1. kolokvij (6.12.2022)

1.) Podano funkcijo zapiši v eksplicitni PDNO in eksplicitni PKNO obliki!

$$f(x_1, x_2, x_3) = ((x_1 \to x_2) \downarrow x_3) \nabla x_2$$

$$f(x_1,x_2,x_3) = \overline{\overline{((x_1 \to x_2) \downarrow x_3)} \nabla x_2} =$$

$$= (\overline{(\bar{x}_1 \vee x_2) \vee x_3}) \, x_2 \vee \overline{((\bar{x}_1 \vee x_2) \vee x_3)} \cdot \bar{x}_2 =$$

$$= x_2 \vee x_1 \bar{x}_2 \bar{x}_3$$

Absorbcija: $x \cdot (x \vee y) = x$

| $x_1$ | $x_2$ | $x_3$ | $((x_1 \to x_2) \downarrow x_3) \nabla x_2$ | $f(x_1,x_2,x_3)$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |

$f_{PDNO}(x_1,x_2,x_3) = V^3(2,3,4,6,7) =$

$= \bar{x}_1 x_2 \bar{x}_3 \vee \bar{x}_1 x_2 x_3 \vee$

$x_1 \bar{x}_2 \bar{x}_3 \vee x_1 x_2 \bar{x}_3 \vee$

$x_1 x_2 x_3$

$f_{PKNO}(x_1,x_2,x_3) = \&^3(0,1,5) =$

$= (x_1 \vee x_2 \vee x_3) \cdot$

$(x_1 \vee x_2 \vee \bar{x}_3) \cdot$

$(\bar{x}_1 \vee x_2 \vee \bar{x}_3)$

2) Določi MDNO in MKNO obliko podane funkcije. Pri obeh oblikah ovrednoti število operatorjev (vrat) in operandov (vhodov) in na podlagi tega določi MNO obliko.

$$f(x_1, x_2, x_3, x_4) = V^4(1,2,3,5,8,9,11,15)$$

MDNO:

| $x_1x_2$ \ $x_3x_4$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | 1 | 1 | 1 |
| 01 | | 1 | | |
| 11 | | | 1 | |
| 10 | 1 | 1 | 1 | |

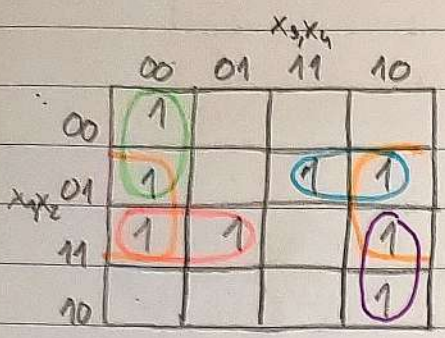
| 4 | 3 | 2 | 1 |
|---|---|---|---|
| (1) $\bar{x}_1\bar{x}_2\bar{x}_3x_4$ | (1,3) $\bar{x}_1\bar{x}_2x_4$ | ((1,3),(9,11)) $\bar{x}_2x_4$ | |
| (2) $\bar{x}_1\bar{x}_2x_3\bar{x}_4$ | (1,5) $\bar{x}_1\bar{x}_3x_4$ | ((1,9),(3,11)) | |
| (3) $\bar{x}_1\bar{x}_2x_3x_4$ | (1,9) $\bar{x}_2\bar{x}_3x_4$ | | |
| (5) $\bar{x}_1x_2\bar{x}_3x_4$ | (2,3) $\bar{x}_1\bar{x}_2x_3$ | | |
| (8) $x_1\bar{x}_2\bar{x}_3\bar{x}_4$ | (3,11) $\bar{x}_2x_3x_4$ | | |
| (9) $x_1\bar{x}_2\bar{x}_3x_4$ | (8,9) $x_1\bar{x}_2\bar{x}_3$ | | |
| (11) $x_1\bar{x}_2x_3x_4$ | (9,11) $x_1\bar{x}_2x_4$ | | |
| (15) $x_1x_2x_3x_4$ | (11,15) $x_1x_3x_4$ | | |

