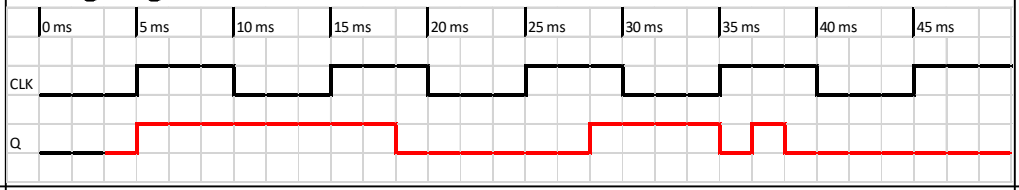
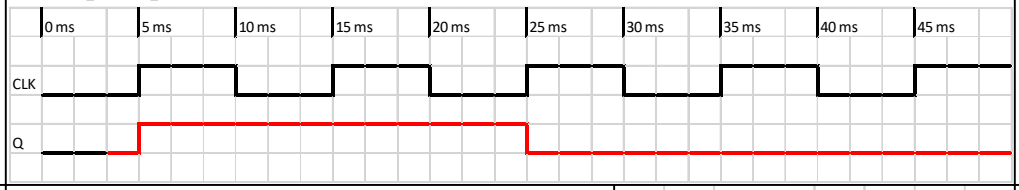
IE1204 Digital Design Answer Form 2020-10-16

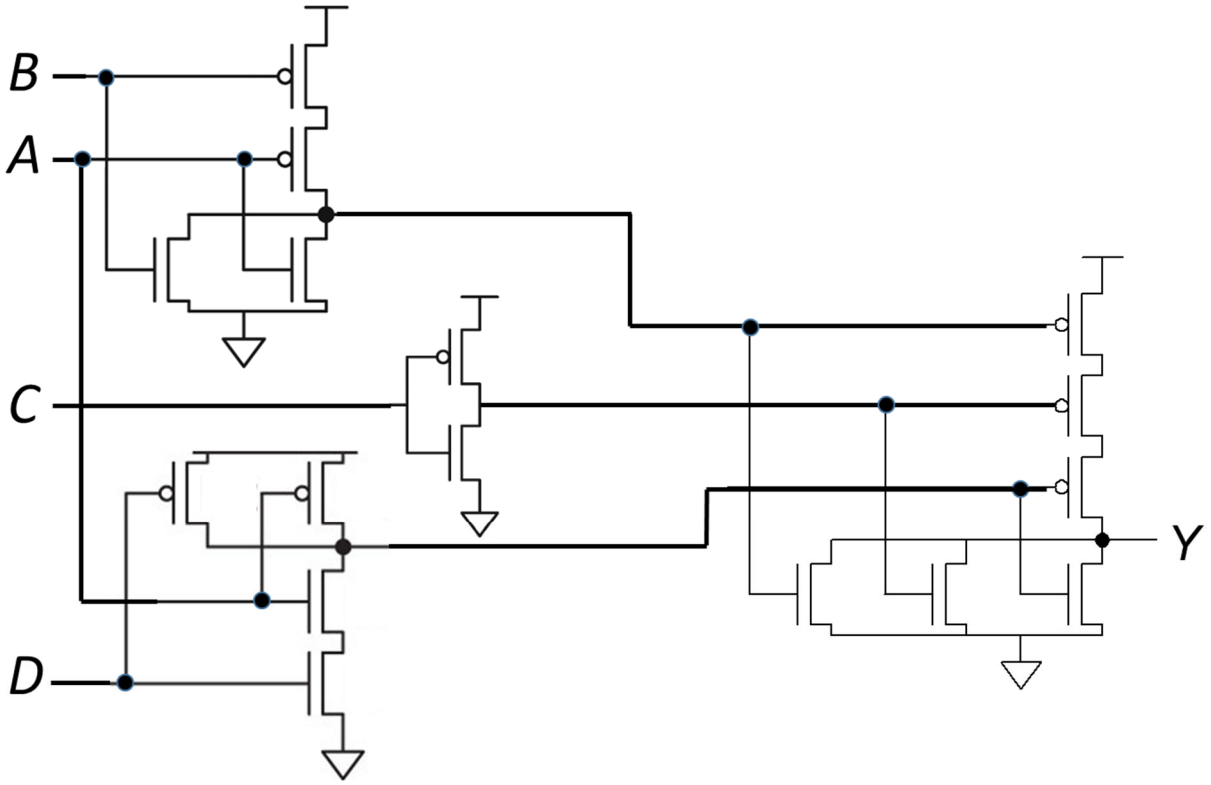
Full Name		Personal Number								Program
Exam Answers 2020-10-16		YYYYMMDD-XXXX								NN
#	Answer with	Answer								Points
1	Decimal number	-72								1
2	8 bit two's complement binary number	0	1	1	1	0	1	0	1	1
3	8 bit two's complement binary number	1	1	1	0	0	1	1	1	1
4	Boolean expression, Y =	$A \cdot C \cdot D$								1
5	Boolean expression, Y =	$(A+B+C)(A+\overline{B}+\overline{C})(\overline{A}+B+\overline{C})$								1
6	Boolean expression, Y = $(\overline{C}+\overline{D})(\overline{B}+D)(\overline{A}+B)$ OR $\overline{A}\cdot\overline{C}+\overline{A}\cdot\overline{B}\cdot\overline{D}+B\cdot\overline{C}\cdot D$									1
7	MUX connections Row CD = 00	1								1
	Row CD = 01	$\overline{A \oplus B}$								
	Row CD = 10	$\overline{B}$								
	Row CD = 11	$A+B$								
8	Timing diagram 									1
9	Timing diagram 									1
10	Setup condition Hold condition	☒ Yes ☐ No ☐ Yes ☒ No								1
11	Boolean expression	$B \cdot \overline{C}$								1
12	16 bit two's complement binary number, MSB LSB	1	1	1	1	1	1	1	0	1
		1	0	0	0	1	1	0	1	
13	8 bit two's complement binary number	1	1	1	0	0	1	1	1	1
14	Number interval	-16 to 15.875								1
15	5 result bits (S4 S3 S2 S1 S0)	1	0	1	0	1				1
16	4 flag bits (V C N Z)	1	1	0	0					1
TOTAL POINTS		Examiner sign CMZ								16

