IE1204 Digital Design Practice Exam Solutions

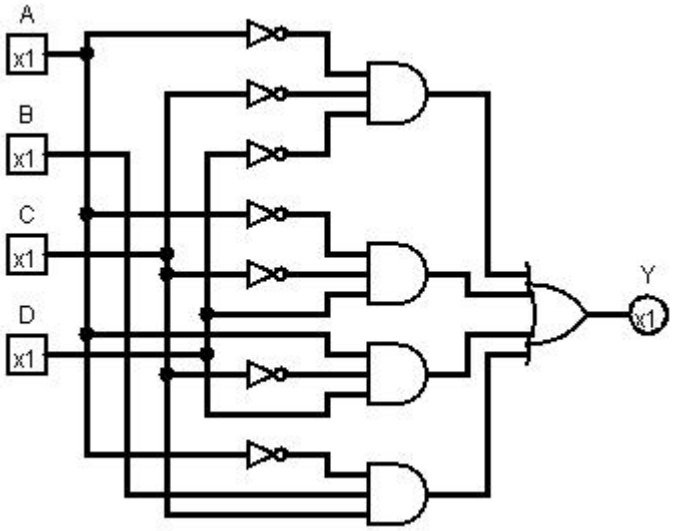
17 Analysis of Combinational Circuit

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.



$$\bar{A}\bar{C}\bar{D} + \bar{A}\bar{C}D + A\bar{C}D + \bar{A}BC$$

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~A ~C ~D + ~A ~C D + A ~C D + ~A B C
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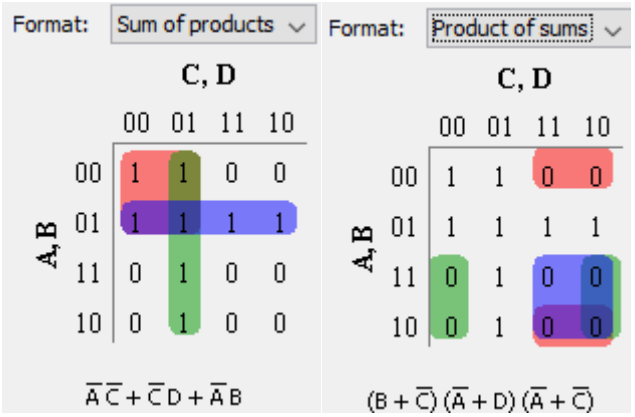
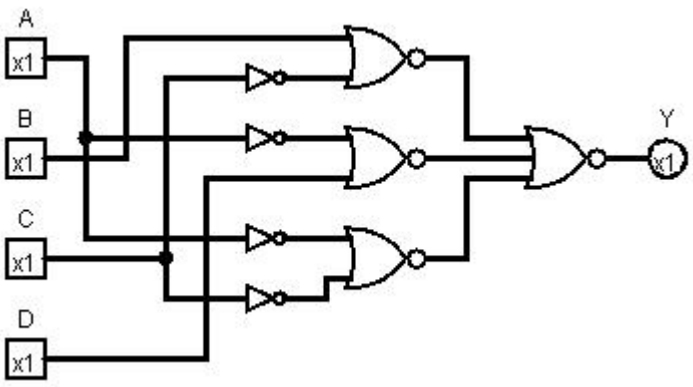
Use POS for NOR only (inverters are ok if you note that they can be made with a NOR)





18 Design of Combinational Circuit

Swedish:
Designa en kombinatorisk krets för Y=f(A, B, C, D) där

Y = 1 för alla udda tal utom de som är jämt delbara med 3
Y = 0 för alla udda tal jämt delbara med 3, utom 15
Y = 0 för alla jämna tal utom talet 0, och de som är jämt delbara med 3
Y = 1 för talet 0
Y = x (don't care) för alla jämna tal delbara med 3, och för talet 15

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.

Notera: A = MSB, D = LSB

English:
Design a combinational circuit for Y=f(A, B, C, D) where

Y = 1 for all odd numbers except those evenly divisible by 3
Y = 0 for all odd numbers evenly divisible by 3, except 15
Y = 0 for all even numbers except the number 0, and those evenly divisible by 3
Y = 1 for the number 0
Y = x (don't care) for all even numbers evenly divisible by 3, and number 15

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.

