Hochschule Bremerhaven

INSTITUTE FOR AUTOMATION- AND ELEKTRICAL ENG.

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Sample Test PS-DIGS W14/15

Time 90 Minutes
– Use of class documents allowed –

Solutions

(1) Conversion of Number Systems and Dual Number Computation

(1.1) Maximum positive number $i_{max} = 2^{16}-1 = 32767$, minimum (negative) number is $i_{min} = -2^{16} = -32768$ (16 bits = 15 bits for representing magnitude, 1 sign bit).

(1.2)

```
348 : 2 = 174,    rem = 0
174 : 2 = 87,     rem = 0
87 : 2 = 43,      rem = 1
43 : 2 = 21,      rem = 1
21 : 2 = 10,      rem = 1
10 : 2 = 5,       rem = 0
5 : 2 = 2,        rem = 1
2 : 2 = 1,        rem = 0
1 : 2 = 0,        rem = 1     (end of algorithm)
```

$\Rightarrow \quad x = 101011100_2$ (from remainders)

(1.3) Representation of $-x$

```
  0000 0001 0101 1100
  1111 1110 1010 0011   (inversion)
+                  1   (add of 1)
--------------------------
  1111 1110 1010 0100   (2's complement of x)
```

(1.4) Grouping four binary digits give one hex digit:

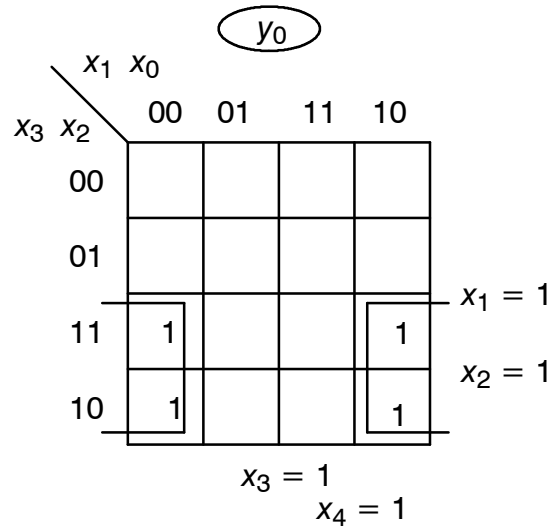
$x = 015C_{16}$

$-x = FEA4_{16}$

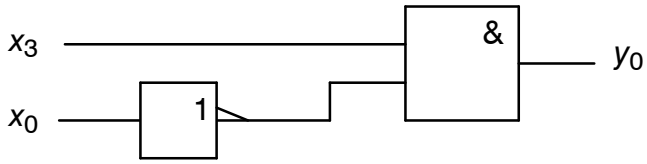
(1) = 8	(2) = 8	(3) = 8	(4) = 8						Σ = 32
1.0 ≥ 27	1.3 ≥ 25	1.7 ≥ 23	2.0 ≥ 21	2.3 ≥ 19	2.7 ≥ 18	3.0 ≥ 17	3.3 ≥ 15	3.7 ≥ 13	4.0 ≥ 12

(2) Combinational Logic (Minimization)

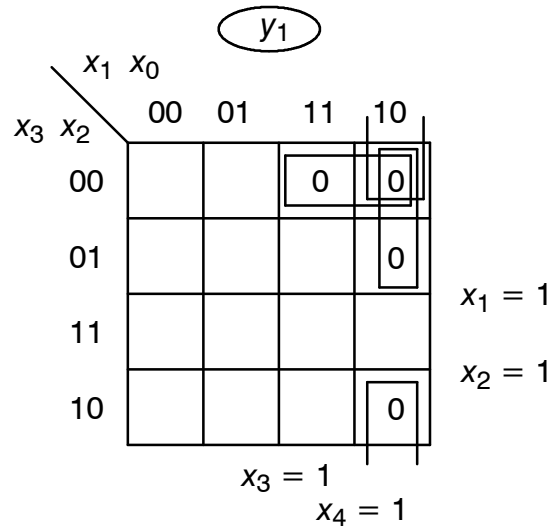
(2.1) Function $y_0 = F_0(x_0, x_1, x_2, x_3)$



