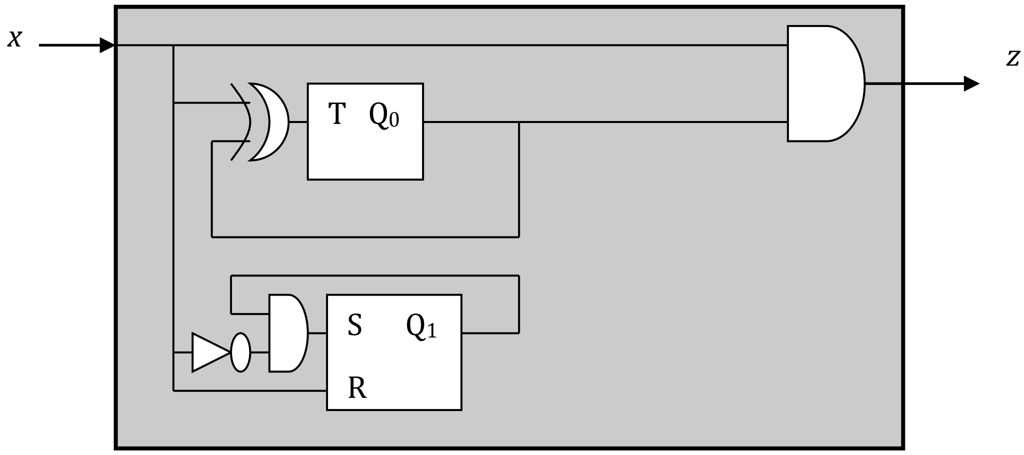
Exercises on the topic of class 20

Exercises with solutions

Ex. 1. Given the following sequential circuit:



Find the corresponding automaton, minimize it and describe its behavior at words. Assume that at the outset all FFs store 0.

SOLUTION:

The BEs are:

$S = Q1\,\overline{x}$ $\qquad R = x \qquad T = x \oplus Q0 \qquad Z = x\,Q0$

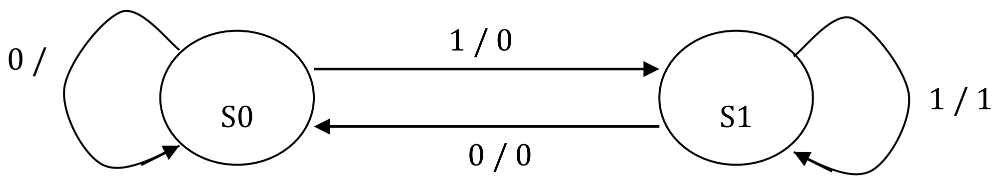
And so the table of the future states is:

x	**Q1**	**Q0**	**S**	**R**	**T**	**z (t)**	**Q1**	**Q0**
	(t)			**(t)**			**(t+1)**	
0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	0	0
0	1	0	1	0	0	0	1	0
0	1	1	1	0	1	0	1	0
1	0	0	0	1	1	0	0	1
1	0	1	0	1	0	1	0	1
1	1	0	0	1	1	0	0	1
1	1	1	0	1	0	1	0	1

From it, the automaton table (whose states are, as usual, called S0 if Q1Q0 = 00, S1 if 01, S2 if 10 and S3 if 11), with initial state S0.

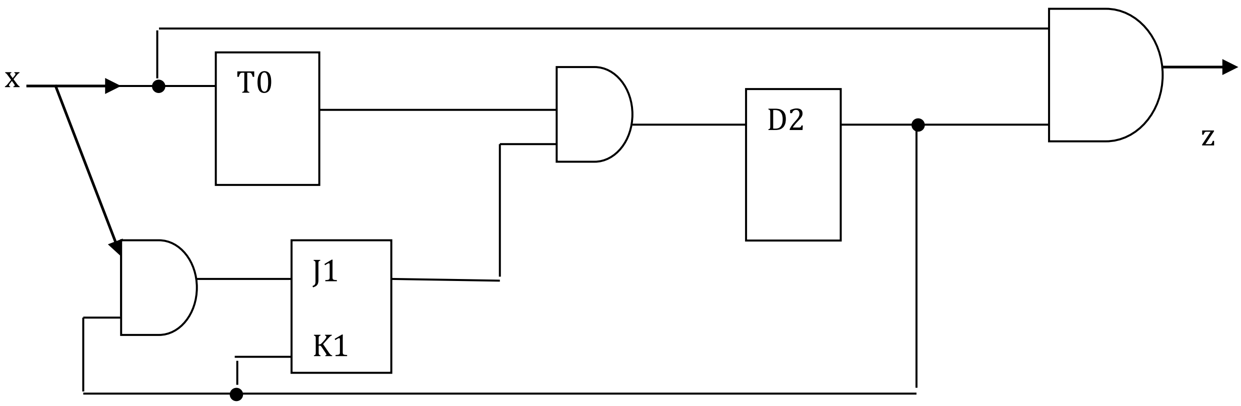
	0	1
S0	S0/0	S1/0
S1	S0/0	S1/1
S2	S2/0	S1/0
S3	S2/0	S1/1

