SCHOOL OF INFORMATION, COMPUTER AND COMMUNICATION TECHNOLOGY
SIRINDHORN INTERNATIONAL INSTITUTE OF TECHNOLOGY
THAMMASAT UNIVERSITY

LAB REPORT

EES 370 DIGITAL CIRCUIT LABORATORY

Lab 03 Digital Logic Simulation with LogicWorks

By

Mr. Makhapoom Euaumpon ID: 6222780833

Mr. Paphana Yiwsiw ID: 6222780379

Group No. 12 Section 2

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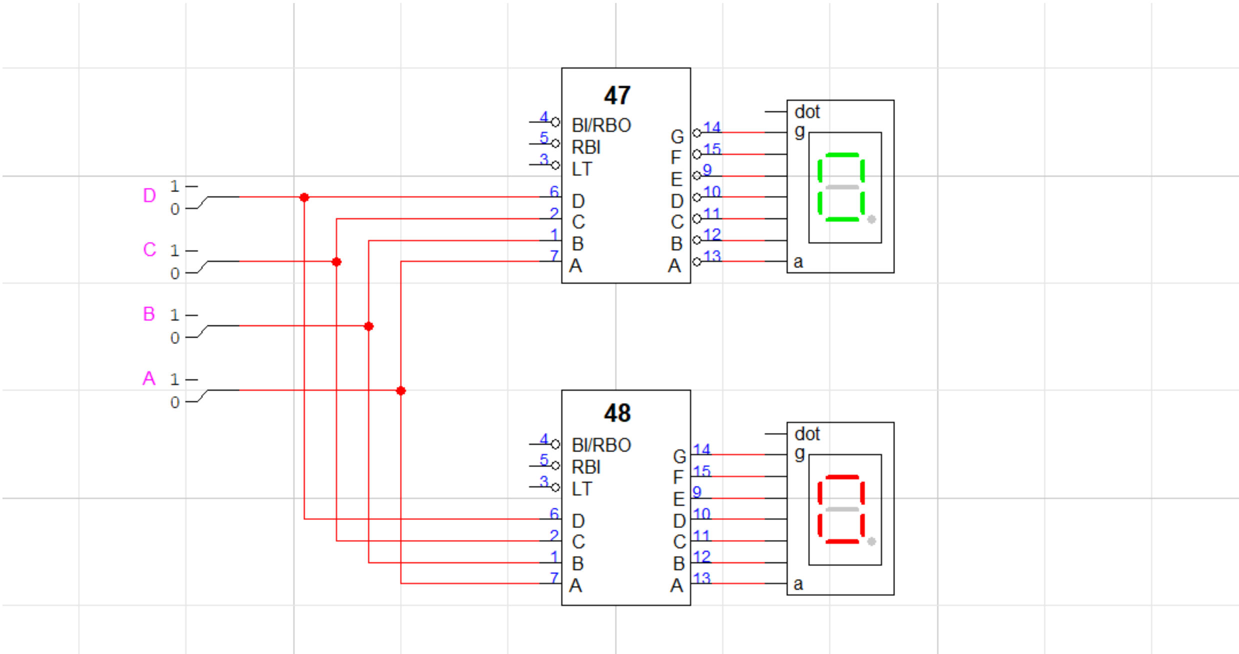
Objectives

1. To know how to create and design a digital circuit in LogicWorks 5.
2. To know how to use digital devices such as decoder and 7-segments display to implement in a designing of digital circuits in LogicWorks 5.

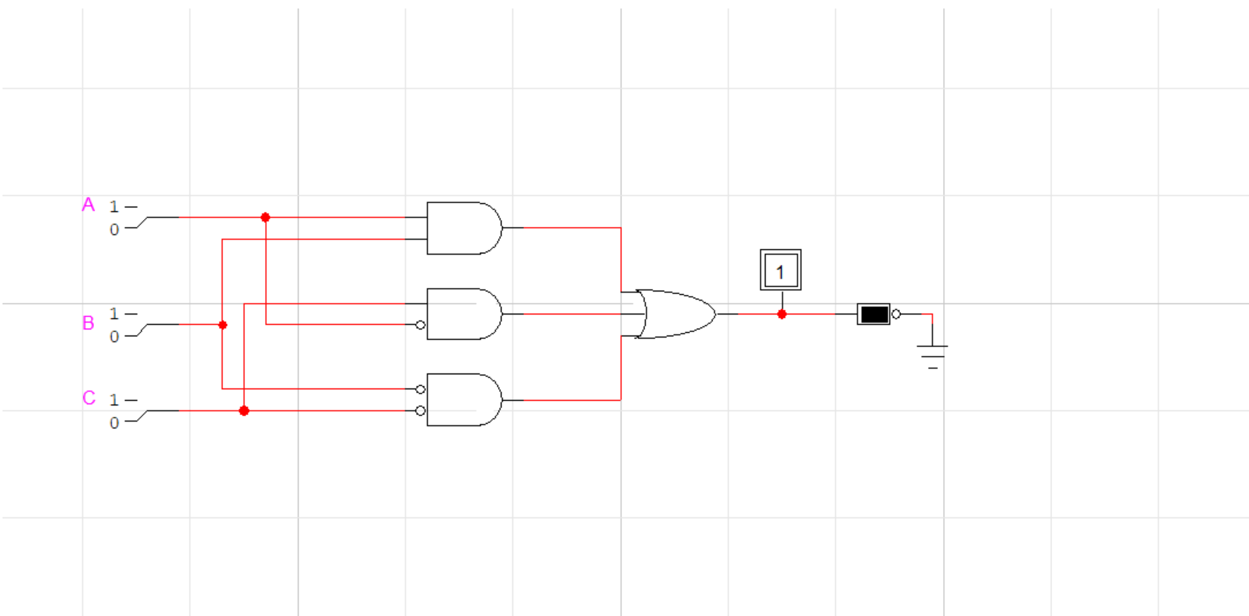
Lab Result

Part A: 7-Segment Display



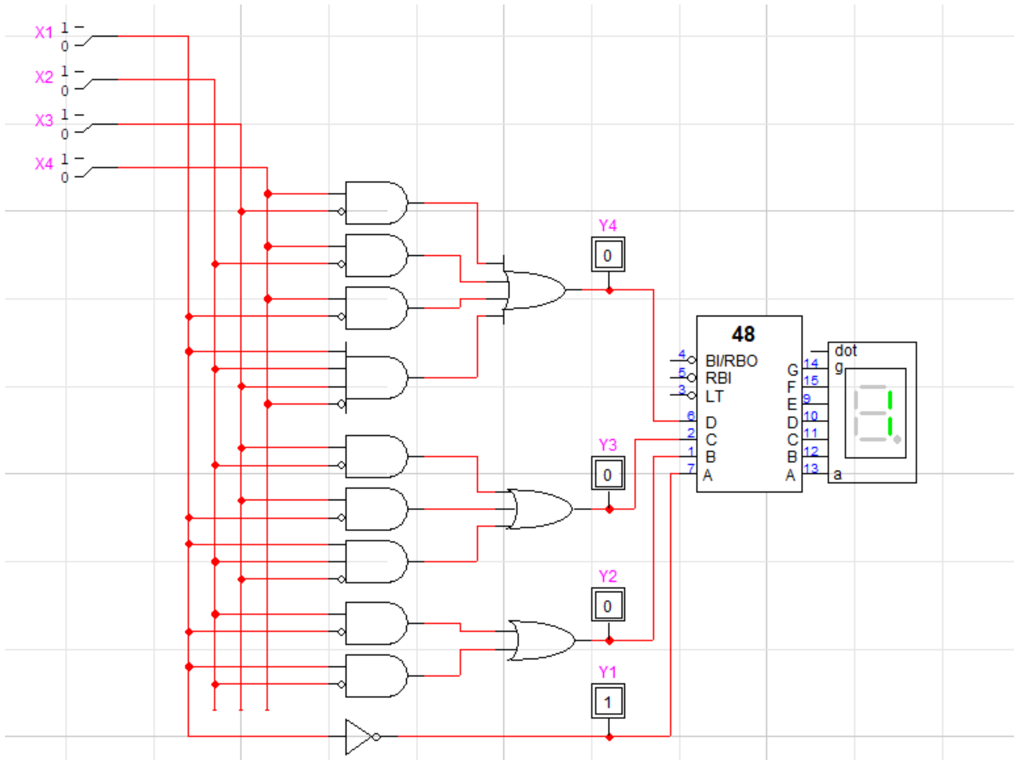
Part B: Logic Equation -> Circuit -> Truth Table

$V_o = V_A V_B + V_A' V_C + V_B' V_C'$

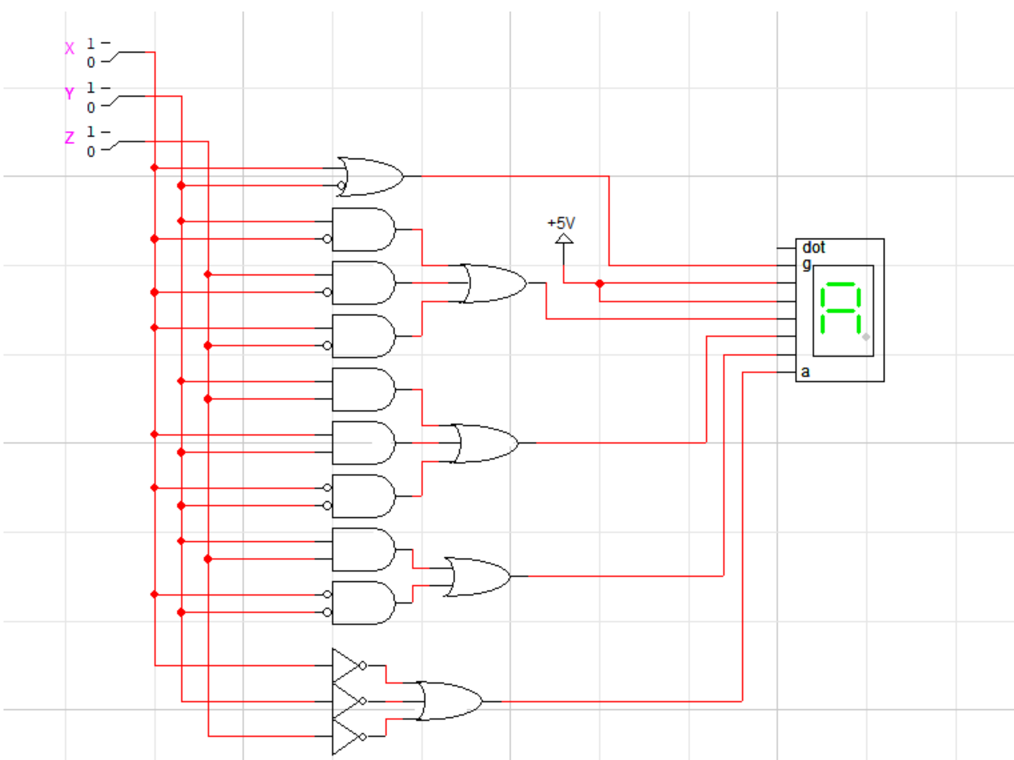


Part C: 4-bit binary input / 4-bit binary output

$Y_4 = X_4X_3' + X_4X_2' + X_4X_1' + X_1X_2X_3X_4'$ / $Y_3 = X_3X_2' + X_3X_1' + X_1X_2X_3'$ / $Y_2 = X_2X_1' + X_1X_2'$ / $Y_1 = X_1'$



Part D: 7-Segment Display Alphabets (A-H)



Discussion

In part A, we create the circuit to display the decimal number in 7-segment display by connect with the BCD-to-7-segment decoder. There are 2 types of BCD-to-7-segment decoder: negative logic which use 74_47 and positive logic which use 74_48. Also, there are 2 types of 7-segment display: negative (7-segment Disp Inv) which needed to connect with 74_47 decoder and positive (7-segment Disp). By connecting corresponding pin, from a to g, from decoder to 7-segment display. The last part is to connect the 4-bit input to the decoder. We can do it by select "Binary Switch" in the part selection, then connect each switch to the corresponding pin at both of decoders. Here is the result sketch from 10 valid input (input from 0000 to 1001).

D	C	B	A	Sketch Output
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	

Figure 1: Sketch of the result obtained from part A.

In Part B, we created the circuit from given Boolean expression, $V_o = V_A V_B + V_A' V_C + V_B' V_C'$. Before drawing the circuit in LogicWorks, we draw circuit and create the truth table on the paper first. Here is what we got:

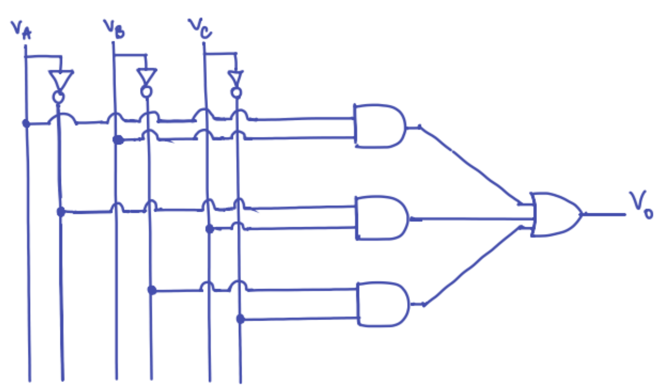


Figure 2: Sketch of the design of circuit in Part B.

Then we can draw the circuit in LogicWorks according to the sketch and observe the output by using “Binary Probe” from the part selection panel and connect to the output line. For the last part, connect the LED to the output line. Then, connect GND to the other end of LED in order to make LED works. To verify the circuit, we can check the result by comparing with the sketch we have done earlier.

In Part C, we use the same process as we did in part B but this time with receive 4-bit input and produce 4-bit output. After we connect all output to the binary probe, we try to connect to the 7-segments display via 74_48 decoder. If we input $X_4X_3X_2X_1$ from 0000 to 1111 to the circuit, the result we get is the display show number 1-9 when input is 0000 to 1000, 5 invalid output when input is 1001 to 1110 and number 0 when input is 1111. Because the output from all 4 Boolean expressions, we get the counter-like result which is 0001 when input is 0000, 0010 when input is 0001, 0011 when input is 0010 and so on.

In part D, we build the 3-bit encoder to display first 8 alphabet(A-H) onto the 7-segment display. First, we create a truth table for all possible input. Then, we use K-mapping to create all 7 Boolean expressions which will correspond to each pin and segment in the 7-segment display.

XY \ Z	0	1
00	1	1
01	1	1
11	1	0
10	1	1

XY \ Z	0	1
00	1	1
01	0	1
11	0	1
10	0	0

XY \ Z	0	1
00	1	1
01	0	1
11	1	1
10	0	0

XY \ Z	0	1
00	0	1
01	1	1
11	1	0
10	1	0

XY \ Z	0	1
00	1	1
01	1	1
11	1	1
10	1	1

XY \ Z	0	1
00	1	1
01	1	1
11	1	1
10	1	1

XY \ Z	0	1
00	1	1
01	0	0
11	1	1
10	1	1

Figure 3: K-map of 7 output (Top row from left to right: a, b, c, d / Bottom row from left to right: e, f, g)

Here are 7 expressions we retrieved from using K-map.

a = X’+ Y’+Z’ / b = X’Y’+YZ / c = X’Y’+XY+YZ / d = XZ’+ZX’+YX’ / e = f = 1 / g = X+Y’

After that, we can build encoder in similar process as in part B and C then directly connect each output to the corresponding pin of the 7-segment display. As you can see, e and f are always sending 1 as its output. We do this by using “+5V” part and connect it directly to pin e and f. Finally, we can verify the output with the sketch we did earlier.

Conclusion

In this experiment, we learn how to use LogicWorks to create circuits to display output onto 7-segment Display by using BCD-to-7-Segments decoders from 4-bit binary input. Also, we can build circuits from different Boolean expressions and gives us desire output that we designed on the paper. After this experiment, we can design and create various type, according to truth table and Boolean expressions with using K-mapping technique, of digital circuit in LogicWorks program.