F4 - Logic Circuit Design Exercises

2nd Semester, 2008

Lab 4

Ben A. Abderazek
The University of Aizu
E-mail:benab@u-aizu.ac.jp

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1 Today's Laboratory Objective

Practice how to minimize two-level logic circuit [**?**].

2 Background

For information about how to use Cadence tool, you can jump to the following tutorials:
`http://www.u-aizu.ac.jp/~benab/classes/cs/doc/cadence/`
You may also refer to the following document for LC clossary:
`http://www.u-aizu.ac.jp/~benab/classes/ld/doc/clossary.html`

3 Exercise 4.1 - Two-level logic functions

Design one of the logic functions shown in **??** according to the last digit of your ID.
Note: More designs more scores!

3.1 Exercise 4.1 Tasks

1. Design the **minterm** canonical disjunctive form from the truth table.
2. Design the **maxterm** canonical conjunctive form from the truth table.
3. Design of the minimized $sum - of - products$ form:
   - Using $Karnaugh$ map, minimze the **minterm** canonical disjunctive form.
   - Using laws of Boolean Algebra, minimize the **minterm** canonical disjunctive form.
4. Design of the minimzed $product - of - sums$ form:
   - Using $Karnaugh$ map, generate the minimized negative logic function. form.
   - Invert the negative logic function and apply **De Morgan**'s law to obtain the minimized POS form.

Table 1: Truth Table.

Last Digit	0.5	1,6	2,7	3,8	4,9
a3a2a1a0	F1	F2	F3	F4	F5
0000	0	1	0	1 0	
0001	0	0	1	0 1	
0010	1	1	1	0 1	
0011	0	1	0	0 0	
0100	0	0	1	1 1	
0101	1	0	1	1 0	
0110	1	0	0	1 0	
0111	0	1	1	0 1	
1000	1	0	0	1 0	
1001	0	1	1	0 1	
1010	1	1	1	1 1	
1011	1	0	1	0 0	
1100	1	0	0	0 1	
1101	0	0	0	1 0	
1110	1	0	0	0 1	
1111	0	1	1	1 0	

5. Show the complexity (total number of literals) of the obtained four logic functions for F.
6. For the simplest function in four logic functions, draw the logic circuit using *icsd*.
7. Prepare the "testfixure.new" from the truth table.
8. Simulate the logic circuit with the "testfixure.new". Verify the correctness of the designed circuit.

4 Exercise 4.2 - Incompletely specified logic function

4.1 Exercise 4.2 Tasks

1. For the selected truth table in the previous Exercise, change the function values between 1000 (a3a2a1a0) and 1111 to don't cares.
2. Using *Karnaugh* map, generate the minimal $sum - of - products$ form.
3. Show the complexity of obtained logic functions for F. Compare the complexity to the one obtained in Ex.4.1.
4. Draw the logic circuit using *icds*.
5. Prepare the "testfixure.new" from the truth table.
6. Simulate the logic circuit with the "testfixure.new". Verify the correctness of the designed circuit.

5 Report submission

5.1 Contents

Your report should be prepared in English and should contain the following:

1. Your name, your ID and the Lab #.
2. **Exercise 4.1**
   - Truth table
   - The **minterm** canonical disjunctive form
   - The **maxterm** canonical conjunctive form
   - Show the method to obtain the minimized function:
     - *Karnaugh* map.
     - Laws of Boolean Algebra
   - Show the process to obtain the minimized function.
   - Show the complexity of each logic function.
   - Schematics
   - Testfixure files
   - Waveform (draw values of signals)
   - Show the correctness of your designed circuit
3. **Exercise 4.2**
   - Truth table
   - Show the process to obtain the minimized function.
   - Show the complexity of the minimized logic function. Compare the complexity to the one obtained in Ex. 4.1.
   - Schematic
   - Testfixure files
   - Waveform
   - Show the correctness of your circuit

5.2 Submission Format

Hard Copy.

References

[1] Hiroshi Saito, Logic Circuit Design Course Web page, Second Semester, 2008.