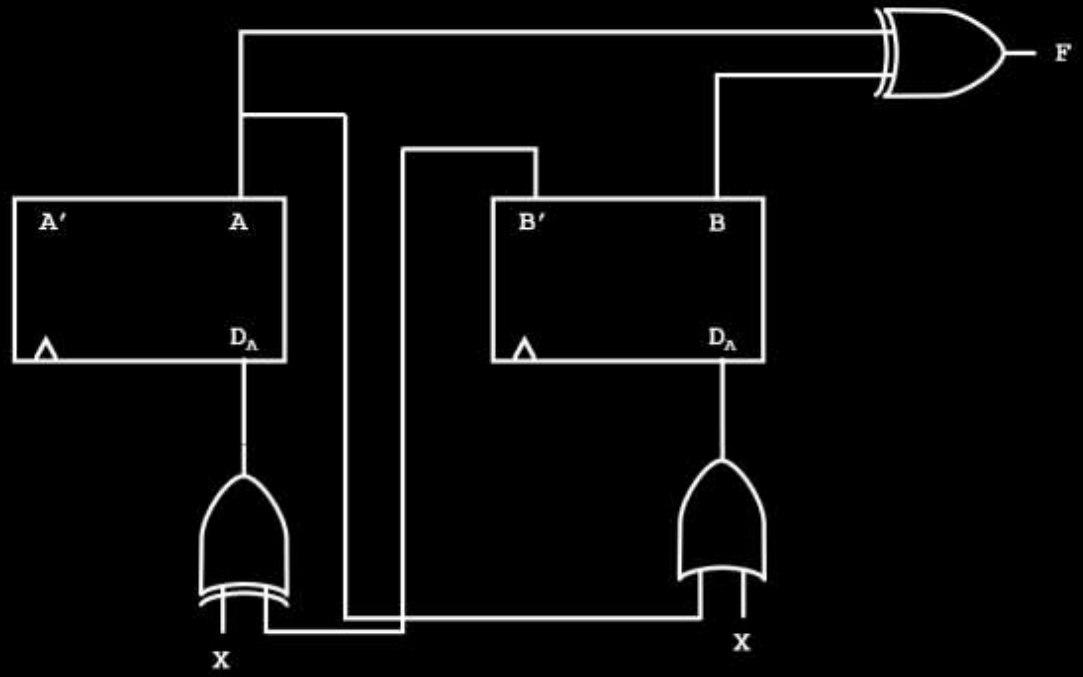
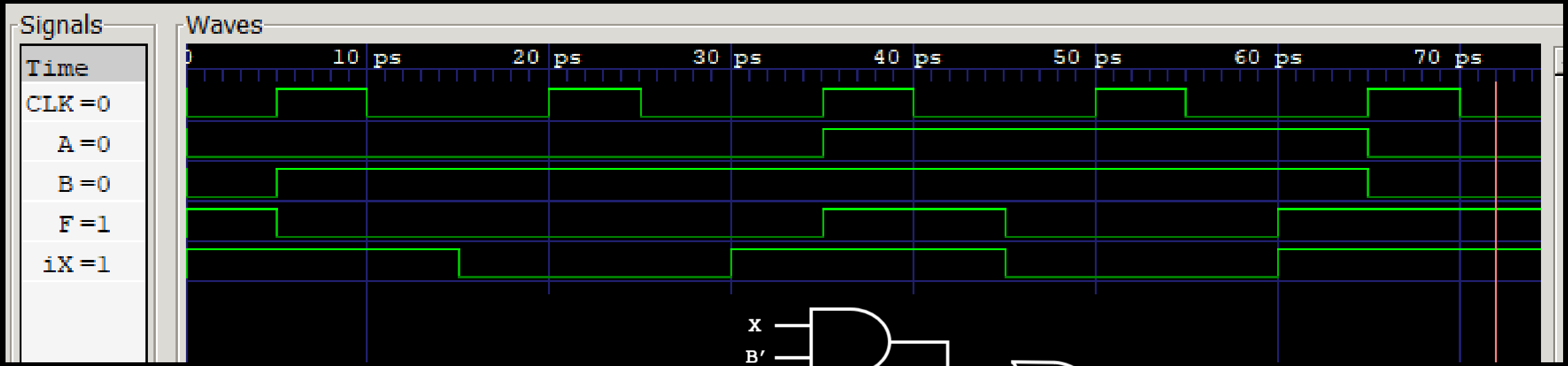
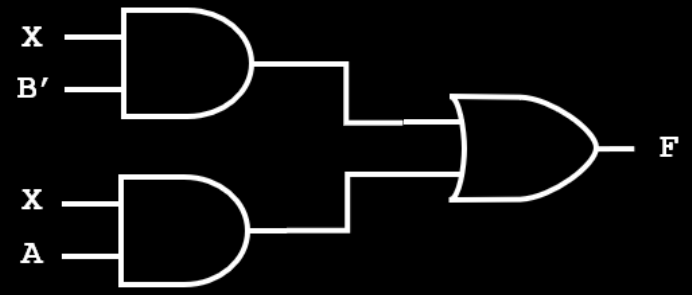
Timing Charts

