GORAZD PUCIHAR 13.10.2011

AM-305 M3 pet $11^{30} - 12^{30}$ → g. ure

gorazd.pucihar@fe.uni-lj.si lab vaje od 24.10 →

seminar: 3 ned. stare stavba

- zbirka nalog - Dig strukture G. Pucihar, T. Kotnik
- rešeni primeri iz preklopnih vezij - A. Stefanovska
- preklopna vezja in strukture, priročnik za vaje - M. Trebar

---

X {0,1}

$1+1 \neq 2$

$= 1$ → logično seštevanje - ALI funkcija

1. BOOLE-OVA ALGEBRA

X {0,1}

- disjunkcija → "OR" → "+" → $X+y$
- konjunkcija → "AND" → "·" → $X \cdot y$
- negacija → "NOT" → "‾" → $\overline{X}$

} s temi funkcijami opišemo vse.

0 | 1 | 0

0,1 predstavljata napetostne nivoje

1.1 Osnovna pravila:

$1+1 = 1 \cdot 1 = 1$

$0+0 = 0 \cdot 0 = 0$

$0+1 = 1+0 = 1$

$0 \cdot 1 = 1 \cdot 0 = 0$

1.2 Postulati:

P1)	$X+0=X$	P1')	$X \cdot 1 = X$
P2)	$X+Y=Y+X$	P2')	$X \cdot Y = Y \cdot X$
P3)	$X+(Y \cdot Z) = (X+Y)\cdot(X+Z)$	P3')	$X(Y+Z) = X \cdot Y + X \cdot Z$
P4)	$X+\overline{X} = 1$	P4')	$X \cdot \overline{X} = 0$

1.3 Teoremi:

$X+1 = 1$

$X \cdot X = X$

dokaz: $X \cdot X \overset{P1}{=} X \cdot X + 0 \overset{P4'}{=} X \cdot X + X \cdot \overline{X} \overset{P3'}{=} X(X+\overline{X}) \overset{P4}{=} X \cdot 1 \overset{P1'}{=} \underline{X}$

$X + X\cdot y = X$ → dokaz: $X + X\cdot y \overset{P1'}{=} X\cdot 1 + X\cdot y \overset{P3'}{=} X\cdot(\overbrace{1+y}^{T1=1}) = X\cdot 1 = \underline{\underline{X}}$

1.4 DeMorgan:

$\overline{X+y} = \overline{X}\cdot\overline{y}$ → dokaz (s pravilnostno tabelo)

$\overline{X\cdot y} = \overline{X} + \overline{y}$

X	y	$X+y$	$\boxed{\overline{X+y}}$	$\overline{X}$	$\overline{y}$	$\boxed{\overline{X}\cdot\overline{y}}$
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

S pravili B. algebre poenostavimo naslednji izraz:

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

$f = AB + BB + B\overline{C} + \overline{B}C =$ $\qquad B\cdot B = B$

$= AB + B + B\overline{C} + \overline{B}C =$

$= B(\underbrace{(A+1+\overline{C})}_{\text{kao "x"}+1=1}) + \overline{B}C =$

$= B\cdot 1 + \overline{B}\cdot C =$

$= B + \overline{B}C \overset{P3}{=}$

$= \underbrace{(B+\overline{B})}_{1}\cdot(B+C) = \underline{\underline{B+C}}$

b) $f = A\overline{B} + \overline{C}\,(\overline{\overline{A}+B})$ ← "izpitna naloga"

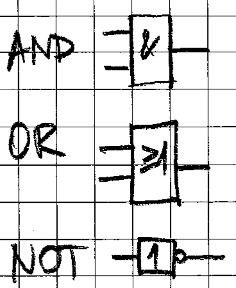
$f = A\overline{B} + \overline{C}\,(\overline{\overline{A}}\cdot\overline{B}) =$

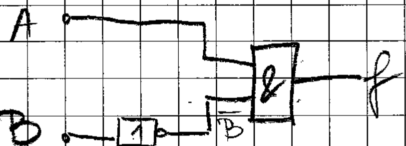
$= A\overline{B} + \overline{C}\,(A\overline{B}) =$

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

$= A\overline{B}\,(\underbrace{1+\overline{C}}_{1}) = \underline{\underline{A\overline{B}}}$

1.5 logična vrata:





$A = 1$
$B = 0$
$f = ?$

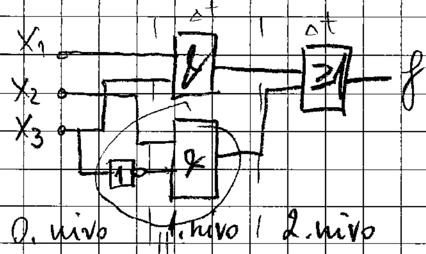
$f = 1\cdot\overline{0} = 1\cdot 1 = \underline{\underline{1}}$

Poiščite minimalno obliko funkcije in narišite vezje: 20.10.2011

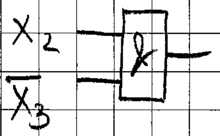
$f(x_1,x_2,x_3) = x_1\bar{x}_2 x_3 + x_2(\bar{x}_3 + x_1 \cdot x_3) =$

$= x_1\bar{x}_2 x_3 + x_2\bar{x}_3 + x_1x_2x_3 = x_1x_3(\underbrace{\bar{x}_2 + x_2}_{1}) + x_2\bar{x}_3 =$

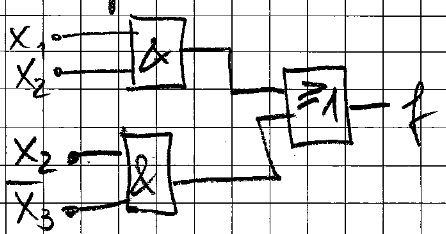
$= x_1x_3 + x_2\cdot\bar{x}_3$



2-nivojska realizacija → normalna



funkcijo na izhodu vezja napišite v obliki pravilnostne tabele:



$f = x_1x_2 + x_2\cdot\bar{x}_3$

x_1	x_2	x_3	y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Poiščite analitični zapis funkcije podane s tabelo in narišite vezje.

