Lab 2: Logic Minimization with K-Map
ECEN 248 - 505
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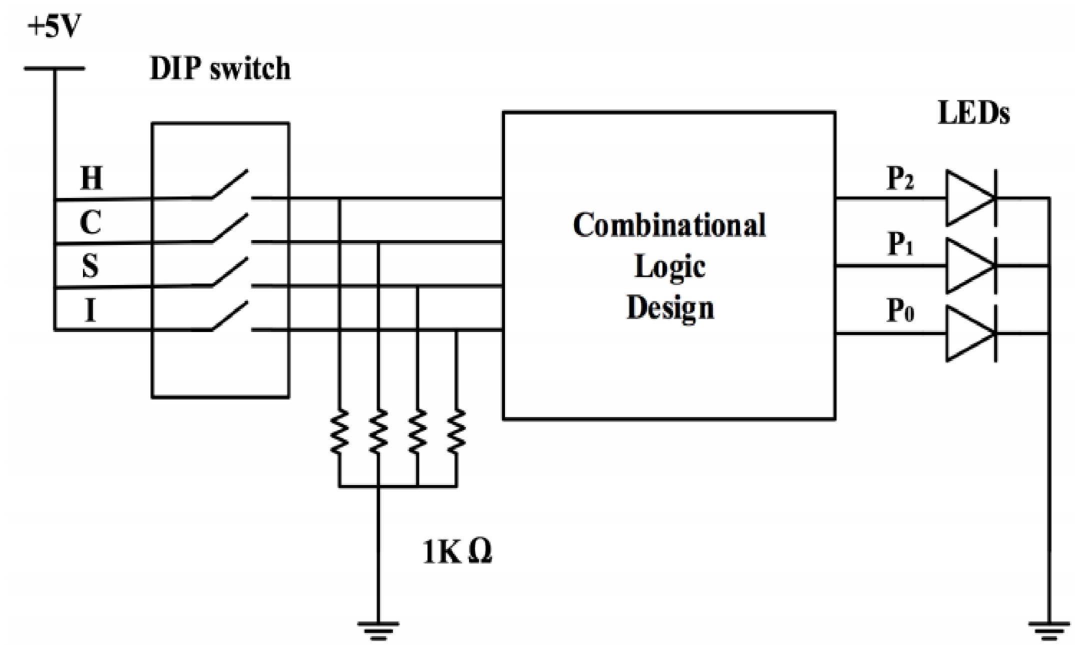
Date: September 15, 2020

Objectives

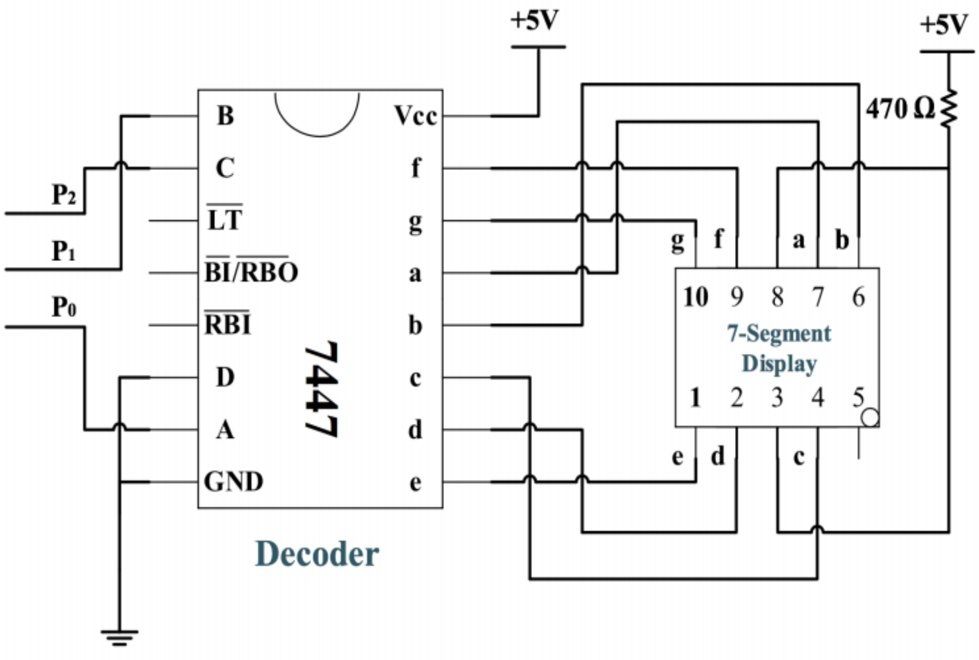
The objective of this lab is to be able to design and create a digital circuit that can calculate profits. Outputs of the circuit will be displayed on three separate LEDs in the binary form and on a seven-segment LED display in the decimal format. This also targets the understanding of logic minimization by using karnaugh maps, implementation of gate-level schematics, and debugging any errors.

<u>Design</u>

In this lab, there were 3 outputs, P0, P1, and P2, with four different inputs which are I, S, C, and H. Different combinations of 0s and 1s as the input will give us different results. The process begins with converting the truth tables to maps to minimize the expression or equation. This then will help us determine the logic gates that are used and how to connect them. The expressions for the 3 outputs were: P0=I+H+CS, P1= H xor S +CI, P2= I'C+HS.



For the second part of this experiment, I placed the 7 figure display circuit on the breadboard. Then plugged the corresponding values on the decoder inputs to the right. Then plugged the power source to test the display and tested it according to the truth table.



<u>Results</u>

The results from this lab were expected to be, as it represents the truth table done in the prelab. While I faced multiple challenges throughout the lab, whether it was because of loose wires, or incorrect connection, in the beginning, testing and debugging was key.

For part 1, I tested the breadboard with the LED's using the test cases from the truth table. Like starting out the values of S, I, H, C as 0 then the LEDs won't light up. Using the truth table, and test cases given by the TA, I was able to test the logic behind the circuit. For example, when the input values are 0010 then the output is P1 and P0 lighting up. And similarly, I went ahead and used more input values such as 0001, 0100, etc, and recorded the output.

For part 2, I used the truth table to create a profit calculator, which is denoted by the 7 figure display. I started with all 0's and this gave me the values of 0. To further test this, I used 0010, 0001, and 1000. These inputs gave me output values of 3, 4, and 2.

<u>Conclusion</u>

In this lab, I learned how to convert a truth table into a k-map and simply that into a workable expression. This helped me improve my understanding of logic gates. I also learned how to used a decoder and 7 figure display chip. I was able to test the LEDs using the truth table with the input values of SIHC and output of P0, P1, P2. This way I was able to send digital signals through logic gates using the 3 equations. While learning how to utilize this equipment and the purpose of them, I was successfully able to execute this lab, getting the correct corresponding results.