Note: A = MSB, D = LSB

AB \ CD =	00	01	11	10
00				
01				
11				
10				

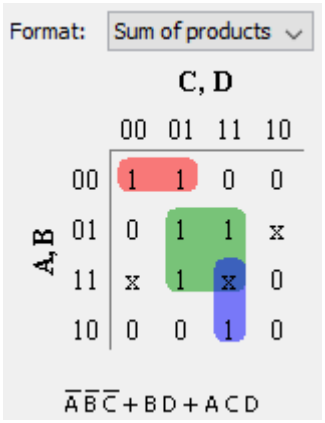
Rita om K-map i dina inlämnade svar.

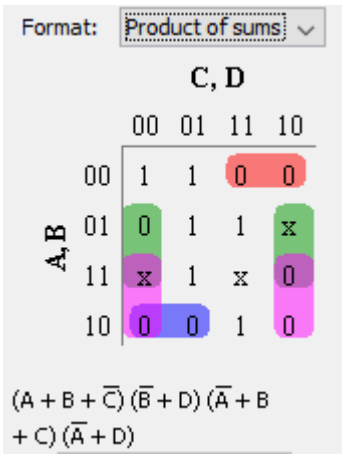
Redraw the K-map in your answer sheets.

(Answer on next page)

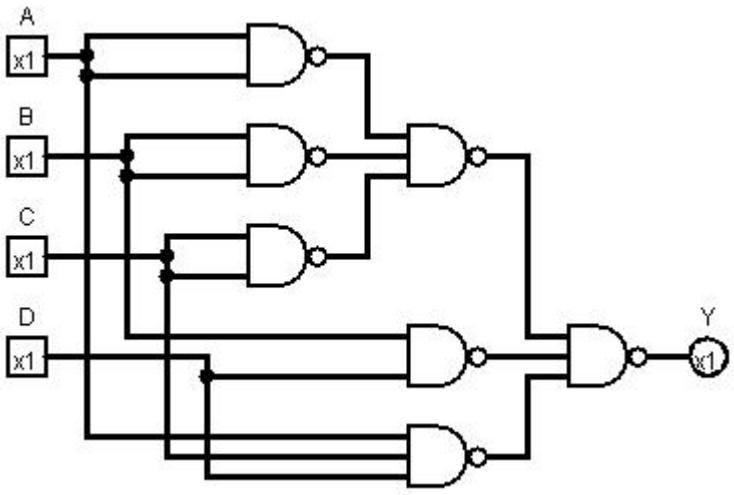
18 Design of Combinational Circuit

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	x
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	x
1	1	0	1	1
1	1	1	0	0
1	1	1	1	x





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



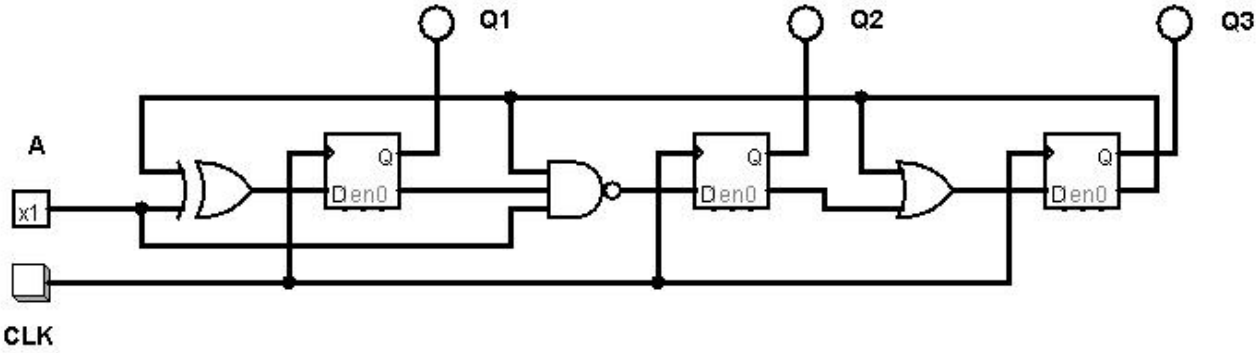
19 Analysis of FSM

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.