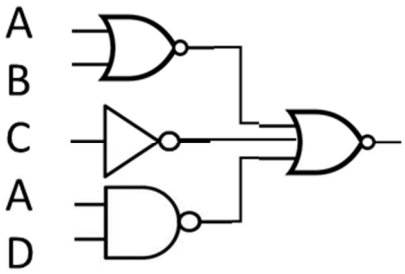
IE1204 Digital Design Exam 2020-10-16 K-maps

4 CMOS

Swedish: Bestäm den logiska funktionen Y = f(A, B, C) för CMOS-grindnätet.
Förenkla så långt som möjligt.

English: Determine the logic function Y = f(A, B, C) for the CMOS-circuit.
Simplify as much as possible.





$$Y = \overline{\overline{(A+B)} + \overline{C} + \overline{(A \cdot D)}} = A \cdot C \cdot D$$

5 SoP / PoS

Swedish: Ta fram booleskt uttryck på PoS form för sanningstabellen nedan.

English: Derive the Boolean expression in PoS form for the truth table below.

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Y \ AB / C	00	01	11	10
0	0	1	1	1
1	1	0	1	0

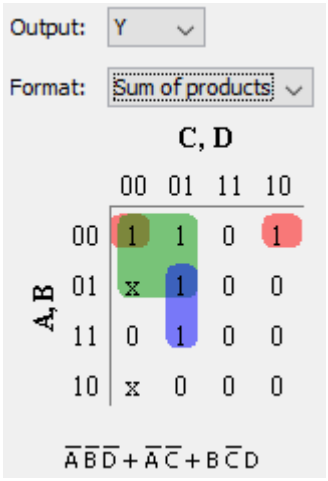
$$Y = (A + B + C)(A + \overline{B} + \overline{C})(\overline{A} + B + \overline{C})$$