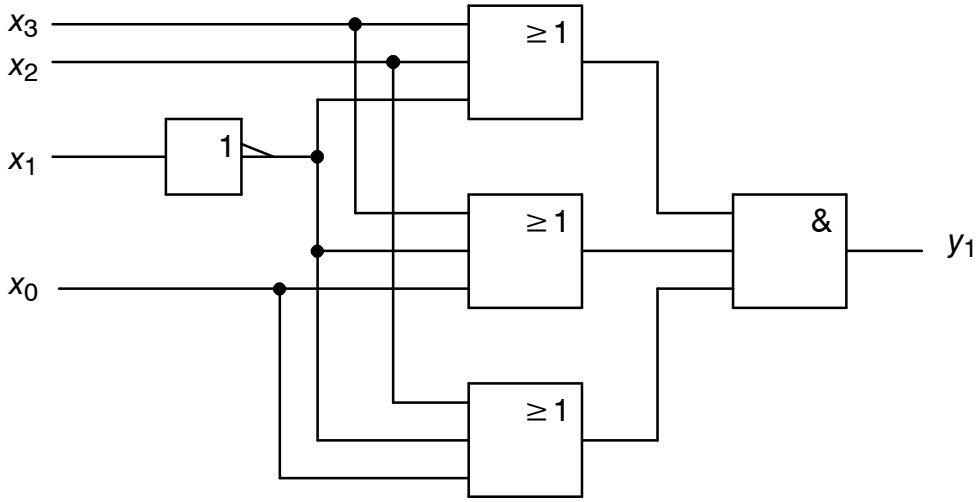
$$y_0 = x_3 \cdot x_0'$$



(2.2) Function $y_1 = F_1(x_0, x_1, x_2, x_3)$

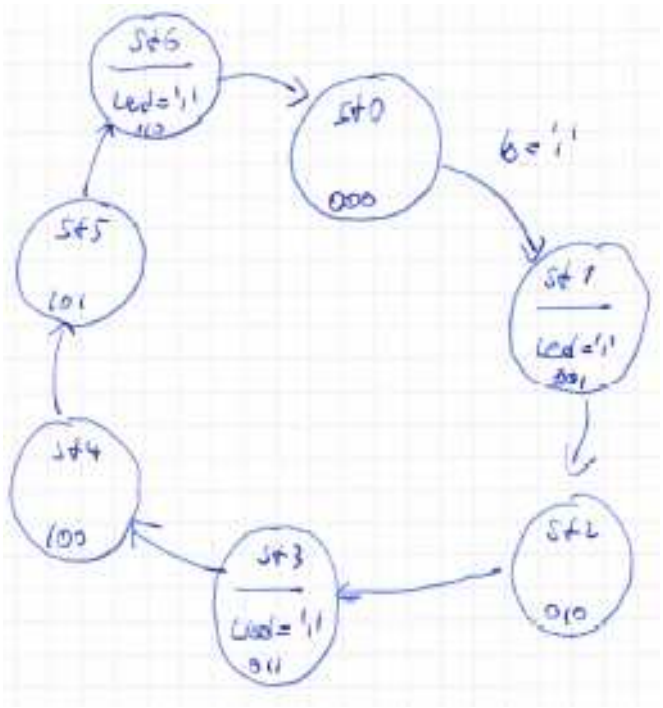


$$y_1 = (x_3 + x_2 + x_1') \cdot (x_3 + x_1' + x_0) \cdot (x_2 + x_1' + x_0)$$



(3) Hardware State Machine (Moore Machine)