Post - Lab Questions

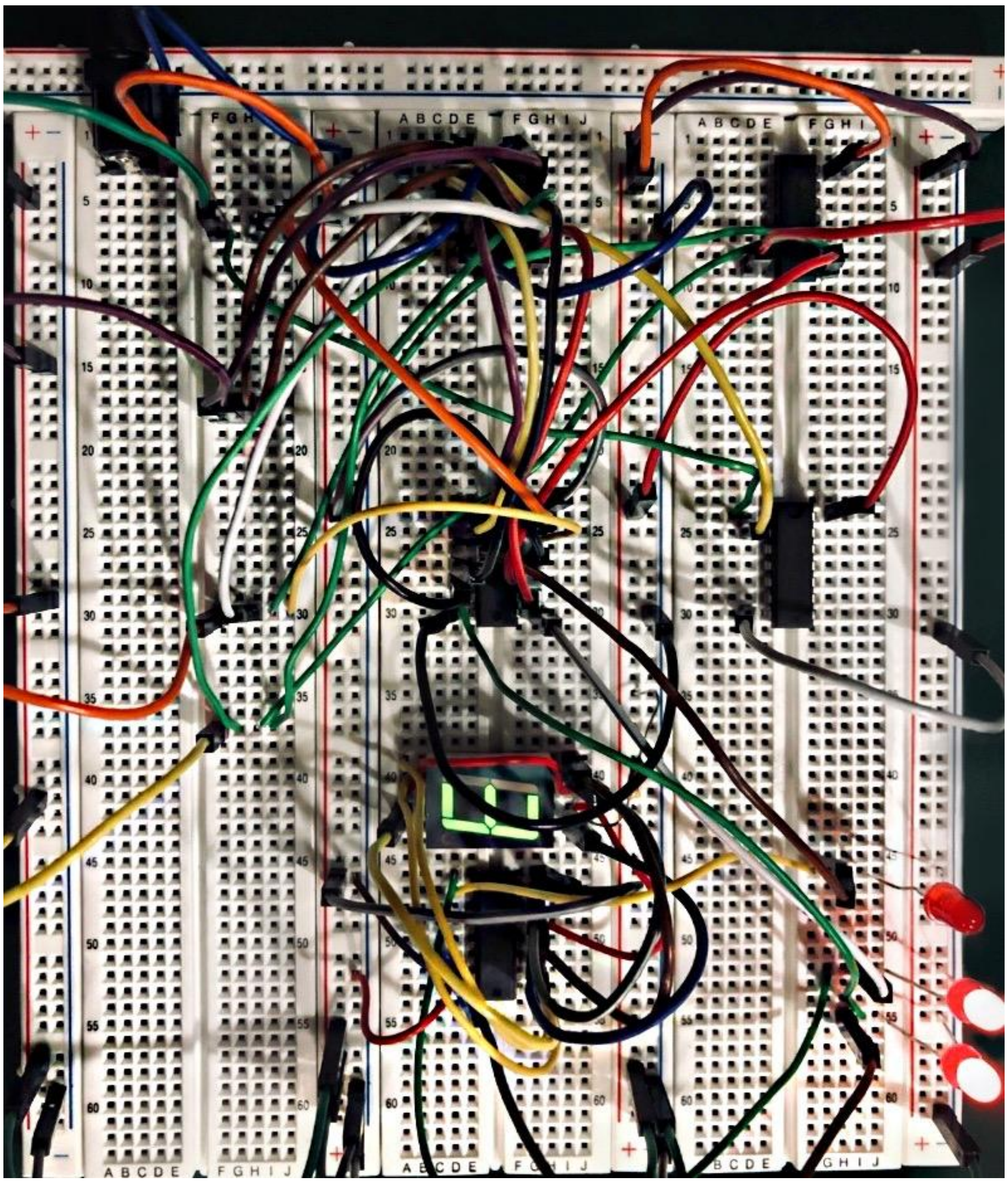
1. Make a table with 16 rows showing the digital inputs and outputs of your circuit observed during the lab. For input combinations not allowed by the aforementioned guidelines, provide the output values observed rather than 'X'.

S	I	H	C	P2	P1	P0	Output of display
0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	1
0	0	1	0	0	1	1	3
0	0	1	1	1	1	1	7
0	1	0	0	0	0	1	1
0	1	0	1	0	1	1	3
0	1	1	0	0	1	1	3
1	0	0	0	0	1	0	2
1	0	0	1	1	1	1	7
1	0	1	0	1	0	1	5
1	1	0	0	0	1	1	3
0	1	1	1	0	1	1	3
1	0	1	1	1	0	1	5
1	1	0	1	0	1	1	3
1	1	1	1	0	0	1	1
1	1	1	0	0	0	1	1

2. What values does your circuit output for the "don't care" and why?

The "don't care" values consist of regular inputs due to the fact that the circuit not knowing how to utilize those values. The values are displayed in binary code from P0, P1, P2 expressions. The circuit shows the binary number derived from the equations. Since there are three expressions, that value forms with 3 bits, hence the number displayed is a decimal format. These "don't care" values is when the input has more than two 1s because the circuit doesn't know what to do with the values and displayed them as regular inputs.

3. Take a picture of your complete circuit with a seven-segment display. Try your best to introduce your product to John and teach him how to use it.



The three LEDs in the image represent the output of the expressions P0, P1, and P2. The seven-figure display in between the breadboard shows the output of the display. And the logic gates are integrated circuits and combine to represent the equations P0, P1, and P2. Utilizing the truth tables to test, the goal was to use the input values SIHC and make sure that the right corresponding LED would turn on. The wires are what connects everything on the breadboard together, through the logic gates. And the left most wires represent the input value SIHC. Plugging in those four wires between positive or negative represents the 0 and 1 on the truth table.