

IE1204 Digital Design Answer Form 2020-10-16

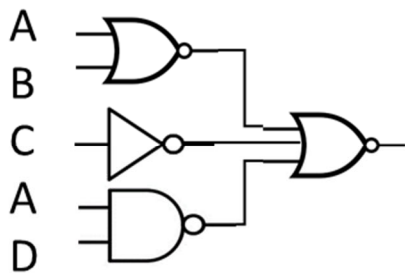
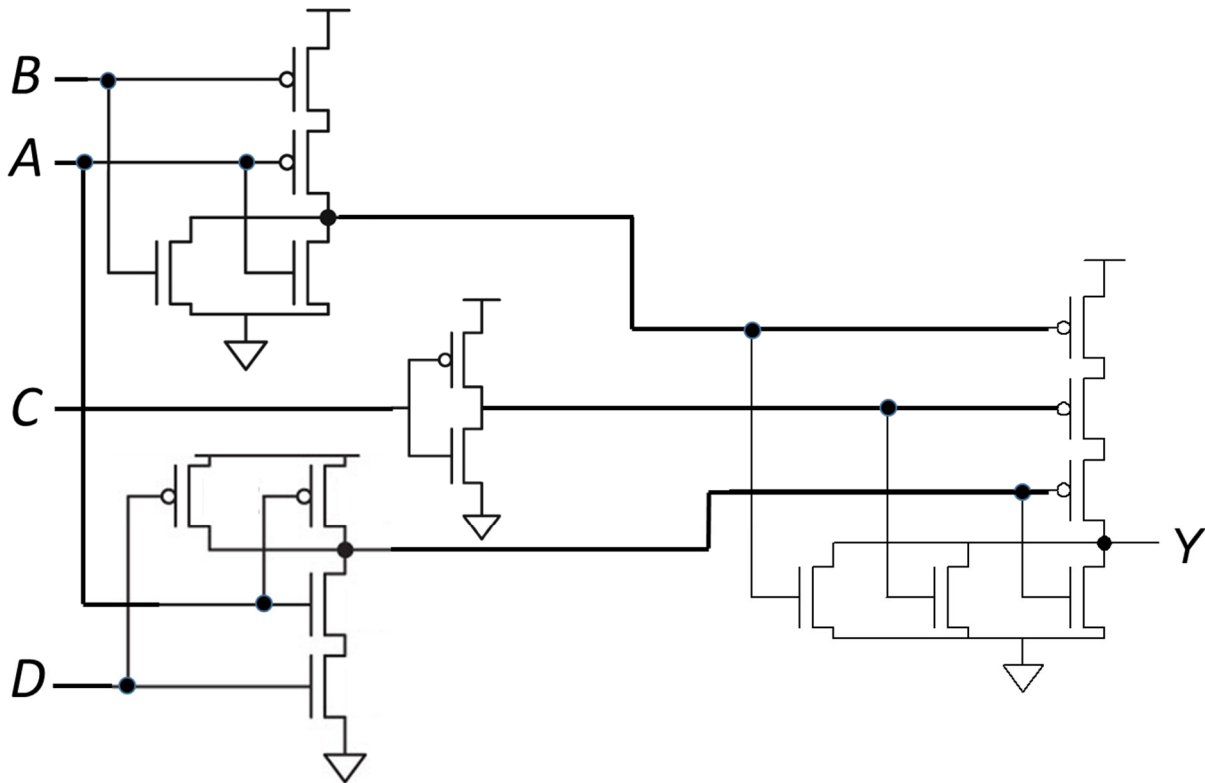
Full Name		Personal Number						Program		
Exam Answers 2020-10-16		YYYYMMDD-XXXX						NN		
#	Answer with	Answer						Points		
1	Decimal number	-72						1		
2	8 bit two's complement binary number	0	1	1	1	0	1	0	1	1
3	8 bit two's complement binary number	1	1	1	0	0	1	1	1	1
4	Boolean expression, Y =	$A \cdot C \cdot D$						1		
5	Boolean expression, Y =	$(A + B + C)(A + \bar{B} + \bar{C})(\bar{A} + B + \bar{C})$						1		
6	Boolean expression, Y = OR $\bar{A} \cdot \bar{C} + \bar{A} \cdot \bar{B} \cdot \bar{D} + B \cdot \bar{C} \cdot D$	$(\bar{C} + \bar{D})(\bar{B} + D)(\bar{A} + B)$						1		
7	MUX connections	1						1		
	Row CD = 00	$\overline{A \oplus B}$								
	Row CD = 01	\bar{B}								
	Row CD = 10	$A + B$								
	Row CD = 11									
8	Timing diagram							1		
9	Timing diagram							1		
10	Setup condition	<input checked="" type="checkbox"/> Yes		<input type="checkbox"/> No				1		
	Hold condition	<input type="checkbox"/> Yes		<input checked="" type="checkbox"/> No						
11	Boolean expression	$B \cdot \bar{C}$						1		
12	16 bit two's complement binary number, MSB	1	1	1	1	1	1	1	0	1
	LSB	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 $Y = f(A, B, C, D)$ för CMOS-grindnätet. Förenkla så långt som möjligt.