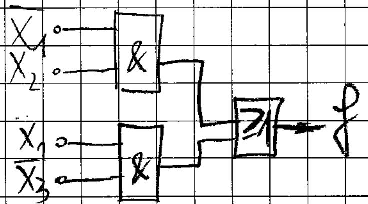
x_1	x_2	x_3	f
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

a) "1" $f = \bar{x}_1\bar{x}_2\bar{x}_3 + \bar{x}_1\bar{x}_2x_3 + x_1\bar{x}_2\bar{x}_3 + \underbrace{x_1x_2\bar{x}_3}_{m_3}$ ← disjunktivna oblika funkcije Σ produktov je popolna PDNO

$f = \bar{x}_1\bar{x}_2(\underbrace{\bar{x}_3 + x_3}_{1}) + x_1\bar{x}_3(\underbrace{\bar{x}_2 + x_2}_{1})$

$f = \bar{x}_1\bar{x}_2 + x_1\bar{x}_3$ ← minimalna oblika disjunktivna MDNO

(najbolj skrčena funkcija)



2-nivojska/normalna oblika

AND-OR oblika

b) "0"

$\bar{f} = \bar{x}_1x_2\bar{x}_3 + \bar{x}_1x_2x_3 + x_1\bar{x}_2x_3 + x_1x_2x_3$

$\overline{(\bar{f})} = f = \overline{(\bar{x}_1x_2\bar{x}_3) + (\bar{x}_1x_2x_3) + (x_1\bar{x}_2x_3) + (x_1 \cdot x_2x_3)} =$

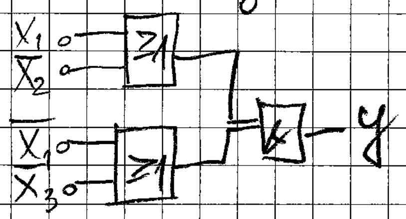
$= (x_1 + \bar{x}_2 + x_3)\cdot(x_1 + \bar{x}_2 + \bar{x}_3)\cdot(\bar{x}_1 + x_2 + \bar{x}_3)\cdot(\bar{x}_1 + \bar{x}_2 + \bar{x}_3)$ popolna konjuktivna oblika PKO

P3: $X + (y \cdot z) = (x+y) \cdot (x+z)$

$$f = (x_1 + \bar{x}_2 + \underbrace{x_3 \cdot \bar{x}_3}_{0}) \cdot (\bar{x}_1 + \bar{x}_3 + \underbrace{x_2 \cdot \bar{x}_2}_{0}) = (x_1 + \bar{x}_2) \cdot (\bar{x}_1 + \bar{x}_3)$$

minimalna konjuktivna oblika

MKNO



$$\bar{x}_1 \bar{x}_2 + x_1 \bar{x}_3 = (x_1 + \bar{x}_2) \cdot (\bar{x}_1 + \bar{x}_3) \quad ?$$

$$f_{MKNO} = \underbrace{x_1 \bar{x}_1}_{0} + x_1 \bar{x}_3 + \bar{x}_2 \bar{x}_1 + \bar{x}_2 \cdot \bar{x}_3 =$$

$$= x_1 \bar{x}_3 + \bar{x}_2 \bar{x}_1 + \bar{x}_2 \cdot \bar{x}_3 \cdot (x_1 + \bar{x}_1) =$$

$$= x_1 \bar{x}_3 + \bar{x}_2 \cdot \bar{x}_1 + \bar{x}_2 \bar{x}_3 \cdot x_1 + \bar{x}_2 \bar{x}_3 \bar{x}_1$$

$$x_1 \bar{x}_3 \underbrace{(1 + \bar{x}_2)}_{1} + \bar{x}_2 \bar{x}_1 \underbrace{(1 + \bar{x}_3)}_{1} = x_1 \bar{x}_3 + \bar{x}_2 \bar{x}_1 = f_{MDNO}$$

KARNAUGH-jevi DIAGRAMI

Poenostavimo funkcijo iz prejšnje naloge s K diagramom:

x_3 \ $x_1 x_2$	00	01	11	10
0	1	0	1	1
1	1	0	0	0

$$f: \bar{x}_1 \bar{x}_2 + x_1 \bar{x}_3$$

Zapišimo M_2 v K-diagram:

$$M_2 = (\bar{x}_1 + x_2 + \bar{x}_3)$$

	00	01	11	10
0				
1				

$$M_2 = \overline{m_5}$$

$$x_1 \bar{x}_2 x_3 = m_5$$

27.10.2011

$$f(x_1, x_2, x_3) = M_1 \cdot M_3 \cdot M_7 = \prod 1,3,7 = (\bar{x}_1 + \bar{x}_2 + x_3)(\bar{x}_1 + x_2 + x_3)(x_1 + x_2 + x_3) =$$

0 0 1 0 1 1 1 1 1

PKNO

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

76543210 m

01234567 M

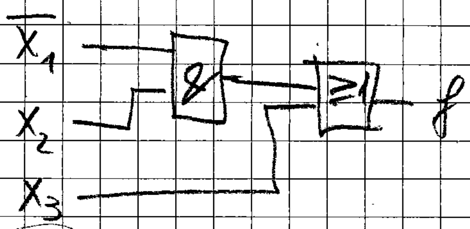
$$= \underbrace{\bar{x}_1 \bar{x}_2 x_3 + \bar{x}_1 x_2 \bar{x}_3 + \bar{x}_1 x_2 x_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 x_3}_{PDNO}$$

x_3 \ $x_1 x_2$	00	01	11	10
0		1		
1	1	1	1	1

=

$= X_3 + \overline{X_1}X_2$

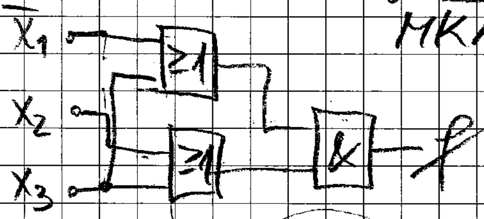
MDNO



$X_3 \backslash X_1X_2$	00	01	11	10
0	0		0	0
1				

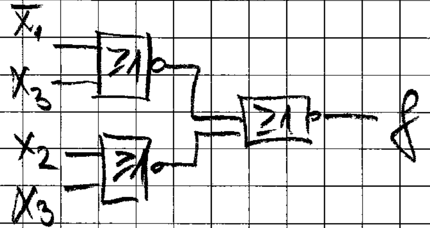
$= (\overline{X_1} + X_3)\cdot(X_2+X_3)$

MKNO



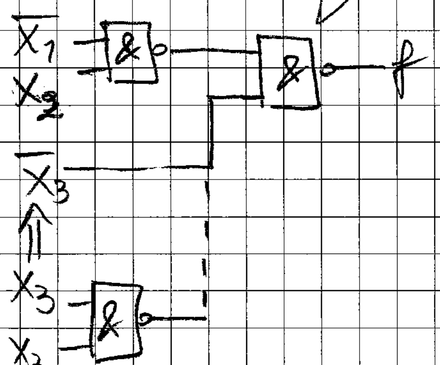
$$\overline{\overline{X_3+\overline{X_1}\cdot X_2}} = \overline{\overline{X_3}\cdot\overline{\overline{X_1}X_2}} = \overline{\overline{X_3X_3}\cdot\overline{\overline{X_1}X_2}}$$

$$\overline{\overline{(\overline{X_1}+X_3)\cdot(X_2+X_3)}} = \overline{\overline{\overline{X_1}+X_3}+\overline{X_2+X_3}} = \underbrace{\downarrow(\downarrow(\overline{X_1},X_3),\downarrow(X_2,X_3))}_{NOR}$$