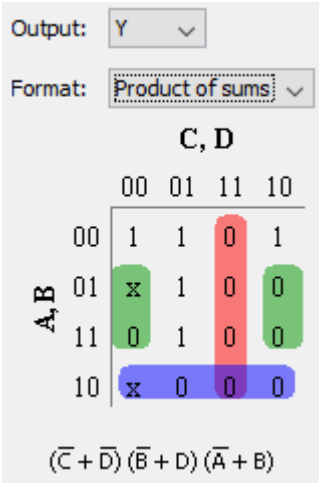
6 K-map

Swedish: Uttnyttja x = don't care.
Ta fram enklast möjliga booleska uttryck från K-map.

English: Use x = don't care.
Derive simplest possible Boolean expression from the K-map.

Y	CD 00	CD 01	CD 11	CD 10
AB 00	1	1	0	1
AB 01	X	1	0	0
AB 11	0	1	0	0
AB 10	X	0	0	0





IE1204 Digital Design Exam 2020-10-16 Solutions

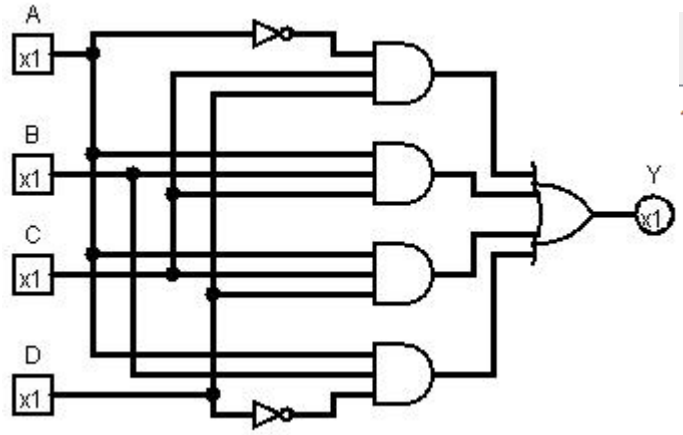
17 Analysis of Combinational Circuit

Swedish:

1. Ta fram booleskt uttryck för kretsen nedan.
2. Rita K-map för kretsen med variabelordning som i figuren.
3. Förenkla uttrycket med hjälp av K-map.
4. Rita ny krets med enbart 2- och 3-ingångars NOR-grindar.

English:

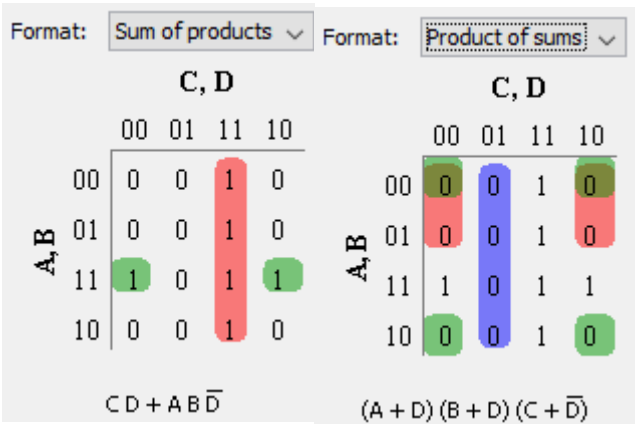
1. Derive the Boolean expression for the circuit below.
2. Draw a K-map for the circuit with variables as in the figure.
3. Simplify the expression using the K-map.
4. Draw a new circuit using only 2 and 3 input NOR gates.

