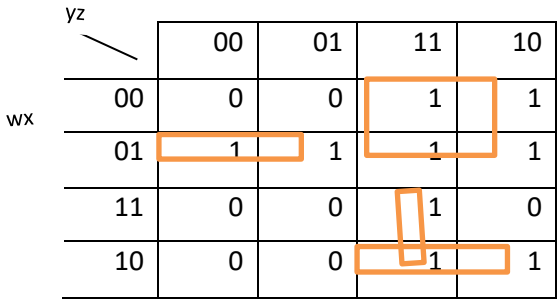
Individual Assignment -I for Section One only

1. Simplify the following Boolean function in sum-of-products and product-of sums by means of a four-variable map. Draw the logic diagram with (a) AND-OR gates; (b) NAND gates.

$F(w, x, y, z) = \sum(2,3,4,5,6,7,11,14,15)$

Mseries	w	x	y	z	out
M0	0	0	0	0	0
M1	0	0	0	1	0
M2	0	0	1	0	1
M3	0	0	1	1	1
M4	0	1	0	0	1
M5	0	1	0	1	1
M6	0	1	1	0	1
M7	0	1	1	1	1
M8	1	0	0	0	0
M9	1	0	0	1	0
M10	1	0	1	0	0
M11	1	0	1	1	1
M12	1	1	0	0	0
M13	1	1	0	1	0
M14	1	1	1	0	1
M15	1	1	1	1	1



SOP: $(\overline{w}x\overline{y})$+(y)+(wyz)

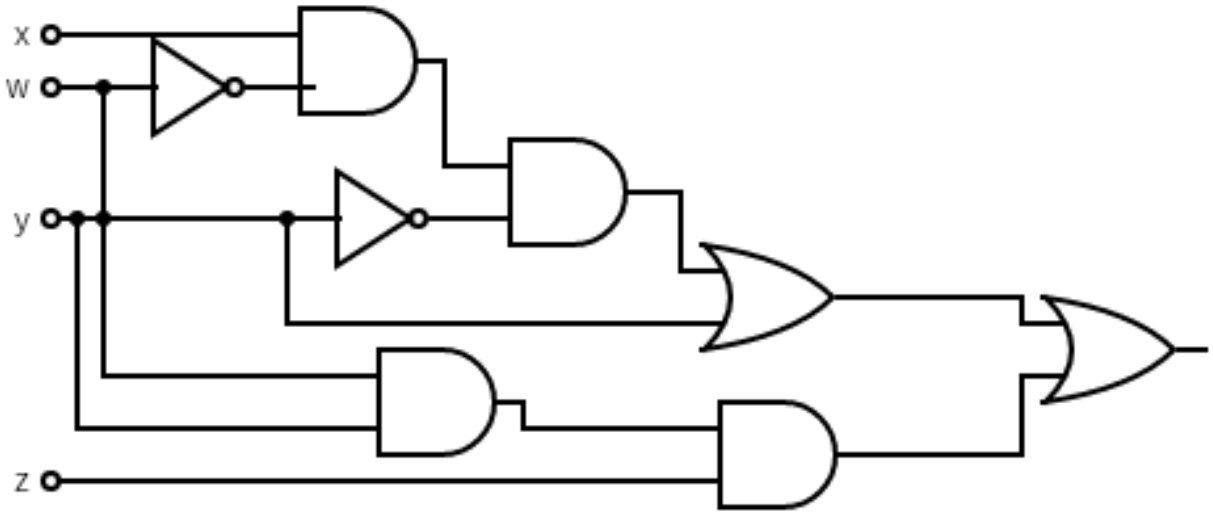


Figure 1. AND-OR for SOP

wx \ yz	00	01	11	10
00	0	0	1	1
01	1	1	1	1
11	0	0	1	0
10	0	0	1	1

POS: (y)*($\overline{w}$+$\overline{x}$+z)

