Ve270 Introduction to Logic Design

Homework 2

Assigned: May 23, 2019

Due: May 30, 2019, 2:00pm.

The homework should be submitted in hard copies.

1. Prove DeMorgan's Law. (5 points)
2. Problem 2.25. (10 points)

2.25 Let variables T represent being tall, H being heavy, and F being fast. Let's consider anyone who is not tall as short, not heavy as light, and not fast as slow. Write a Boolean equation to represent each of the following:
(a) You may ride a particular amusement park ride only if you are either tall and light, or short and heavy.
(b) You may NOT ride an amusement park ride if you are either tall and light, or short and heavy. Use algebra to simplify the equation to sum of products.
(c) You are eligible to play on a particular basketball team if you are tall and fast, or tall and slow. Simplify this equation.
(d) You are NOT eligible to play on a particular football team if you are short and slow, or if you are light. Simplify to sum-of-products form.
(e) You are eligible to play on both the basketball and football teams above, based on the above criteria. Hint: combine the two equations into one equation by ANDing them.

3. Problem 2.28. (5 points)

2.28 Use algebraic manipulation to convert the following equation to sum-of-products form:
F = a'b(c + d') + a(b' + c) + a(b + d)c

4. Problem 2.30. (5 points)

2.30 Use DeMorgan's Law to find the inverse of the following equation: F = ac' + abd' + acd. Reduce to sum-of-products form.

5. Problem 2.40 (5 points)

2.39 Convert the function F shown in the truth table in Table 2.10 to an equation. Don't minimize the equation.
2.40 Use algebraic manipulation to minimize the equation obtained in Exercise 2.39.

TABLE 2.10 Truth table.

a	b	c	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

6. Problem 2.48 (c) (5 points)

2.48 Convert the following Boolean equations to canonical sum-of-minterms form:

(a) F(a,b,c) = a'bc + ab

(b) F(a,b,c) = a'b

(c) F(a,b,c) = abc + ab + a + b + c

(d) F(a,b,c) = c'

7. Problem 2.51 (5 points)

2.51 Determine whether the Boolean function G = a'b'c + ab'c + abc' + abc is equivalent to the function represented by the circuit in Figure 2.80.

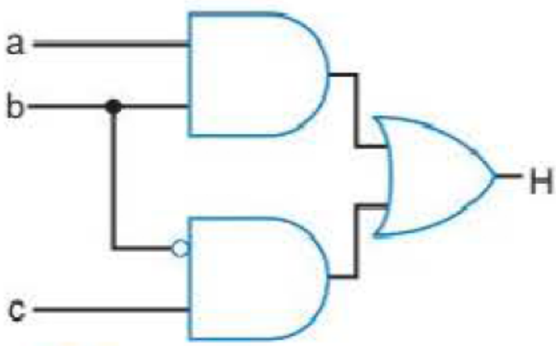

Figure 2.80 Combinational circuit for *H*.

8. Problem 2.56 (10 points)

2.54 A museum has three rooms, each with a motion sensor (m0, m1, and m2) that outputs 1 when motion is detected. At night, the only person in the museum is one security guard who walks from room to room. Create a circuit that sounds an alarm (by setting an output A to 1) if motion is ever detected in more than one room at a time (i.e., in two or three rooms), meaning there must be one or more intruders in the museum. Start with a truth table.

2.56 Consider the museum security alarm function of Exercise 2.54, but for a museum with 10 rooms. A truth table is not a good starting point (too many rows), nor is an equation describing when the alarm should sound (too many terms). However, the inverse of the alarm function can be straightforwardly captured as an equation. Design the circuit for the 10-room security system by designing the inverse of the function, and then just adding an inverter before the circuit's output.

9. Problem 6.3 (10 points)

6.3 Perform two-level logic size optimization for F(a,b,c) = ab'c + abc + a'bc + abc' using (a) algebraic methods, (b) a K-map. Express the answers in sum-of-products form.

10. Problem 6.4, using both algebraic methods and K-map. (10 points)

6.4 Perform two-level logic size optimization for F(a,b,c) = a + a'b'c + a'c using a K-map.

11. Problem 6.8. (10 points)

6.8 Perform two-level logic size optimization for F(a,b,c,d) = a'bc'd + ab'cd', assuming that a and b can never both be 1 at the same time, and that c and d can never both be 1 at the same time (i.e., there are don't cares).

12. Problem 6.11 (a) (10 points)

6.11 For the equation F(a,b,c,d) = ab'c' + abc'd + abcd + a'bcd + a'bcd', determine all prime implicants and all essential prime implicants: (a) using a K-map, (b) using the tabular method.

13. Problem 6.14 (10 points)

6.14 Using algebraic methods, reduce the number of gate inputs for the following equation by creating a multilevel circuit: F(a,b,c,d,e,f,g) = abcde + abcd'e'fg + abcd'e'f'g'. Assume only AND, OR, and NOT gates will be used. Draw the circuit for the original equation and for the multilevel circuit, and clearly list the delay and number of gate inputs for each circuit.