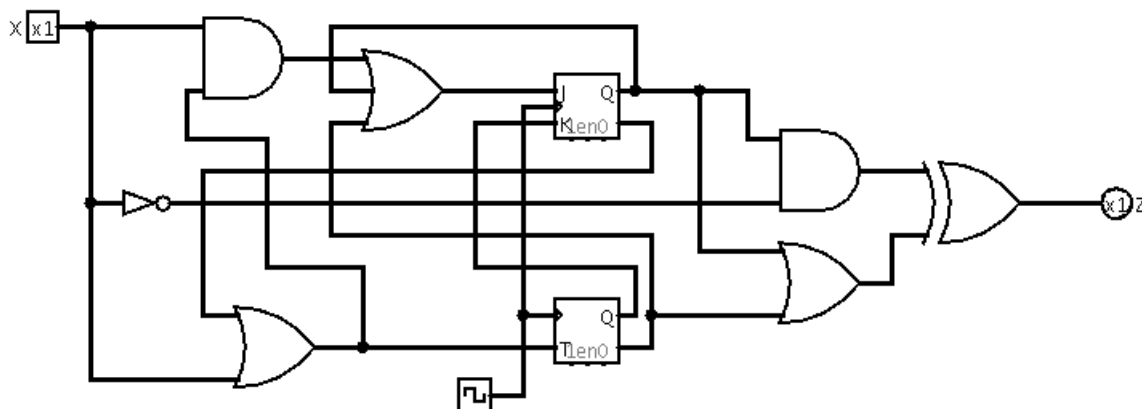


1. For the following circuit, the top flip-flop is a JK flip-flop and the bottom flip-flop is a T flip-flop.
 - (a) Create the transition tables for the two flip-flops.
 - (b) Create the transition table.
 - (c) Create the next state table.
 - (d) Create the output table.
 - (e) Create the next state/output table.
 - (f) Create the state diagram.



Solution:

Flip-Flop Transition Tables

JK flip-flop (Q_1):

$$J = x(x + Q'_1) + Q_1 + Q'_2 = x + xQ'_1 + Q_1 + Q'_2 = x(1 + Q'_1) + Q_1 + Q'_2 = x + Q_1 + Q'_2$$

$$K = Q_2$$

Input Table for J

Q_1Q_2	X	
	0	1
00	1	1
01	0	1
10	1	1
11	1	1

Input Table for K

Q_1Q_2	X	
	0	1
00	0	0
01	1	1
10	0	0
11	1	1

Input Table for JK

Q_1Q_2	X	
	0	1
00	10	10
01	01	11
10	10	10
11	11	11

Transition Table

Q_1Q_2	X	
	0	1
00	1	1
01	0	1
10	1	1
11	0	0

T flip-flop (Q_2): $T = x + Q_1'$

Input Table

Q_1Q_2	X	
	0	1
00	1	1
01	1	1
10	0	1
11	0	1

Transition Table

Q_1Q_2	X	
	0	1
00	1	1
01	0	0
10	0	1
11	1	0

Circuit Tables

$$Z = Q_1x' \oplus (Q_1 + Q_2')$$

State Transition Table

Q_1Q_2	X	
	0	1
00	11	11
01	00	10
10	10	11
11	01	00

Next State Table

	X	
	0	1
A	D	D
B	A	C
C	C	D
D	B	A

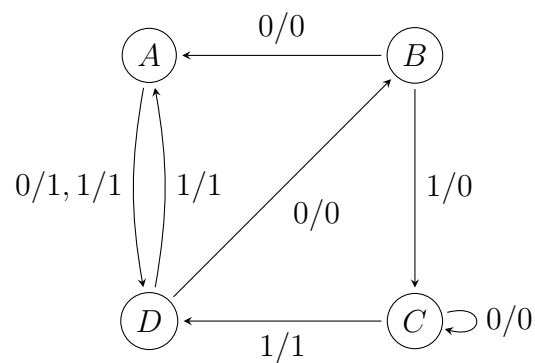
Output Table

Q_1Q_2	X	
	0	1
00	1	1
01	0	0
10	0	1
11	0	1

Next State/Output Table

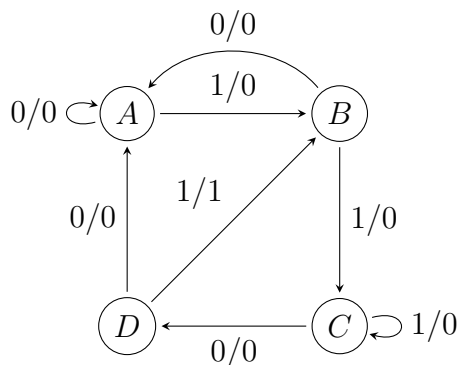
	X	
	0	1
A	D/1	D/1
B	A/0	C/0
C	C/0	D/1
D	B/0	A/1

State Diagram



2. Design a sequential circuit that detects an input sequence of 1101 with overlap. Use only JK flip-flops in your construction.

