Exercise 5: Synthesis of synchronous circuit

Please design synchronous circuit with one input x and two outputs Z_1 and Z_2 which operation will be as follows: first logic value 1 in an input sequence generates $Z_1=1$, second logic value 1 generates $Z_2=1$, third logic value 1 generates $Z_1=1$, fourth logic value 1 generates $Z_2=1$, etc. Additionally you should assume that in each given moment $Z_1Z_2=0$. When x=0 then $Z_1=0$ and $Z_2=0$. On figure 1 the illustration of circuit operation is shown for example input sequence (in moment t_1 x=0, in moment t_2 x=1, in moments t_3,t_4,t_5 x=0, in moment t_6 x=1, etc.).

In other words, the circuit should transfer odd ones to output Z_1 and even ones to output Z_2 ("even/odd one's separator").
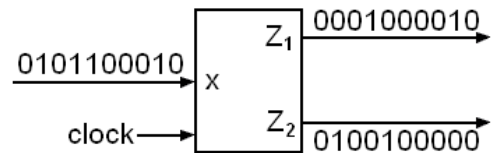

Figure 1

The steps of the exercise:

1. Construct the circuit of Moore machine and verify if its behavior is proper for two test input sequences prepared earlier (sequence 1 and sequence 2),
2. Ask the teacher to verify proper behavior of the circuit. Do not disassemble the circuit.
3. Construct the circuit of Mealy machine and verify if its behavior is proper for two test input sequences prepared earlier (the same as in step 1),
4. Compare behavior of circuits of Moore and Mealy machines (show it on the time diagram).
5. Ask the teacher to verify proper behavior of both circuits.

Content of the report:

- On pages 1 and 2: synthesis of the circuit of the Moore machine with the following steps:
    - a.) graph of states-outputs,
    - b.) minimization of states-outputs table,
    - c.) coding of states,
    - d.) excitation tables/functions of flip-flops,
    - e.) state output tables/functions.

  Please use D flip-flops and only those logic chips which are available on the breadboards in lab.
- On page 3 synthesis of the circuit of the Mealy machine (with the same steps as above). Please use JK flip-flops.
- On the last page please show diagrams of realized logic circuits along with time diagrams (see: Fig. 2)
- The print-out of circuits and of their simulation from CAD is optional but increases the grade.
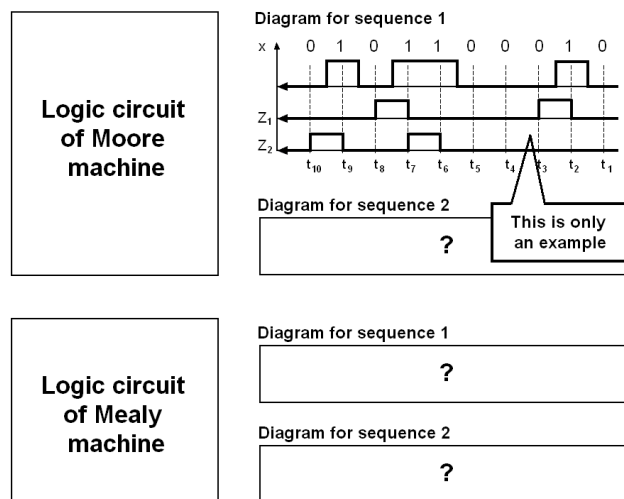
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Figure 2

Comments:

1. Please do not forget to connect asynchronous inputs of flip-flops.
2. Please do not use the setter of logical values. When a certain input of the system should always be a constant value (0 or 1). In such case use the available values directly from the breadboard (red wire - value 1, black / blue wire - value 0).
3. Use LED display to show values of x, Z_1 and Z_2.