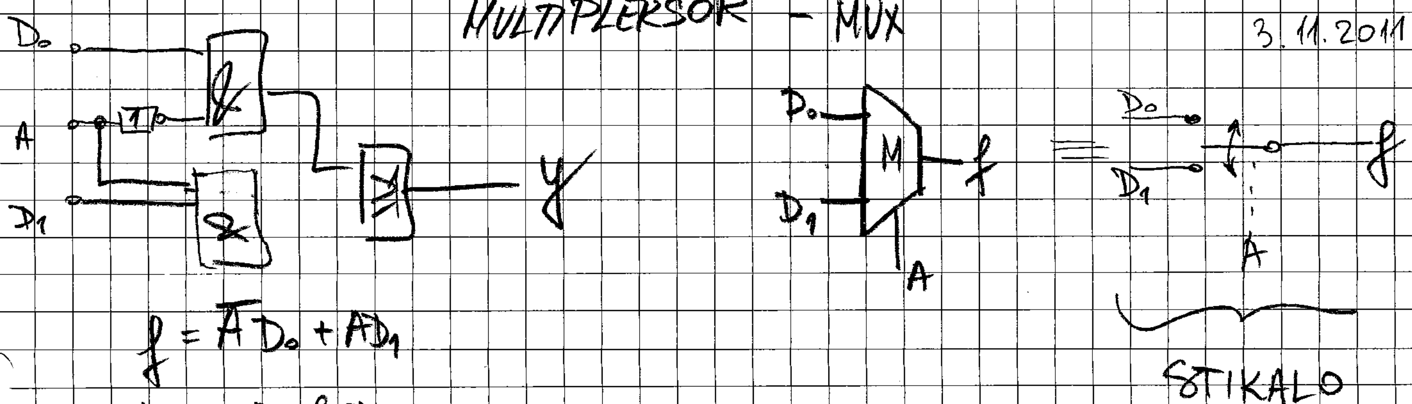
potrebujemo samo 1 čip, ki ima 4 dvovhodna NOR vrata

tudi negacijo lahko izvedemo z NOR



MULTIPLEKSOR - MUX

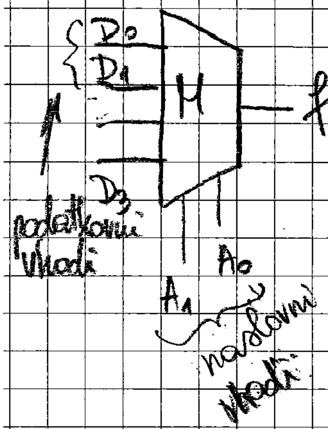
3.11.2011



$f = \overline{A}D_0 + AD_1$

$A = 0 \Rightarrow f = D_0$

$A = 1 \Rightarrow f = D_1$



$$f = m_0 D_0 + m_1 D_1 + \dots + m_{2^n-1} D_{2^n-1}$$

$m_0 \to \overline{A_1}\,\overline{A_0}$, $m_1 \to \overline{A_1}A_0$

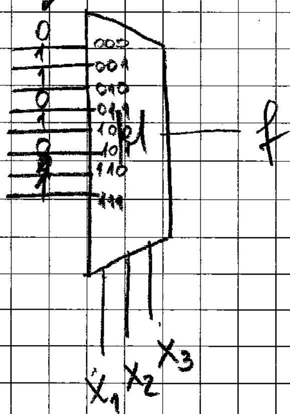
samo podatkovni vhodi gredo na izhod

Preklopno funkcijo realizirajte z MUX z 8, 4, 2 podatkovnimi vhodi.
a) b) c)

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

$$f = \overline{x_1}\,\overline{x_2}x_3 + \overline{x_1}x_2\overline{x_3} + x_1\overline{x_2}\,\overline{x_3} + x_1x_2\overline{x_3} + x_1x_2x_3$$

a)



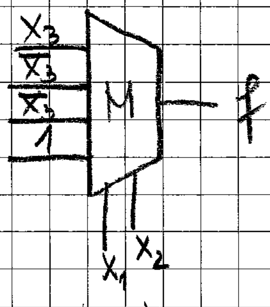
x_1	x_2	x_3	y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

$$\underbrace{\overline{x_1}\,\overline{x_2}\,\overline{x_3}}_{m_0}\underbrace{(0)}_{D_0} + \overline{x_1}\,\overline{x_2}x_3(1) + \overline{x_1}x_2\overline{x_3}(1) + \dots + x_1x_2x_3(1)$$

MUX
8-1 ali 8/3

0 → masa
1 → Vcc

b)



MUX
4/1 ali 4/2

$$f = \underbrace{\overline{x_1}\,\overline{x_2}}_{m_0}\underbrace{(x_3)}_{D_0} + \underbrace{\overline{x_1}x_2}_{m_1}\underbrace{(\overline{x_3})}_{D_1} + x_1\overline{x_2}(\overline{x_3}) + x_1x_2\underbrace{(\overline{x_3} + x_3)}_{1}$$

izberemo si dve od treh spremenljivk (ponavadi izberemo tiste, ki se ponovita v vseh členih)

c) $f = \bar{x}_1\bar{x}_2x_3 + \bar{x}_1x_2\bar{x}_3 + x_1\bar{x}_2\bar{x}_3 + x_1x_2\bar{x}_3 + x_1x_2x_3$

