15.10.$\overline{08}$

Boolova algebra

x, y, z
$\hookrightarrow \{0, 1\}$

- Disjunkcija (logično ALI, OR, $+$)
  to je boolovo seštevanje
- Konjunkcija (logično IN, AND, $\cdot$)
  boollovo množenje
- Negacija (logično NE, NOT, $\bar{x}$)

Postulati:

P1: $x + 0 = x$
P2: $x + y = y + x$
P3: $x + (yz) = (x+y)\cdot(x+z)$
P4: $x + \bar{x} = 1$

P1': $x \cdot 1 = x$
P2': $x \cdot y = y \cdot x$
P3': $x\cdot((y+z)) = xy + xz$
P4': $x \cdot \bar{x} = 0$

Teoremi Boolove algebre

1) $x + 1 = 1$ dokazano na predavanjih

2) $x + x = x$

3) $x \cdot x = x$

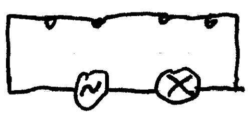
4) $x + xy = x$

Dokažimo $x \cdot x = x$ z uporabo aksiomov

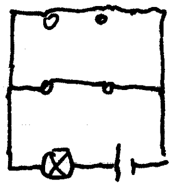
$$x \cdot x = \underset{P1}{x \cdot x + 0} = \underset{P4'}{x\cdot x + x\bar{x}} = \underset{P3'}{x\cdot\overbrace{(x+\bar{x})}^{1}} = x \checkmark$$

$x = \{0, 1\}$
$x = 1: \ 1 \cdot 1 = 1$

"1" =
"0" =



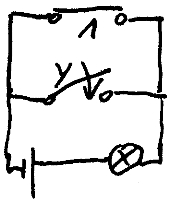
zaporedna vezava za AND



Vzporedno za OR

Dalje: $x + xy = x$

$$x + xy = \underset{P1}{x \cdot 1} + xy = x(\overbrace{1+y}^{1}) = x \quad ✓$$



Demorganova teorema

$\overline{x + y} = \bar{x} \cdot \bar{y}$ $\qquad\qquad$ $\overline{x \cdot y} = \bar{x} + \bar{y}$

Dokažimo

• $(x + y) + \bar{x}\bar{y} = 1$ $\quad$ in $\quad$ $(x+y) \cdot \bar{x}\bar{y} = 0$

• $(x + y) + \bar{x}\bar{y} = 1$ $\quad$ Uporabimo zdaj P3: $x + (y z) = (x+y)(x \cdot z)$

$[(x+y) + \bar{x}] \cdot [(x+y) + \bar{y}] = 1$ ✓✓

$\underbrace{x + \bar{x}} + y$

$1 + y = 1$

• $(x+y) \cdot \bar{x}\bar{y} = 0$ ✓✓ isto P3

↓

$x\bar{x}\bar{y} + \bar{x}y\bar{y} = 0$

$0 \cdot \bar{y} = 0$

$$\left.\begin{array}{l} A + B = 1 \\ A \cdot B = 0 \end{array}\right\} \begin{array}{l} A = \bar{B} \\ B = \bar{A} \end{array} \qquad \begin{array}{l} A = x + y \\ B = \bar{x}\bar{y} \end{array}$$

↓

$\overline{(x+y)} = \bar{x}\bar{y}$ ✓✓

Drug je v knjigi.

22.10.08

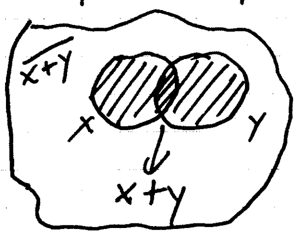
Dokažimo še enkrat! To pot s pravilnostno tabelo.

$\overline{x+y} = \bar{x}\cdot\bar{y}$

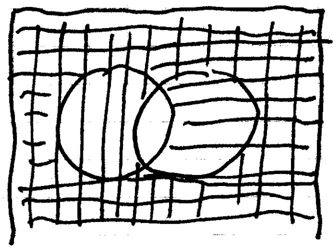
x	y	x+y	$\overline{x+y}$	$\bar{x}$	$\bar{y}$	$\bar{x}\cdot\bar{y}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

sedaj pa še z Vennovimi diagrami

$\overline{x+y} = \bar{x}\cdot\bar{y}$



• → presek
+ → unija



≡ $\bar{x}$
||| $\bar{y}$
\# $\bar{x}\cdot\bar{y}$

• Motor se zavrti, ko sta sklenjena kontakta A in B ali ko je B sklenjen, C pa ne, ali ko A in C dva nista sklenjena. Zapišite boolovo funkcijo in funkcijo poenostavite in narišite vezje.

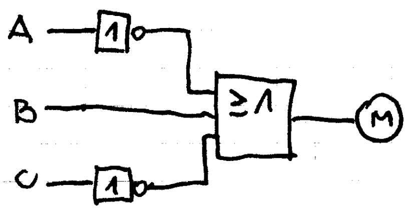
$$f(A,B,C) = A\cdot B + B\cdot\bar{C} + \overline{A\cdot C}$$

$$= A\cdot B + B\bar{C} + \bar{A} + \bar{C} \quad \leftarrow \text{deMorgan}$$

$$= A\cdot B + \bar{C}\,(B+1) + \bar{A} = AB + \bar{A} + \bar{C}$$

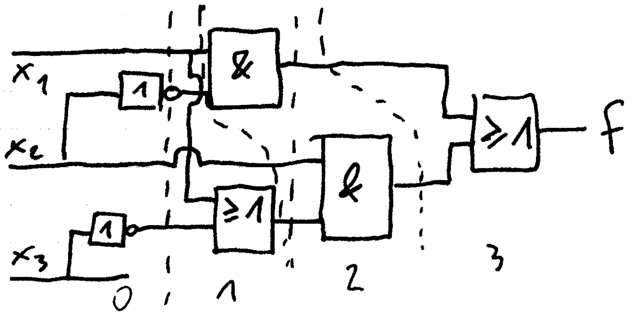
$$= \underbrace{(\bar{A}+A)}_{1}\cdot(\bar{A}+B) + \bar{C}$$

$$= \bar{A} + B + \bar{C}$$



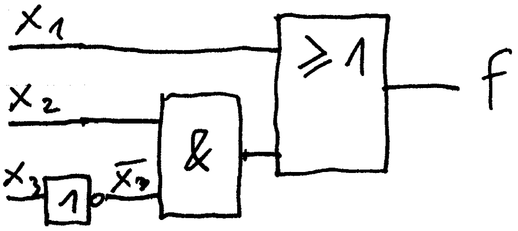
• Za podano funkcijo narišite vezje, potem za minimalno obliko vezje ~~vezje~~.

$$f(x_1, x_2, x_3) = x_1\overline{x_2} + x_2 \cdot (x_1 + \overline{x_3})$$

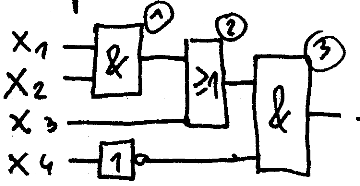


Minimalitiramo

$$f(x_1, x_2, x_3) = x_1\overline{x_2} + x_2 \cdot x_1 + x_2\overline{x_3} = x_1(\overline{x_2}\, x_2) + x_2\overline{x_3} =$$
$$= x_1 + x_2\overline{x_3}$$



• Zapišite izraz za funkcijo na izhodu vezja



$f(x_1, x_2, x_3, x_4) =$

1 $x_1 \cdot x_2$
2 $(x_1 \cdot x_2) + x_3$
3 $[(x_1 \cdot x_2) + x_3] \cdot \overline{x_4}$

• Poiščite analitični zapis funkcije, podane s tabelo in narišite vezje.

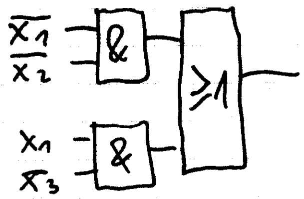
x_1	x_2	x_3	f	
0	0	0	1	←
0	0	1	1	←
0	1	0	0	
0	1	1	0	
1	0	0	1	←
1	0	1	0	
1	1	0	1	←
1	1	1	0	

negirano pomeni da vrednost=0

$$f(x_1, x_2, x_3) = \overline{x_1} \cdot \overline{x_2} \cdot \overline{x_3} + \underset{(0\,0\,1)}{\overline{x_1}\,\overline{x_2}\,x_3} +$$
$$+ \underset{m_4(1\,0\,0)}{x_1\,\overline{x_2}\,\overline{x_3}} + \underset{m_6(1\,1\,0)}{x_1\,x_2\,\overline{x_3}}$$
$$= \overline{x_1}\,\overline{x_2}(\overline{x_3} + x_3) + x_1(\overline{x_2}\,\overline{x_3} + x_2\,\overline{x_3}) =$$
$$= \overline{x_1}\,\overline{x_2} + x_1\overline{x_3}$$

Kadar vsak člen vsebuje vse vhodne spremenljivke je funkcija zapisana v popolni obliki. Pokrajšana funkcija je minimalna oblika.
Če so zapisane vsote produktov, je to DISJUNKTIVNA oblika.

