

Practice test for Pearl 000 of Computer Science (201300070)

8 september 2016

- 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: $\overline{\overline{CA} \cdot CB}$ 8

Continued on next page.

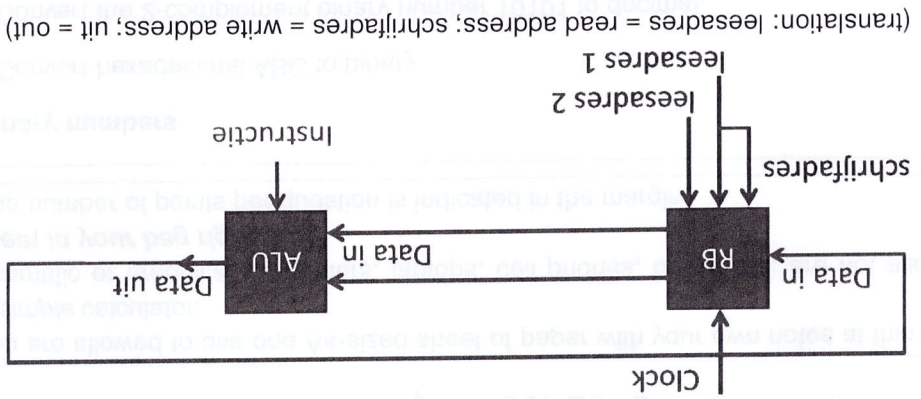
After this program has been executed, what are the contents (in decimal) of registers R16, R17, R18 and R19 ?
 And how long will this program take? Each instruction takes 1 clock cycle, except BRNE. If the jump to a different address is indeed performed, BRNE takes 2 clock cycles; otherwise 1.

0	LDI	R16, \$0	
1	LDI	R17, \$80	
2	LDI	R18, \$03	
3	ADD	R17, R16	
4	INC	R16	
5	MOV	R19, R16	
6	SUB	R19, R18	
7	BRNE	-5	12

12 = 0000
 22 = 0010
 17 = 0001
 16 = 0001
 15 = 0001
 14 = 0001
 13 = 0001
 12 = 0001

4. An AVR program
 Given the following AVR program ("BRNE" means "Branch if Not Equal", "MUL" means multiply, "INC" means "Increment (increase by 1)" and "SUB" means "Subtract"):

The above processor has 32 registers and instructions for 2 arithmetic operations.
 (a) How many bits should an instruction at least have, to allow both kinds of operations on all registers? Explain.
 (b) This processor only has arithmetic instructions. Mention another kind of instruction, and explain what such instructions do.



3. A processor