

Fall 2025 / EC311
Pre-Lab-B: Simplification of Boolean Functions

1. Goals

- Design simple combinational circuits.
- Simplify Boolean Functions.
- Program the FPGA board.

2. Overview

This lab demonstrates the design of a system that counts a sequence of binary numbers. In addition, this lab utilizes simplification of Boolean function to generate a simplified logic circuit.

3. Tasks**1. Learn to program the FPGA Board**

Complete the tutorial on Programming the FPGA board in the Vivado. This tutorial has been posted on Blackboard.

2. Design a combinational logic for Flashing Lights

Design a combinational circuit using logic gates that takes as input a 4-bit binary number, represented via the positions of four switches, and has its outputs control two LEDs as described below. The LEDs should change according to the following table:

Input Values	Light setting	
	Left LED	Right LED
0-3	On	On
4-7	On	Off
8	Off	On
9	Off	Off
10-11	Off	On
12-15	Off	Off

Your design and implementation process should use the following steps:

- (a) Create a truth table for all of the possible inputs and outputs.
- (b) Derive a standard Boolean expression from the truth table.
- (c) Use K-maps to determine the minimal expression for each of the desired outputs.
- (d) Write the Verilog code for your design.
- (e) Use User Constraint File (UCF) to connect your inputs to switches on the board, and your outputs to LEDs on the board. You should use the 4 rightmost switches for the 4-bit inputs with the rightmost one corresponding to the least significant bit. For output, you should use the 2 rightmost LEDs.
- (f) Synthesize your design and generate the bitstream.

- (g) To program the FPGA using .bit file, follow the instructions for programming the FPGA board in the Vivado Tutorial.
- (h) Test the circuit to determine if it works correctly for all inputs. To do so, you will need to manually make the switches count from 0 to 15, and compare the lights to your truth table.

4. Deliverables

Show your K-map and minimized expressions to TA, and also demo your design on FPGA board.