


Problem 1. A beginner digital designer tried to design the complement $\overline{F}_{\text{wrong}} = \overline{A} \overline{B} + \overline{C}$ of the logic function $F = A + B C$ using the rule: swap all AND- and OR-operations and complement all variables. However, the logic didn't work correctly. What went wrong? **Present the logic function of the correct complement $\overline{F}_{\text{correct}}$ as a product of sums** and show with truth tables and with K-maps the operation of the logic functions F , $\overline{F}_{\text{wrong}}$ and $\overline{F}_{\text{correct}}$.

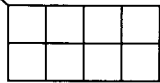
Answer here:

ABC	F	$\overline{F}_{\text{wrong}}$	$\overline{F}_{\text{correct}}$

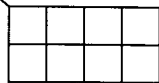
F



$\overline{F}_{\text{wrong}}$



$\overline{F}_{\text{correct}}$

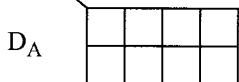


$\overline{F}_{\text{correct}} = \underline{\hspace{10em}}$

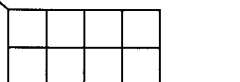
Problem 2. Analyse the enclosed logic diagram. Initial state is 00 and the input X is synchronised to the clock CLK. X can be logic one for several clock cycles. As your answer, present the **state diagram** showing the operation and adequate intermediate stages (e.g. flip-flop input logic functions, state transfer table ...). Also **explain** with one sentence **what the logic does**.

Answer here:

$D_A = \underline{\hspace{10em}}$

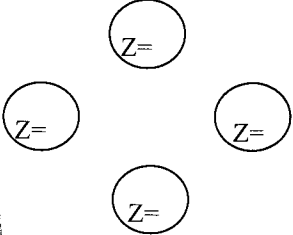


$D_B = \underline{\hspace{10em}}$

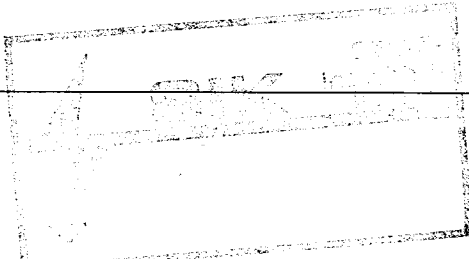


Present state	Next state		Output
	0	X	
AB			Z

State diagram



Explanation:

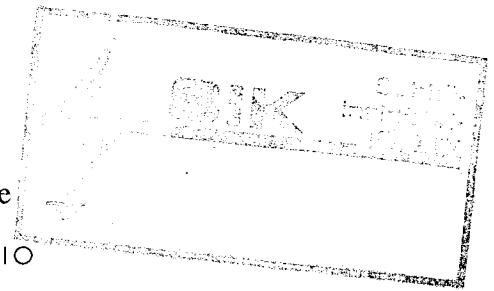


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Examination 28.02.2003



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Exercise 3. For each question, one of the listed choices is intended to be clearly the best answer. Circle the letter of your choice and write it into the box on the right.

3.1 The figure **8C2₁₆** is in binary form:

- a) 011110100010 b) 011110110010 c) 100010110010 d) 100010110011 e) 111011010

3.1

3.2 Which of the following theorems is **not** true?

- a) $X(X + Y) = \bar{X}$ b) $X + YX = X$ c) $X(\bar{X} + Y) = XY$

3.2

3.3 How many Boolean functions can be constructed from four (4) variables?

- a) 2^3 b) 2^4 c) 8 d) 10000_{16} e) FF_{16}

3.3

3.4 Which One of the following switching functions implements a four channel multiplexer (MUX)?

- a) $Y(A, B, C, D, E, F) = \bar{A}\bar{B}C + \bar{A}BD + A\bar{B}E + ABF$
b) $Y(A, B, C) = \bar{A}B + AC$ c) $Y(A, B, C) = \sum m(1,3,5,6)$
d) $Y(A, B, C) = \prod M(1,3,5,6)$

3.4

3.5 How many 2-input NAND-gates, approximately, are needed to implement the combinational logic of switching function $Y(A, B, C) = \sum m(1,4,7)$?

- a) 80 b) $7\frac{1}{2}$ c) 30 d) 40 e) 20 f) 150

3.5

3.6 A logic element has a General Qualifying Symbol = **4**. What switching function it represents?

- a) $Y = \bar{A}\bar{B}\bar{C}\bar{D}$ b) $Y = ABCD$ c) $Y = \bar{A} + \bar{B} + \bar{C} + \bar{D}$ d) $Y = A + B + C + D$

3.6

3.7 Which of the following is a code word of **biquinary** code for the number 0? (Hint: **biquinary code** is 5043210-weighted number code)

- a) 0100001 b) 0100010 c) 0110000 d) 1000100 e) 0011000 f) 0000110

3.7

3.8 Which one of the following binary codes has even parity?

- a) 011001 b) 011010 c) 0110000 d) 011001 e) 0000100000 f) 01110

3.8

3.9 How many address bits is needed to address 20 billion (20×10^9) brain cells?

- a) 25 b) 33 c) 34 d) 35 e) 36 f) 37

3.9

3.10 The General Qualifying Symbol of a counter, which is capable to count the number of days of a month is:

- a) CTR4 b) CTR5 c) CTR9 d) CTR7 e) CTR7DIV100

3.10

(Your score will be: $(30 - 4 \times \# \text{ wrong answers} - 3 \times \text{missing answers})/10$. Maximum is 3 points)



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Handwritten signature and name in a rectangular box.

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Exercise 4. Fill in!

a)

TOTUUSTAULUKKO TRUTH TABLE		
A	B	Y

K-kartta
K-map

$Y(A,B) = A \cdot B$

d)

TOTUUSTAULUKKO TRUTH TABLE			
A	B	C	Y

K-kartta
K-map

Boolean funktio
Boolean function

$Y(A,B,C) =$

c)

TOTUUSTAULUKKO TRUTH TABLE					
A	B	C	D	Y1	Y2

Y2:n K-kartta
K-map of Y2

$Y1(A,B) =$
 $Y2(A,B,C,D) =$