Vsak člen z vsemi vhodnimi spremenljivkami je minterm (m), kjer so v tabeli pri izhodu 1, so to mintermi.



0. nivo 1. nivo 2. nivo

Funkcija v dveh nivojih je normalna oblika funkcije.

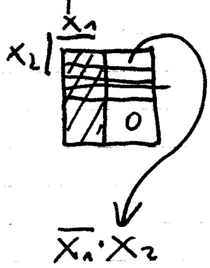
PDNO – popolna disj. norm. oblika
MDNO – minimalna "

Dalje: primer – $\underbrace{(x_1 + \overline{x_2} + \overline{x_3})}_{M3}(x_1 + x_2 + x_3) \cdot \ldots (\;)$ 1. nivo, 2. nivo
to je pa PKNO – popolna konjunktivna normalna oblika! Tak člen je maksterm (M).

Grafični načini – Veitch
1. spremenljivka

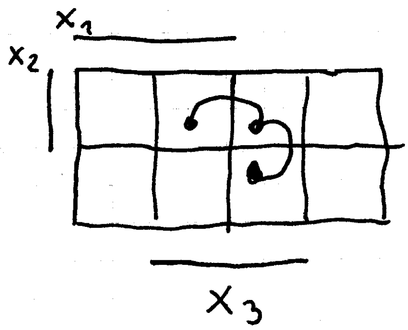
torej dve polji – eno za nič in eno za ena.

2. spremenljivki

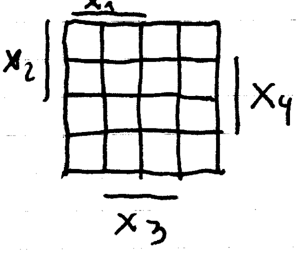


x_1	x_2
0	0
0	1
1	0
1	1

3. spremenljivke



4. spremenljivke



Pri prehodu med polji se spremeni samo ena spremenljivka.

Aleta

29.10.08

$f(x_1,x_2,x_3) = x_1x_2\bar{x}_3 + x_1x_2x_3$

$= x_1x_2(\bar{x}_3 + x_3) = x_1x_2$

Poenostavimo z V.E.

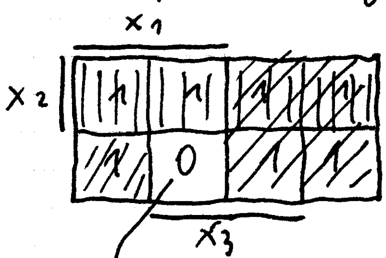
Združujemo sosednje enice

→ minterm $m_0 = \underset{0}{\bar{x}_1}\underset{0}{\bar{x}_2}\underset{0}{\bar{x}_3}$

→ x_1x_2 poenostavljena rešitev

Napišimo še maksterm

$f(x_1,x_2,x_3) = (\underset{0}{\bar{x}_1} + \underset{1}{x_2} + \underset{0}{\bar{x}_3}) = M_2$



vse to je maksterm

$\underset{1}{x_1}\,\underset{0}{\bar{x}_2}\,\underset{1}{x_3} = m_5 \rightarrow \overline{m_5} = \overline{x_1\bar{x}_2x_3} = \bar{x}_1 + x_2 + \bar{x}_3 =$

$= M_2$

Zapišite f-jo v popolni in minimalni disjunktivni in konjunktivni obliki.

$f(x_1,x_2,x_3) = M_1 \cdot M_3 \cdot M_7 = \prod 1,3,7$

$= (\bar{x}_1+\bar{x}_2+x_3)\cdot(\bar{x}_1+x_2+x_3)\cdot(x_1+x_2+x_3)$

to je popolna konjunktivna oblika

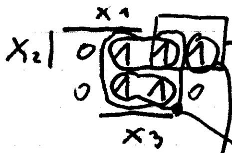
V disjunktivno:

konj	M_i	0	1	2	3	4	5	6	7
disj	m_i	7	$\cancel{6}$	5	$\cancel{4}$	3	2	1	$\cancel{0}$

$f_{PDNO} = m_1 + m_2 + m_3 + m_5 + m_7 = \sum 1,2,3,5,7$

$= (\bar{x}_1\bar{x}_2x_3) + (\bar{x}_1x_2\bar{x}_3) + (\bar{x}_1x_2x_3) + (x_1\bar{x}_2x_3) + (x_1x_2x_3)$

Poiščimo še minimalne. To naredimo z Veitchem. Vpišemo minterme. Potrebno znati tudi za maksterme

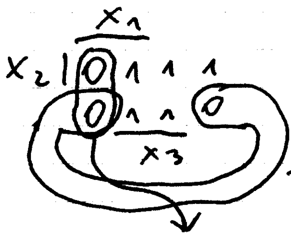


$f_{MDNO} = x_3 + x_2\bar{x}_1 \Rightarrow (x_3+\bar{x}_1)\cdot(x_3+x_2)$

P3: $x+yz=(x+y)(x+z)$

ali: $\bar{x}_1 x_2 \bar{x}_3$ ampak to je daljše

isto mora biti!



minimizirajmo ničle

TO JE SKORAJ VEDNO NA IZPITU. PAZI NA NEGACIJO!

$f = x_1\bar{x}_3 + \bar{x}_2\bar{x}_3$

$f_{MKNO} = \bar{f} = \overline{(x_1\bar{x}_3 + \bar{x}_2\bar{x}_3)} = \overline{x_1\bar{x}_3} \cdot \overline{\bar{x}_2\bar{x}_3} =$

$= (\bar{x}_1 + x_3)\cdot(x_2+x_3)$

Dalje:

- $f(x_1,x_2,x_3) = x_1x_2 + x_1x_3$ zapišite v popolni obliki:

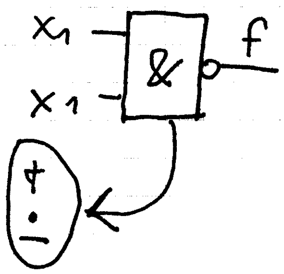
$f(PDNO)(x_1,x_2,x_3) = x_1x_2(x_3+\bar{x}_3) + x_1x_3(x_2+\bar{x}_2)$

- $f = (x_1+x_2)(x_1+x_3)$

$f_{PKNO} \Rightarrow (x_1+x_2+x_3\bar{x}_3)(x_1+x_3+x_2\bar{x}_2)$

Funkcijo iz prejšnje naloge realizirajte z logičnimi vrati nand ali nor

- realizacija z NAND



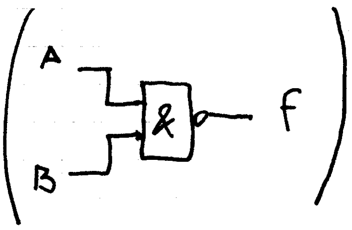
$= \overline{x_1x_2}$

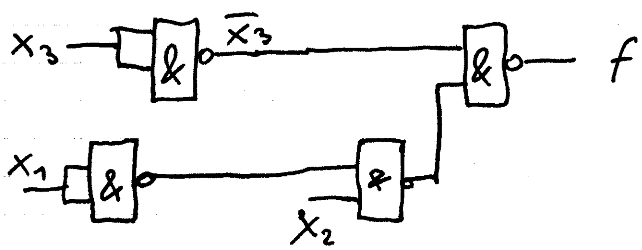
Prednost: vse lahko realiziramo le s temi vrati
POPOLN SISTEM

Funkcijo v MDNO 2x negiramo. Dober je tudi PDNO (samo, da je disjunktivna).