English: Determine the logic function $Y = f(A, B, C, D)$ 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

		AB			
		00	01	11	10
C	0	0	1	1	1
	1	1	0	1	0

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

6 K-map

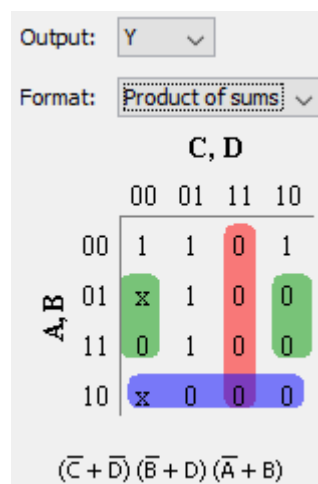
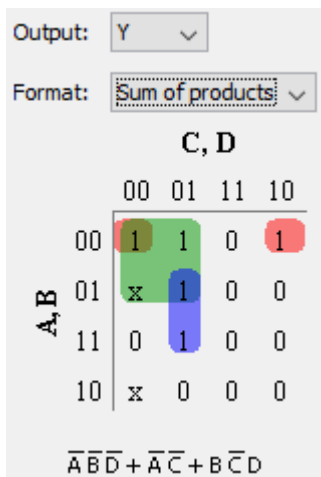
Swedish: Uttnyttja x = don't care.

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

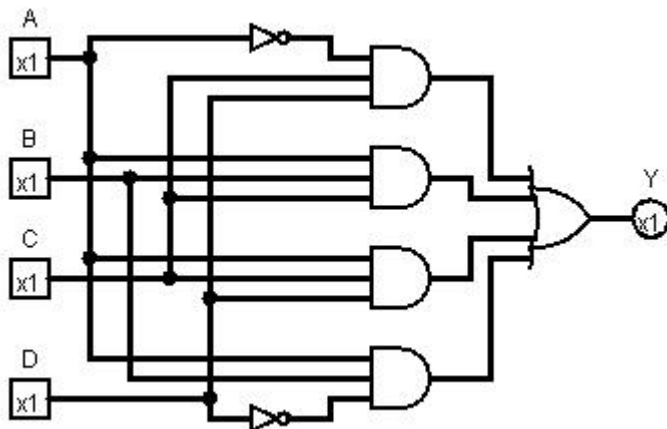
17 Analysis of Combinational Circuit

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:

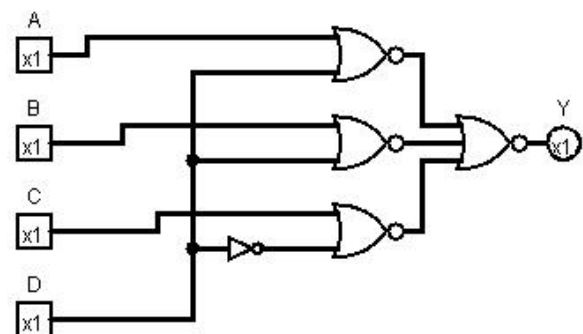
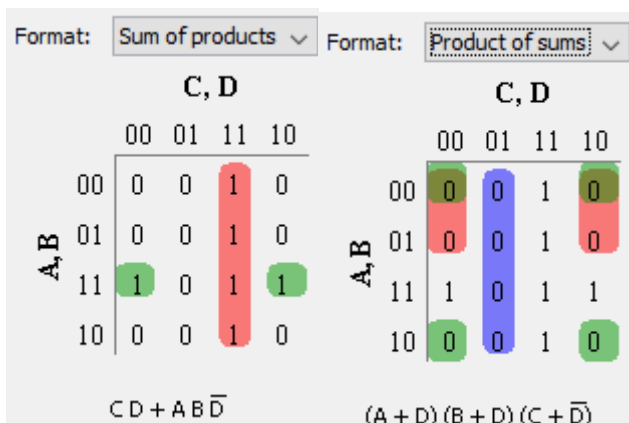
1. Derive the Boolean expression for the circuit below.
2. Draw a K-map for the circuit with variables as in the figure.
3. Simplify the expression using the K-map.
4. Draw a new circuit using only 2 and 3 input NOR gates.



