OULUN YLIOPISTO

Exam: 15.05.2009

Name:_____

Student card number: _____

Assignment 1

The following picture presents the symbols shown with an electronic dice depending on the combination (0...7) of the input signals (A,B,C). Let's assume that the filled circle represents a lamp with a light on, in which case the corresponding control signal is a logic one. The input signals are A (MSB), B and C (LSB). With the combinations ABC = 000 (0) and ABC = 111 (7) the lamps are off. Design a combinational logic that controls the lamps of the dice according to the following picture. A single control (output) signal can control several lamps at the same time! Try to optimise the number of outputs. Name the outputs with letters h, i, j, k, l, m, n, o, ...
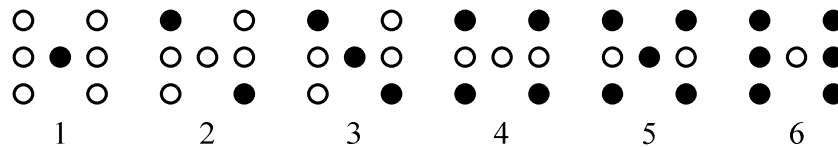

Present:
a) the truth table of the logic
b) the Karnaugh maps of the output signals
c) the logic functions of the outputs as minimised sums of products
d) the logic functions of the outputs as minimised products of sums
e) the logic diagram using a minimum number of 2- and 3-input AND- and OR-gates. Also the complements $\overline{A}, \overline{B}, \overline{C}$ of the A, B and C are available, so you don't need NOT-gates for them. (Can you use terms that are common to several outputs? A maximum of eight logic gates should be sufficient:)

Assignment 2

Design a synchronous state machine the output signal of which (ainakin_kolme) is a logic one if the synchronous input signal X has been logic one for at least three consecutive clock cycles according to the following timing diagram. Present:
a) the state diagram
b) the state transfer table
c) the minimised logic functions of the next state coding in the inputs of the D-flip-flop as minimised sums of products
d) the logic diagram using D-flip-flops and AND-, OR- and NOT-gates
e) what is the clock frequency of the state machine used in the simulation?

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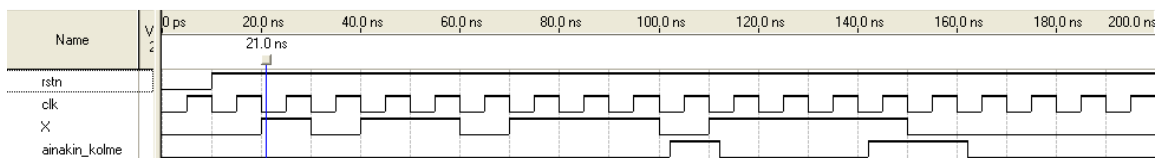
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Assignment 3

a) Convert a binary number 110010110 to a decimal system number.
b) Convert a decimal number 235 to a binary number.
c) The display of a measuring equipment is capable to show numbers in the range -1.999 … +1.999. How many bits are needed to represent them?
d) Explain what kind of digital component FPGA's Look-up-Table (LUT) is?
e) What is the arithmetic sum and product of binary numbers 100100 and 011101?

Assignment 4.

a) If a digital clock displays time 23:19:16, what is the content of binary vectors at points a, b, c, d, e, f, g, h, i, j, k, l, m, n and o in the RTL diagram below. Give the values of binary vectors in binary and also in hexadecimal form.
b) If the frequency f of the crystal oscillator is 500 kHz, what has to be the value of N of the frequency divider CTRDIVN?
c) How many D Flip-Flops is needed to implement a digital clock?