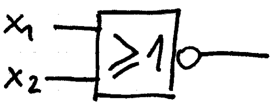
$f_{MDNO} = x + \bar{x}_1 x_2$

$\bar{\bar{f}}_{MDNO} = \overline{\overline{x_3 + \bar{x}_1 x_2}} = \overline{\underbrace{(\overline{x_3})}_{\Downarrow \atop A} \cdot \underbrace{(\overline{\bar{x}_1 \cdot x_2})}_{\Downarrow \atop B}} = \overline{A \cdot B}$





Še z vrati NOR

 $f = \overline{x_1 + x_2}$

f_{MKNO} 2x negiramo. Reš. Dokaz:

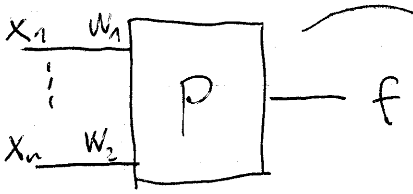
$f_{MKNO} = (\bar{x}_1 + x_3)(x_2 + x_3)$

$\bar{\bar{f}}_{MKNO} = \overline{\overline{(\bar{x}_1 + x_3) \cdot (x_2 + x_3)}} = \overline{\overline{(\bar{x}_1 + x_3)} + \overline{(x_2 + x_3)}}$.

5.11.08

Pragovne funkcije

uteži W
prag P $\rightarrow \sum w_i \cdot x \geq P \rightarrow f(x_1, \dots x_n) = 1$



→ nevronske mreže

- Realizirajte fjo s pragovnim elementom
$F(x_1, x_2, x_3) = \overline{x}_2 x_3 + x_1 x_3$

– ali je fja pragovna?
pogledamo, ali je enotipna : v MDNO spremenljivki x_i in $\overline{x}_i$ ne nastopata hkrati. to je potrebni pogoj za pragovnost!

– zadostni pogoj: poiščemo uteži in prag.
vzamemo pare

x_1 (1)	x_2 (-1)	x_3 (2)	f	$Pl = \sum w_i x_i$
0	0	0	0	0
0	0	1	1	2
0	1	0	0	-1
0	1	1	0	1
1	0	0	0	1
1	0	1	1	3
1	1	0	0	0
1	1	1	1	2

① $0 \cdot w_1 + 0 \cdot w_2 + 1 \cdot w_3 > 0w_1 + 0w_2 + 0w_3$
$\downarrow$
$w_3 > 0$

kje je fja 1

$P \rightarrow \min Pl$, ko je $F(x) = 1$
torej $\underline{P = 2}$

② $w_3 > w_2 + w_3 \rightarrow w_2 < 0$

③ $w_1 > 0$

če ne najdemo relacije, sta oba enaka.

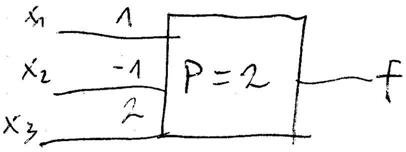
④ $w_3 > w_1$

Določimo uteži : vzamemo najmanjša cela števila (razen $\emptyset$)

$w_2 = -1$ $w_1 = 1$ $w_3 = 2$

Da ugotovimo pragovnost!

P > Pk, ko F(x)=0. Takrat je pragovna.



Drug tip naloge je določiti obratno.

Simetrične funkcije

$F(x_1, x_2, x_3) = \Sigma 1, 2, 4, 5, 7$

$x_i \sim x_j$ simetrične (lokalno simetrična)

$x_i \sim \bar{x}_j$ kako jih obrnemo.

Težko se jih minimizira.

Če je simetrična na vse $x_{i,j}$ → globalno simetrična. Najprej zapišimo minterme.

	x_1	x_2	x_3	št. enic v vrsticah
	0	0	1	1
	0	1	0	1
	1	0	0	1
	1	0	1	2
	1	1	1	3
$\Sigma 0$:	2	3	2	
$\Sigma 1$:	3	2	3	

ni simetrična na ta nabor.

Potrebni pogoj za simetričnost – št. ničel in št. enic v stolpcih enako (do recipročnosti).

Št. kombinacij z
- 0 enicami : 1 komb (0,0,0)
- 1 –"– : 3 komb (0,0,1), (0,1,0), (1,0,0)
- 2 –"– : 3 komb (0,1,1), (1,0,1), (1,1,0)
- 3 –"– : 1 komb (1,1,1)

$x_1 \sim x_2$

$f(0,1,x_3)$	$F(1,0,x_3)$
0	0
	1

//

$x_1 \sim \bar{x}_2$ ✓✓ ker negiran

$f(0,0,x_3)$	$F(1,1,x_3)$
1	1 ✓✓

$x_1 \sim x_3$: $f(0, x_2, 1)$ | $f(1, x_2, 0)$

0 | 0 ✓✓

sledi: $\tilde{x}_2 \sim x_3$.

Funkcija

$$S_{0,2,3}(x_1, \overline{x_2}, x_3) = S_{0,1,3}(\overline{x_1}, x_2, \overline{x_3})$$

IZPIT!
simetrična?
realiziraj z NOR
vrati!

x_1	$\overline{x_2}$	x_3	št. enic	$\overline{x_1}$	x_2	$\overline{x_3}$
0	1	1	2			
0	0	0	0			
1	1	0	2			
1	1	1	3			
1	0	1	2			
Σ0: 2	2	2				
Σ1: 3	3	3				

Dokaz

x_3	x_2	x_1	
1	0	1	✓
0	1	0	✓
0	0	0	✓
1	0	1	✓
1	1	1	✓

ali obstajajo tudi v prvotni – preverimo

Kako dobimo originalni zapis (tipska naloga)

$$S_{0,2,3}(x_1, \overline{x_2}, x_3) = \underbrace{\overline{A}\,\overline{B}\,\overline{C}}_{0} + \underbrace{AB\overline{C} + A\overline{B}C + \overline{A}BC}_{2} + ABC$$

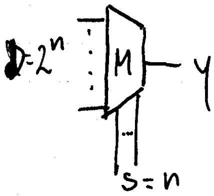
$a \quad b \quad c$

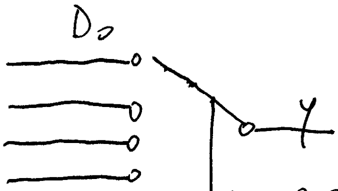
↑ enice

$$f = \underset{m_2}{\overline{x_1}\, x_2\, \overline{x_3}} + \underset{m_4}{x_1\, \overline{x_2} + \overline{x_3}} + \underset{m_7}{x_1\, x_2\, x_3} + \underset{m_1}{\overline{x_1}\, \overline{x_2}\, x_3} + \underset{m_5}{x_1\, \overline{x_2}\, x_3}$$

12.11.08

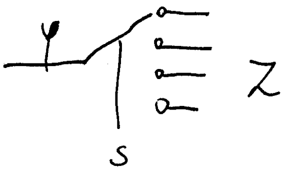
MULTIPLEKSORJI

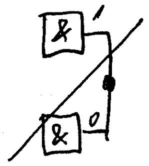


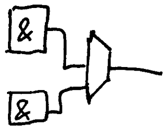


$S = 00\ldots0 \rightarrow y = D_0$

DEMUX





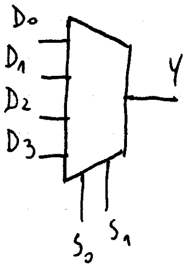


Splošna enačba multiplekorja

$y = m_0 D_0 + m_1 D_1 + \ldots + m_{n-1} D_{n-1}$

$\hookrightarrow \bar{S_0}\,\bar{S_1}\,\bar{S_2}\ldots\overline{S_{n+1}}$

4 - 1 MUX



	S_0	S_1	y
m_0	0	0	D_0
$\vdots$	0	1	D_1
$\vdots$	1	0	D_2
m_3	1	1	D_3

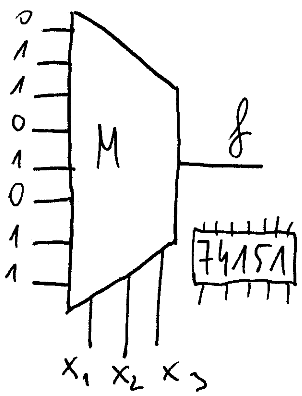
$y = m_0 D_0 + m_1 D_1 + m_2 D_2 + m_3 D_3$

$= \bar{S_0}\bar{S_1} D_0 + \bar{S_0} S_1 D_1 + S_0 \bar{S_1} D_2 + S_0 S_1 D_3 =$
$= 0 \cdot 1 \cdot D_0 + 0 \cdot 0 \cdot D_1 + 1 \cdot 1 \, D_2 + 1 \cdot 0 \, D_3 =$
$= y = D_2$

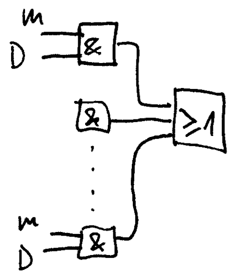
Preklopno Fjo realizirajte z multipleksorji
a) 8mimi vhodoma b) štirimi! c) dvema podatkovnima

$f(x_1, x_2, x_3) = \sum 1, 2, 4, 6, 7$

a) 8 vhodni MUX ⇒ 813

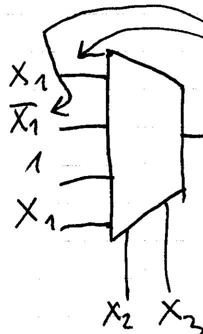


x_1	x_2	x_3	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1



$\boxed{\text{trivialna izvedba}}$!