$f^4_{MDNO} = x_1x_2x_4 \vee \bar{x}_1\bar{x}_3x_4 \vee x_1\bar{x}_2\bar{x}_3 \vee \bar{x}_1\bar{x}_2x_3$

| | $m_1$ | $m_2$ | $m_3$ | $m_5$ | $m_8$ | $m_9$ | $m_{11}$ | $m_{15}$ |
|---|---|---|---|---|---|---|---|---|
| ✓ $\bar{x}_1\bar{x}_3x_4$ | ✓ | | | ✓ | | | | |
| ✓ $\bar{x}_1\bar{x}_2x_3$ | | ✓ | ✓ | | | | | |
| ✓ $x_1\bar{x}_2\bar{x}_3$ | | | | | ✓ | ✓ | | |
| ✓ $x_1x_3x_4$ | | | | | | | ✓ | ✓ |
| $\bar{x}_2x_4$ | ✓ | | ✓ | | | | ✓ | ✓ |

MKNO:

$f^4 = V^4(0,4,6,7,10,12,13,14)$




| 4 | 3 | 2 | 1 |
|---|---|---|---|
| (0) $\bar{x}_1\bar{x}_2\bar{x}_3\bar{x}_4$ | (0,4) $\bar{x}_1\bar{x}_3\bar{x}_4$ | ((4,6),(12,14)) $x_2\bar{x}_4$ | |
| (4) $\bar{x}_1x_2\bar{x}_3\bar{x}_4$ | (4,6) $\bar{x}_1x_2\bar{x}_4$ | ((4,12),(6,14)) | |
| (6) $\bar{x}_1x_2x_3\bar{x}_4$ | (4,12) $x_2\bar{x}_3\bar{x}_4$ | | |
| (7) $\bar{x}_1x_2x_3x_4$ | (6,7) $\bar{x}_1x_2x_3$ | | |
| (10) $x_1\bar{x}_2x_3\bar{x}_4$ | (6,14) $x_2x_3\bar{x}_4$ | | |
| (12) $x_1x_2\bar{x}_3\bar{x}_4$ | (10,14) $x_1x_3\bar{x}_4$ | | |
| (13) $x_1x_2\bar{x}_3x_4$ | (12,13) $x_1x_2\bar{x}_3$ | | |
| (14) $x_1x_2x_3\bar{x}_4$ | (12,14) $x_1x_2\bar{x}_4$ | | |

$f_{MDNO} = \bar{x}_1\bar{x}_3\bar{x}_4 \vee x_1x_2\bar{x}_3 \vee \bar{x}_1x_2x_3 \vee x_2x_3\bar{x}_4$

$f_{MDNO} = \overline{\bar{x}_1\bar{x}_3\bar{x}_4 \vee x_1x_2\bar{x}_3 \vee \bar{x}_1x_2x_3 \vee x_2x_3\bar{x}_4}$

$= (x_1 \vee x_3 \vee x_4)\cdot(\bar{x}_1 \vee \bar{x}_2 \vee x_3)\cdot(x_1 \vee \bar{x}_2 \vee \bar{x}_3)\cdot(\bar{x}_1 \vee \bar{x}_3 \vee x_4)$

| | $m_0$ | $m_4$ | $m_6$ | $m_7$ | $m_{10}$ | $m_{12}$ | $m_{13}$ | $m_{14}$ |
|---|---|---|---|---|---|---|---|---|
| $\bar{x}_1\bar{x}_3\bar{x}_4$ | ✓ | ✓ | | | | | | |
| $\bar{x}_1x_2x_3$ | | | ✓ | ✓ | | | | |
| $x_1x_2\bar{x}_3$ | | | | | ✓ | | | ✓ |
| $x_2x_3\bar{x}_4$ | | ✓ | ✓ | | | ✓ | | ✓ |

3. Za obe funkciji iz nabora $\{\nabla, 0\}$ preveri pripadnost osnovnim zaprtim razredom (zapiši tabelo pripadnosti). Po potrebi nabor razširi do funkcijske polnosti!