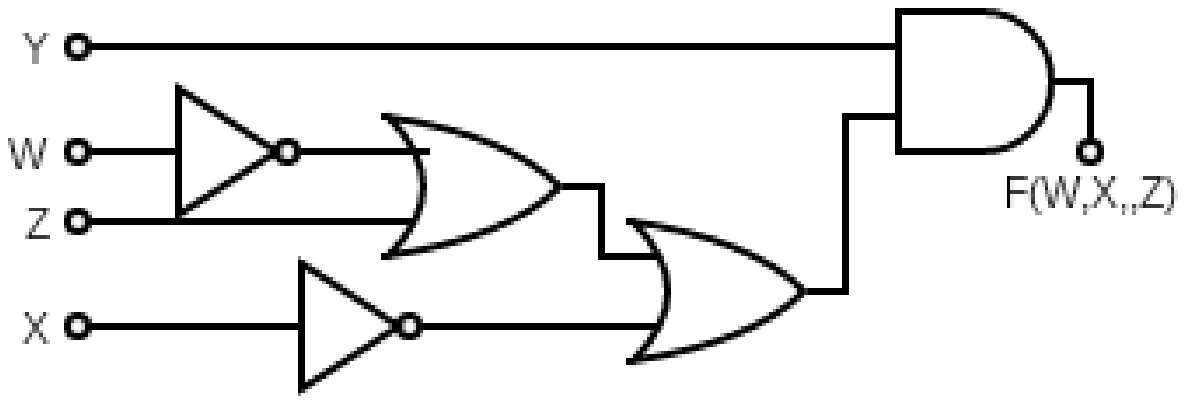


Figure 2. AND-OR for POS

2. Design a sequential circuit with two JK flip flops A and B and two inputs E and X. If E = 0 , the circuit remains in the same state regardless of the value of x. When E =1 and X =1 the circuit goes through the state transitions from 00 to 01 to 10 to 11 back to 00, and repeat. When E =1 and X =0, the circuit goes through the state transitions from 00 to 11 to 10 to 01 back to 00, and repeat**.**

	Inputs		Present state		Next state		FlipFlops (Excitation)			
	E	X	A	B	A	B	JA	KA	JB	KB
Case 1	0	x	0	0	0	0	0	X	0	X
	0	x	0	1	0	1	0	X	X	0
	0	x	1	0	1	0	X	0	0	X
	0	x	1	1	1	1	X	0	X	0
Case 2	1	1	0	0	0	1	0	X	1	X
	1	1	0	1	1	0	1	X	X	1
	1	1	1	0	1	1	X	0	1	X
	1	1	1	1	0	0	X	1	X	1
Case 3	1	0	0	0	1	1	1	X	1	X
	1	0	1	1	1	0	X	0	X	1
	1	0	1	0	0	1	X	1	1	X
	1	0	0	1	0	0	0	X	X	1