4/2

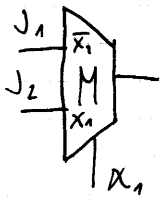


$$y = \overline{x}_1 \overline{x}_2 x_3 + \overline{x}_1 x_2 \overline{x}_3 + x_1 \overline{x}_2 \overline{x}_3 + x_1 x_2 \overline{x}_3 + x_1 x_2 x_3$$

$$y = \boxed{\overline{x}_2 \overline{x}_3 (x_1)} + \overline{x}_2 x_3 (\overline{x}_1) + x_2 \overline{x}_3 \underbrace{(\overline{x}_1 + x_1)}_{1} + x_2 x_3 (x_1)$$

m D

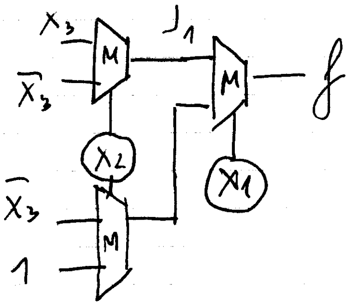
c) dvovhodni



$$y = x_1 \underbrace{(\cancel{1}\, \overline{x}_2 \overline{x}_3 \cancel{3} + \overline{x}_3 x_2 + x_2 x_3)}_{J_2} + \overline{x}_1 \underbrace{(\overline{x}_2 x_3 + x_2 \overline{x}_3)}_{J_1}$$

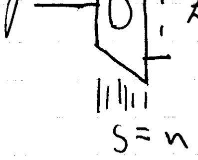
x_3 \ x_2	0	1
0	0	1
1	1	0

$$J_1 = \overline{x}_2 x_3 + x_2 \overline{x}_3 = x_2 (\overline{x}_3) + \overline{x}_2 (x_3)$$
$$J_2 = \overline{x}_2 (\overline{x}_3) + x_2 \underbrace{(\overline{x}_3 + x_3)}_{1}$$



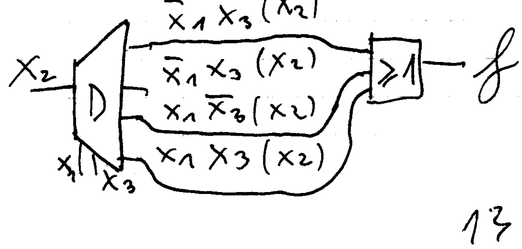
Demux: realizirajte funkcijo z 4 izhodi in OR vrati

$$F(x_1, x_2, x_3) = \sum 2, 6, 7$$



$$Z_0 = m_0 y = \overline{x}_1 \overline{x}_3 y$$
$$Z_1 = m_1 y \qquad \overline{x}_1 x_3 y$$
$$\vdots \qquad x_1 \overline{x}_3 y$$
$$\qquad x_1 x_3 y$$
$$Z_{n-1} = m_{n-1} y$$

$$f = \overline{x}_1 x_2 \overline{x}_3 + x_1 x_2 \overline{x}_3 + x_1 x_2 x_3$$



19.11.08

Zgradite vezje, pri katerem bo izhod 1 le tedaj, ko bo vsota dveh dvobitnih števil večja od 3.
a) z logičnimi vrati b) multipleksor s tremi izbirnimi vhodi

$A + B > 3 \rightarrow f = 1$

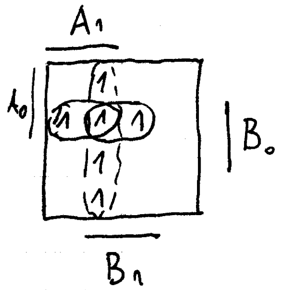
$A_1 A_0$ $B_1 B_0$

0 0 = 0
0 1 = 1
1 0 = 2
1 1 = 3

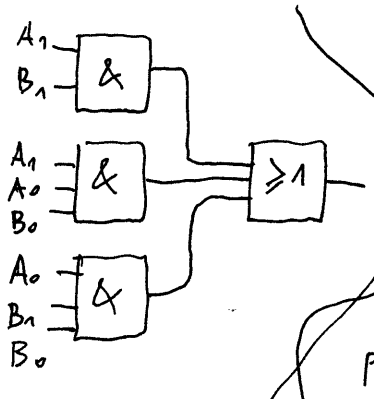
vse te naloge na tak način

	A_1	A_0	B_1	B_0	f
	0	0	0	0	0
	0	0	0	1	0
	0	0	1	0	0
	0	0	1	1	0
	0	1	0	0	0
	0	1	0	1	0
	0	1	1	0	0
1+3 →	0	1	1	1	1
	1	0	0	0	0
	1	0	0	1	0
	1	0	1	0	1
	1	0	1	1	1
	1	1	0	0	0
	1	1	0	1	1
	1	1	1	0	1
	1	1	1	1	1

a)



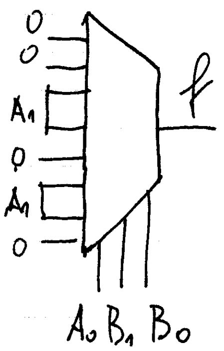
$$f = A_1 B_1 + A_1 A_0 B_0 + A_0 B_1 B_0$$



ponavadi za izbirne vzamemo tiste, ki se največkrat ponovijo

$A_1 A_0 B_0 (B_1 + \bar{B}_1)$

b) mux 3 izb. vhodi



Zgradite vezje za pretvorbo BCD kode v 1N-3 kodo
vezja ni potrebno risati

excess-3

0 – 9 → binarno

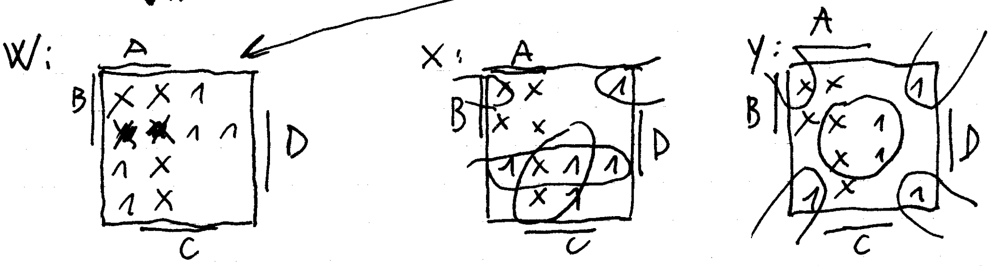
	A B C D	f_1 f_2 f_3 f_4 W X Y Z
0	0 0 0 0	0 0 1 1
1	0 0 0 1	0 1 0 0
2	0 0 1 0	0 1 0 1
3	0 0 1 1	0 1 1 0
4	0 1 0 0	0 1 1 1
5	0 1 0 1	1 0 0 0
6	0 1 1 0	1 0 0 1
7	0 1 1 1	1 0 1 0
8	1 0 0 0	1 0 1 1
9	~~10001~~ (BCD) 1 0 0 1	1 1 0 0
	1 0 1 0	x x x x = 0 ali 1
	1 0 1 1	⋮
	⋮ ni v BCD	⋮
		x x x x

$11_{BCD} = 0001\,0001$

Za vsak izhod poiščimo minimalno fjo.

1010
1011
1100
1101
1110
1111

W: X: Y: Z: D.N.



