

Name _____

EET 1131 Lab #5

Logic Simplification Techniques

OBJECTIVES: Upon completing this lab, you'll be able to:

- 1) Obtain the experimental truth table of a logic circuit.
- 2) Use Boolean algebra to simplify a logic circuit.
- 3) Use Karnaugh maps to simplify a logic circuit.
- 4) Verify that a logic circuit and its simplified version give the same output.
- 5) Use Multisim software to obtain a circuit's truth table and simplified expression.

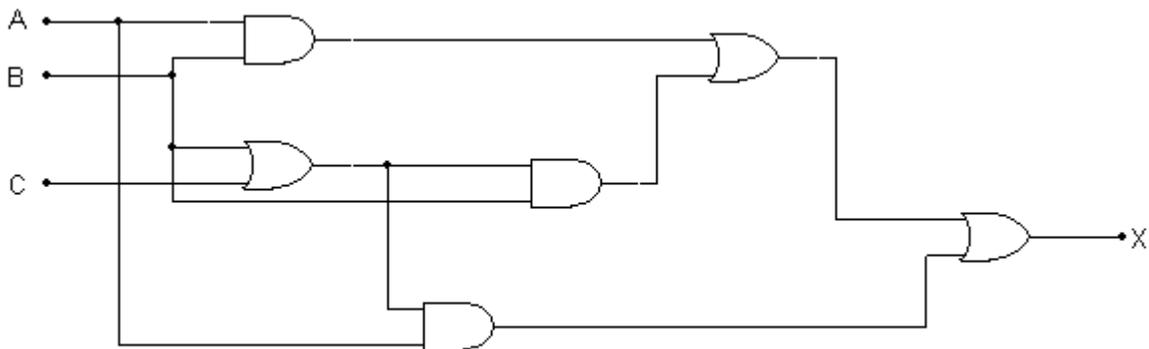
EQUIPMENT REQUIRED:

- Safety glasses
- ICs: 7408, 7432, and other chips as needed
- ETS-7000 Digital-Analog Training System
- Quartus II software and Altera DE2-115 board
- Multisim simulation software

PART 1. Simplification Using Boolean Algebra

PROCEDURE:

1. Consider the schematic diagram shown below.



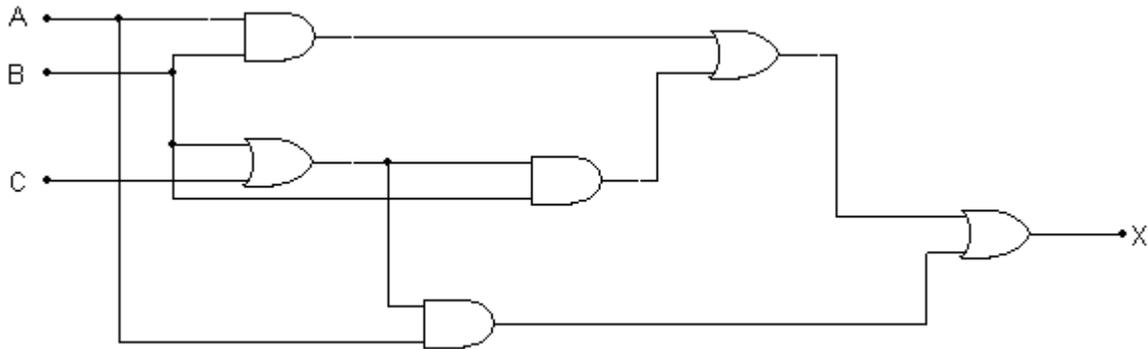
2. In Quartus II, create a new project named **Lab5Circuit1**. Following the steps you learned in the previous lab, create a block diagram/schematic file that implements the circuit shown above. Then perform analysis and synthesis, assign input and output pin numbers so that you can use three switches as your inputs and an LED for your output, compile your design, and download your design to the FPGA on the DE2-115 board.

- Obtain and write the circuit's experimental truth table, **using a straight edge** to draw the lines in your truth table.

- When your truth table is complete, ask me to check your work.

Circuit works correctly? _____

- From the schematic diagram (repeated below), write the Boolean expression for X as a function of A, B, and C. **Do not simplify the expression using** any of our rules or theorems—just write the expression that you get directly from the diagram.