K-map

AB \ JA	00	01	11	10

AB JB

EX					
	00	0	0	X	X
	01	0	0	X	X
	11	0	1	X	X
	10	1	0	X	X

JA= EXB +E$\overline{XB}$

EX					
		00	01	11	10
	00	0	X	X	0
	01	0	X	X	0
	11	1	X	X	1
	10	1	X	X	1

JB=E

KA

EX	AB				
		00	01	11	10
	00	X	X	0	0
	01	X	X	0	0
	11	X	X	1	0
	10	X	X	0	1

KA=EXB+E$\overline{XB}$

KB

EX	AB				
		00	01	11	10
	00	X	0	0	X
	01	X	0	0	X
	11	X	1	1	X
	10	X	1	1	X

KB=E

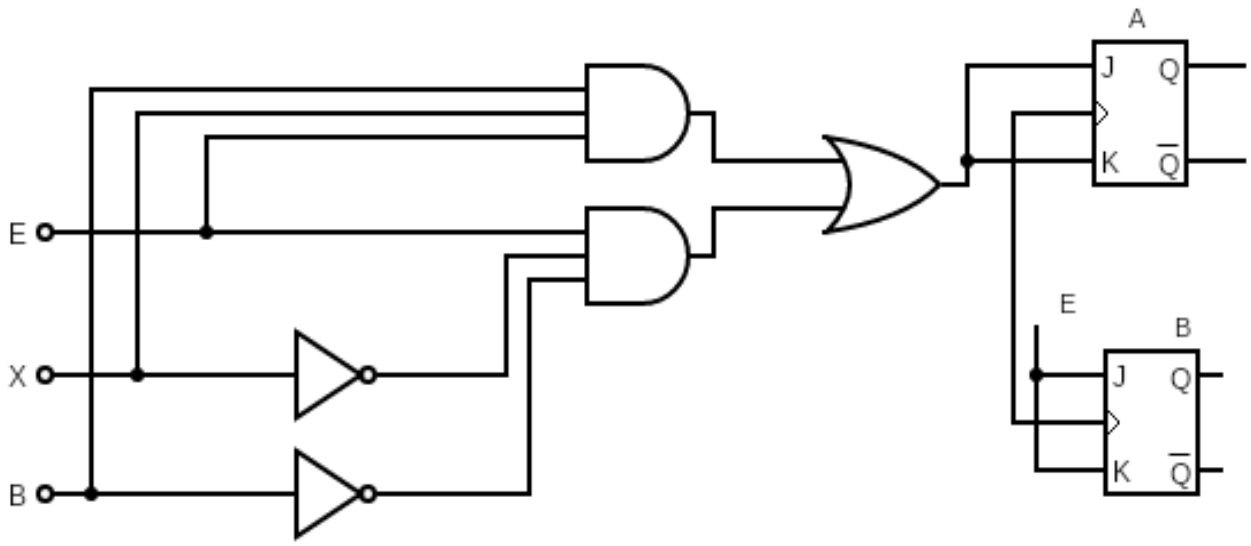
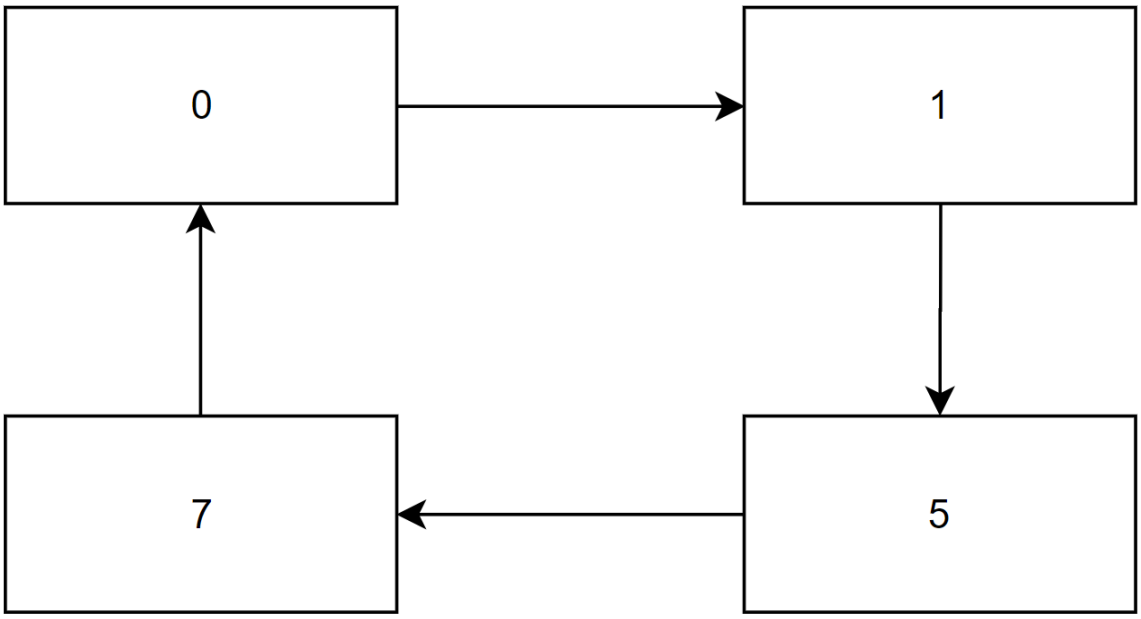


Figure 3. JK flip flop circuit

3. A counter has a special counting sequence: 0,5,7,1,0,5,7,1, and so on. Design this counter with minimal number of states.

a) Draw a state diagram for the counter



b) Construct a state-assigned table including the next state and output

Present state			**Next State(state 0)**		
Q2	**Q1**	**Q0**	**Q2+**	**Q1+**	**Q0+**
0	**0**	**0**	**1**	**0**	**1**
0	**0**	**1**	**0**	**0**	**0**
1	**0**	**1**	**1**	**1**	**1**
1	**1**	**1**	**0**	**0**	**1**

c) Draw the circuit diagram for the counter using D flip-flops

Present state			**Next State**					
Q2	**Q1**	**Q0**	**Q2+**	**Q1+**	**Q0+**	**D2**	**D1**	**D0**

0	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**1**
1	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
1	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**1**
0	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**