Za x nam je vseeno

$W = A + BD + BC$

$X = \bar{B}D + \bar{B}C + B\bar{C}\bar{D}$

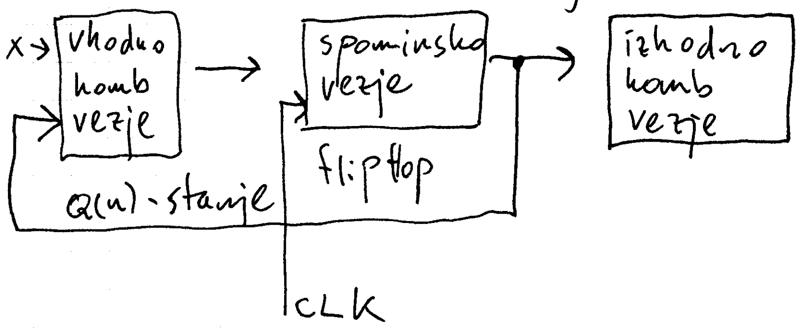
$Y = CD + \bar{C}\bar{D}$

$Z = \bar{D}$

Na n.p. seštevalniki in odštevalniki

26.11.08

Sekvenčna vezja - sinhronska



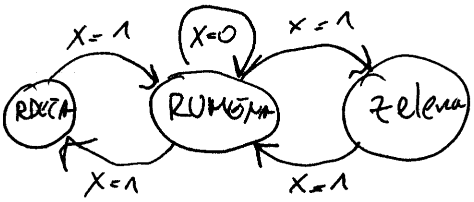
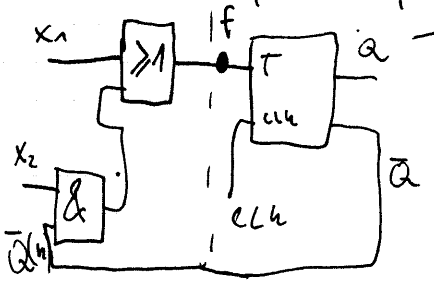


diagram stanj

Analizirajte podano sekvenčno vezje



→ spremenljivke stanj

Q=0	=	S_0
Q=1	=	S_1

kodirna tabela

kombinacijski del | spominski del

$$f = T = x_1 + x_2 \overline{Q(n)}$$

↑ sedanje stanje

To je vzbujalna enačba.

T	Q(n)	Q(n+1)
0	0	0
0	1	1
1	0	1
1	1	0

Vzbujalna tabela → nasledje stanje

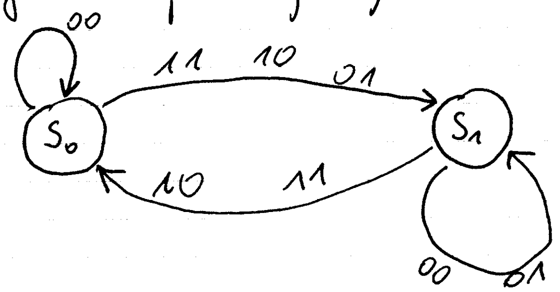
x_1	x_2	$Q(n)$	$Q(n+1)$	T (najprej zračunamo)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	0	1
1	1	0	1	1
1	1	1	0	1

tabela prehajanja stanj

sedanje stanje	nasledje stanje 00	01	10	11
S_0	S_0	S_1	S_1	S_1
S_1	S_1	S_1	S_0	S_0

← x_1x_2

diagram prehajanja stanj



Števec, ki šteje navzgor po modulu 3. Uporabite D spominske celice in logična vrata

3 stanja

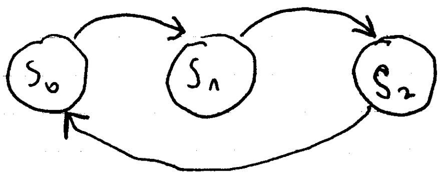


Tabela prehajanja stanj

sedanje stanje	nasledje stanje
00: S_0	S_1
S_1	S_2
S_2	S_0

2 flipflopa

kodirna tabela:

Q_1Q_2	stanje
00	S_0
01	S_1
10	S_2
11	

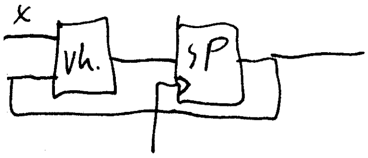
Vzbujalna tabela

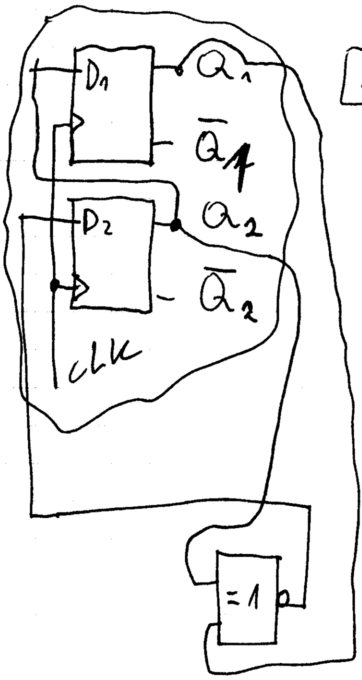
$Q_1(n)$	$Q_2(n)$	$Q_1(n+1)$	$Q_2(n+1)$	D_1	D_2
0	0	0	1	0	1
0	1	1	0	1	0
1	0	0	0	0	0
1	1	x	X	x	x

$Q(n+1) = D$

vhodi v kombinacijsko vezje

izhod komb. vezja





$D_1 = \overline{Q}_1 Q_2(n) + Q_1 Q_2(n)$

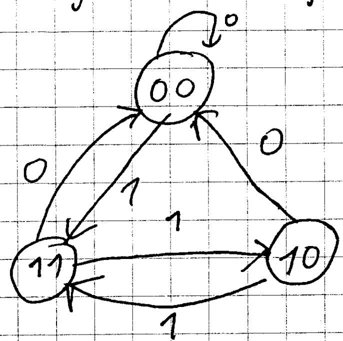
$\boxed{D_1 = Q_2(n)}$

$D_2 = \overline{Q}_1(n)\overline{Q}_2(n) + Q_1(n) Q_2(n)$

$D_2 = Q_1 \equiv Q_2(n)$ XNOR

03.12.2008

Zgradite vezje iz podanega diagrama stanj s T celicami



	$Q_1 Q_2$
S_1 =	0 0
S_2 =	1 0
S_3 =	1 1

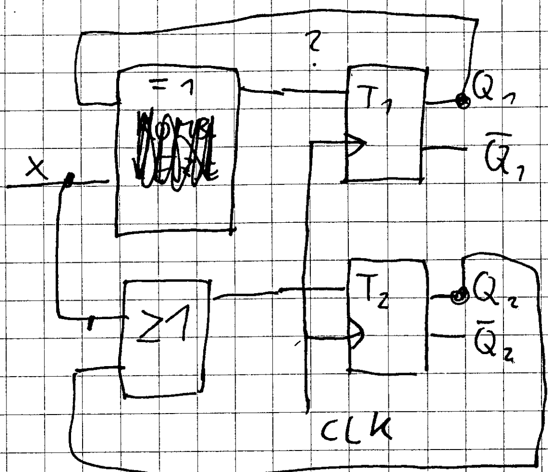


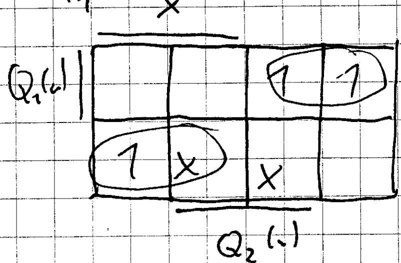
tabela preh. stanj

sed. sta.	nasle. stanje x=0	nasle. stanje x=1
0 0	0 0	1 1
1 0	0 0	1 1
1 1	0 0	1 0

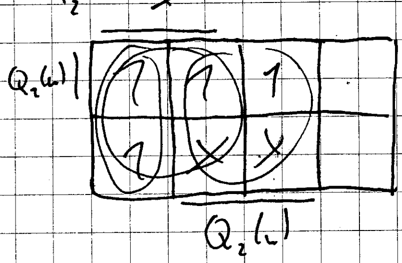
vzb. tabela

x	$Q_1(n)$	$Q_2(n)$	$Q_1(n+1)$	$Q_2(n+1)$	T_1	T_2
0	0	0	0	0	0	0
0	0	1	x	x	x	x
0	1	0	0	0	1	0
0	1	1	0	0	1	1
1	0	0	1	1	1	1
1	0	1	x	x	x	x
1	1	0	1	1	0	1
1	1	1	1	0	0	1

T_1:



T_2:



$T_1 = \bar{x}\, Q_1(n) + x\, \bar{Q}_1(n)$

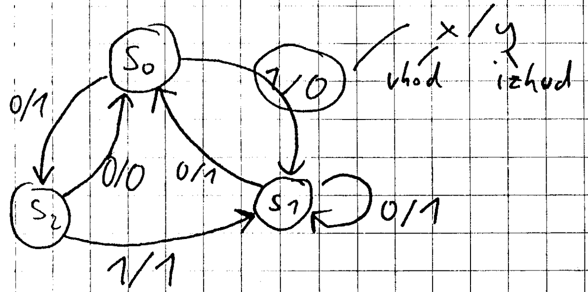
$= x \oplus Q_1(n)$

XOR

EXOR

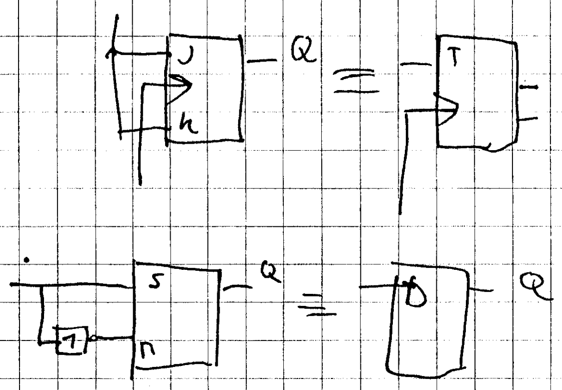
$T_2 = x + Q_2(n)$

Zgradite sekv. vezje iz podanega diagrama, uporabite JK celic. Za kateri tip avtomata gre?



