ECEN 248 - Lab Report

Lab Number: 2

Lab Title: A Simple Logic Circuit

Section Number: 510

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The Objective

The objective of this lab is to design and implement a digital circuit that calculates the total profit of a small farm based on the types of animals being raised. By applying Boolean logic and logic gate operations, the circuit processes four input signals representing different animals and outputs a binary value corresponding to the total profit.This lab reinforces key digital design concepts, including Boolean algebra, logic minimization, and circuit implementation using integrated circuits (ICs). Through hands-on experience with breadboarding, logic circuit debugging, and circuit analysis, students will develop a deeper understanding of efficient digital circuit design.

Design:

The aim of this laboratory experiment is to create a digital circuit that can process input signals representing different types of animals found on a farm (specifically, Chicken, Sheep, Cow, Hog) and generate a binary number that represents the corresponding profit, with P2 being the most significant bit. The experiment begins by providing a truth table with eleven valid input combinations, along with Boolean functions that define the logic for P2, P1, and P0, as well as a gate-level schematic for the circuit design. To implement this, LEDs are used to visually display the output bits (P2 through P0), while the 4 individual jumper wires indicate the inputs for the circuit which are (S,I,H,C). The procedure starts with setting up the breadboard, ensuring that the integrated circuits (ICs) are correctly placed and connected. VCC and GND connections are established for all chips. Input signals are defined using jumper wires , which are connected to ground and will be moved to power whenever we want to set input to 1. Next, the output P0 is implemented based on the gate-level schematic and connected to an LED for debugging purposes. The provided truth table is used as a reference to verify the correctness of the output.

This iterative process is repeated for P1 and P2, with each component being debugged individually. Finally, the logic design is thoroughly validated by testing various valid input combinations to ensure that the LEDs accurately display the corresponding binary profit. Throughout the experiment, great importance is placed on maintaining a neat and organized circuit layout.

Results :

During the laboratory experiment, I carried out the implementation of a truth table to account for all possible combinations of animals, following the guidelines provided by John. The inputs of the circuit correspond to the different types of animals being raised, while the outputs represent the binary representations of the profits obtained from each combination. It is important to consider the potential variations in profit resulting from different animal combinations. Based on the guidelines mentioned, the truth table is filled in accordance with the inputs provided. In cases where certain combinations of animals are not feasible, such as combinations involving more than two types of animals, these entries are marked as 'X' or deemed not possible. Subsequently, a series of tests were conducted to obtain the corresponding output values for each entry in the truth table.

Boolean Algebra Expressions :

$P0 = I + H + CS$ (I or H or C and S)

$P1 = H \oplus S + CI$ (H xor S or C and I)

$P2 = \bar{I}C + HS$ (not I or C or H and S)

Truth table provided to with the corresponding outputs for P0,P1and P2:

	S	I	H	C	P_2	P_1	P_0	
	0	0	0	0	0	0	0	0
C	0	0	0	1	1	0	0	4
H	0	0	1	0	0	1	1	3
HC	0	0	1	1	1	1	1	7
I	0	1	0	0	0	0	1	1
IC	0	1	0	1	0	1	1	3
IH	0	1	1	0	0	1	1	3
S	1	0	0	0	0	1	0	2
SC	1	0	0	1	1	1	1	7
SH	1	0	1	0	1	0	1	5
SI	1	1	0	0	0	1	1	3

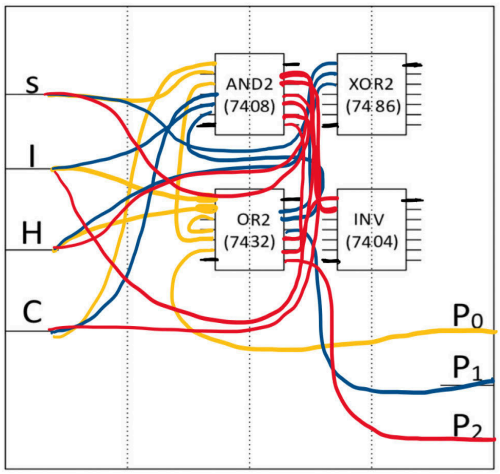
The Truth table X (These values are found in the pre –deliverables) & complete circuit:

	INPUT				OUTPUT		
	C	S	I	H	P_2	P_1	P_0
1	0	0	0	0	0	0	0
2	0	0	0	1	0	1	1
3	0	0	1	0	0	0	1
4	0	0	1	1	0	1	1
5	0	1	0	0	0	1	0
6	0	1	0	1	1	0	1
7	0	1	1	0	0	1	1
8	0	1	1	1	X	X	X
9	1	0	0	0	1	0	0
10	1	0	0	1	1	1	1
11	1	0	1	0	0	1	1
12	1	0	1	1	X	X	X
13	1	1	0	0	1	1	1
14	1	1	0	1	X	X	X
15	1	1	1	0	X	X	X
16	1	1	1	1	X	X	X

$P_0 = I + H + CS$

$P_1 = H \oplus S + CI$

$P_2 = \bar{I}C + HS$



Conclusion:

The Profit Calculator circuit was effectively implemented in the lab through the utilization of integrated circuits and breadboard techniques. By paying careful attention to detail, the circuit's inputs and outputs were clearly defined and connected, showcasing precise binary profit calculations that were dependent on different input combinations. Rigorous testing and debugging procedures were carried out to guarantee the circuit's functionality, promptly addressing any discrepancies to ensure reliable operation. In summary, the lab demonstrated a thorough comprehension of digital logic principles and proficient techniques for practical circuit design

Post lab deliverables :

Expanding the truth table resulted in the following : (5 rows are highlighted)

Explanation :Testing the results using the provided truth table confirms that the circuit produces the correct outputs, validating the outcomes observed during the lab. These results are derived from applying the given logic gate expressions to the specified input values.

S	I	H	C	P0	P1	P2	
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	2
0	0	1	0	1	1	0	3
0	0	1	1	1	1	1	4
0	1	0	0	1	0	0	5
0	1	0	1	1	1	0	6
0	1	1	0	1	1	0	7
0	1	1	1	1	1	0	8
1	0	0	0	0	1	0	9
1	0	0	1	1	1	1	10
1	0	1	0	1	0	1	11
1	0	1	1	1	0	1	12
1	1	0	0	1	1	0	13
1	1	0	1	1	1	0	14
1	1	1	0	1	0	1	15
1	1	1	1	1	1	1	16

Lab Full Circuit (during lab):