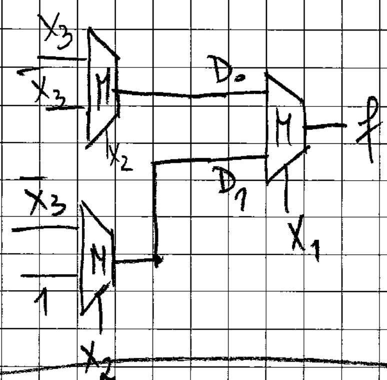
MUX 2-1 ali 2/1

Ker so nam ostale funkcije dodamo še 2 MUX-a v kaskado

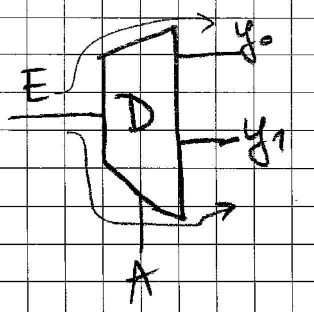
$$\bar{x}_1(\underbrace{\bar{x}_2x_3 + x_2\bar{x}_3}_{D_0}) + x_1(\underbrace{\bar{x}_2\bar{x}_3 + x_2\bar{x}_3 + x_2x_3}_{D_1})$$

$$D_0 = \bar{x}_2x_3 + x_2\bar{x}_3 = \bar{x}_2(x_3) + x_2(\bar{x}_3)$$

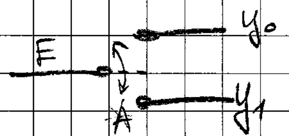
$$D_1 = \bar{x}_2\bar{x}_3 + x_2\bar{x}_3 + x_2x_3 = \bar{x}_2(\bar{x}_3) + x_2(\underbrace{\bar{x}_3 + x_3}_{1})$$



DEMULTIPLEKSOR – DEMUX



≡



$A = 0 \Rightarrow y_0 = E$

$A = 1 \Rightarrow y_1 = E$

$y_0 = m_0 \cdot E$

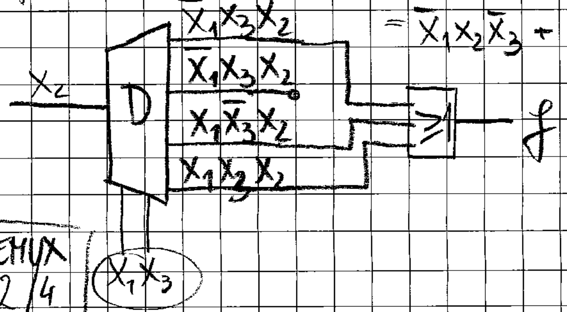
$y_1 = m_1 \cdot E$

$y_{2^n-1} = m_{2^n-1} \cdot E$

Preklopno f. realizirajte z DEMUX s štirimi izhodi in OR vrati

$f(x_1, x_2, x_3) = \sum 2,6,7 = \bar{x}_1x_2\bar{x}_3 + x_1x_2\bar{x}_3 + x_1x_2x_3$

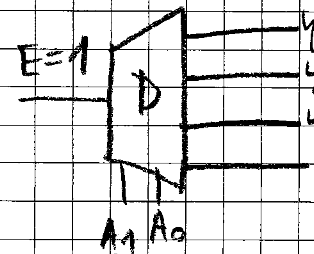
$x_2(\bar{x}_1\bar{x}_3 + x_1\bar{x}_3 + x_1x_3)$



DEMUX 2/4

1-4

KAJ DOBIMO NA IZHODU, ČE JE NA VHODU VEDNO 1?



y_0	1	0	0	0
y_1	0	1	0	0
y_2	0	0	1	0
y_3	0	0	0	1

A_1	A_0
0	0
0	1
1	0
1	1

DEKODIRNIK

10.11.2011

Zapiši funkcijo v HKNO:

$$f = \overline{x}_1\overline{x}_3x_4 + \overline{x}_2x_3x_4 + x_1\overline{x}_3x_4 + x_2x_3x_4$$

x_3x_4 \ x_1x_2	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	1	1	1	1
10	0	0	0	0

$f_{MDNO} = x_4$

$f_{MKNO} = x_4$

} 2 različna zapisa iste funkcije

$$f = (\overline{x}_2+\overline{x}_3)\cdot(\overline{x}_1+\overline{x}_2+x_3)\cdot(\overline{x}_1+x_2+x_4)$$

x_3x_4 \ x_1x_2	00	01	11	10
00	1	1	0	0
01	1	1	0	1
11	1	0	0	1
10	1	0	0	0

$$\overline{\overline{f}}_{MKNO} = \overline{x_2x_3 + x_1x_2 + x_1\overline{x}_4}$$

$$f_{MKNO} = (\overline{x}_2+\overline{x}_3)\cdot(\overline{x}_1+\overline{x}_2)\cdot(\overline{x}_1+x_4)$$

$$f_{MDNO} = \overline{x}_1\overline{x}_2 + \overline{x}_1\overline{x}_3 + \overline{x}_2x_4$$

Vezje – pri katerem bo na izhodu 1, če sta 2 dvobitni števili večji od 3

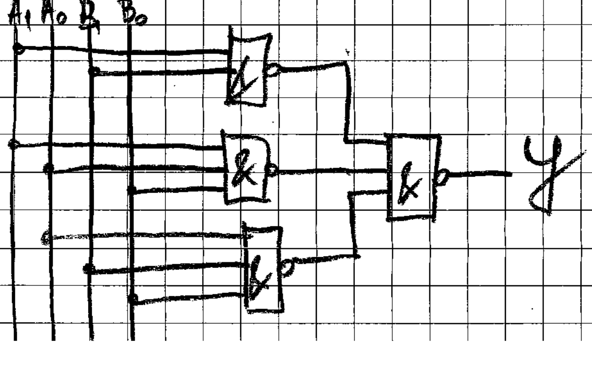
A_1 (8)	A_0 (4)	B_1 (2)	B_0 (1)	
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

NAND

B_1B_0 \ A_1A_0	00	01	11	10
00				
01			1	
11		1	1	1
10			1	1

$$f_{MDNO} = \overline{\overline{A_1B_1 + A_1A_0B_0 + A_0B_1B_0}}$$

$$f = \overline{\overline{A_1B_1}\cdot\overline{A_1A_0B_0}\cdot\overline{A_0B_1B_0}}$$



Zapodite vezje s pretvorbo BCD kode v IN3 (ex. EXCESS 3)

BCD – binarno kodirano desetiško število (0-9)

	A (8)	B (4)	C (2)	D (1)	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	1	0	0	1	1	1	0	0
10	1	0	1	0				
11	1	0	1	1				
12	1	1	0	0				
13	1	1	0	1				
14	1	1	1	0				
15	1	1	1	1				

(W X Y Z = IN+3)

Začnemo s 3.