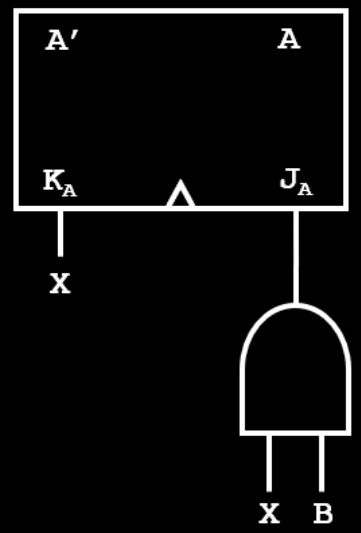
- We’ve already seen timing charts in our Verilog project.
- The GTKWave files that we view from our test benches are timing charts.

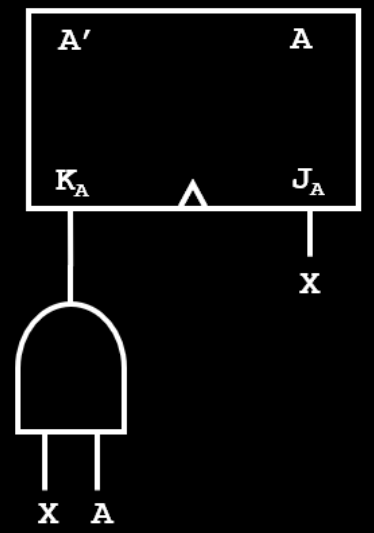

Signals
Waves
Time
CLK
iX
A
B
F
10 ps
20 ps
30 ps
40 ps
50 ps
60 ps
70 ps


F
A'
A
D
B'
B
D
X
X


Signals
Waves
Time
CLK =0
A =0
B =0
F =1
iX =1
10 ps
20 ps
30 ps
40 ps
50 ps
60 ps
70 ps


X
B′
X
A
F


A′
A
K_A
J_A
X
X
B


A′
A
K_A
J_A
X
X
A

What questions do you have?

EXAM QUESTION: Timing Charts

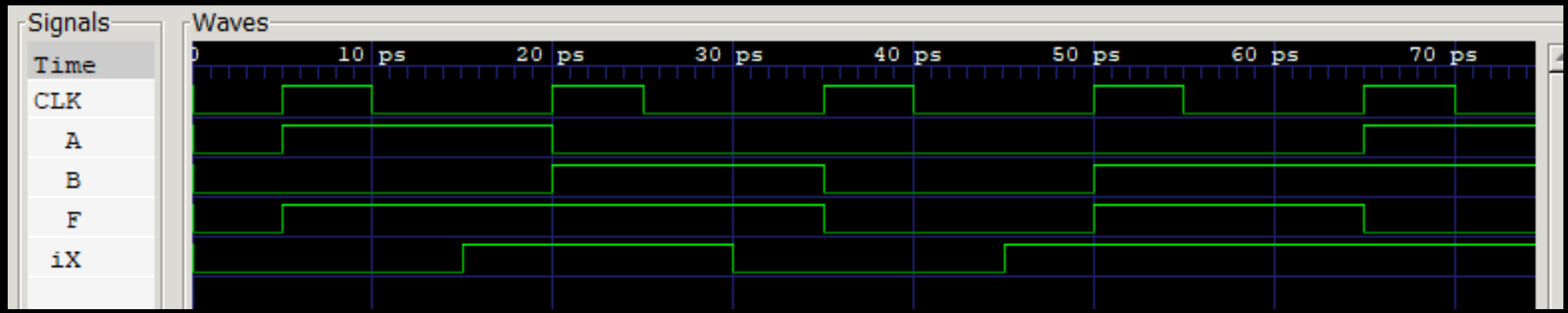
What is the input sequence, X, that is shown in the following timing chart?