Q1Q2

Q0	00	01	11	10
0	1	0	0	0
1	0	1	0	0

D2=$\overline{Q2Q1Q0}$ + Q2$\overline{Q1}$Q0

Q1Q2

Q0	00	01	11	10
0	0	0	1	0
1	0	0	0	0

D1=Q2$\overline{Q1}$Q0

Q1Q2

Q0	00	01	11	10
0	1	0	0	0
1	0	0	1	1

D0=$\overline{Q2Q1Q0}$ +Q2Q0

d) Repeat (c) using T flip-flops

Characteristics table

T	**Q(next)**
0	**Q**
1	**Q'**
Q(next) = TQ' +T'Q	

Present state			**Next State**					
Q2	**Q1**	**Q0**	**Q2+**	**Q1+**	**Q0+**	**T2**	**T1**	**T0**

0	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**1**
1	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**0**
1	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**0**
0	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**

Q1Q2

Q0 \	00	01	11	10
0	1	0	0	0
1	0	0	1	0

T2=$\overline{Q2Q1Q0}$ + Q2Q1Q0

Q1Q2

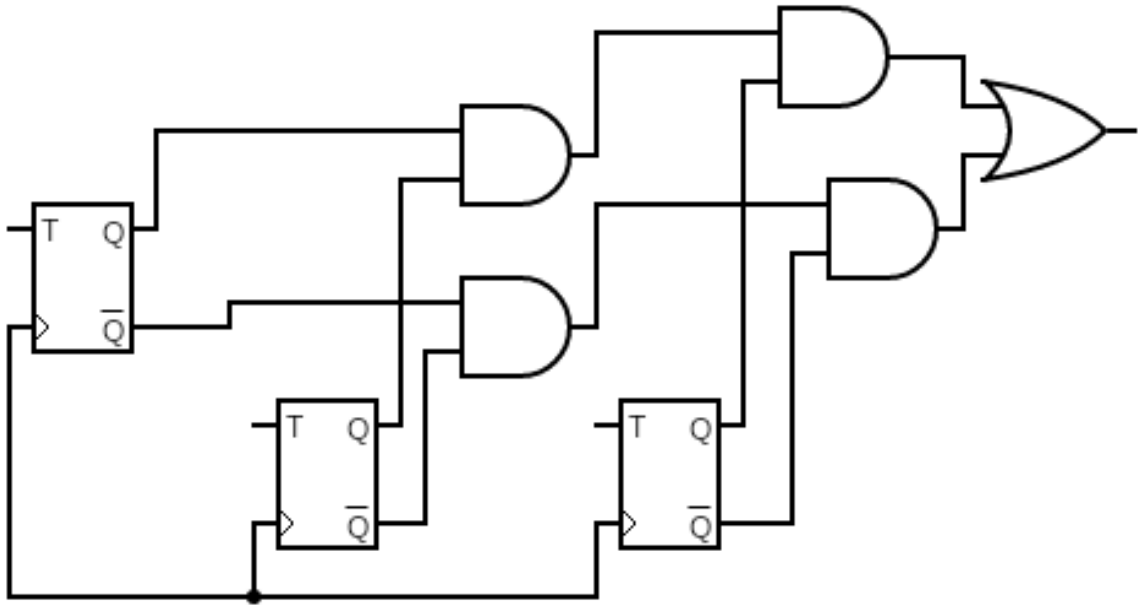
Q0 \	00	01	11	10
0	0	0	1	0
1	0	0	1	0

T1=Q2Q1

Q1Q2

Q0 \	00	01	11	10
0	1	0	0	0
1	1	0	0	0

T0=$\overline{Q2Q1}$



e) Repeat (c) using JK flip-flops

Present state			Next State								
Q2	**Q1**	**Q0**	**Q2+**	**Q1+**	**Q0+**	**JQ2**	**KQ2**	**JQ1**	**JK1**	**JQ0**	**JK0**
0	**0**	**0**	**1**	**0**	**1**	**1**	**X**	**0**	**X**	**1**	**X**
1	**0**	**1**	**1**	**1**	**1**	**X**	**0**	**1**	**X**	**X**	**0**
1	**1**	**1**	**0**	**0**	**1**	**X**	**1**	**X**	**1**	**X**	**0**
0	**0**	**1**	**0**	**0**	**0**	**0**	**X**	**0**	**X**	**X**	**1**