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# Lab 3: Logic Minimization with K-map

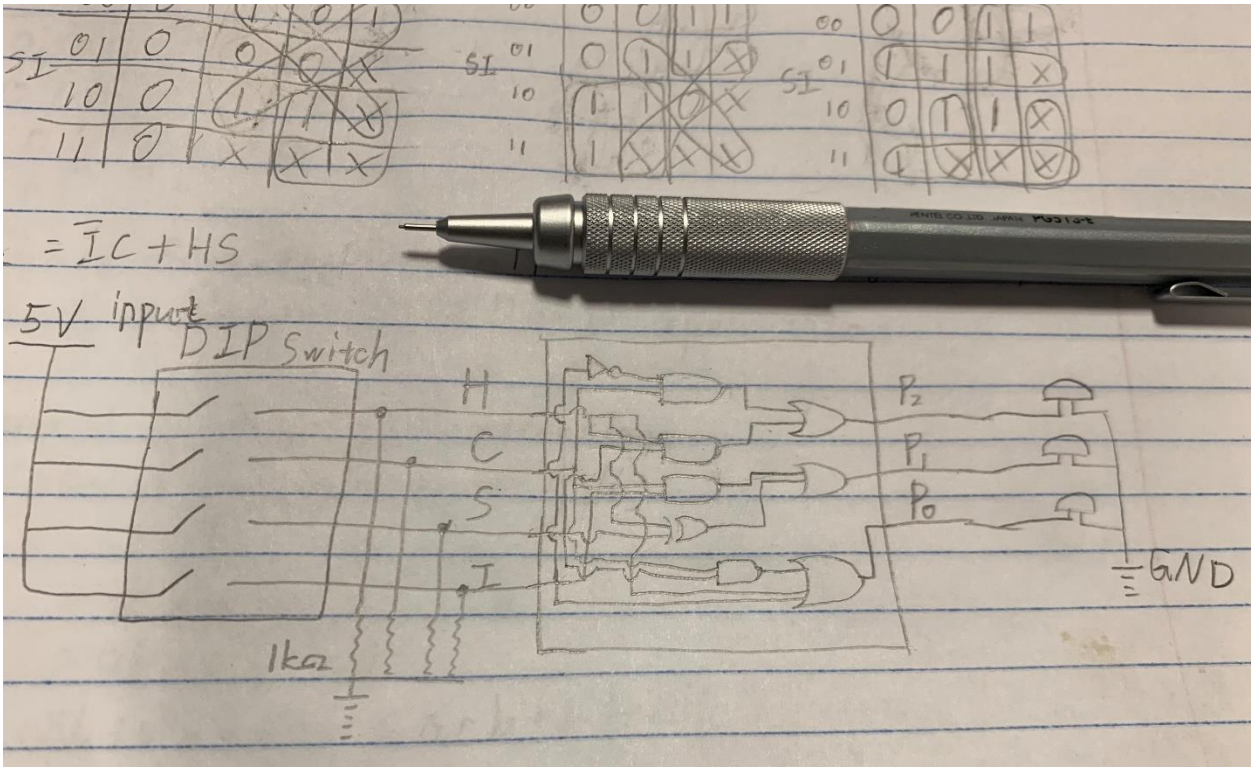
ECEN248-507 TA: Rachel Yeh Sep 20th

Objectives:

The main purpose of Lab 3 is to transfer signals in switch form, through multi-logic gates, into digital display for practical application, calculation of profits generated by a farm. During the process, the relationships between the inputs are concluded by K-map, then achieve minimization in logic expression.

Design:

The first step of the lab is to plan out a schematic for entire circuit. As shown below, we will be using one XOR gate, four AND2 gates, four OR2 gates, and one INV gate, then I placed those chips on the bread board.




Picture 1: schematic of lab

Secondly, connect VCC and GND for all the chips to enable their functions.

After placing the DIP switch onto the bread board, at the left-hand side, provide 5V input for four wires. At the right-hand side, define four outputs for each of the animal. ( H C S I ) Also place 1kΩ of resistor for each of the wires to the GND.