A. $X = \{1, 1, 0, 1, 0\}$

B. $X = \{0, 1, 0, 1, 1\}$

C. $X = \{1, 0, 0, 0, 1\}$

D. $X = \{0, 1, 0, 0, 1\}$



EXAM QUESTION: Timing Charts

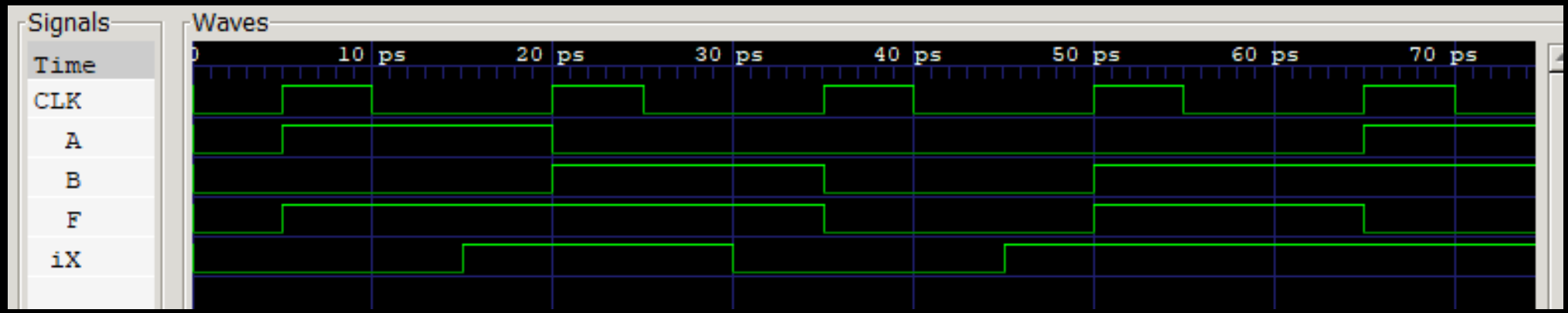
What is the input sequence, X, that is shown in the following timing chart?

~~*A.* $X = \{1, 1, 0, 1, 0\}$~~

B. $X = \{0, 1, 0, 1, 1\}$

~~*C.* $X = \{1, 0, 0, 0, 1\}$~~

~~*D.* $X = \{0, 1, 0, 0, 1\}$~~



Mealy versus Moore Machines

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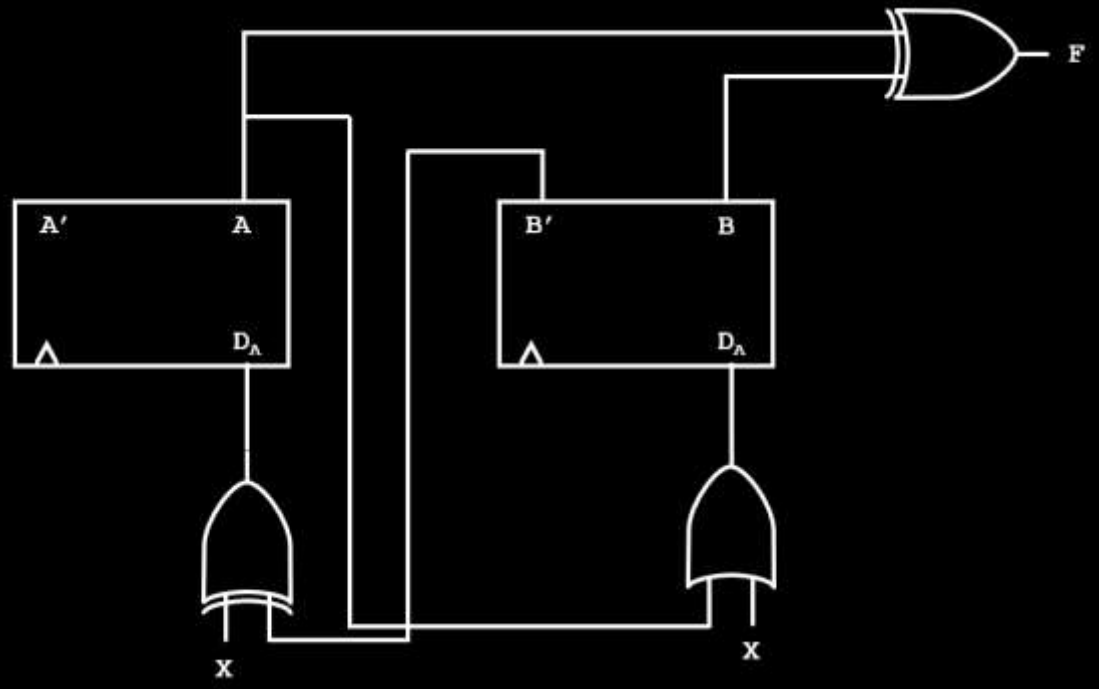
Mealy versus Moore Machines