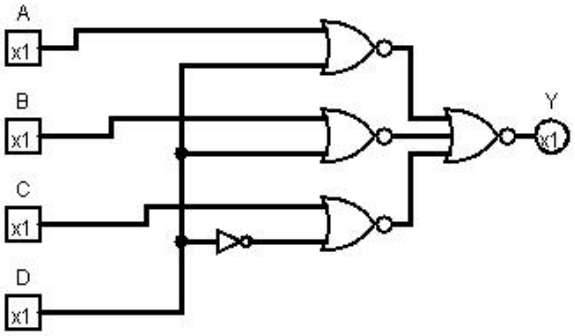


$\bar{A}CD + ABC + ACD + AB\bar{D}$

~A C D + A B C + A C D + A B ~D

Use POS for NOR only (inverters are ok if you note that they can be made with a NOR)





18 Design of Combinational Circuit

Swedish:
Designa en kombinatorisk krets för Y=f(Q3, Q2, Q1, Q0) där

Y = x (don't care) för talet 1
Y = x (don't care) för alla jämna tal som är tvåpotenser, dvs 2, 4 och 8
Y = 1 för alla udda primtal, dvs 3, 5, 7 11, och 13
Y = 0 för alla övriga udda tal
Y = 0 för alla övriga jämna tal

1. Rita sanningstabellen.
2. Rita K-map för sanningstabellen med variabelordning som i figuren.
3. Uttnyttja x = don't care. Ta fram enklast möjliga booleska uttryck från K-map.
4. Rita en krets för uttrycket med enbart 2- och 3-ingångars NAND-grindar.

English:
Design a combinational circuit for Y=f(Q3, Q2, Q1, Q0) where

Y = x (don't care)for the number 1
Y = x (don't care) for all even numbers that are powers of 2, i.e. 2, 4, and 8
Y = 1 for all odd prime numbers, i.e. 3, 5, 7, 11, and 13
Y = 0 for all other odd numbers
Y = 0 for all other even numbers

1. Draw the truth table.
2. Draw a K-map for the truth table with variables as in the figure..
3. Use x = don't care. Derive simplest possible Boolean expression from the K-map.
4. Draw a circuit for the expression using only 2 and 3 input NAND-gates.

	Q_1Q_0 = 00	01	11	10
Q_3Q_2 = 00				
01				
11				
10				

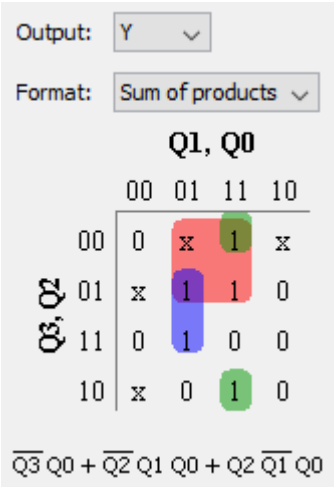
Rita om K-map i dina inlämnade svar.

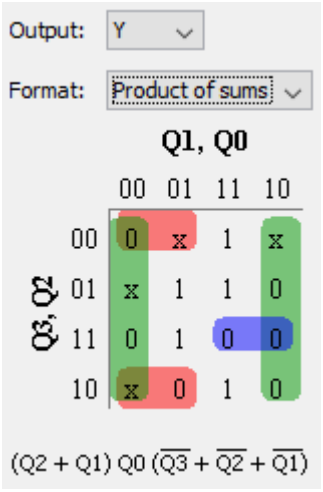
Redraw the K-map in your answer sheets.

(Answer on next page)

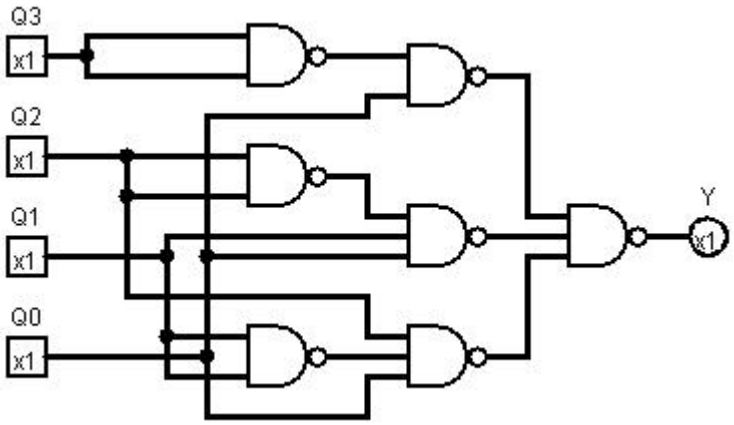
18 Design of Combinational Circuit

Q3	Q2	Q1	Q0	Y
0	0	0	0	0
0	0	0	1	x
0	0	1	0	x
0	0	1	1	1
0	1	0	0	x
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	x
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0





