Computer Architecture Unit 1 – Sept. 6th, 2022

Exercise 1 (6 points) Design an automaton that takes in input binary sequences and gives in output 1 every time that the number of subsequences 01 received up to that moment equals the number of subsequence 10 received (also with overlapping), and gives 0 otherwise. Design the corresponding circuit by using FF of kind D and a ROM for the combinatorial part.
Example:
IN: 01011100010
OUT: 10100011101

Exercise 2 (6 points) A control circuit receives in input the boolean values a, b, c, d and gives in output z1 e z0 such that:

- z1=1 if $a \cdot b = 1$ or $\bar{b} + \bar{c} + d = 0$ or $b \oplus \bar{d} = 1$
- z0=1 if $\bar{b} \cdot d = 1$ or $a + \bar{c} + \bar{d} = 0$ or $a \oplus c = 0$

i. Give the truth table
ii. Realize z1 and z0 by using a PLA
iii. Implement z1 by a MUX 4-to-1, by using a and b as control variables.

Exercise 3 (3 points) Given values X = 3607 and Y = 6275 represented in base 10:
- turn them in base 16
- calculate Z=X+Y by working in base 16
- turn Z in base 10 and check its correctness
- turn Z in base 2

Exercise 4 (5 points) Design an interconnection between 3 source registers S1..S3 and 3 destination registers D1..D3 such that

1. D1 receives the content of S1, S2 or S3 according to whether, respectively, S1 is greater, smaller or equal to S2;
2. transfers S3 in D2, if the maximum between S2 and S3 is negative, in D3 otherwise.

All transfers are enabled if the content of D1 is multiple of 4.

Exercise 5 (4 points) Given A= -0.6875, represent it in floating point by using the IEEE half-precision standard. Calculate the sum between A and B, with B= < 1 ; 01111 ; 1100000000 >, and represent the result by using the same format. Finally, turn in hexadecimal the binary number obtained by the 16 bits of the IEEE half-precision representation of the result.

Exercise 6 (6 points) Consider the following Boolean expression:

$$\left(a\bar{c} \oplus \bar{b}\right)\left(\overline{b + c}\right) + \bar{d}(a + b)(a \oplus c) + \left(\overline{a + \bar{c}}\right)$$

1. Put it in SOP normal form
2. Provide its truth table
3. Give a minimal POS expression
4. Provide an ALL-NOR expression