Let's first observe that S2 and S3 are unreachable when the starting state is S0; it is then easy to check that the remaining automaton is minimal and can be drawn as follows:



The automaton return 1 if it reads at least two '1s' in sequence.

Ex. 2. Analyze the following sequential circuit, by assuming that at the outset the FFs are set to q2 q1 q0 = 110.



SOLUTION:

The BEs associated to the inputs of the FFs and to the output of the circuit are:

T0 = x
J1 = x Q2
K1 = Q2
D2 = Q0 Q1
z = x Q2

From them, we can build the future states table:

x Q2 Q1 Q0	T0	J1 K1	D2	Q2' Q1' Q0'	z
0 0 0 0	0	0 0	0	0 0 0	0
0 0 0 1	0	0 0	0	0 0 1	0
0 0 1 0	0	0 0	0	0 1 0	0
0 0 1 1	0	0 0	1	1 1 1	0
0 1 0 0	0	0 1	0	0 0 0	0
0 1 0 1	0	0 1	0	0 0 1	0
0 1 1 0	0	0 1	0	0 0 0	0
0 1 1 1	0	0 1	1	1 0 1	0
1 0 0 0	1	0 0	0	0 0 1	0
1 0 0 1	1	0 0	0	0 0 0	0
1 0 1 0	1	0 0	0	0 1 1	0
1 0 1 1	1	0 0	1	1 1 0	0
1 1 0 0	1	1 1	0	0 1 1	1
1 1 0 1	1	1 1	0	0 1 0	1
1 1 1 0	1	1 1	0	0 0 1	1
1 1 1 1	1	1 1	1	1 0 0	1

Since the initial configuration is the one with Q2 Q1 Q0 = 110, we obtain the following automaton (REMARK: some states are unreachable starting from 110; hence, they can be safely discarded):

	0	1
110	000/0	001/1
000	000/0	001/0
001	001/0	000/0

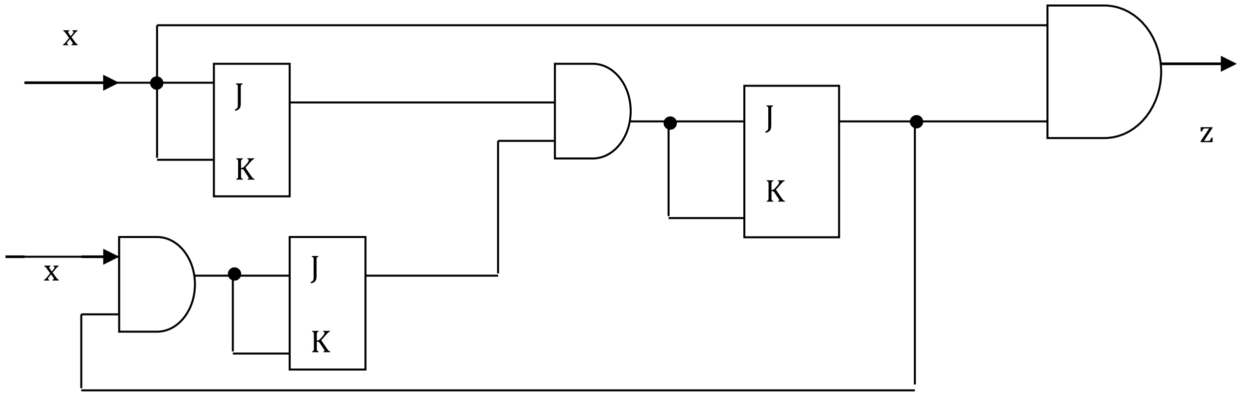
We can notice that the automaton is not minimal: we can merge 000 and 001, and obtain