State Diagram



Circuit Tables

Next State/Output Table

	X	
	0	1
A	A/0	B/0
B	A/0	C/0
C	D/0	C/0
D	A/0	B/1

Next State Table

	X	
	0	1
A	A	B
B	A	C
C	D	C
D	A	B

State Transition Table

Q_1Q_2	X	
	0	1
00	00	01
01	00	10
10	11	10
11	00	01

Output Table
 $Z = xQ_1Q_2$

Q_1Q_2	X	
	0	1
00	0	0
01	0	0
10	0	0
11	0	1

Flip-Flop Transition Tables

JK flip-flop (Q_1): $J_1 = xQ_2$ $K_1 = Q_2$

Transition Table

Q_1Q_2	X	
	0	1
00	0	0
01	0	1
10	1	1
11	0	0

Input Table for JK

Q_1Q_2	X	
	0	1
00	0d	0d
01	0d	1d
10	d0	d0
11	d1	d1

Input Table for J

Q_1Q_2	X	
	0	1
00	0	0
01	0	1
10	d	d
11	d	d

Input Table for K

Q_1Q_2	X	
	0	1
00	d	d
01	d	d
10	0	0
11	1	1

JK flip-flop (Q_2): $J_2 = x'Q_1 + xQ_1' = x \oplus Q_1$ $K_2 = x' + Q_1'$

Transition Table

Q_1Q_2	X	
	0	1
00	0	1
01	0	0
10	1	0
11	0	1

Input Table for JK

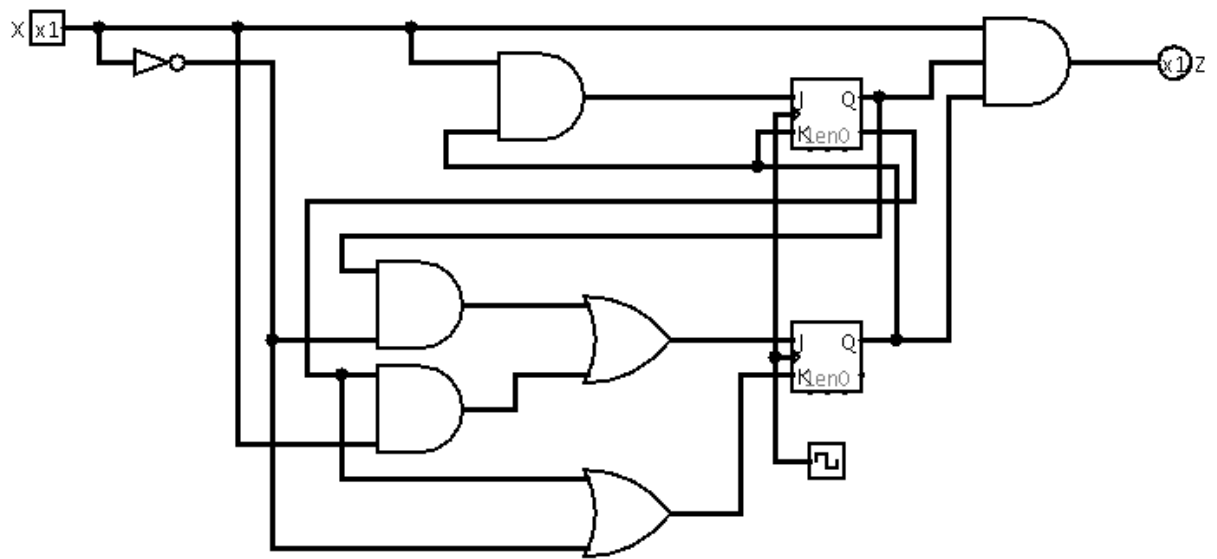
Q_1Q_2	X	
	0	1
00	0d	1d
01	d1	d1
10	1d	0d
11	d1	d0

Input Table for J

Q_1Q_2	X	
	0	1
00	0	1
01	d	d
10	1	0
11	d	d

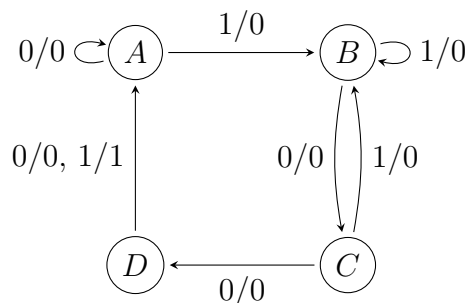
Input Table for K

Q_1Q_2	X	
	0	1
00	d	d
01	1	1
10	d	d
11	1	0



3. Design a sequential circuit that detects an input sequence of 1001 without overlap. Use only T flip-flops in your construction.

