AI | Angewandte Informatik

Hochschule Fulda
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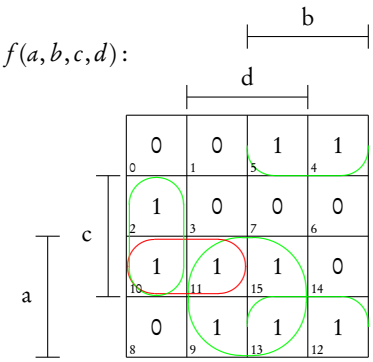
Musterlösung Prüfungsklausur Digitaltechnik und Rechnersysteme

für die Bachelor-Prüfung im Wintersemester 2024/2025

Aufgabe 1: Verständnisfragen

1.1 $101,101_2 = 5,625$

1.2



KIPs REPIs REPIs

Indizes Primimplikant	KPI	API	REPI
2,10	☒	☐	☐
10,11	☐	☒	☐
11,15,9,13	☒	☐	☐
12,13	☐	☐	☒
4,12	☐	☐	☒
4,5	☒	☐	☐

1.3 `EBBCAD`=111 01 01 10 00 110

1.4

$-69_{10} = \overline{01000101}_2 + 1 = 10111010_2 + 1 = 10111011_2$

98_{10}	01100010_{2K}
$+(-69_{10})$	$+10111011_{2K}$
20_{10}	00011101_{2K}

Aufgabe 2: Boolesche Algebra

2.1 – 2.10

☐	$\overline{ab+\overline{c}\,\overline{d}} = \overline{a\,\overline{b}} \cdot cd$
☒	$\overline{ab+\overline{c}\,\overline{d}} = \overline{a\,\overline{b}}(c+d)$
☐	$\overline{ab+\overline{c}\,\overline{d}} = \overline{a\,\overline{b}}\,c+d$
☐	$\overline{ab+\overline{c}\,\overline{d}} = (a+b)(c+d)$
☒	$\overline{ab+\overline{c}\,\overline{d}} = (\overline{a}+\overline{b})(c+d)$

☐	$\overline{a}\,bc+cd+\overline{a}\,b+\overline{c}\,\overline{d} = \overline{a}\,bc+\overline{a}\,b$
☒	$\overline{a}\,bc+cd+\overline{a}\,b+\overline{c}\,\overline{d} = cd+\overline{a}\,b+\overline{c}\,\overline{d}$
☐	$\overline{a}\,bc+cd+\overline{a}\,b+\overline{c}\,\overline{d} = \overline{a}\,bc+\overline{a}\,b+\overline{c}\,\overline{d}$
☒	$\overline{a}\,bc+cd+\overline{a}\,b+\overline{c}\,\overline{d} = c(\overline{a}\,b+d)+\overline{a}\,b+\overline{c}\,\overline{d}$
☐	$\overline{a}\,bc+cd+\overline{a}\,b+\overline{c}\,\overline{d} = \overline{a}\,bc+cd+\overline{a}\,b$

2.11

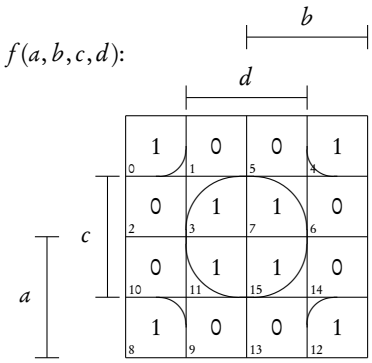
$$
\begin{aligned}
& BA(CD+\overline{C}\,A\overline{B}+CABD)(\overline{A}+\overline{B}) \\
=&(CD+\overline{C}\,A\overline{B}+CABD)(BA\overline{A}+BA\overline{B}) \\
=&(CD+\overline{C}\,A\overline{B}+CABD)0 \\
=&0
\end{aligned}
$$

Aufgabe 3: KV-Minimierung

3.1

a	b	c	d	f
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

$f(a,b,c,d)$:



DNF: $f(a,b,c,d) = cd + \overline{c}\,\overline{d}$

KNF: $f(a,b,c,d) = (\overline{c} + d)(c + \overline{d})$

3.2 Äquivalenz oder XNOR

Aufgabe 4: Automaten-Analyse synchroner Automat

4.1

$q_0^{n+1} = Aq_1^n$

$q_1^{n+1} = \overline{q_1^n(B + q_0^n)} = \overline{q_1^n} + \overline{B}\,\overline{q_0^n}$

$z = q_1^n(B + q_0^n + \overline{A}) = Bq_1^n + q_0^n q_1^n + \overline{A}q_1^n$

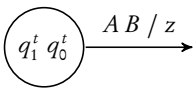
4.2

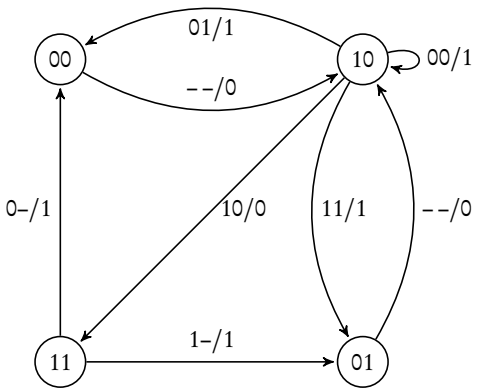
q_1^n	q_0^n	A	B	q_1^{n+1}	q_0^{n+1}	z
0	0	0	0	1	0	0
0	0	0	1	1	0	0
0	0	1	0	1	0	0
0	0	1	1	1	0	0
0	1	0	0	1	0	0
0	1	0	1	1	0	0
0	1	1	0	1	0	0
0	1	1	1	1	0	0
1	0	0	0	1	0	1
1	0	0	1	0	0	1
1	0	1	0	1	1	0
1	0	1	1	0	1	1
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	1	1
1	1	1	1	0	1	1

4.3

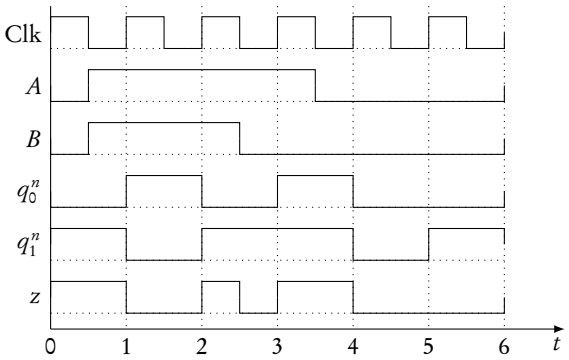
- ☐ Es handelt sich um einen Moore-Automat, da der Zustand von der Eingabe abhängt.
- ☐ Es handelt sich um einen Moore-Automat, da die Ausgabe von der Eingabe abhängt.
- ☐ Es handelt sich um einen Mealy-Automat, da der Zustand von der Eingabe abhängt.
- ☒ Es handelt sich um einen Mealy-Automat, da die Ausgabe von der Eingabe abhängt.

Notation:

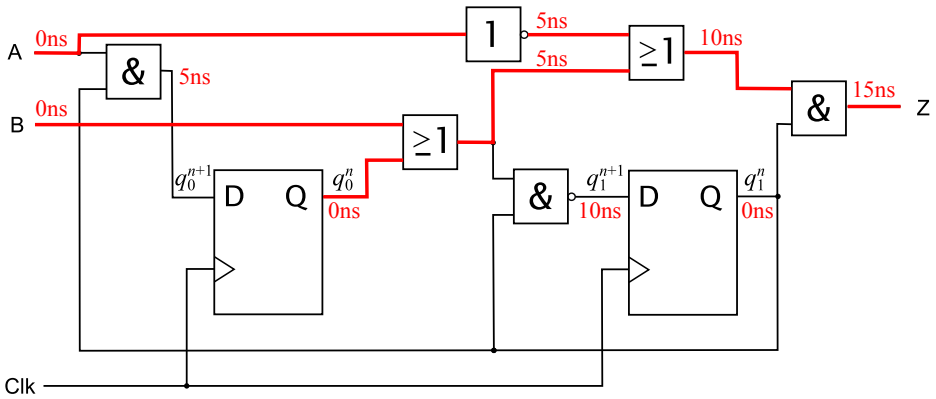




4.4



4.5



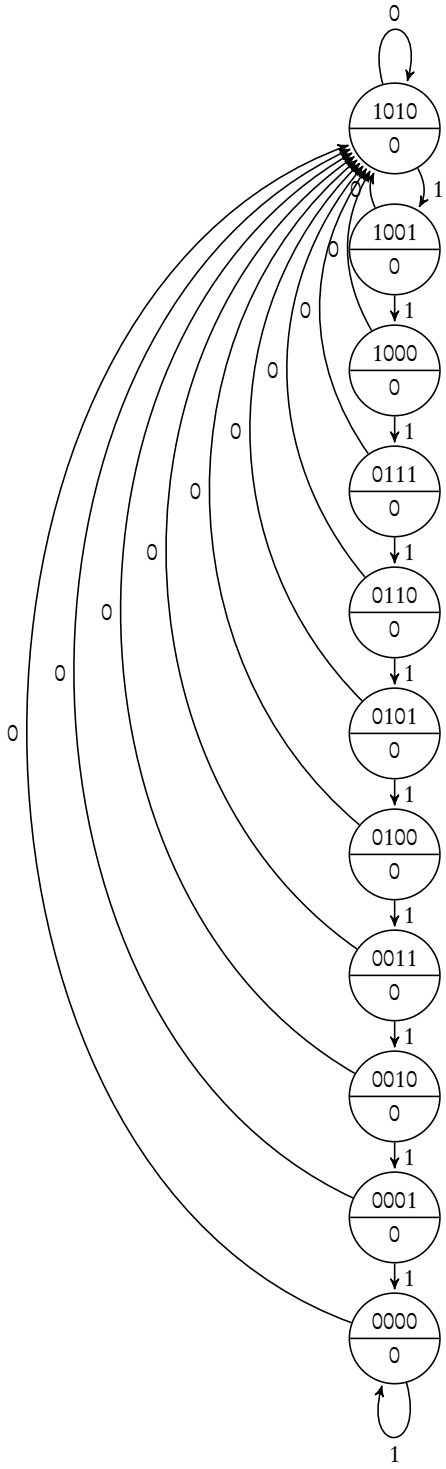
$t_{\mathrm{PD,max}} = 15\ \mathrm{ns}$

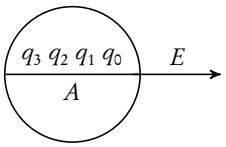
4.6

$T_{\mathrm{clk}} = (15+7+3)\,\mathrm{ns} = 25\,\mathrm{ns}$

$f_{\mathrm{clk}} = \frac{1}{T_{\mathrm{clk}}} = 40\,\mathrm{MHz}$

Aufgabe 5: Automatenentwurf





Aufgabe 6: Minimal-Computer

PC	r0	r1	r2	r3
0	0	0	0	0
1	1	0	0	0
2	1	1	0	0
3	1	1	1	0
4	1	1	1	0
5	1	2	1	0
3	1	2	1	0
4	2	2	1	0
5	2	3	1	0
3	6	3	1	0

Aufgabe 7: MIPS

7.1

`sub $3, $1, $2`

Alternativ: `sub $v1 $at $v0`

7.2

```
addi $2,$1,1  # y <- x + 1
addi $3,$1,2  # t <- x + 2
mul  $2,$2,$3 # y <- y * t = (x + 1)(x + 2)
addi $3,$1,-1 # t <- x - 1
mul  $2,$2,$3 # y <- y * t = (x + 1)(x + 2)(x - 1)
```

Alternativ (etwas aufwändiger aber genauso korrekt):

```
addi $2,$1,1  # y <- x + 1
addi $3,$1,2  # t <- x + 2
mul  $2,$2,$3 # y <- y * t = (x + 1)(x + 2)
addi $3,$0,1  # t <- 1
sub  $3,$1,1  # t <- x - t = x - 1
mul  $2,$2,$3 # y <- y * t = (x + 1)(x + 2)(x - 1)
```