	0	1
S0	S1/0	S1/1
S1	S1/0	S1/0

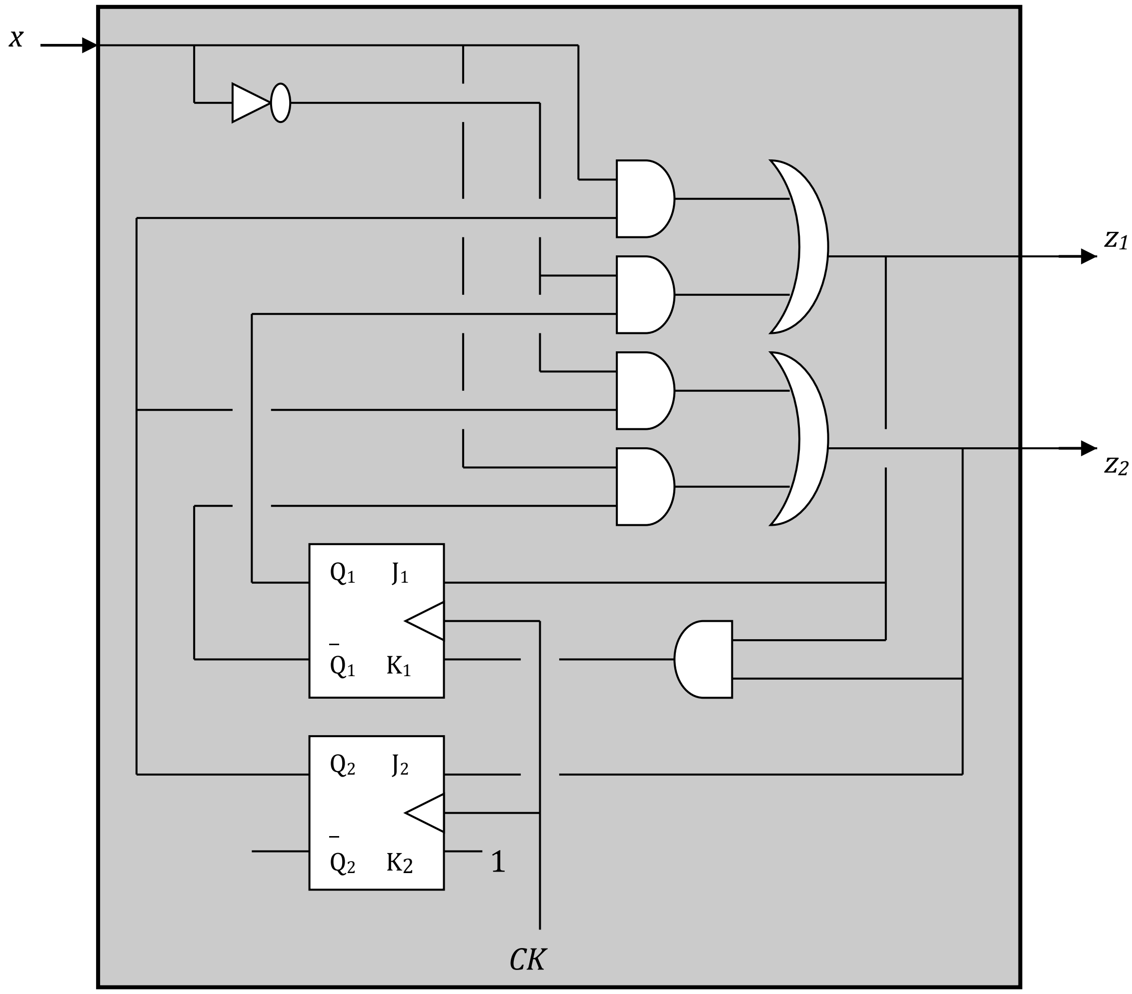
This circuit gives 1 upon reception of input sequences of the form 1000…0

Exercises without solutions

Ex. 1. Analyze the following sequential circuit:



Ex. 2. Given the following circuit, analyze it by assuming that both FFs initially store 0:



Ex. 3. Analyze the following circuit, whose FF initially stores 0: