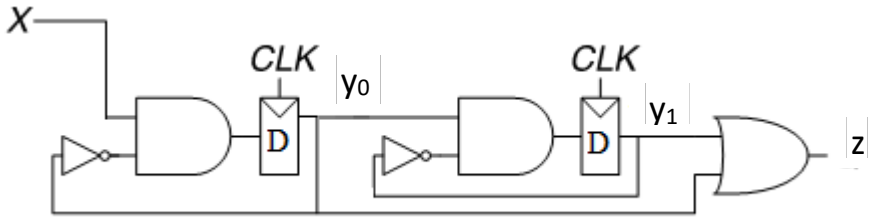
Exam Computer Architecture – Unit 1 --- June 15th, 2021

Exercise 1 (5 points): Analyze the following sequential net, up to the final automaton:



Exercise 2 (7+2 points): Design a sequential circuit with input x and two outputs z1 and z0: z1 is 1 if the last 3 bits in input represent a negative number in 2-complement; z0 is 1 if the last 3 bits contain at least two 0's. In designing the automaton, do NOT consider superpositions.

Example: x: 010111
z1: 000001
z0: 001000

Finally, draw the temporal diagram for the input 010111.

Exercise 3 (1+2+1 points): Represent X = - 42 and Y = 95 in 2-complement, each with the minimum number of bits. Then, calculate the minimum number needed for representing both the sum X+Y and the difference X-Y, turn X and Y to such length and perform the two operations in 2-complement. Finally, check the obtained results by turning them in base 10.

Exercise 4 (3 points): By using the axioms of Boolean algebra, prove the following equality:

$$\overline{(\bar{b}+c)(a+b\bar{c})}+(\bar{a}c+b)\overline{(a\oplus bc)}=b+\bar{a}$$

Exercise 5 (6 points): Design an interconnection net such that:

- R_4 receives: R_0, if R_4 and R_5 are both negative; R_1, if R_4 and R_5 are both non-negative; R_2, if R_4 is negative and R_5 is non-negative; R_3, if R_4 is non-negative and R_5 negative;
- R_4 is copied into R_6, if the content of R_4 is even, in R_7, otherwise;
- R_5 receives the maximum between R_6 and R_7.

All transfers are enabled if R_5 is not multiple of 4.

Exercise 6 (3 points): Given the hexadecimal numbers X=C9B0 and Y=4890, turn them in binary and then consider the sequences obtained as values in floating point, in the standard IEEE half-precision format. Sum the obtained floating point numbers; then, convert in base 10 both the operands and the result.