Using the schematic planed above, connect H C S I to corresponding chips then to three LED light bulbs, which represents P0, P1, and P2. At the meantime, test out all the possible combinations and record it in truth table as shown below.

| H | C | S | I | P0 | P1 | P2 |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 |

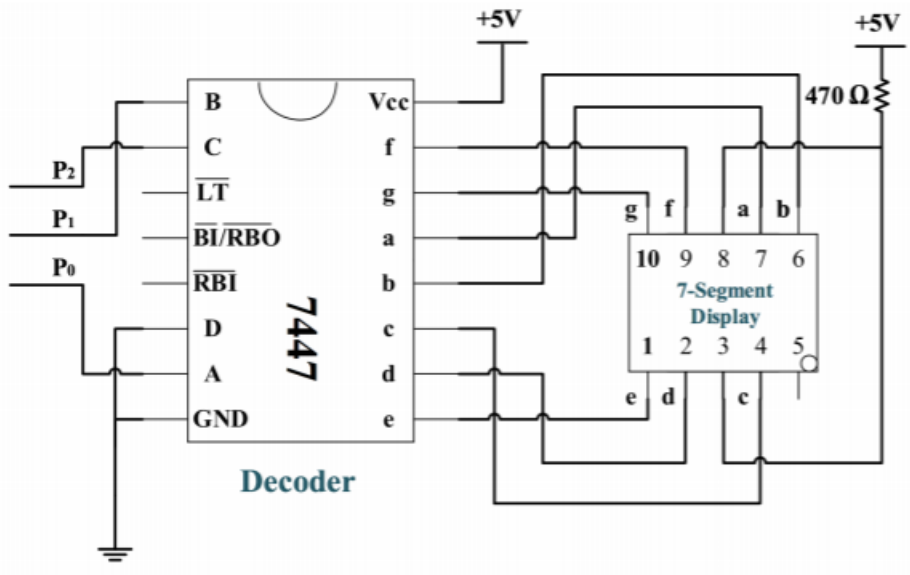
| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1(X) | 1(X) | 0(X) |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1(X) | 0(X) | 1(X) |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1(X) | 1(X) | 0(X) |
| 1 | 1 | 1 | 0 | 1(X) | 0(X) | 1(X) |
| 1 | 1 | 1 | 1 | 1(X) | 1(X) | 1(X) |

Table 1:truth  table of lab result

For each of the 1 signal means the voltage is around 3 – 5 V , 0 represents less then 1V.

1 for light bulbs is on, 0 is off.

In the part 2 of Lab, we connected signals from three LED to 7477 chip then connected to the 7-segment display to show the calculated profit in digital form.