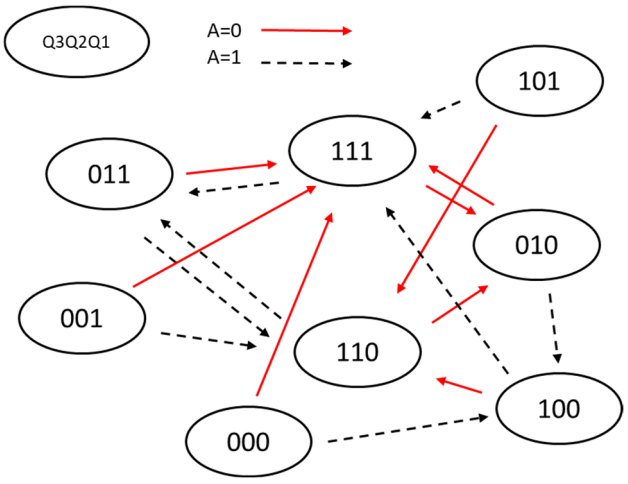


$Q3+= \overline{Q3} + \overline{Q2}$

$Q2+= \overline{\overline{Q3} \cdot \overline{Q1} \cdot A} = Q3 + Q1 + \overline{A}$

$Q1+= \overline{Q3} \oplus A = Q3 \cdot A + \overline{Q3} \cdot \overline{A}$

Present state			Next state A = 0			Next state A = 1		
Q3	Q2	Q1	Q3+	Q2+	Q1+	Q3+	Q2+	Q1+
0	0	0	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0
0	1	0	1	1	1	1	0	0
0	1	1	1	1	1	1	1	0
1	0	0	1	1	0	1	1	1
1	0	1	1	1	0	1	1	1
1	1	0	0	1	0	0	1	1
1	1	1	0	1	0	0	1	1



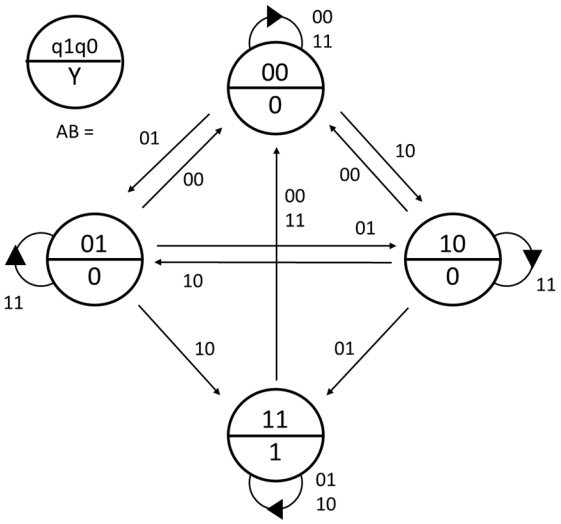
20 Design of FSM

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.

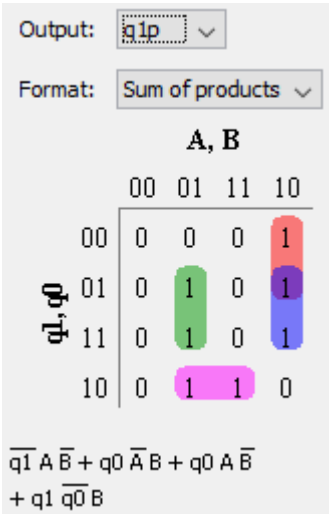
Redraw the K-map in your answer sheets.

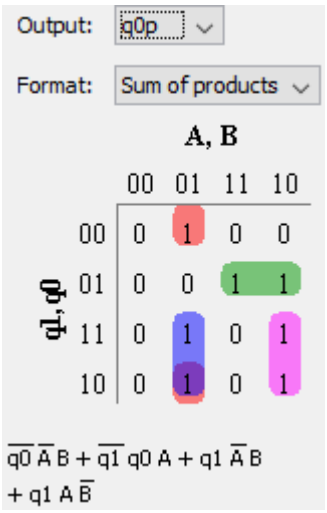
		Next state								
Present state		AB = 00		AB = 01		AB = 11		AB = 10		Out
q1	q0	q1+	q0+	q1+	q0+	q1+	q0+	q1+	q0+	Y
0	0	0	0	0	1	0	0	1	0	0
0	1	0	0	1	0	0	1	1	1	0
1	1	0	0	1	1	0	0	1	1	1
1	0	0	0	1	1	1	0	0	1	0