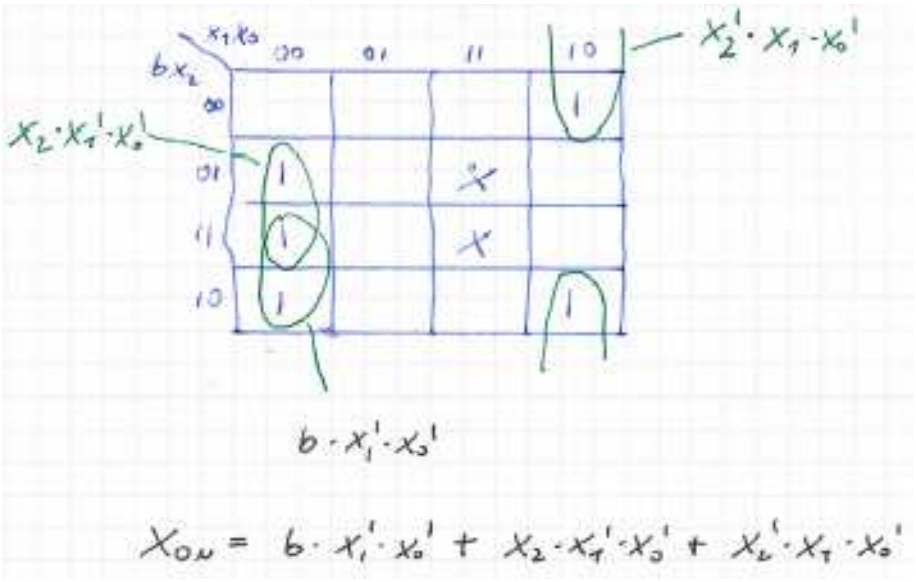
(3.1) State diagram



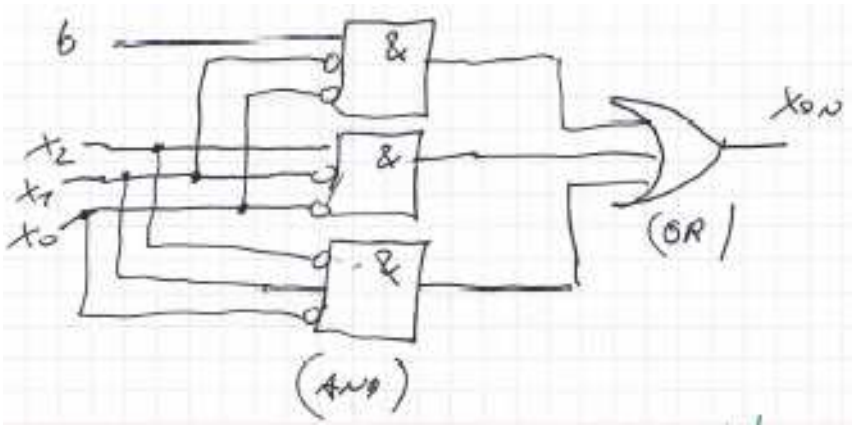
(3.2) 6 states <=> 3 FFs. However, if your state diagram is different other number of states are possible.

(3.3) Input logic, truth table

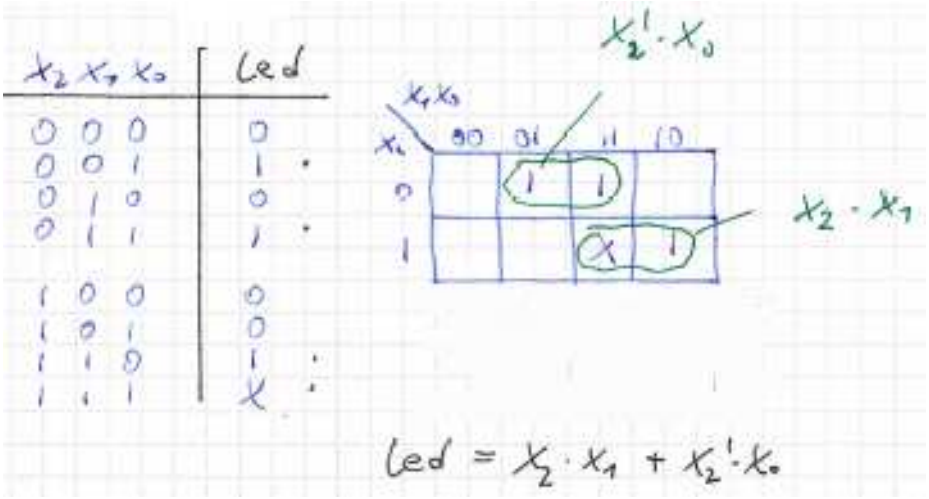
The truth table for the next state x_{0n} corresponds to the Karnaugh map:



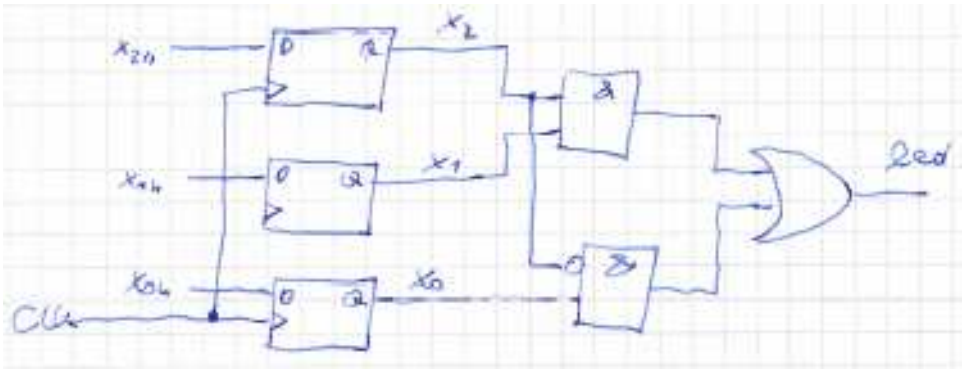
The cirucuit for x_{0n} is as follows:



(3.4) Output logic, truth table:



matching the circuit schematics (only FFs and output logic):



(4) PicoBlaze Program “Moving Lights”

Attach program listing (with comments!) to your written exam.