CE100 Lab Report 2


Student Name:

Tutor:

Lab Sec:

Date:
Description:
The purpose for this lab was to get more familiar with electronic devices (DVM or oscilloscope) by measuring voltage; to get more familiar with using the Xilinx CAD tool and demonstration board; and to get started with implementing a logic function of a given truth table, verify the design both by building the circuit with discrete components on the breadboard and by entering the design into the Xilinx schematic; then simulating, compiling and then downloading it to the Xilinx demonstration board. The lab consisted of the following three parts.

PART A – The resistor network
Construct the circuit shown in Figure 1. Compute the voltage at B and C using the methods covered in class (resistors in parallel and resistors in series). Measure the voltage at A, B, C, and D. This part of the lab will require me to use a breadboard, three 200Ω resistors and one 330Ω resistor, plus a voltage measuring device, like a DVM or Oscilloscope, etc.

![Figure 1](image)

PART B – The Proto board check
Begin by opening a new project and wiring 5 input nodes directly to output nodes. This will be your schematic for this section. You will bind (referred to as “pinning”) each input to one of the pushbuttons on the Xilinx circuit board. You should have the Xilinx CAD tool and its demonstration board to do this part.

PART C – Miscellaneous function
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Given the truth table in Figure 2 design a circuit which includes an XOR gate that implements the functionality. Now build the circuit with discrete components on your bread board and test it by applying all possible inputs and verify the outputs. Once that is completed, open up the Xilinx schematic capture program and enter your circuit and assign the inputs to push buttons and the output to an LED. Remember they are active low so do you need to put inverters in your design? Verify that for all given inputs the output is correct.
RESULTS:

PART A
Voltage computation:
As we know when two resistors $R_1$, $R_2$ are in serial, their equivalent resistance is $R_{eq} = R_1 + R_2$

While when they are in parallel, $R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2}$

$$R_{total} = 200\Omega + \frac{200\Omega \times 200\Omega}{200\Omega + 200\Omega} + 330\Omega = 630\Omega$$

According to Ohm’s law,
$$I = \frac{V}{R} = \frac{5.0V}{630\Omega} = 7.9mA$$

$V_A = 5.0V$, $V_D = 0.0V$

$V_B = V_A - 200\Omega \times I = 5.0V - 200\Omega \times 7.9mA = 3.41V$

$V_C = V_B - 100\Omega \times I = 2.62V$

(OR: $V_D = 0.0V$, $V_C = V_D + 330\Omega \times I = 2.62V$, $V_B = V_C + 100\Omega \times I = 3.41V$, $V_A = 5.0V$)

I built the circuit shown in Figure 1, and used the DVM to measure the voltages at A, B, C and D, the data from these measurements plus the results from the calculation are listed in Table 1.

<table>
<thead>
<tr>
<th>Voltage Calculated (Volt)</th>
<th>Voltage Measured (Volt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_A$</td>
<td>5.0</td>
</tr>
<tr>
<td>$V_B$</td>
<td>3.41</td>
</tr>
<tr>
<td>$V_C$</td>
<td>2.62</td>
</tr>
<tr>
<td>$V_D$</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 1: We can see that the measured results were in accordance with the calculated ones, the differences were very small.

PART B
In this part, I needed to design a schematic circuit to test the proto boards. We needed to pin the 5 inputs to 5 push buttons, and to pin the 5 output pins to 5 LED displays. From the Xilinx hardware document, we see we have 4 black push buttons on the top-right of the demo board and 1 grey SPARE pushbutton at the bottom left. When using XC4003A Components, the pin numbers for the black buttons are (from left to right): P80 P79 P77 P78, the SPARE is P18. The lower row of the LEDs have pin numbers (from left to right): P61, P62, P65, P66, P57, P58, P59, P60. I chose the first 4 LEDs.

(Your printed Schematic Diagram should be pasted here)

Figure 3  Schematic diagram for Part B

When the project had been built, inputs and outputs had been pinned to the right buttons or LEDs, I compiled and downloaded the design to the Xilinx hardware demo board. The results showed that when I pushed the button attached to pin P80, the LED on pin P61 was turned on, when I release the button, the LED on pin P61 was turned off. The same phenomena happened.
to the other 4 buttons and respective LEDs. I then concluded this meant that the design worked properly and that the demo board was in good condition.

PART C
From the truth table, we know that the SOP form of the logic function could be written as:

\[
Z = A'B'C' + A'B'C + AB'C' + ABC' + ABC
= (A'B'C' + A'B'C) + (A'B'C' + AB'C') + (ABC' + ABC)
= A'B' + B'C' + AB
= A \oplus B' + B'C'
\]

![Figure 4. Engineering circuit for the logic function implementation](image)

I built a circuit using the discrete components on my breadboard for the above logic design, and used an LED to display the result, by testing all inputs I showed that the above design was correct.

I then built a project in the Xilinx tools to verify the above logic function; the schematic diagram is shown below in Figure 5. I also pinned the three inputs A, B and C to pushbuttons P80, P79, P77, the output Z pinned to P61. Note that since the pushbuttons and LEDs are all active low, I put an inverter on each input and before the output to make them work correctly.

![Figure 5. Schematic Diagram for the Design.](image)

I then did a simulation for the function, which shows that it correctly implemented the function given in the truth table. Note that I named the signal after the inverter for the input signal and named the signal before the inverter for output signal to make the simulation work correctly. Figure 6 shows the timing diagram with my simulation results.

![Figure 6. Timing Diagram for the Simulation](image)

I then downloaded the design to the Xilinx demo board and tested all the combination of inputs and got the expected output.
Conclusion:

In part A of this lab, I first used equivalent resistor knowledge to determine voltages at various points in a given circuit. I then built the circuit with discrete components on the breadboard and measured the voltages at same points and compared the values measured with the theoretical values. The result showed that they were in accordance. In part B, I did a little project with the Xilinx tools to get familiar with pinning, and downloaded the project to the Xilinx demo board. In part C, I practiced implementing a logic function. I used switching algebra to get the logic equation for Z, then verified it both by building a circuit on the breadboard and by creating a project with the Xilinx tool. I simulated and downloaded the design to the demo board. All forms of verification showed that the logic equation for the function I came up with was correct. In general, I got more familiar with the Xilinx tool usage and circuit building on the breadboard. I also got to have more fun writing nice lab reports and hanging out in the lab with my buddies in CE100.