1. **(10 points)** Consider the configuration in Figure 1 showing a Finite State Machine (FSM) $M$ as the composition of two FSMs $M_1$ and $M_2$. The overall specification for $M$ is the following: "The output $y$ should be 1 if and only if the number of 1’s observed in $x$ so far is odd." Thus, for input sequence 10011 on $x$, the sequence of values at $y$ should be 11101. The state transition diagrams of $M_1$ and $M_2$ are given in Figure 2.

(a) It is possible to derive a Mealy FSM which replaces $M_1$ while having less states?

(b) If the answer to the previous question is yes, what is the minimum state FSM replacing $M_1$?

(c) Derive a two-state, deterministic Mealy machine that corresponds to the specification for $M$.

2. **(10 points)** Figure 3 illustrates a sequential logic module $M$ having two inputs $x$ and $y$ and two outputs $e$ and $z$. The overall specification for $M$ is the following: $e$ is equal to 1 at clock cycle $\tau_i$ if $x$ and $y$ were carrying 1.
the same Boolean value at the previous cycle \( \tau_{i-1} \). \( z \) is equal to one at cycle \( \tau_i \) if the output value of \( e \) at cycle \( \tau_i \) is equal to the output value of \( e \) at cycle \( \tau_{i-1} \).
illustrated in Figure 4. We want to keep the same input/output behavior while designing separately the two modules.

(a) Derive the STDs of two Mealy Deterministic FSMs for $M_1$ and $M_2$ which together realize the same behavior of $M$.

(b) Derive the STDs of two Moore Deterministic FSMs for $M_1$ and $M_2$ which together realize the same behavior of $M$.

(c) Which conclusions can you derive from this exercise?

3. (10 points) Implement and test in Esterel some of the FSMs involved in the exercises above. In particular you should make available (web URL, unix directory in the cad group, e-mail attachment (if anything above fails)) a tar or zip archive containing the tested Esterel source files for

(a) the communicating $M_1$ and $M_2$ machines in exercise 1. For $M_2$ you should use the STD in Figure 2 and for $M_1$ either the machine you derived for part (b) (if such machine exists) or the STD in Figure 2 (if the Mealy machine does not exist).

(b) the two communicating FSMs, $M_1$ and $M_2$, in exercise 2, both for the Mealy and the Moore case (sounds like 4 machines). (Hint: playing with Esterel might clarify the differences in the composition of Mealy and Moore machines.)