

Design of Digital Circuits: Lab Report		
Lab 4: Finite-State Machines		
Date		Grade
Names		
		Lab session / lab room

**You have to submit this report via Moodle.**

**Use a zip file or tarball that contains the report and any other required material. Only one member from each group should submit the report. All members of the group will get the same grade.**

**The name of the submitted file should be *Lab1\_LastName1\_LastName2.zip* (or *.tar*), where *LastName1* and *LastName2* are the last names of the members of the group.**

**Note 1: Please include all the required material. No links/shortcuts are accepted.**

**Note 2: The deadline for the report is a hard deadline and it will not be extended.**

## Exercise 1. Implementing Dimmed LEDs

We know that an LED is turned off when the signal driving the LED has logic-0 value. On the other hand, as long as the value of a signal connected to an LED is logic-1, the LED glows with constant light intensity. In digital circuits, since a signal can only drive logic-0 or logic-1, we cannot make an LED glow with less intensity by driving a value between 0 and 1.

To see an LED glowing with different intensity, we need to design a circuit that will continuously transition between the ON and OFF states of an LED. Depending on the ratio of time spent while in ON and OFF state, the LED will illuminate at a different level. For example, if the circuit repeats the sequence of keeping the LED ON for 1 cycle and then keeping the LED OFF for 1 cycle, the LED will be slightly dimmed compared to the case where the LED is always in ON state. By spending more time in OFF state would reduce the LED intensity further.

In this part, you need to make the transitions in Thunderbird tail lights smoother. Instead of directly turning on the LED when performing the left or right sequence, gradually increase the intensity of the next LED to see smoother transitions. It is completely up to you to design an appropriate state machine and decide on the implementation details. We recommend you to start simple by first experimenting with a single LED to make it dimmed.

## **Feedback**

If you have any comments about the exercise please add them here: mistakes in the text, difficulty level of the exercise, or anything that will help us improve it for the next time.