Assignment 3.5

Exercise 1. A digital alarm system has three inputs (a, b, c) and one output (z). The system can be on (a=1) or off (a=0) and ha a presence sensor (b=1 if presence is detected) and a contact sensor at the front door (c=1 if the door is open). When the system is on, the alarm is activated (z=1) if presence is detected or the front door is open. When the system is off, the alarm is still activated if presence is detected and the door is open (the user forgot to close the door while in the house).

Describe the circuit using Verilog and design a test bench to test it. You are advised to use the code of lesson 3.1 (alarm) in the Verilog Course[1] as reference and starting point.

Exercise 2. Design in Verilog a combinational circuit that takes a 5-bit signal 'x[4:0]' as input and activates an output signal 'z' when the value of the input bits in natural binary representation is a multiple of 7. Write a test bench and check that the description is correct. You may use lesson 3.2 (primes) of the Verilog Course as reference.

Exercise 3. Describe in Verilog a combinational circuit that takes a 4-bit input signal 'x[3:0]' and outputs a 2-bit signal 'q[1:0]' which is the integer quotient of the division x/3. Do two alternative designs:

a) Using only conditional statements (if, case, etc.) and logic operators.

b) Using arithmetic operators.

Write and use a test bench for the circuit. Can you use the same test bench for a) and b)?

Exercise 4. 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[3:0]'. Design a combinational circuit using Verilog that takes 'x' 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. Check the operation of the circuit by writing an appropriate test bench.

Exercise 5. A line-follower robot car has two infrared proximity sensors on its sides. The right and left sensors generate signals 'sr' and 'sl' respectively. Signal are set to 1 when the black line is below the sensor. The wheels of the robot only move forward and are controlled by signal 'mr' and 'ml' for the right and left motors respectively. The motors move when the control signals are 1. Design a control circuit for the robot car using two techniques:

a) Obtain minimal expressions using K-maps.

b) Describe the circuit in Verilog and use a test bench to test it.

1 https://gitlab.com/jjchico/verilog-course.v