Assignment 3

Exercise 1. Obtain the following functions in sum-of-minterms and product-of-maxterms form:

a) $f_1 + f_2$ b) $f_1 \cdot f_2$ c) $f_1 \oplus f_2$ d) $f_1 \odot f_2$

where f1 = $\prod(1, 2, 3, 5, 6 , 7, 13, 14, 15)$ and f2 = $\sum(0, 4, 8, 9, 10, 14, 15)$

Exercise 2. Using Karnaugh maps, obtain the minimum sum-of-products and product-of-sums expressions for the following functions:

a) f(a, b, c, d) = $\sum(0, 4, 6, 7, 10, 12, 13, 14)$
b) f(a, b, c, d) = $\prod(3, 5, 7, 11, 13, 15)$
c) f(a, b, c, d) = $\sum(1, 2, 5, 6, 9) + d(10, 11, 12, 13, 14, 15)$
d) $f(a,b,c,d)=(a\,\overline{b}+c)(\overline{cd})+\overline{(b+\overline{d})}$

Exercise 3. Draw an optimal two-level combinational circuit (plus inverters) corresponding to the functions in sections b and c of the previous exercise. "Optimal" means using the minimum number of gates.

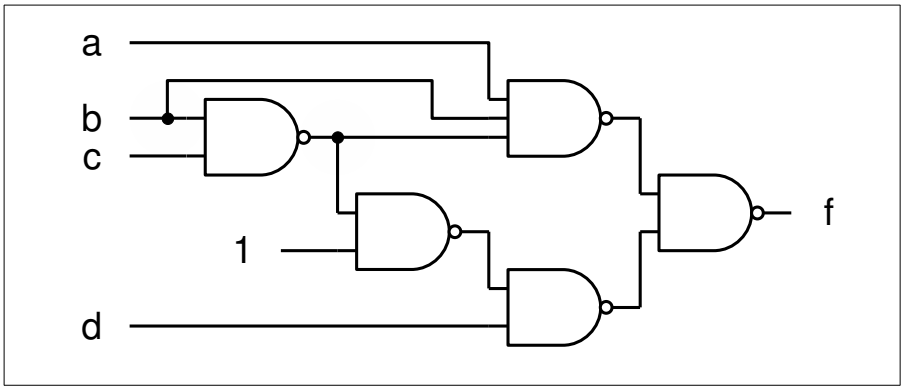
Exercise 4. We need to design a circuit that can compares two 2-bit numbers A (a1, a0) and B (b1, b0). The circuit should have three binary outputs G, E, L so that:

- G=1 if and only if A>B
- E=1 if and only if A=B
- L=1 if and only if A<B

Design the required circuit using only NAND gates.

Exercise 5. A water tank has a sensor system that provides the water level in the tank with a number from 0 to 12. This number is given as a 4 bit digital signal in natural binary code (x_3, x_2, x_1, x_0). Design a combinational circuit that takes (x_3, x_2, x_1, x_0) as inputs and generates an output signal 'z' which is '1' when the tank level is equal or less than 5 and is '0' otherwise. Make an optimum design using only NOR gates.

Exercise 6. In the circuit depicted below all the gates have the same delay Δ.



a) Obtain a minimum sum-of-products expression for function *f*.

b) Obtain the truth table of *f*. ¿Can you figure out a possible application for *f*?

c) Determine the waveform of f when b=d=1 and a and c change as depicted below. Comment the results.