Use SOP for NAND only (inverters are ok if you note that they can be made with a NAND)



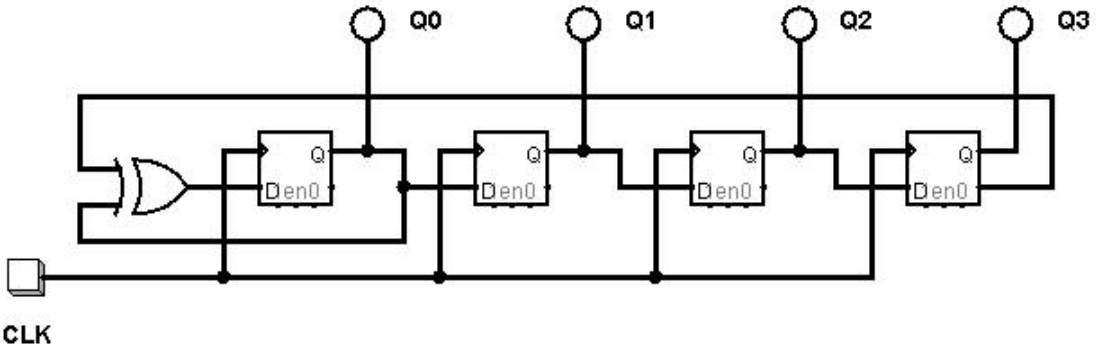
19 Analysis of FSM

Swedish: Analysera vad nedanstående tillståndsmaskin (FSM) utför.

1. Ta fram Boolska uttryck för nästa tillstånd.
2. Rita tillståndstabell.
3. Rita tillståndsdiagram.

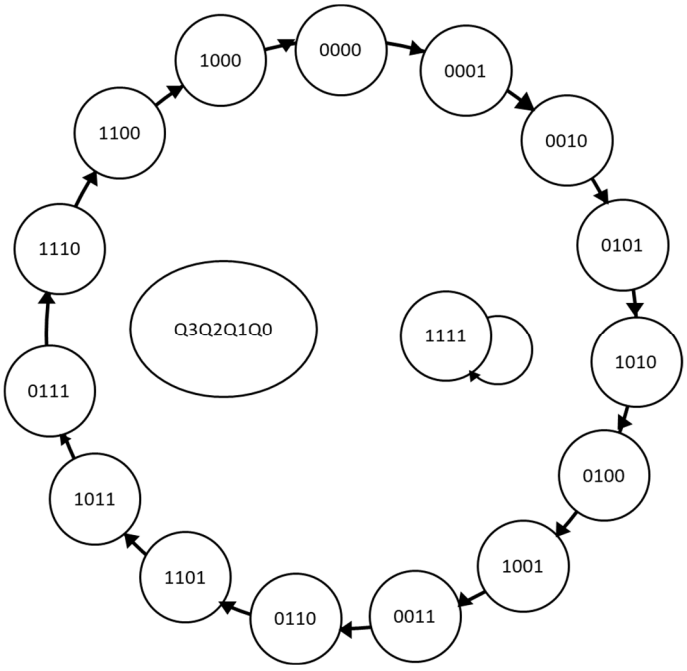
English: Analyze the state machine (FSM) below.

