Exam - Computer Architecture Unit I [14/09/2023] (A)

Surname: _____ Name: _____

Student ID Number (Matricola): _____

DSA Students should solve only the first 4 exercises (grade will be scaled accordingly)

Exercise 1 (6 points)

An automata receives an input *x* and produces an output *z.* If the reminder of the division by 3 of the natural number represented by the last three received bits is 1, the automata outputs 1, otherwise it outputs 0.

Design the automata and the corresponding sequential circuit. **Overlaps are not allowed.**

Example: Input: 1010000011110
Output: 0000100000100

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Exercise 2 (5 points)

The function $f(a,b,c,d)$, outputs 0 if $a\bar{b}\bar{c}=1$ or $ab\bar{d}=1$. Otherwise, it outputs 1. The function $g(a,b,c,d)$ outputs 1 if $a+\bar{b}+\bar{c}=0$ or $cd=1$, while the output is not specified when $c+\bar{d}=0$.

Write down the truth table, express *f* and *g* in minimal SOP form and design the circuits that implement *f* using 2:1 multiplexers, and *g* using a 4:1 multiplexer.

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Exercise 3 (3 points)

Consider the expression $f = \bar{a} + bc + \bar{b}\bar{a} + (bc + a\bar{c})\bar{a}$. Derive the minimal POS form using boolean algebra theorems and axioms.

Then, derive the all-NAND and all-NOR forms.

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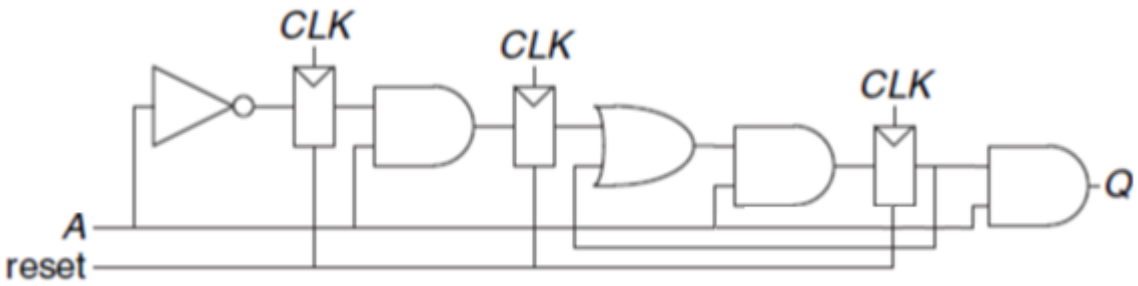
Exercise 4 (6 points)

Analyze the sequential circuit shown in the figure. Write down the next state table and the output table and draw the automata (the state transition diagram). Then, draw the corresponding Moore automata.



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Exercise 5 (4 points)

Consider the hexadecimal number X=D1BD.

- Subtract to it the hexadecimal number Y=A3D (using hexadecimal subtraction).
- Convert the result Z in a 16 bit binary sequency, and interpret it as a fractional number in IEEE 754 half-precision format.
- Take the 16 bit binary sequence W=0100'0110'0000'0000_2, interpret it as a fractional number in IEEE 754 half-precision format.
- Sum these two half-precision numbers and write the result in IEEE 754 half-precision format.

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Exercise 6 (6 points)

Consider the circuit in the following figure and write down the expression of the function *f*

- Derive its normal SOP form using Boolean theorems and axioms
- Write down *f* truth table
- Write down the minimal POS form of *f*