Sequential circuits are categorized into two types:

1. Moore Machines
2. Mealy Machines

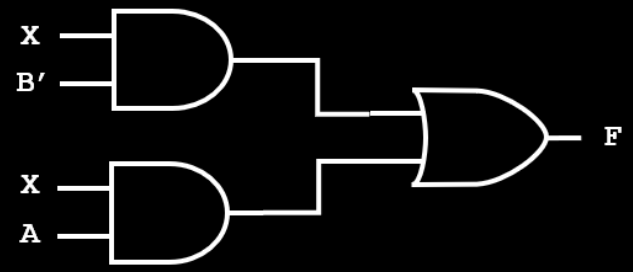
Moore Machines

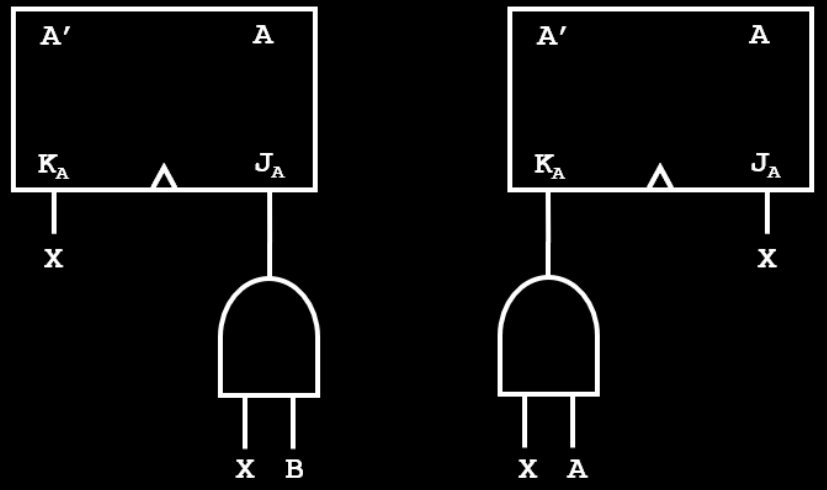
A Moore Machine is a sequential circuit in which the output is a function only of the present state.



Mealy Machine

A Mealy Machine is a sequential circuit in which the output is a function of both the present state and the input.



