

Practice test for Pearl 000 of Computer Science (201700139)
7 September 2017

- You are allowed to use one A4-sized sheet of paper with your own notes at this exam, and a *simple* calculator.
- Scientific or graphical calculators, laptops, cell phones, books etc. are not allowed. **Put them in your bag right now!**
- The number of points per question is indicated in the margin.

1. Binary numbers

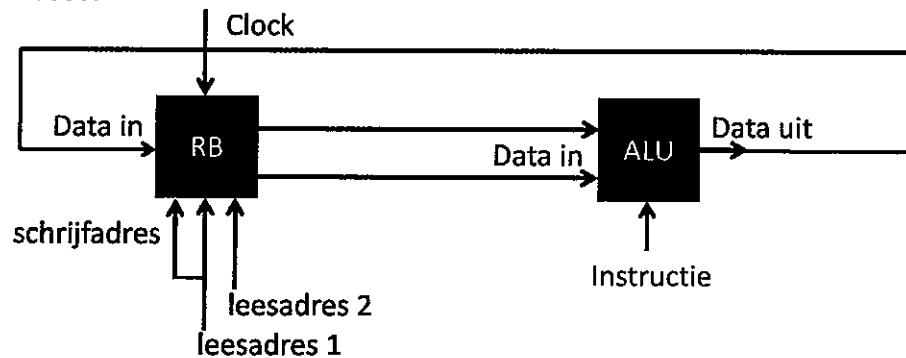
- (a) Convert hexadecimal ABC to binary. 8
- (b) Convert the 2-complement binary number 10101 to decimal. 8
- (c) Suppose you have an (unsigned) binary number and you move all bits 1 position to the left, and insert a 0 at the right-most position. What computation is this? Explain your answer. 9

2. Boolean logic

- (a) In the lecture on datapath and control we saw so-called switches (or selectors), which select one from several inputs and pass it to the output. Consider a switch, with 2 data inputs called A and B, each 1 bit wide, and a control input C that determines which of the inputs will be passed on to the output D: if C=0, A will be passed on to D, otherwise B. Give the truth table of such a switch. 9
- (b) Simplify the following Boolean formula such that no '+' sign remains: $\overline{C} \cdot A + C \cdot B$ 8
- (c) Realise the following formula with only NAND gates: $\overline{\overline{CA} \cdot \overline{CB}}$ 8

Continued on next page.

3. A processor



(translation: leesadres = read address; schrijfadres = write address; uit = out)

The above processor has 32 registers and instructions for 2 arithmetic operations.

- How many bits should an instruction at least have, to allow both kinds of operations on all registers? Explain.
- This processor only has arithmetic instructions. Mention another kind of instruction, and explain what such instructions do.

4. An AVR program

Given the following AVR program ("BRNE" means "BRanch if Not Equal", "MUL" means MULtiply, "INC" means "INCReament (increase by 1)" and "SUB" means "Subtract"):

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LDI    R16, $0
LDI    R17, $80
LDI    R18, $03
ADD    R17,R16
INC    R16
MOV    R19, R16
SUB    R19, R18
BRNE   -5

```

After this program has been executed, what are the contents (in decimal) of registers R16, R17, R18 and R19 ?

And how long will this program take? Each instruction takes 1 clock cycle, except BRNE. If the jump to a different address is indeed performed, BRNE takes 2 clock cycles; otherwise 1.