Mealy ⇒ $y = f(x, Q)$

Moore ⇒ $y = f(Q)$



kodirana tabela stanj

	Q_1	Q_2
s_0	0	0
s_1	0	1
s_2	1	0

tabela preh. stanj

sed. stanje	nasle. stanje/izhod $x=0$	$x=1$
s_0	$s_2/1$	$s_1/0$
s_1	$s_1/1$	$s_0/0$
s_2	$s_0/0$	$s_1/1$

vzbujalna tabela

x	$Q_1(n)$	$Q_2(n)$	$Q_1(n+1)$	$Q_2(n+1)$	J_1	K_1	J_2	K_2	y
0	0	0	1	0	1	X	0	X	1
0	0	1	0	1	0	X	X	0	1
0	1	0	0	0	X	1	0	X	0
0	1	1	X	X	X	X	X	X	X
1	0	0	0	1	0	X	1	X	0
1	0	1	0	0	0	X	X	1	0
1	1	0	0	1	X	1	1	X	1
1	1	1	X	X	X	X	X	X	X

$K_1 = 1$

z Veitchijev

$J_1 = \bar{x}\,\bar{Q}_2(n)$

$J_2 = x$

$K_2 = x$

y:

	$\bar{x}$	$\bar{x}$		
$Q_1(n)$	1	X	X	
			1	1
			$Q_2(n)$	$Q_2(n)$

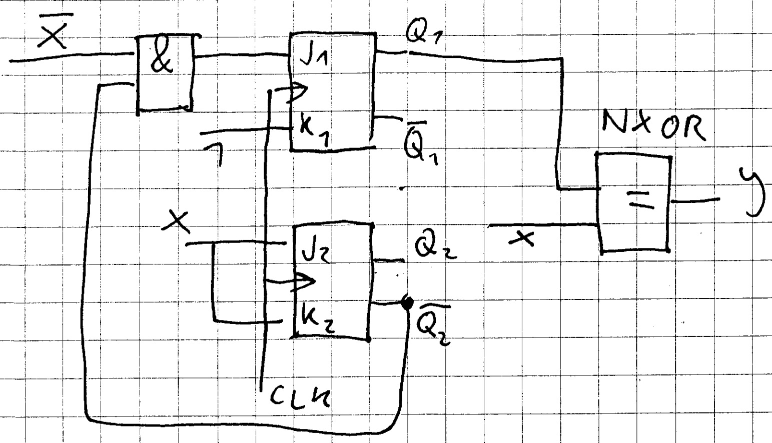
$y = x\,Q_1(n) + \bar{x}\,\bar{Q}_1(n)$

$= x \equiv Q_1(n)$

XNOR

XOR

Mealyjev avtomat.

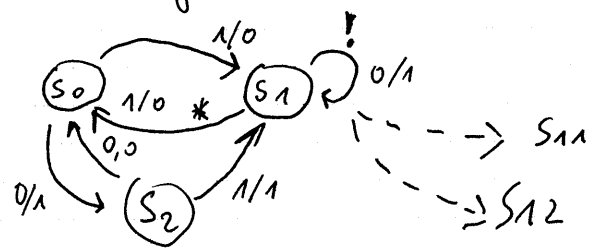


Akta®

10.12.08

$\boxed{3.12.08\,!}$

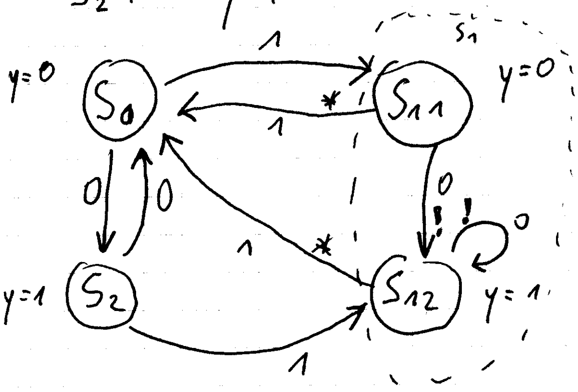
Pretvorite Mealeyev avtomat iz prejšnje naloge v Mooreovega.



x / y
vhod izhod

MOORE $y = f(Q)$ odvisen od stanj

S_0 : $y=0$
S_1 : $y=0$ $y=1$ } → S_{11} $y=0$; → S_{12} $y=1$
S_2 : $y=1$



Realiziramo z JK Flipflopi.

tabela prehajanj stanj

		x=0	x=1	y
00 =	S_0	S_2	S_{11}	0
01 =	S_{11}	S_{12}	S_0	0
10 =	S_{12}	S_{12}	S_0	1
11 =	S_2	S_0	S_{12}	1

} y določeni s stanji

zakodiramo

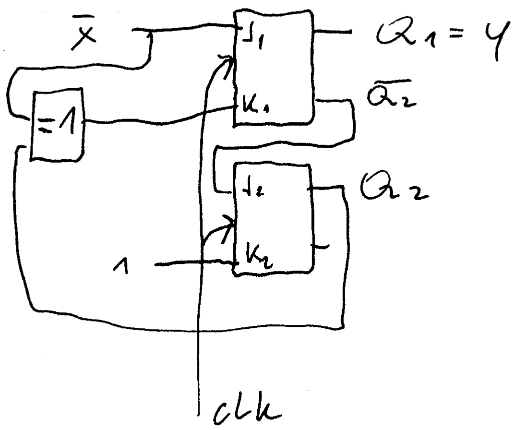
→ vzbujalna tabela

Aleta

	X	Q_1	Q_2	Q'_1	Q'_2		J_1	K_1	J_2	K_2	Y
S_0:	0	0	0	1	1	: S_2	1	x	1	x	0
	0	0	1	1	0		1	x	x	1	0
	0	1	0	1	0		x	0	0	x	1
	0	1	1	0	0		x	1	x	1	1
	1	0	0	0	1		0	x	1	x	0
	1	0	1	0	0		0	x	x	1	0
	1	1	0	0	0		x	1	0	x	1
	1	1	1	1	0		x	0	x	1	1

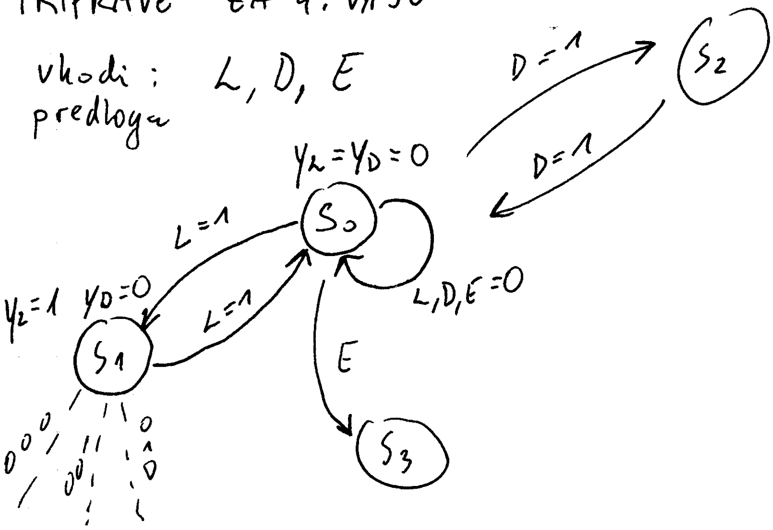
ithodi stanj

minimizirano
$y = Q_1$ — to je značilnost mooreovega avtomata
$J_1 = \overline{X}$
$K_2 = 1$
$J_2 = \overline{Q_1}$
$K_1 = X \otimes Q_2$



PRIPRAVE ZA 4. VAJO

vhodi : L, D, E
predloga



17.12.08

Minimizirajte podano tabelo stanj sinhronskega sekvenčnega vezja.

	x=0	x=1	Y
000 = S_1	S_3	S_2	1
001 = S_2	S_4	S_3	1
010 = S_3	S_3	S_1	0
011 = S_4	S_2	S_5	1
100 = S_5	S_3	S_1	0

združujemo lahko samo tista stanja, ki imajo iste izhode.