W:

CD \ AB	00	01	11	10
00			X	1
01		1	X	1
11		1	X	X
10		1	X	X

$W = A + BD + BC$

X:

CD \ AB	00	01	11	10
00		1	X	
01	1		X	1
11	1		X	X
10	1		X	X

$X = B\overline{C}\,\overline{D} + \overline{B}D + \overline{B}C$

Y:

CD \ AB	00	01	11	10
00	1	1	X	1
01			X	
11	1	1	X	X
10			X	X

$Y = \overline{C}\,\overline{D} + CD$

Z:

CD \ AB	00	01	11	10
00	1	1	X	1
01			X	
11			X	X
10	1	1	X	X

$Z = \overline{D}$

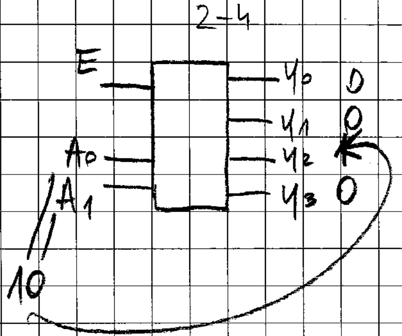
f:

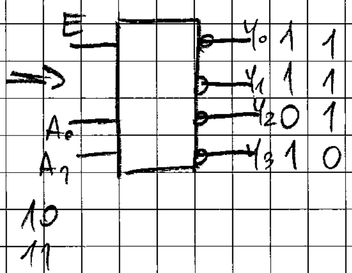
X_3X_4 \ X_1X_2	00	01	11	10
00	1			1
01		1	1	
11		1	1	
10	1			1

$f: X_2X_4 + \overline{X_2}\,\overline{X_4}$

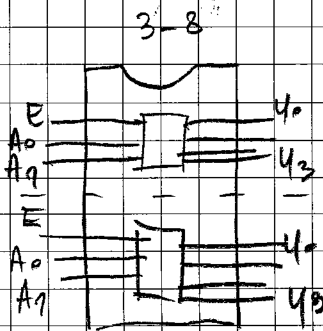
PRIPRAVA NA LAB. VAJO

b) DEKODIRNIK

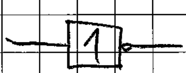




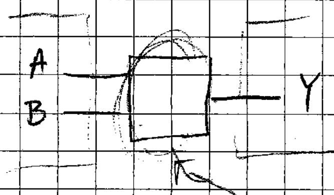
c)



$A_2A_1A_0$ — $Y_0 \cdots Y_7$



1.12.2011

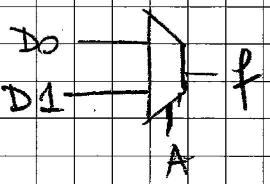


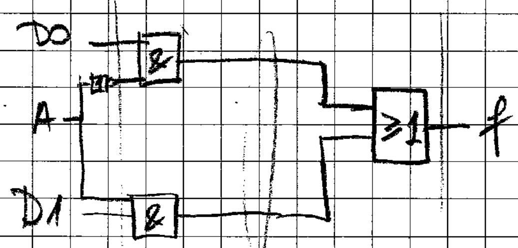
entity / vmesnik (a,b,f)
architecture / zgradba

```
Library IEEE;
use .
```
} vključimo knjižnice

```
entity vrata_and is
  Port (a, b: in STD_LOGIC;
        f: out STD_LOGIC);
end vrata_and;
architecture P1 of vrata_and is
begin
f <= a and b;
end;
```
← ime vezja

z log. vrati





2 notranje signala

z when ... else

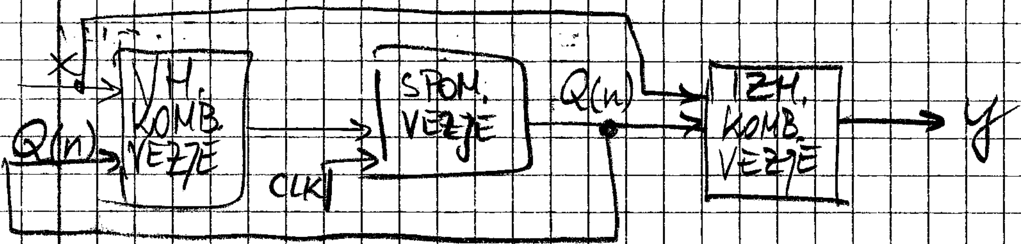
<= → priredimo
= → primerjamo

8.12.2011

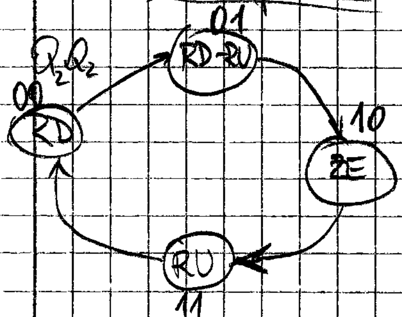
SINHRONSKA SEKVENČNA VEZJA

- komb. vezje: $y = f(x)$
- sinhr... : $y(n) = f(x(n), Q(n))$; $Q(n+1) = f(x(n), Q(n))$

izhod vhod stanje



primer: semafor



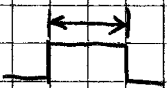
1 pomnilna celica < 0, 1

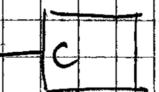
št. stanj $= 2^n$; $n \to$ št. pomnilnih celic

1 celica = 2 stanji
2 celici = 4 stanja

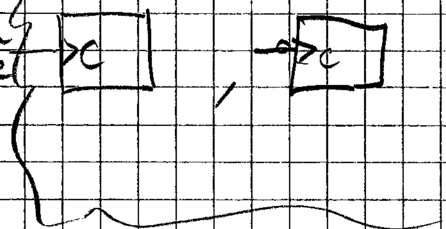
spominske celice: zapah (latch), preklopna vezja (flip-flop)

CLK
C - control
E - enable





zapomne si vrednost pri prehodu $0 \to 1$, $1 \to 0$



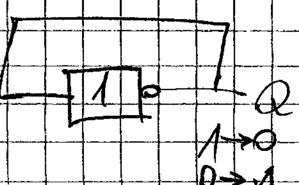
data (zapomne si kakšen je vhod in ga prenese na izhod)

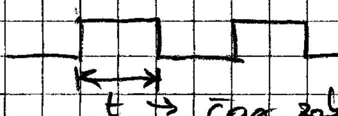
set, reset, toggle

	S-R,	T,	D,	JK
Latch	✓	X	✓	X
F-F	X	✓	✓	✓

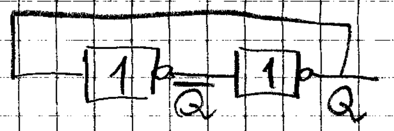
JK → set, reset

$Y(n+1) = f(x(n), y(n))$

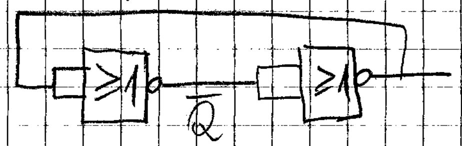




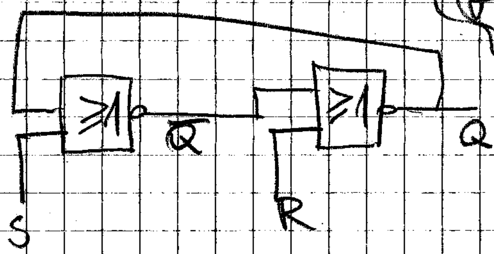
$t \to$ čas zakasnitve vrat



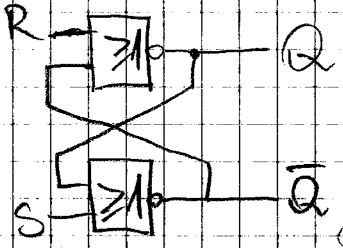
negator spremenimo v NOR



R-S flip-flop



S = 1, R = 0	S = 0, R = 1	S = 0, R = 0
↓	↓	↓
Q = 1	Q = 0	Q = Q

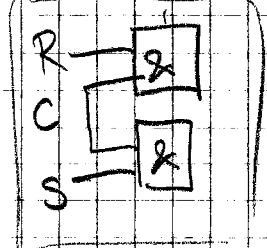


S	R	Q	$\overline{Q}$
0	0	Q	$\overline{Q}$
0	1	0	1
1	0	1	0
1	1	0	0

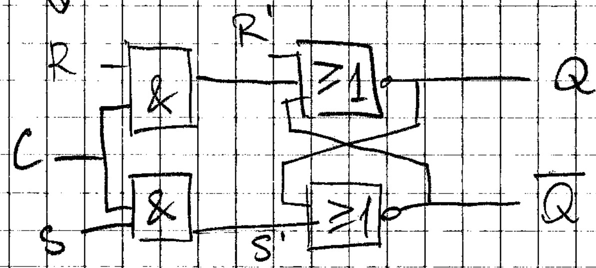
NOR

x_1	x_2	x
0	0	1
0	1	0
1	0	0
1	1	0

prepovedano stanje



dodamo, da dobimo sinhronska vrata

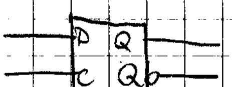


RS LATCH

$C = 0 \Rightarrow R', S' = 0 \quad Q = Q$

$C = 1 \Rightarrow R' = R,\ S' = S$

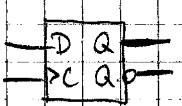
D - LATCH



C	D	Q	$\overline{Q}$
0	X	Q	$\overline{Q}$
1	0	0	1
1	1	1	0

X = 1 ali 0

D - FF



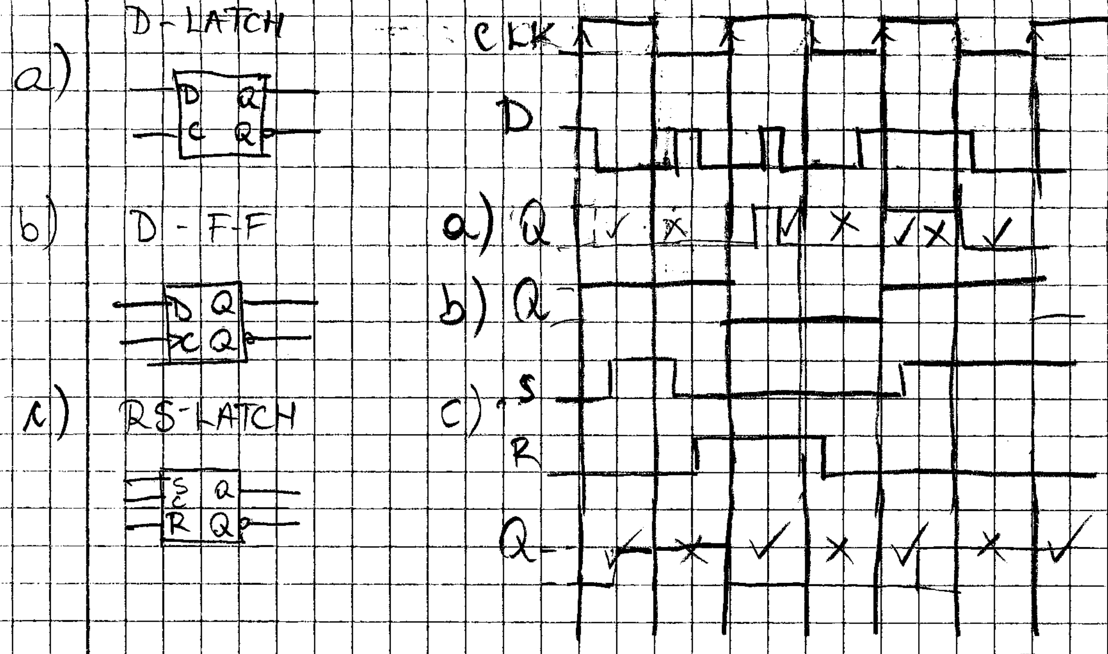
poz. fronta

C	D	Q	$\overline{Q}$
X	X	Q	$\overline{Q}$
↑	0	0	1
↑	1	1	0

X = 1 ali 0 ali ↓

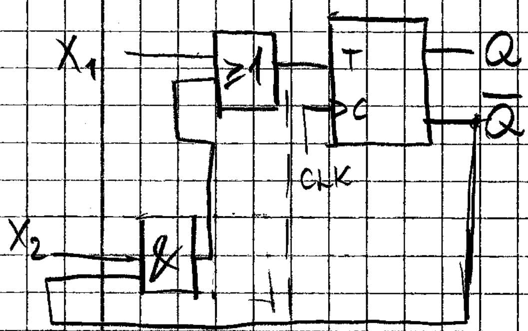
neg. fronta

NALOGA 4.1 – zbirka rešenih nalog



15.12.2011

1.) Analizirajte podano sekv. vezje in narišite diagram stanj.



Vh. komb. vezje   spom. vezje

S	Q
S_0	0
S_1	1

$$T = X_1 + X_2\overline{Q}$$

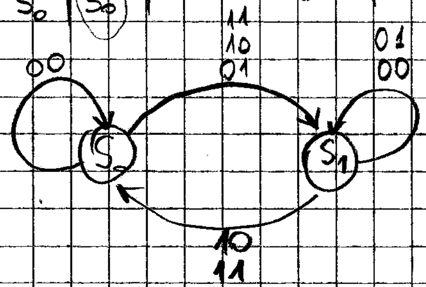
X_1	X_2	$Q_{(n)}$	$Q_{(n+1)}$	$T_{(n)}$
0	0	0 = S_0	0	0
		1 = S_1	1	0
	1	0	1	1
		1	1	0
1	0	0	1	1
		1	0	1
	1	0	1	1
		1	0	1

Ko je T=1, se $Q_{(n+1)}$ spremeni.

Tabela prehodnih stanj:

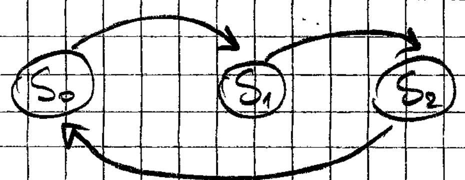
$Q_{(n)}$ \ x=	00	01	10	11
S_0	S_0	S_1	S_1	S_1
S_1	S_1	S_1	S_0	S_0

primerjamo spremembe



2.) Zgradite sinhronski števec, ki šteje navzgor po modulu 3. Uporabi D-flip-flop

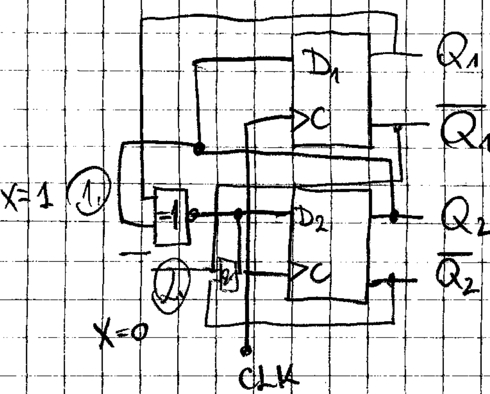
MODUL 3 → 3 stanja, šteje → 0, 1, 2, 0, 1, 2, 0, ...



3 stanja ⇒ 2 spom. celici

št. stanj $= 2^n$ → št. števil. celic

S	Q_1	Q_2
S_0	0	0
S_1	0	1
S_2	1	0
S_3	1	1



VZBUJALNA TABELA

Q_1	Q_2	$Q_1(n+1)$	$Q_2(n+1)$	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

$D_1 = Q_2$

$D_2 = \overline{Q_1}\,\overline{Q_2} + Q_1 Q_2 =$

X=1 ⇒ NXOR vrata =

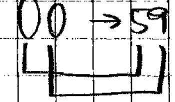
⇒ $Q_1 = Q_2$

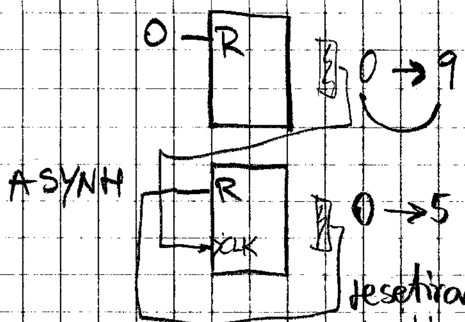
X=0 : $D_2 = \overline{Q_1} \cdot \overline{Q_2}$

6. LAB. VAJA c)

74LS390 → čip

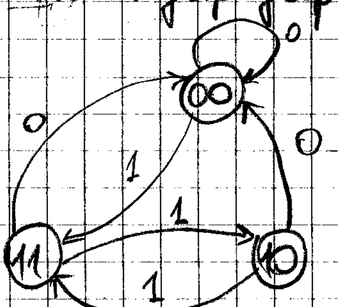
2x DEKADNI ŠTEVEC ⇒ 0 → 9





resetiramo, ko pride na 60 potem se takoj resetira.

3.) Iz podanega diagrama stanj zgradite sinhronsko sekvenčno vezje. Uporabite T-flip-flop

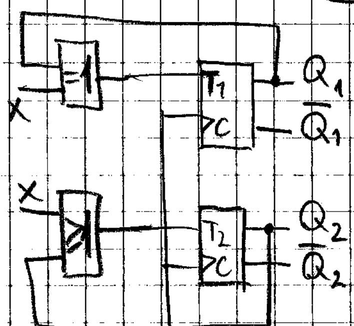


$Q(n)$	X=0	X=1
0 0	0 0	1 1
1 0	0 0	1 1
1 1	0 0	1 0
? 0 1	x x	x x

T zamenja stanje, če je 1, ohrani če je 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:

	00	01	11	10
Q_2 0	0	1	0	1
1	X	X	0	X

$T_1: \bar{x}Q_1 + x\bar{Q}_1 = x \oplus Q_1$ ← XOR

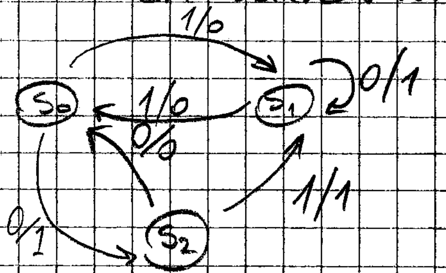
T_2:

	00	01	11	10
Q_2 0	0	0	1	1
1	X	1	1	X

$T_2: x + Q_2$

22.12.2011

SINTEZA SEKVENČNIH VEZIJ



Iz podanega diagrama zgradite sekvenčno vezje, J-K ff, ugotovi za katero vezje gre

1.) kodirna tabela:

	Q_1	Q_2
S_0	0	0
S_1	0	1
S_2	1	0

2.) Tabela stanj:

0/1: x vhod, y izhod

Q(n)	Q(n+1) x = 0	x = 1
S_0	$S_2/1$	$S_1/0$
S_1	$S_1/1$	$S_0/0$
S_2	$S_0/0$	$S_1/1$

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

Q(n)	Q(n+1)	J	K
0	0	0	0/1
0	1	1	0/1
1	0	0/1	1
1	1	0/1	0

J_1:

	00	01	11	10
Q_2 0	1	X	X	
1		X	X	

$J_1: \bar{x}\bar{Q}_2$

K_1:

	00	01	11	10
Q_2 0	X	1	1	X
1	X	X	X	X

$K_1 = 1$

J_2:

	00	01	11	10
0			1	1
1	X	X	X	X

$J_2: Q_1$

K_2:

	00	01	11	10
0	X	X	X	X
1		X	X	1

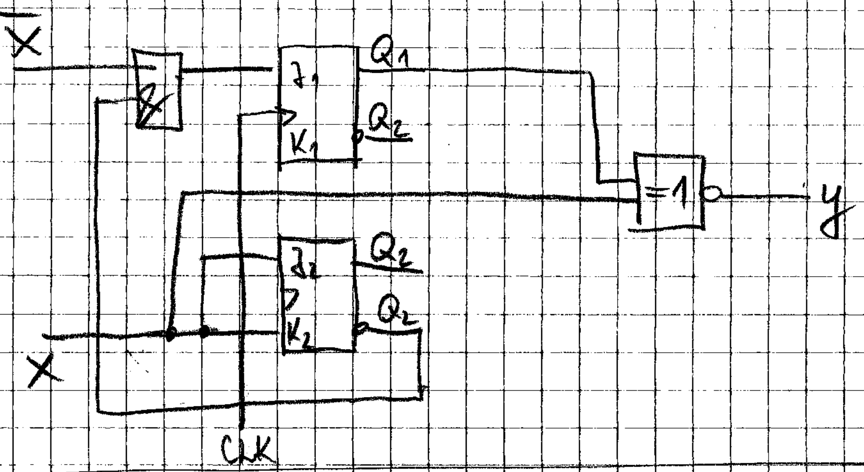
$K_2: x$

y:

	00	01	11	10
0	1	0	1	0
1	1	X	X	0

$y: \bar{x}\bar{Q}_1 + xQ_1 =$

$= x \equiv Q_1$



Prejšnje vezje spremenite v Moore-ovo

S_0 $y=0$
S_1 $y=0,1$ ← S_1 razbijemo na dve stanji
S_2 $y=1$

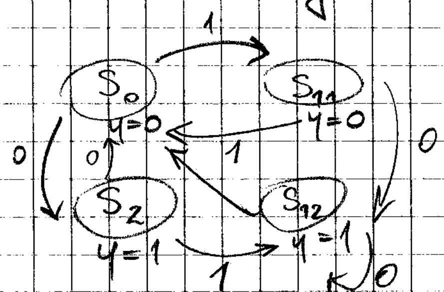
→ S_{11} , $y=0$
S_{12} , $y=1$

1.) kodirna tabela

	Q_1	Q_2
S_0	0	0
S_{11}	0	1
S_{12}	1	0
S_2	1	1

2.) tabela stanj

$Q(n)$	$Q(n+1)$: $x=0$	$Q(n+1)$: $x=1$	y
S_0	S_2	S_{11}	0
S_{11}	S_{12}	S_0	0
S_{12}	S_{12}	S_0	1
S_2	S_0	S_{12}	1

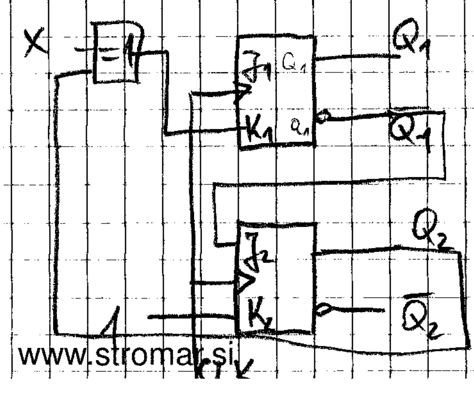


J_1: $\overline{X}$
K_1: $\overline{X}Q_2 + X\overline{Q_2} = X \oplus Q_2$

J_2: $\overline{Q_1}$
K_2: 1

y: Q_1 → Moore-ov "avtomat", ker izhod ni odvisen od vhoda

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



5. 1. 2012

1.) Minimizirajte tabelo stanj:

sed. st.	x=0	x=1	y
S_1	S_3	S_2	1
S_2	S_4	S_3	1
S_3	S_3	S_1	0
S_4	S_2	S_5	1
S_5	S_3	S_1	0

združujemo lahko le tista stanja, ki imajo enake izhode

	s.s.	x=0	x=1		← naslednje stanje
y=1	S_1,S_2	S_3,S_4	S_2,S_3	//	
	S_1,S_4	S_3,S_2	S_2,S_5	//	
	S_2,S_4	S_4,S_2	S_3,S_5	✓	
y=0	S_3,S_5	S_3,S_3	S_1,S_1	✓	

$S_3 = 0$, $S_4 = 1$ } nista združljiva ⇒ tudi S_1, S_2 nista združljiva

$S_1 = S_A$ → $S_2 \equiv S_4$

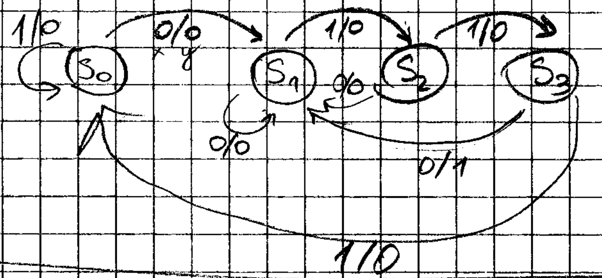
$S_2 = S_B$

$S_3 = S_C$ → $S_3 \equiv S_5$

s.s.	n.s. 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

2.) Narišite diagram prehajanja stanj za sek. vezje v Mealyjevi obliki, ki da na izhod 1, vsakič ko se na izhodu pojavi sekvenca 0110

y : 1
x : 0110

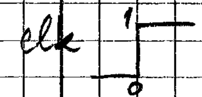


0110 0110

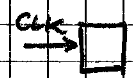
0110 110

---

7. LAB. VAJA




```
Oznaka : PROCESS (CLK)
IF (CLK'EVENT AND CLK = '1') THEN
  STAVKI;
END IF;
END PROCESS
```



3.) Minimizacija

s.s.	x=0	x=1	y
S_1	S_2	S_3	1
S_2	S_4	S_6	1
S_3	S_6	S_5	0
S_4	S_2	S_7	1
S_5	S_6	S_3	0
S_6	S_5	S_4	0
S_7	S_6	S_7	0

	S.S	x=0	x=1		
y=1	S_1,S_2	S_2,S_4	S_3,S_6	✓	//
	S_1,S_4	S_2,S_2	S_3,S_7	✓	✓
	S_2,S_4	S_4,S_2	S_6,S_7	✓	//
y=0	S_3,S_5	S_6,S_6	S_5,S_3	✓	✓
	S_3,S_6	S_6,S_5	S_5,S_4	//	//
	S_3,S_7	S_6,S_6	S_5,S_7	✓	✓
	S_5,S_6	S_6,S_5	S_3,S_4	//	//
	S_5,S_7	S_6,S_6	S_3,S_7	✓	✓
	S_6,S_7	S_5,S_6	S_4,S_7	//	//

$S_1 S_4 \equiv S_A$ $S_2 \equiv S_B$

$S_3 S_5 \equiv S_C$ $S_6 = S_D$

$S_5 S_7 \equiv$, $S_3 S_7 \equiv$ } S_C

$S_3 = S_7 = S_5 = S_C$

	$X=0$	$X=1$	Y
S_A	S_B	S_C	1
S_B	S_A	S_D	1
S_C	S_D	S_C	0
S_D	S_C	S_A	0