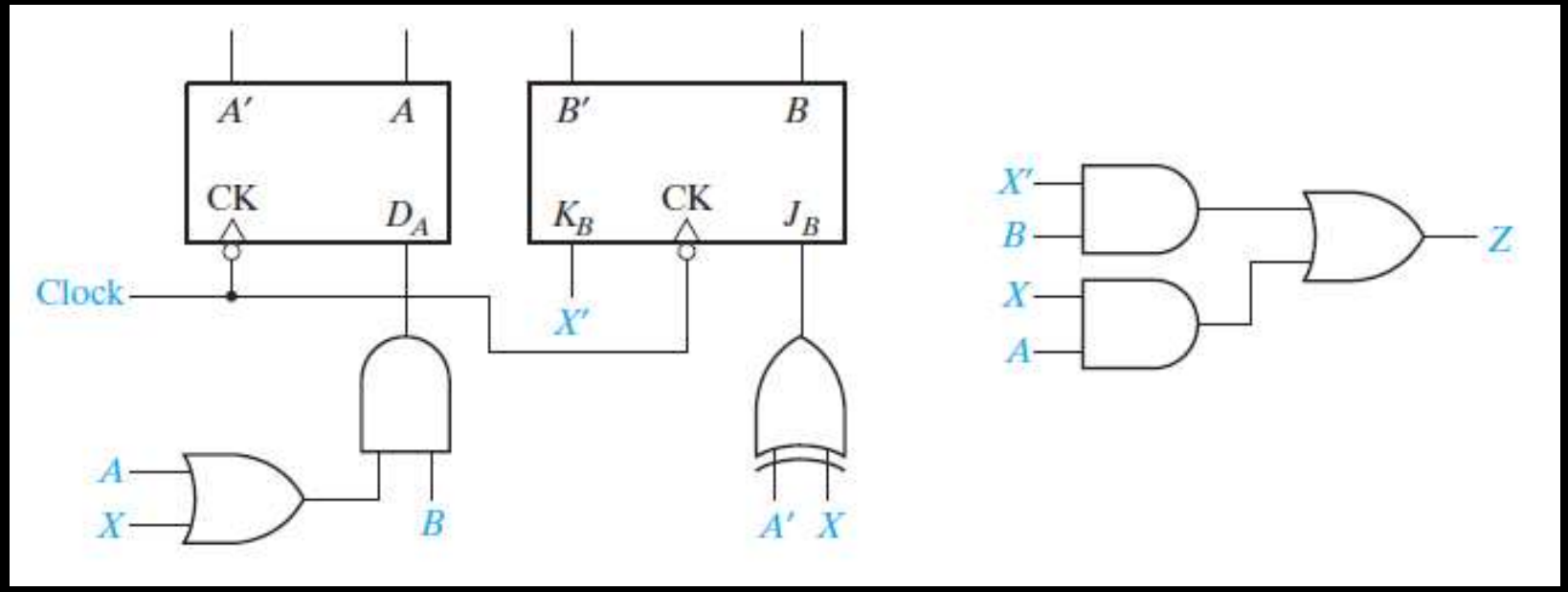


What questions do you have?

EXAM QUESTION: Mealy vs. Moore Machines

Is the sequential circuit a Mealy Machine or a Moore Machine?

A. Mealy Machine
B. Moore Machine

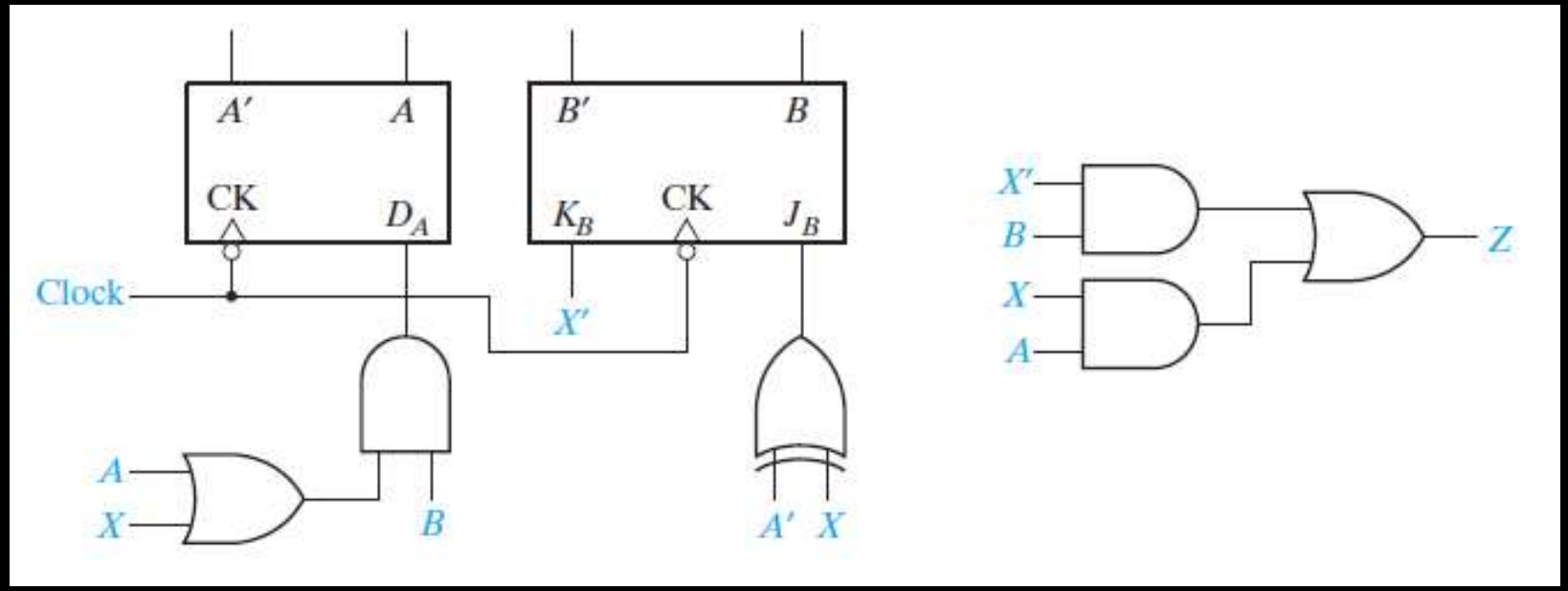


EXAM QUESTION: Mealy vs. Moore Machines

Is the sequential circuit a Mealy Machine or a Moore Machine?

A. Mealy Machine

~~B. Moore Machine~~



Lecture Recap

Signal Tracing

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What questions do you have?

Sequential Circuit Analysis

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