Exam of Computer Architectures – UNIT 1 - July 13th, 2021

Exercise 1 (5 points) Design a circuit that provides how many days there are in a month. The month is specified by a 4 bits input, $a_3a_2a_1a_0$. For example, with input 000 the month is January; if the input is 1100 the month is December. The circuit output Y_2 must be 1 only when the input month has 31 days; Y_1 is 1 when the month has 30 days; and Y_0 is 1 when the month has 28 days. Write the minimal SOP and POS formulae. Then, implement Y2 with a 4-to-1 multiplexer.

Exercise 2 (5 points): Design an interconnection of 4 registers R0, .., R3 such that:

- R0 receives the minimum value among the remeining three registers; this transfer is enabled only if R0 is positive;
- R0 is moved into R1 and R2, if R1 is even, in R3, otherwise.

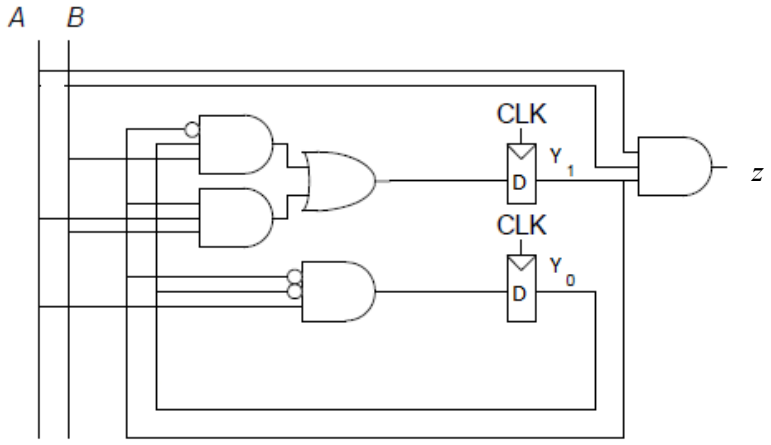
Exercise 3 (4 points)

a. Turn the decimal numbers X=111 and Y=78 in 2-complement with 8 bits and calculate Z=X-Y and W=X+Y. Then, turn the results in hesìxadecimal.
b. Sum $3EAB_{16}$ and $2E73_{16}$, turn the result in base 4 and subtract 31321_4.

Exercise 4 (5 points): Design an automaton that receives in input x and produces in output z. The output is 1 if and only if the natural number given by the last 3 bits received so far has reminder 1 when divided by 3. You can accept overlappings. Ignore the first two outputs (that can be any value).

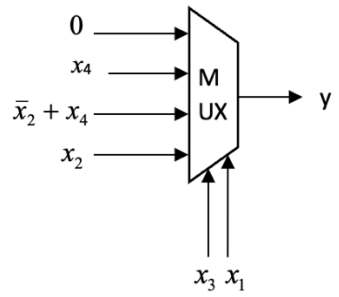
Example: INPUT: 1101100011110
OUTPUT: - - 00001010110

Exercise 5 (4 points): Analyze the following sequential circuit and give the associated automaton.



Exercise 6 (3 points) Given the expression $f = \left(\bar{a} + \overline{b(b + \overline{cde})}\right) \oplus (\bar{a} + cd)$, simplify it and write it in canonical SOP form. Then, realize f in ALL-NAND form.

Exercise 7 **(4 points)** Consider the following combinatorial circuit:



Write the boolean expression for Y and from it derive the minimal BE equivalent to it.