1. Derive Boolean expressions for next state.
2. Draw a state table.
3. Draw a state diagram.



$Q3+= Q2$
$Q2+= Q1$
$Q1+= Q0$
$Q0+= \overline{Q3} \oplus Q1 = Q3 \cdot Q1 + \overline{Q3} \cdot \overline{Q1}$

Present state				Next state			
Q3	Q2	Q1	Q0	Q3+	Q2+	Q1+	Q0+
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	1	0	0	1
0	1	0	1	1	0	1	0
0	1	1	0	1	1	0	1
0	1	1	1	1	1	1	0
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	1
1	0	1	0	0	1	0	0
1	0	1	1	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	1	1
1	1	1	0	1	1	0	0
1	1	1	1	1	1	1	1



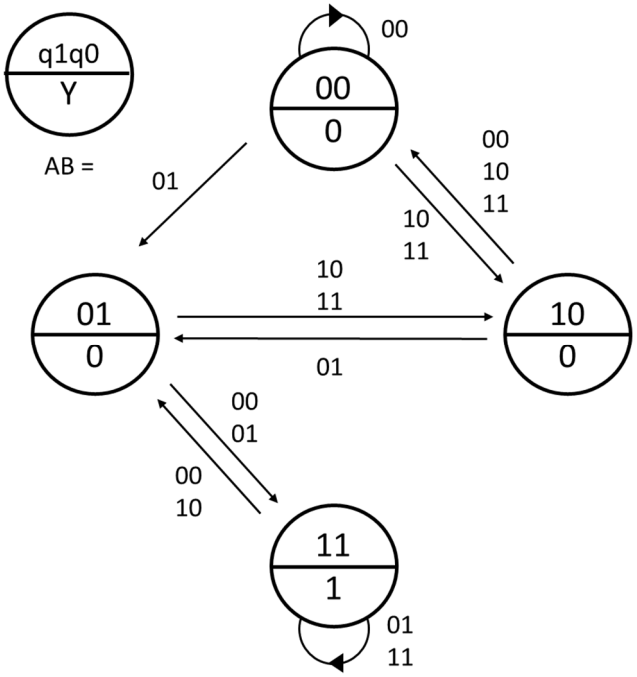
20 Design of FSM

Swedish: Konstruera en tillståndsmaskin (FSM) enligt tillståndsdiagrammet nedan.

1. Rita tillståndstabell.
2. Ta fram K-map för nästa tillstånd och utsignal.
3. Ta fram minimerade uttryck för nästa tillstånd och utsignal.
4. Rita kretsschema för en FSM med DFFs och vilka grindar som helst.

English: Design a state machine (FSM) according to the state diagram below.

1. Draw a state table.
2. Derive K-maps for next state and output.
3. Derive minimized expressions for next state and output.
4. Draw the FSM circuit diagram with DFFs and any gates.



	A B = 00	01	11	10
q1q0 = 00				
01				
11				
10				

Rita om K-map i dina inlämnade svar.

Redraw the K-map in your answer sheets.

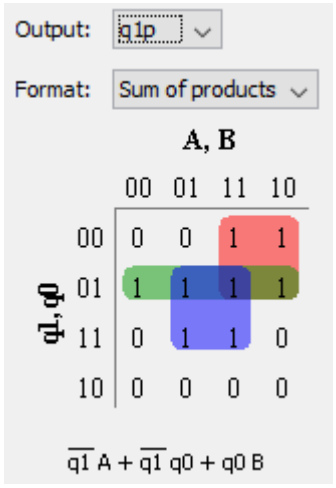
		Next state								
Present state		AB = 00		AB = 01		AB = 11		AB = 10		Out
q1	q0	q1+	q0+	q1+	q0+	q1+	q0+	q1+	q0+	Y
0	0	0	0	0	1	1	0	1	0	0
0	1	1	1	1	1	1	0	1	0	0
1	1	0	1	1	1	1	1	0	1	1
1	0	0	0	0	1	0	0	0	0	0