3 flipflopi

Možni združljivi pari:

	x=0	x=1	
(S_1, S_2)	$= (S_3, S_4)$	(S_2, S_3)	X
(S_1, S_4)	$= (S_2, S_3)$	(S_2, S_5)	X
(S_2, S_4)	$= (S_2, S_4)$	(S_3, S_5)	✓
(S_3, S_5)	$= (S_3, S_3)$	(S_1, S_1)	✓

gledamo izhode → ker 3 in 4 različna izhoda

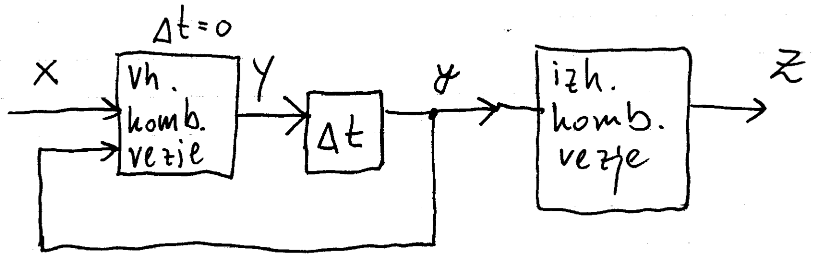
$S_2 \equiv S_4 = S_B$
$S_3 \equiv S_5 = S_C$

$S_1 = S_A$

	x=0	x=1	Y
S_A	S_C	S_B	1
S_B	S_B	S_C	1
S_C	S_C	S_A	0

dva flipflopa

Asinhronska sekvenčna vezja



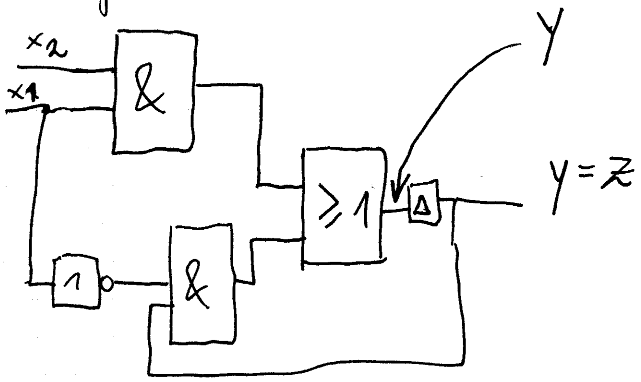
- kadar Y in y enaka, je vezje v stabilnem stanju
- kadar $Y \neq y$, stanje nestabilno

vhodna stanja: $x_1 x_2$

$\hookrightarrow 00 \not\rightarrow 11$ ne gre

$00 \rightarrow 01 \rightarrow 11$ to pa je
$00 \rightarrow 10 \rightarrow 11$ v redu!

- Analizirajte asinhronsko sekvenčno vezje. Ugotovite, ali lahko pride do statičnega hazarda in ga odpravite.



$Y = x_1 x_2 + \overline{x_1}\, y$

tabela prehajanja stanj

sedanja stanja (y)	naslednja stanja $x_1 x_2$: 00	01	11	10	Z = Y
0	0	0	1	0	0
1	1	1	1	0	1

Y

samo gledamo, kdaj je Y = 1!

Y \ $x_1 x_2$	00	01	11	10
0	0	0	1	0
1	1	1	1	0

poglejmo, kdaj Y = y (obkrožimo ↑)

poglejmo zdaj

$x_2 = 1$
$x_1 = 0$ $\longrightarrow$ iz vezja $\rightarrow$ $Y = 0$ $\rightarrow$ $y = 0$

naslednji prehod

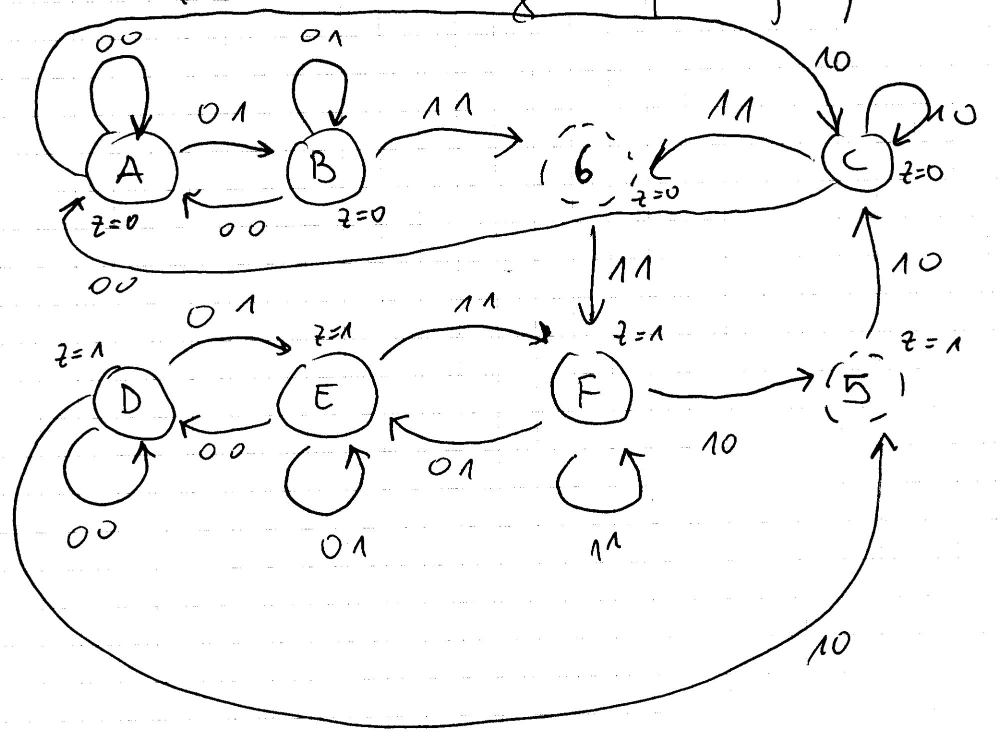
$x_2 = 1$
$x_1 = 1$ $\longrightarrow$ $\rightarrow$ $Y = 1$, $y = 0$ vezje nestabilno

po neki zakasnitvi

$x_2 = 1$
$x_1 = 1$ + y postane 1 in naslednje stanje je v redu (ne vpliva – glej vezje). Vezje ostane v stabilnem stanju

stabilna stanja: prehodi $\leftrightarrow$
nestabilna stanja: $\updownarrow$

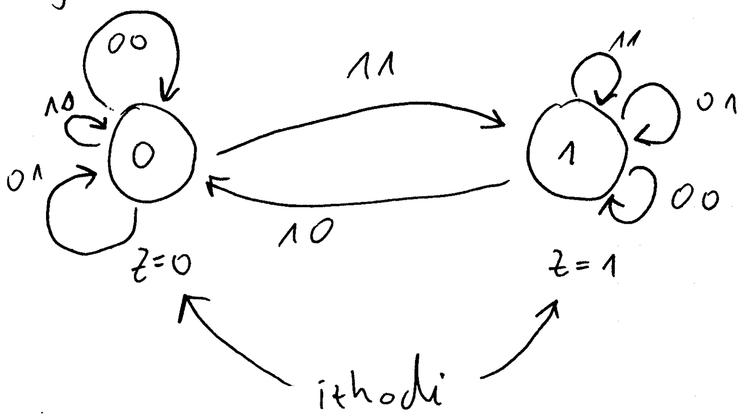
Narišimo si diagram prehajanja osnovnih stanj.



najprej napravimo kako ostanejo stanja enaka

Opomba: To je Mooreov avtomat.

Narišimo še diagram prehajanja stabilnih stanj:



Podobno z D celicami!