X = _____

6. Now simplify this expression using the laws, rules, and theorems of Boolean algebra. Show each step in the simplification, and label each step with the rule, law, or theorem that you used in that step.

When you're finished, ask me to check your simplified expression. _____

7. Draw the schematic diagram for your simplified expression. Write **chip numbers** and **pin numbers** on it.

8. Build the simplified circuit on the breadboard. Obtain and write its experimental truth table, **using a straight edge** to draw the lines in your truth table.

9. When your truth table is complete, ask me to check your work.

Safety glasses? _____ Circuit works? _____ DIPs inserted correctly? _____

Using power/ground busses? _____ Wire colors? _____

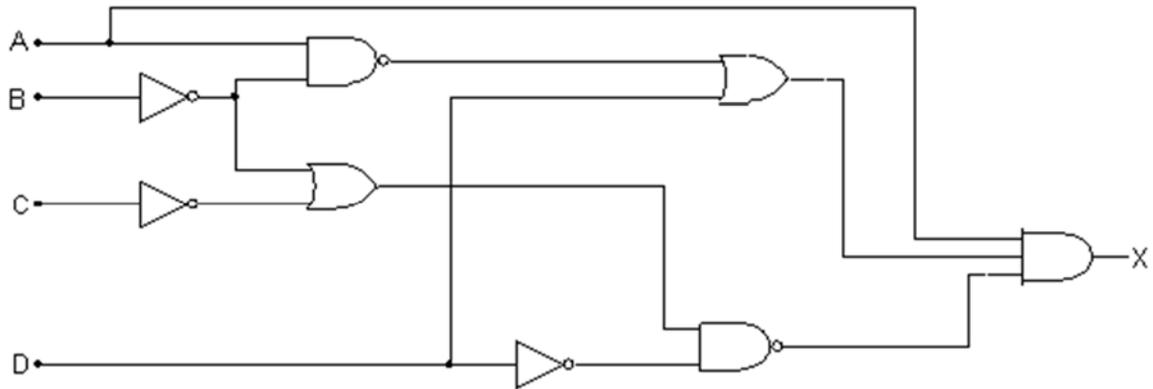
Wire lengths? _____ Wire ends trimmed? _____ DIPs accessible? _____

10. How does your truth table in Step 9 compare to your truth table in Step 4?

PART 2. Simplification Using Karnaugh Maps

PROCEDURE:

12. Consider the new schematic diagram shown below.



13. In Quartus II, create a new project named **Lab5Circuit2**. Create a block diagram/schematic file that implements the circuit shown above. Then perform analysis and synthesis, assign input and output pin numbers so that you can use four switches as your inputs and an LED for your output, compile your design, and download your design to the FPGA on the DE2-115 board.

14. Test your circuit, and write the circuit's truth table **on the next page**.

15. Obtain and write the circuit's experimental truth table, **using a straight edge** to draw the lines in your truth table.

Now write the SOP expression that you get directly from this truth table. **Do not simplify.**

X = _____

16. Ask me to check your work.

SOP expression correct? _____

17. From your SOP expression, **use a straight edge** to draw the circuit's Karnaugh map. Then read off the simplified expression from the K-map.

Simplified expression: $X =$ _____

Call me over to check your K-map and simplified expression. _____

18. Draw the schematic diagram for this simplified expression. Label the gates with chip numbers and pin numbers. (You're free to use chips not listed on the front page of this lab.)