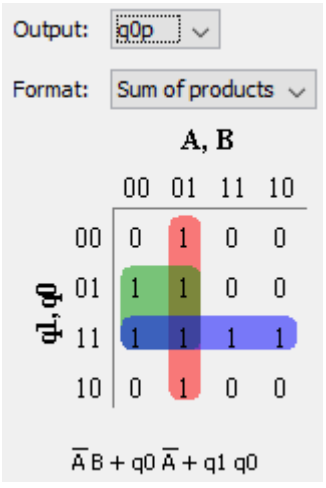
q1+	AB=			
q1q0	00	01	11	10
00	0	0	1	1
01	1	1	1	1
11	0	1	1	0
10	0	0	0	0

q0+	AB=			
q1q0	00	01	11	10
00	0	1	0	0
01	1	1	0	0
11	1	1	1	1
10	0	1	0	0

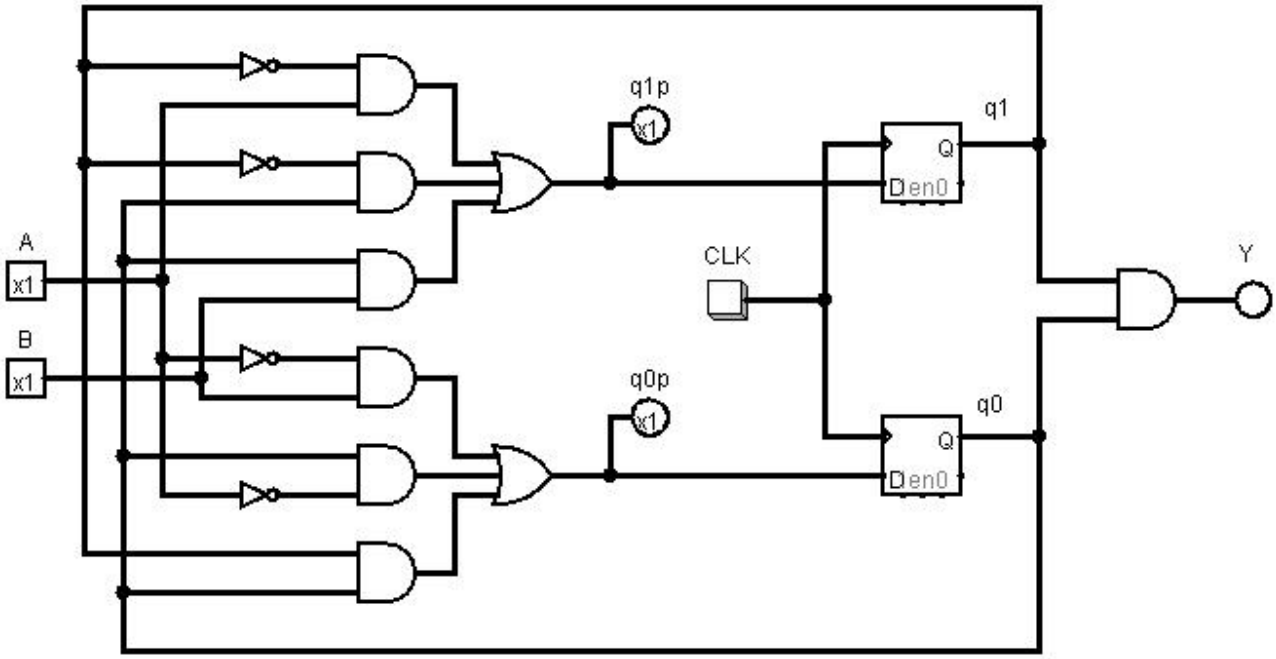
(K-map not needed for Y)

Continues on next page


Output: q1p
Format: Sum of products
A, B
00 01 11 10
q1, q0
00 0 0 1 1
01 1 1 1 1
11 0 1 1 0
10 0 0 0 0
$\overline{q1}\,A + \overline{q1}\,q0 + q0\,B$


Output: q0p
Format: Sum of products
A, B
00 01 11 10
q1, q0
00 0 1 0 0
01 1 1 0 0
11 1 1 1 1
10 0 1 0 0
$\overline{A}\,B + q0\,\overline{A} + q1\,q0$

$Y = q1 \cdot q0$


A
x1
B
x1
q1p
x1
q0p
x1
CLK
Q
Den0
q1
Q
Den0
q0
Y