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

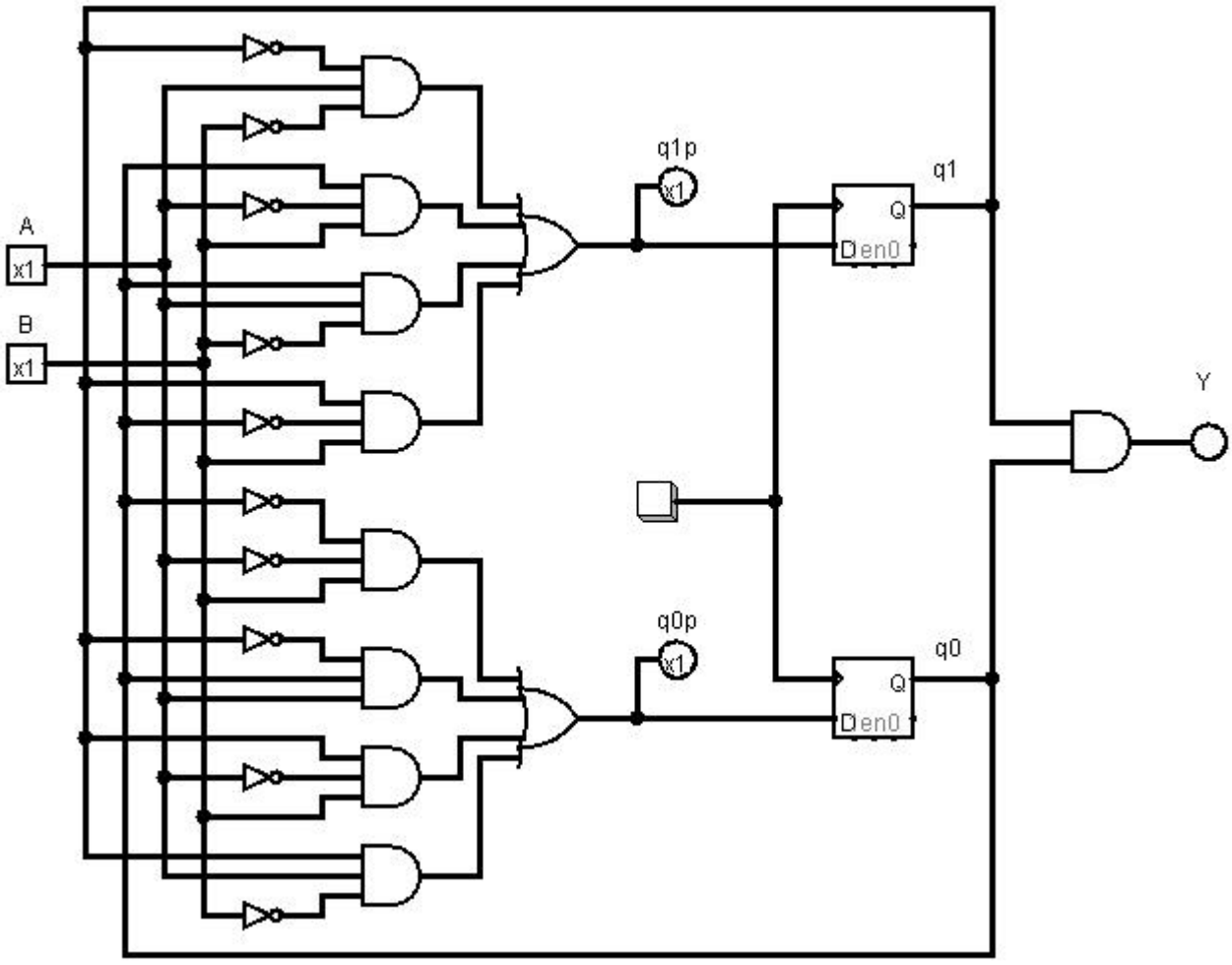
q0+	AB=			
q1q0	00	01	11	10
00	0	1	0	0
01	0	0	1	1
11	0	1	0	1
10	0	1	0	1

(K-map not needed for Y)


Output: q1p
Format: Sum of products
A, B
00 01 11 10
q1, q0
00 0 0 0 1
01 0 1 0 1
11 0 1 0 1
10 0 1 1 0
q1 A B + q0 A B + q0 A B
+ q1 q0 B


Output: q0p
Format: Sum of products
A, B
00 01 11 10
q1, q0
00 0 1 0 0
01 0 0 1 1
11 0 1 0 1
10 0 1 0 1
q0 A B + q1 q0 A + q1 A B
+ q1 A B

$$Y = q1 \cdot q0$$


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