19. Build the simplified circuit on the breadboard. Obtain and write its experimental truth table.

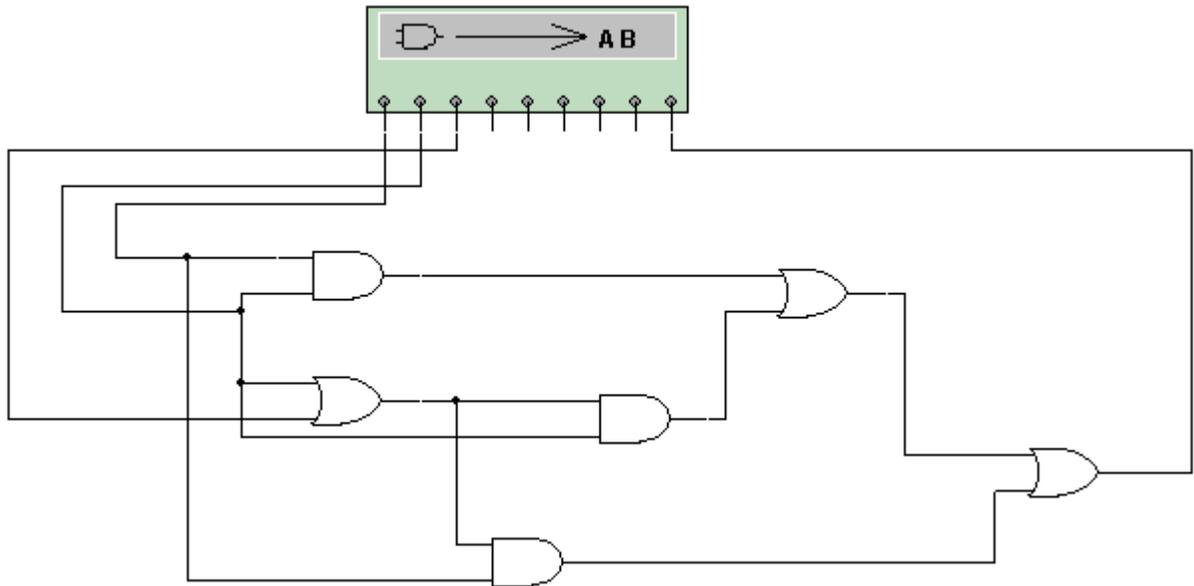
20. When your truth table is complete, ask me to check your work.

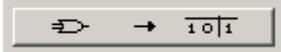
Safety glasses? _____ Circuit works? _____ DIPs inserted correctly? _____
Using power/ground busses? _____ Wire colors? _____
Wire lengths? _____ Wire ends trimmed? _____ DIPs accessible? _____

21. How does your truth table in Step 20 compare to your truth table in Step 16?

PART 3. Simplification Using Multisim

23. Shown below is the circuit from Part 1 of this lab. Draw this circuit in Multisim. Then connect Multisim's Logic Converter as shown below. Notice that you don't need to hook up V_{CC} or ground to use the Logic Converter.



24. Double-click the Logic Converter to open it. Then press its  button to generate a truth table.

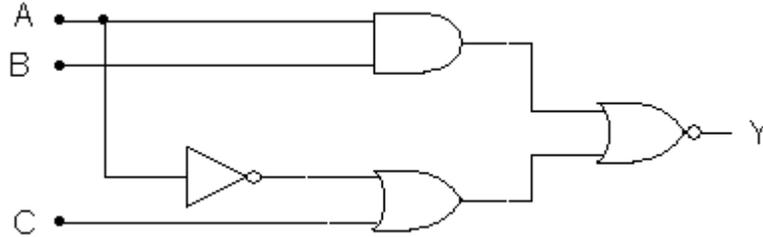
25. How does the Logic Converter's truth table compare to your results from Step 4 and Step 9?

26. Press the Logic Converter's  button to generate a simplified expression.

27. How does the Logic Converter's simplified expression compare to your simplified expression from Step 7?

28. Copy and paste your circuit diagram and the Logic Converter into a Microsoft Word document, so that they both fit on a single page. Make sure that you can read the Logic Converter's truth table and simplified expression. Print this page out and **turn it in** with your lab.

32. Write **chip numbers** and **pin numbers** on each gate in the drawing below. (This is a new circuit, completely different from the circuits that you've been working with on the previous pages.)



33. From the diagram, write the Boolean expression for Y as a function of A, B, and C. **Do not simplify the expression using** any of our rules or theorems—just write the expression that you get directly from the diagram.

Y = _____

34. Draw the circuit in Multisim. Connect Multisim's Logic Converter, and use it to generate the circuit's truth table and simplified expression. Copy and paste your schematic diagram and the Logic Converter into a Microsoft Word document, so that they both fit on a single page. Make sure that you can read the Logic Converter's truth table and simplified expression. Print this page out and **turn it in** with your lab.

35. Note that Multisim uses apostrophes instead of overbars to show that a variable is complemented. For example, the complement of A is written in Multisim as A' instead of \bar{A} . Copy the simplified expression below, but use overbars instead of apostrophes.

Y = _____

36. In the space below, draw the schematic diagram for this simplified expression. Label the gates with chip numbers and pin numbers.