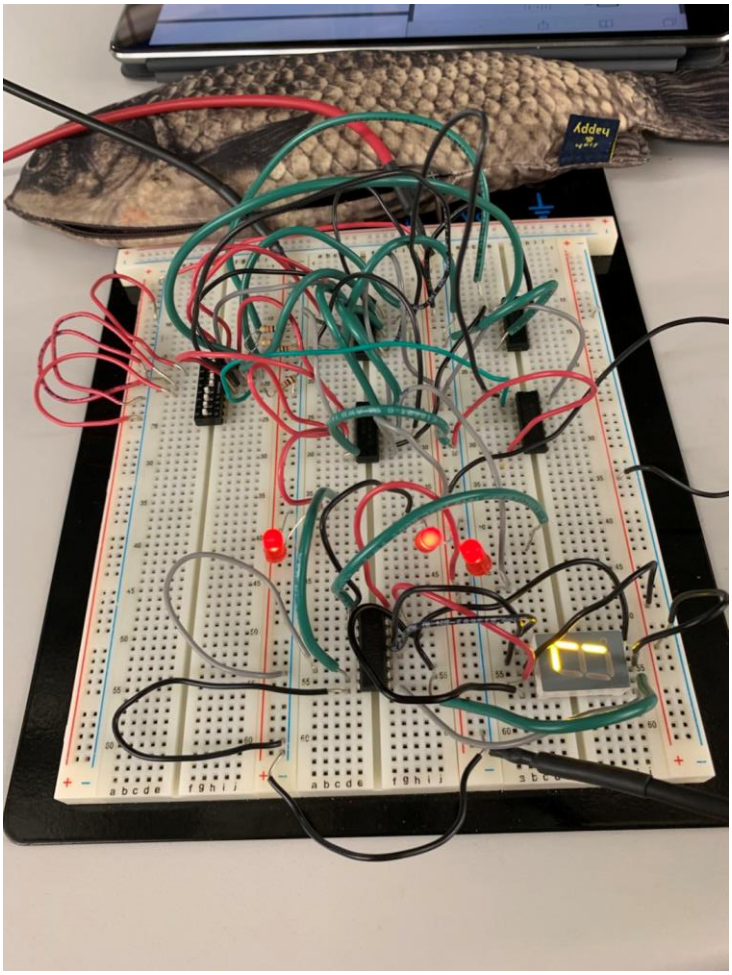

Picture 2: The schematics shown above illustrates how the wires are connected.

We first connect P0 P1 P2 to A B C inputs of 7447 and connect D to the ground, because 7447 requires four inputs but we only have three. Also remember to enable the chip by connecting the VCC and GND.

After placing the 7-segment display onto  bread board, connect outputs from 7447 to corresponding inputs on 7-segment display. e to 1, d to 2, c to 4, b to 6, a to 7, g to 10, f to 9. Be careful with the

direction of the 7-segment display, the corner beside “5” is marked for correct placement. After that, connect 3 and 8 to a 470Ω  resistor then to a 5V power supply to protect the display.

Results:



Picture 3: This is the complete circuit for my Lab3.

By using the table attached above, we rewrite the table into K-map form:

| P0 | | | HC | | |
|---|---|---|---|---|---|
| | | 00 | 01 | 11 | 10 |
| | 00 | 0 | 0 | 1 | 1 |
| SI | 01 | 1 | 1 | x | 1 |
| | 11 | 1 | ***1*** | ***X*** | 1 |
| | 10 | 1 | ***x*** | ***x*** | x |

Table 2: k map of p0

| P1 | | | HC | | |
|---|---|---|---|---|---|

| | | 00 | 01 | 11 | 10 |
|---|---|---|---|---|---|
| | 00 | 0 | 0 | 1 | 1 |
| SI | 01 | 0 | 1 | X | 1 |
| | 11 | 1 | 1 | X | 0 |
| | 10 | 1 | x | x | x |

Table 3: k map of p1

| P2 | | | HC | | |
|---|---|---|---|---|---|
| | | 00 | 01 | 11 | 10 |
| | 00 | 0 | 1 | 1 | 0 |
| SI | 01 | 0 | 0 | X | 0 |
| | 11 | 0 | 0 | X | 1 |
| | 10 | 0 | x | x | x |

Table 4: k map of p2

By circling three k-maps above, we can then confirm that the simplified expression for P0 P1 P2 is true:

P0 = I + H + CS

P1 = H $\oplus$ S + CI

P2 = I'C + HS

Conclusion:

We can certify that the truth tables and simplify expressions are valid by comparing the results. The 7-segments displace can display the profit for each combination. However, if the number of animal beyond two, which the profit generated is more then 7, the displayer won't able to display profit correctly. This is because of our input to the displayer is only 3 bits, so 7 ( 111 in bi ) is the max number that can be displayed. To reach 8, which is 1 0 0 0 in bi, we need the $4^{th}$ bit.

Questions:

Question 1:

(included in result part, and typed down the observed result rather than X, table 1 )

Question 2:

(1 was observed instead of X, shown in table 1 , and explained in conclusion)

Question 3:

(picture3 included above)

John, look at those four switches. They correspond to hog, cow, sheep, and chicken. To see the total profit, switch on the animal combination that you want to calculate. However, the maximum display of the profit will be only 7 due to the design of the circuit. The profit beyond 7 will be displayed as 7.

The displayed is placed horizontally, the marked corner indicates the bottom so you can recognize the display. (e.g. 6 or 9)