| $x_1$ | $x_2$ | $\nabla$ |
|---|---|---|
| 0 | 0 | $0 \to \nabla \in T_0$ |
| 0 | 1 | 1 |
| 1 | 0 | 1 $\}$ X $0\nabla 1 = 1\nabla 0$; $\nabla \notin S$ |
| 1 | 1 | $0 \to \nabla \notin T_1$ |

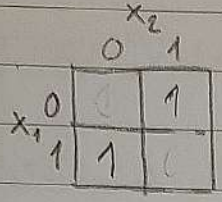
$(1,0) < (1,1)$; $f(1,0) \not\leq f(1,1)$; $\nabla \notin M$

| | $T_0$ | $T_1$ | S | L | M |
|---|---|---|---|---|---|
| $\nabla$ | $\in$ | $\notin$ | $\notin$ | $\in$ | $\notin$ |
| 0 | $\in$ | $\notin$ | $\notin$ | $\in$ | $\in$ |

| x | 0 |
|---|---|
| 0 | $0 \to 0 \in T_0$ |
| 1 | $0 \to 0 \notin T_1$ |

$\bar{0} = 0$; $0 \notin S$

L ∨:




$\bar{x}_1\bar{x}_2 : \bar{x}_1 x_2$ popolnoma različna

$\bar{x}_1 : x_1$ popolnoma različna

$f(x_1,x_2) = a_0 \nabla a_1 x_1 \nabla a_2 x_2 = x_1 \nabla x_2$

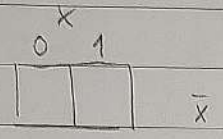
$f(0,0) = a_0 \nabla 0 \nabla 0 = a_0 = 0$ $\quad a_0 = 0$

$f(0,1) = 0 \nabla a_1 0 \nabla a_2 \cdot 1 = a_2 = 1$ $\quad a_2 = 1$

$f(1,0) = 0 \nabla a_1 1 \nabla a_2 \cdot 0 = a_1 = 1$ $\quad a_1 = 1$

$f(x_1,x_2) = x_1 \nabla x_2 = x_1 \nabla x_2$

0:




$f(x) = 0 = a_0$

Nabor $\{0,\nabla\}$ ni funkcijsko poln saj ne odpira razredov T0 in L. Naboru lahko s pomočjo $\neg_2$ → ali ↑ dopolnimo do funkcijske polnosti.

4. Določi šumne meje za visoko in nizko stanje, če je najmanjša dovoljena napetost visokega izhoda enaka 4,3V, visokega vhoda pa 3,4 V. Največja dovoljena napetost nizkega izhoda je 0,2 V, nizkega vhoda pa 1,1V.

$V_{OH}(min) = 4,3V$

$V_{IH}(min) = 3,4V$

$V_{OL}(max) = 0,2V$

$V_{IL}(max) = 1,1V$

Šumne meje: - visoko stanje (H): $V_{OH}(min) - V_{IH}(min) = 4,3V - 3,4V = 0,9V$

- nizko stanje (L): $V_{IL}(max) - V_{OL}(max) = 1,1V - 0,2V = 0,9V$

## 2. kolokvij (10. 1. 2022)

1. Z uporabo multipleksorjev MUX 2/1 realiziraj funkcijo $f(x_1,x_2,x_3,x_4) = V^3(2,3,5,7,8,9,13,15)$!

| $x_1x_2$ \ $x_3x_4$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | | 1 | 1 |
| 01 | | 1 | 1 | |
| 11 | | 1 | 1 | |
| 10 | 1 | 1 | | |

$A_0 = x_2$; $I_0 = \bar{x}_1x_3 \vee x_1\bar{x}_3$ $\longrightarrow$ $A_0 = x_1$; $I_0 = x_3$, $I_1 = \bar{x}_3$

$I_1 = x_4$

$A_0 = x_3$; $I_0 = x_1$, $I_1 = \bar{x}_1$

| $x_1$ | $x_2$ | $x_3$ | $x_4$ | $f^4$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |