

## **Lab 2 Report**

**Name: Joshua Dong**

**UT EID: jid295**

**Section: Wed. 11 - 12p. (16420)**

**Problem No: 8.C**

### **Checklist:**

1. Karnaugh Map + detailed work done to get the Final Equation (handwork)
2. Logic Circuit drawing with all NANDs or all NORs (handwork)
3. Truth Table and Minimized equations from LogicAid
4. Circuit in SimUaid implemented with all NANDs or all NORs
  - a. Should meet the number of gates specified in textbook
  - b. Use virtual connections
  - c. Use the minimum number of input inverters

## Problem Statement

Design a circuit which will yield the product of two binary numbers,  $n_2$  and  $m_2$ , where  $00_2 \leq n_2 \leq 11_2$  and  $000_2 \leq m_2 \leq 101_2$ . For example, if  $n_2 = 10_2$  and  $m_2 = 001_2$ , then the product is  $n_2 \times m_2 = 10_2 \times 001_2 = 0010_2$ . Let the variables A and B represent the first and second digits of  $n_2$ , respectively (i.e., in this example  $A = 1$  and  $B = 0$ ). Let the variables C, D, and E represent the first, second, and third digits of  $m_2$ , respectively (in this example  $C = 0$ ,  $D = 0$ , and  $E = 1$ ). Also let the variables W, X, Y, and Z represent the first, second, third, and fourth digits of the product. (In this example  $W = 0$ ,  $X = 0$ ,  $Y = 1$ , and  $Z = 0$ .) Assume that  $m_2 > 101_2$  never occurs as a circuit input.

## Karnaugh Map

In the tables that follow,  $a = 1$  on the left,  $a = 0$  on the right.

de \ bc	00	01	11	10
00	0000	0010	0110	0100
01	1000	1010	xxxx	xxxx
11	1100	1111	xxxx	xxxx
10	0000	0011	1001	0110

de \ bc	00	01	11	10
00	0000	0000	0000	0000
01	0000	0000	xxxx	xxxx
11	0100	0101	xxxx	xxxx
10	0000	0001	0011	0010

We can break this k-map down for each component W, X, Y, Z:

W

de \ bc	00	01	11	10
00	0	0	0	0
01	1	1	x	x
11	1	1	x	x
10	0	0	1	0

de \ bc	00	01	11	10
00	0	0	0	0
01	0	0	x	x
11	0	0	x	x
10	0	0	0	0

$$W = A(B + C)(C + D)(C + E).$$

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X

bc \ de	00	01	11	10
	00	01	11	10
00	0	0	1	1
01	0	0	x	x
11	1	1	x	x
10	0	0	0	1

bc \ de	00	01	11	10
	00	01	11	10
00	0	0	0	0
01	0	0	x	x
11	1	1	x	x
10	0	0	0	0

$$X = (B + D)(C + D)(B' + C + E')(A + C)$$

Y

bc \ de	00	01	11	10
	00	01	11	10
00	0	1	1	0
01	0	1	x	x
11	0	1	x	x
10	0	1	0	1

bc \ de	00	01	11	10
	00	01	11	10
00	0	0	0	0
01	0	0	x	x
11	0	0	x	x
10	0	0	1	1

$$Y = (A + B)(A + D)(B + E)(D + E)(A' + B' + D' + E').$$

Z

bc \ de	00	01	11	10
	00	01	11	10
00	0	0	0	0
01	0	0	x	x
11	0	1	x	x
10	0	1	1	0

bc \ de	00	01	11	10
	00	01	11	10
00	0	0	0	0
01	0	0	x	x
11	0	1	x	x
10	0	1	1	0

$$Z = BE$$

## Gate Drawings