Oglejmo si še vzbujalno tabelo

($D = a'$) podobnost s sinhronskimi

x_1	x_2	y (a)	Y (a')	Z
0	0	0	0	0
0	0	1	1	1
0	1	0	0	0
0	1	1	1	1
1	0	0	0	0
1	0	1	0	1
1	1	0	1	0
1	1	1	1	1

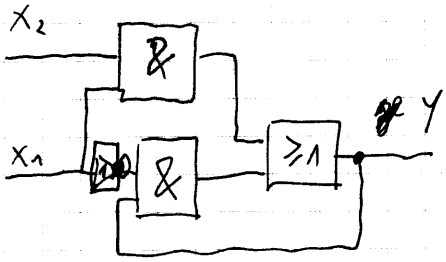
$z = y$

$$Y = x_1 x_2 + \bar{x}_1 y$$

7.1.2009

tori: 21.1.2009, 10h-11h (12h)

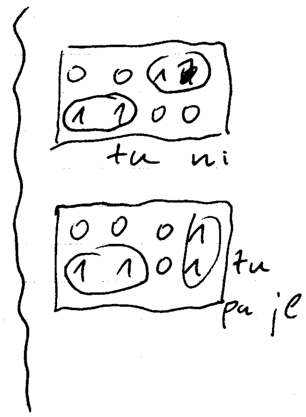
- Preverimo, ali nastopi hazard in ali ga znamo odpraviti.



y \ x_1x_2	00	01	11	10
0	0	0	1	0
1	1	1	1	0

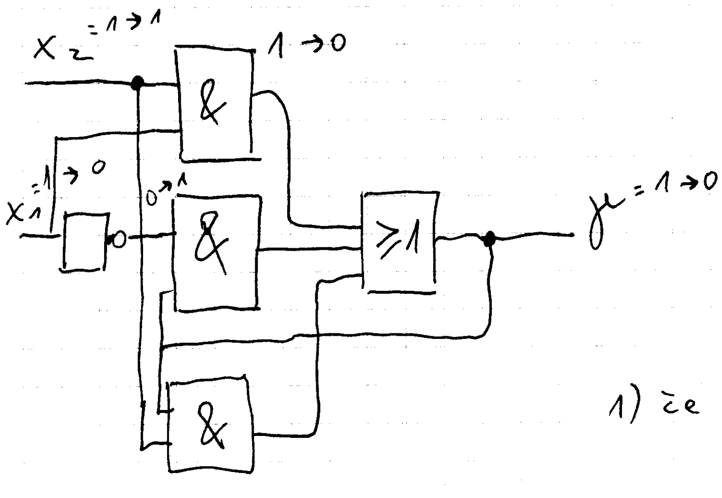
y \ x_1x_2	00	01	11	10
0	0	0	1	0
1	1	1	1	0

tu umes je hazard



Povežimo in dodajmo v vezje.

$$y = \underbrace{\boxed{\overline{x_1}\cdot y + x_1\cdot x_2}}_{\text{originalna enačba}} + \underbrace{\boxed{(x_2 y)}}_{\text{člen, ki smo ga dodali}}$$



Poglejmo, kako se to obnaša (brez popravila)

x_1x_2 : 11 → 01
y : 1 → ?

1) če je negator počasen:

y : 1 → 0 to pa je napačno stanje

2) negator je zelo hiter

- $y: 1 \to 1$ ok.

3) negator primerljiv Δt z ostalimi elementi.

vezje oscilira $y: 1 \to 0 \to 1 \ldots$

4) vrata dodamo (popravimo hazard): $y: 1 \to 1$ ok

IZPITNA

- Poiščite minimalno izvedbo asinhronskega sekvenčnega vezja podanega s tabelo stanj. Ugotovite tip avtomata, prikažite diagram prehajanja osnovnih in stabilnih stanj, stanja zakodirajte in za izbrano kodo ugotovite možne kritične prehode.

	$x=0$	$x=1$
S_1	$S_5/1$	$S_3/1$
S_2	$S_2/0$	$S_1/0$
S_3	$S_5/1$	$S_1/-$
S_4	$S_4/0$	$S_3/0$
S_5	$S_6/0$	$S_5/1$
S_6	$S_6/1$	$S_2/0$

Mealey: upr $S_6/0$
$S_6/1$

združimo stanja: možni pari – gledamo izhode

	$x=0$	$x=1$	
S_1, S_3 :	(S_5, S_5)	(S_1, S_3)	✓✓
S_2, S_4 :	(S_2, S_4)	(S_1, S_3)	✓✓
S_3, S_6 :	(S_5, S_6)	(S_1, S_2)	✗

$S_1 \equiv S_3 = S_A$
$S_2 \equiv S_4 = S_B$
$S_5 = S_C$
$S_6 = S_D$

Naredimo novo tabelo

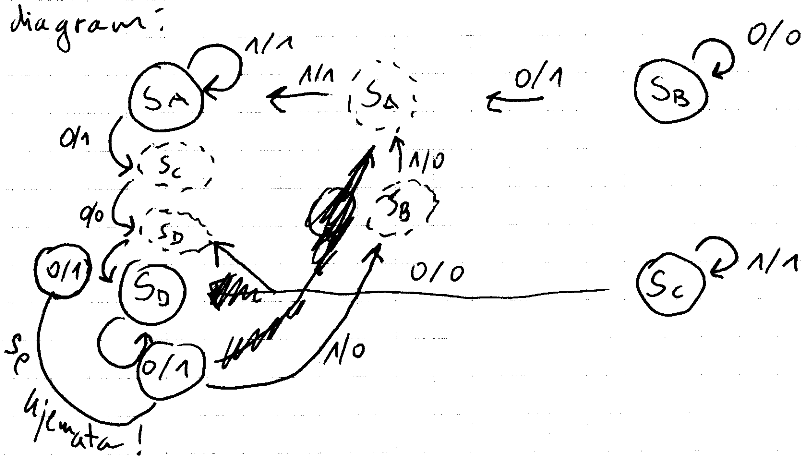
sedanja	naslednja $x=0$	$x=1$
S_A	$S_C/1$	$S_A/1$
S_B	$S_B/0$	$S_A/0$
S_C	$S_D/0$	$S_C/1$
S_D	$S_D/1$	$S_B/0$

Stabilna so tista stanja, ki sta ista.

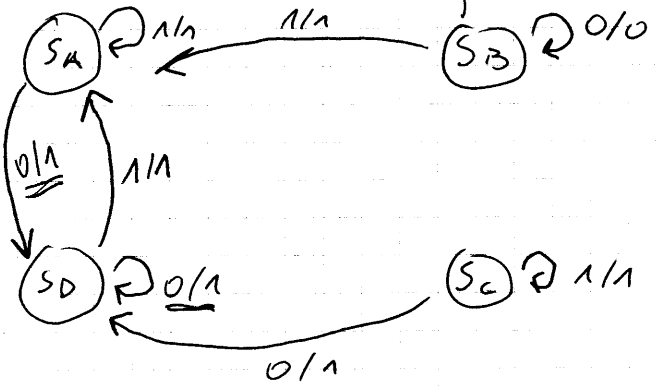
~~[illegible]~~

- ⟷ stabilna   ↕ nestabilna

diagram:



samo stabilna stanja



zakodiramo:

a)

	x=0	x=1
00	11	00
01	01	00
11	10	11
10	10	01

kritični prehodi:

00 → 11 → 10 → 10

00 → 01 → 11
00 → 10 → 11 ?

b)

	x=0	x=1
00	10	00
01	01	00
10	11	10
11	11	01

pri vsakem prehodu se spremeni največ ena spr. Ta koda je v redu.

IZPITNA

- zapišite primitivno tabelo stanj asinhronskega
- sekvenčnega vezja, ki ima izhod 1 vsakič, ko gre x_1 iz 0 na 1. Izhod ostane na 1, dokler se ne pojavi 1 na vhodu x_2. Takrat bo izhod 0.

dva vhoda:

x_1 : $0 \rightarrow 1$: $z = 1$
x_2 : 1 : $z = 0$ (x_2 je kot reset)

primit. tab. st — samo eno stabilno stanje v vrstici

pri asinh. se samo en vhod naenkrat spreminja

sed. st	nasl. st 00	01	11	10	z
S_0	S_0	S_1	—	S_2	0
S_1	S_0	S_1	S_3	—	0
S_2	S_4	—	S_3	S_2	1
S_3	—	S_1	S_3	S_5	0
S_4	S_4	S_1	~~S_4~~ —	S_2	1
S_5	S_0	—	S_3	S_5	0

zmisljujemo si nova stanja, kadar nam ne ustrezajo obstoječa

združimo stanja (gledamo po stolpcih)

$S_0, S_1 = \checkmark\checkmark$
$S_0, S_3 = (S_2, S_5)$
$S_0, S_5 = (S_2, S_5)$
$S_1, S_3 = \checkmark\checkmark$
$S_1, S_5 = \checkmark\checkmark$
$S_2, S_4 = \checkmark\checkmark$
$S_3, S_5 = \checkmark\checkmark$

$\boxed{S_0 \equiv S_1 = S_A}$
~~$S_1 \equiv S_3$~~
~~$S_1 \equiv S_5$~~
$S_3 \equiv S_5 = S_C$
$\boxed{S_2 \equiv S_4} = S_B$

	00	01	11	10	z
S_A	S_A	S_A	S_C	S_B	0
S_B	S_B	S_A	S_C	S_B	1
S_C	S_A	S_A	S_C	S_C	0