State Diagram



Circuit Tables

Next State/Output Table

	X	
	0	1
A	A/0	B/0
B	C/0	B/0
C	D/0	B/0
D	A/0	A/1

Next State Table

	X	
	0	1
A	A	B
B	C	B
C	D	B
D	A	A

State Transition Table

Q_1Q_2	X	
	0	1
00	00	01
01	10	01
10	11	01
11	00	00

Output Table
 $Z = xQ_1Q_2$

Q_1Q_2	X	
	0	1
00	0	0
01	0	0
10	0	0
11	0	1

Flip-Flop Transition Tables

T flip-flop (Q_1): $T = x'Q_2 + xQ_1$

Transition Table

Q_1Q_2	X	
	0	1
00	0	0
01	1	0
10	1	0
11	0	0

Input Table for T

Q_1Q_2	X	
	0	1
00	0	0
01	1	0
10	0	1
11	1	1

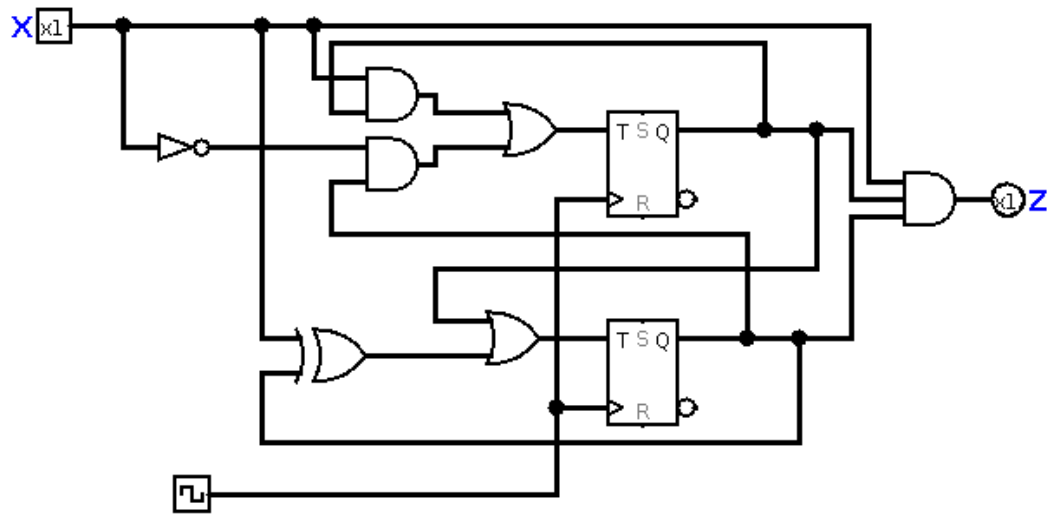
T flip-flop (Q_2): $T = Q_1 + x'Q_2 + xQ_2' = Q_1 + (x \oplus Q_2)$

Transition Table

Q_1Q_2	X	
	0	1
00	0	1
01	0	1
10	1	1
11	0	0

Input Table for T

Q_1Q_2	X	
	0	1
00	0	1
01	1	0
10	1	1
11	1	1



Flip-Flop Characteristic Tables

Q	SR	Q^+
0	00	0
0	01	0
0	10	1
0	11	—
1	00	1
1	01	0
1	10	1
1	11	—

Q	JK	Q^+
0	00	0
0	01	0
0	10	1
0	11	1
1	00	1
1	01	0
1	10	1
1	11	0

Q	D	Q^+
0	0	0
0	1	1
1	0	0
1	1	1

Q	T	Q^+
0	0	0
0	1	1
1	0	1
1	1	0

Flip-Flop Excitation Tables

Q	Q^+	SR	D	JK	T
0	0	0d	0	0d	0
0	1	10	1	1d	1
1	0	01	0	d1	1
1	1	d0	1	d0	0