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

$$\sim A C D + A B C + A C D + A B \sim D$$

**Use POS for NOR only (inverters are ok if you note that they can be made with a NOR)
No deductions if not simplest possible.**



For POS, draw $Y = \overline{\overline{A + D} + \overline{B + D} + \overline{C + \bar{D}}}$ (See figure)

For SOP, draw $Y = \overline{\overline{\overline{C} + \overline{\overline{D}} + \overline{\overline{A} + \overline{B}} + D}}$
(Note the double inversion bars, an extra inverter/NOR is needed)

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 $x = \text{don't care}$. 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 $x = \text{don't care}$. 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				

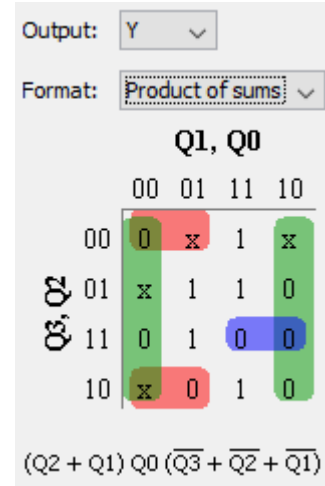
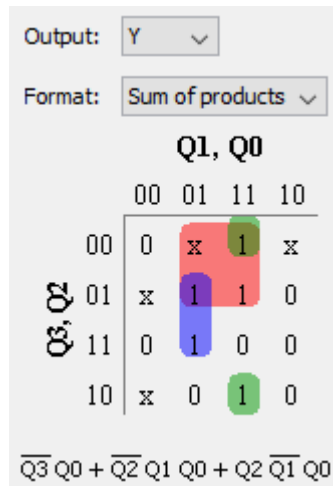
Rita om K-map i dina inlämnade svar.

Redraw the K-map in your answer sheets.

(Answer on next page)

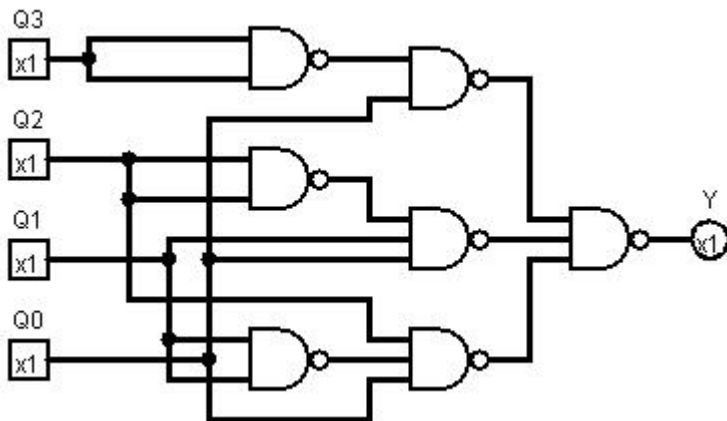
18 Design of Combinational Circuit

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)
No deductions if not simplest possible.**

For SOP draw $Y = \overline{Q3} \cdot Q0 \cdot \overline{Q2} \cdot Q1 \cdot Q0 \cdot Q2 \cdot \overline{Q1} \cdot Q0$ (see figure)



For POS draw $Y = \overline{Q2} \cdot \overline{Q1} \cdot Q0 \cdot \overline{Q3} \cdot Q2 \cdot Q1$

(Note the double inversion bars, an extra inverter/NAND is needed)

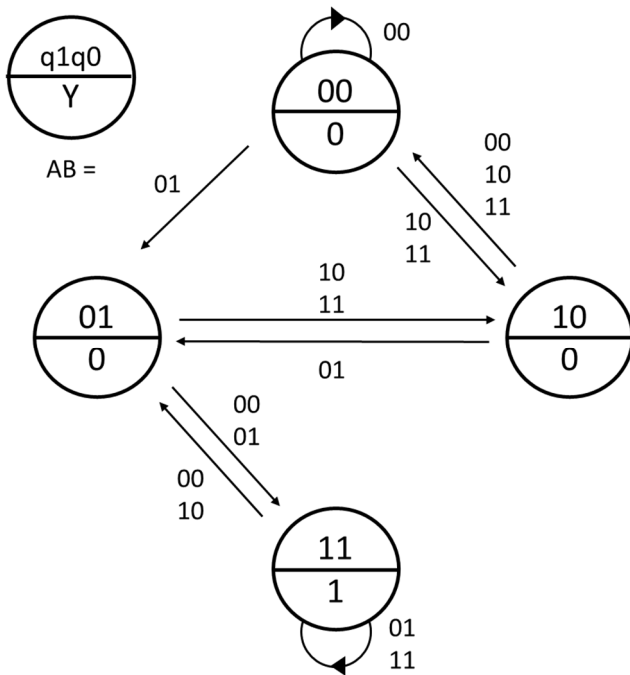
20 Design of FSM

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

1. Rita tillståndstabell.
2. Ta fram K-map för nästa tillstånd.
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 states.
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.

Present state		Next state								Out
		AB = 00		AB = 01		AB = 11		AB = 10		
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: Output:

Format: Format:

		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

$\bar{q1} A + \bar{q1} q0 + q0 B$

		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

$(q0 + A) (\bar{q1} + q0) (\bar{q1} + B)$

Output: Output:

Format: Format:

		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

$\bar{A} B + q0 \bar{A} + q1 q0$

		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

$(q0 + B) (q1 + \bar{A}) (q0 + \bar{A})$

$Y = q1 \cdot q0$

