SYSC 2310 A Introduction to Digital Systems

Lab Report

Lab 5: Combinational Logic Circuits

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Lab Section: L2E

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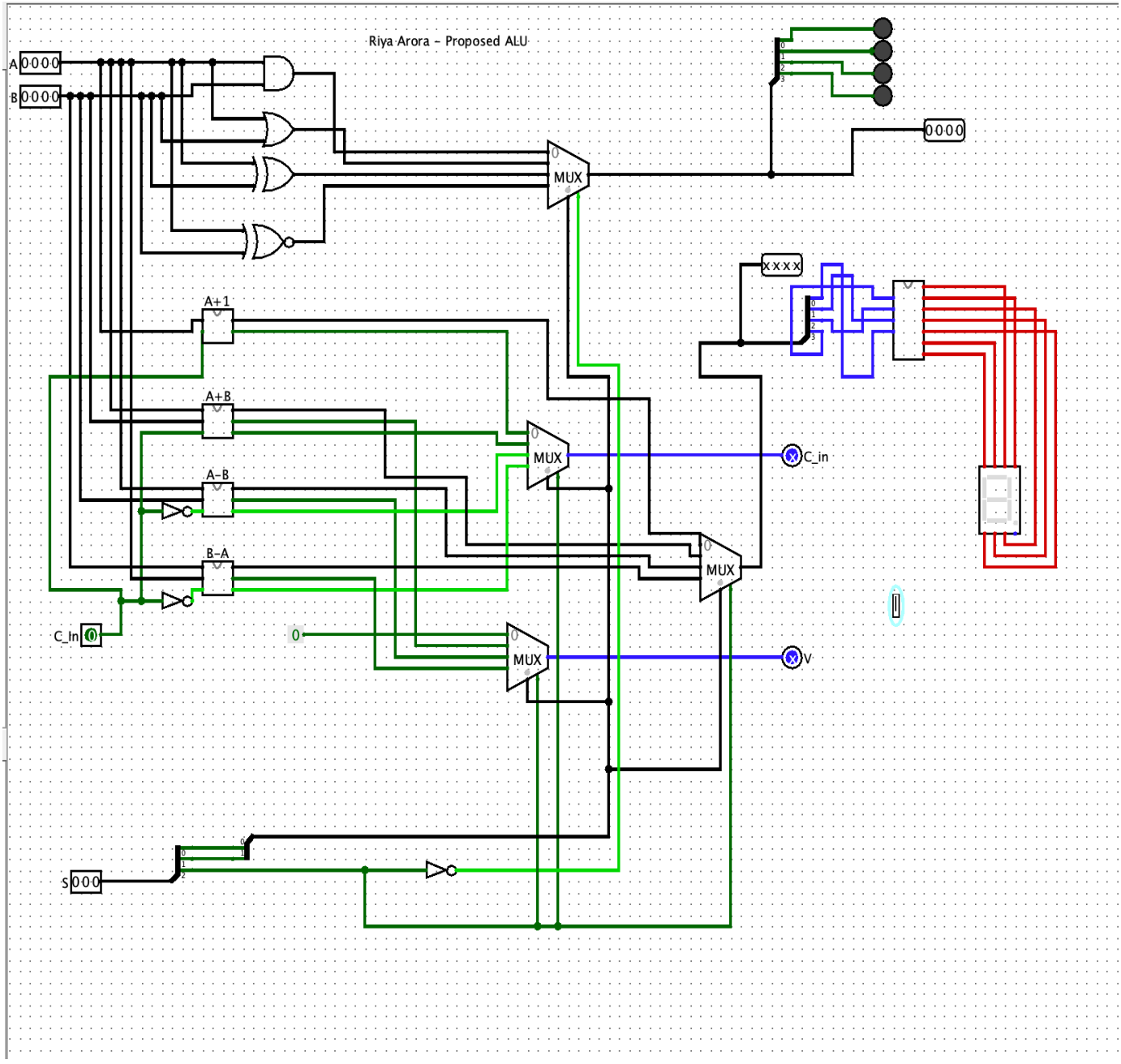
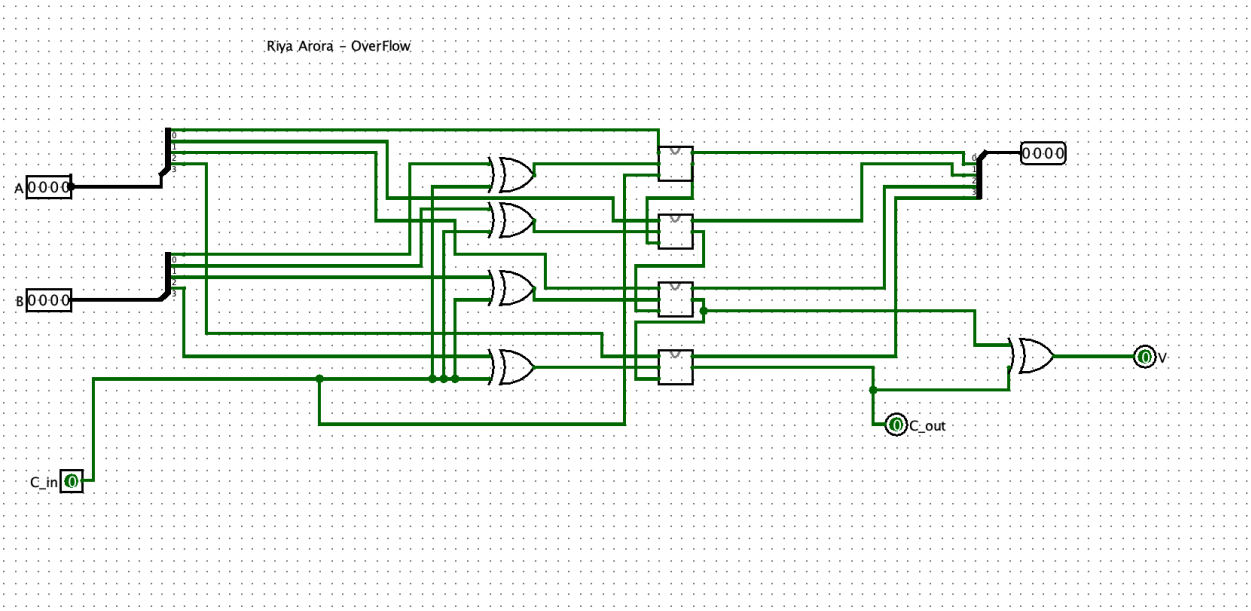
Exercise 1.A: (PRE-LAB)

1. Draw a Complete Block Diagram of proposed ALU

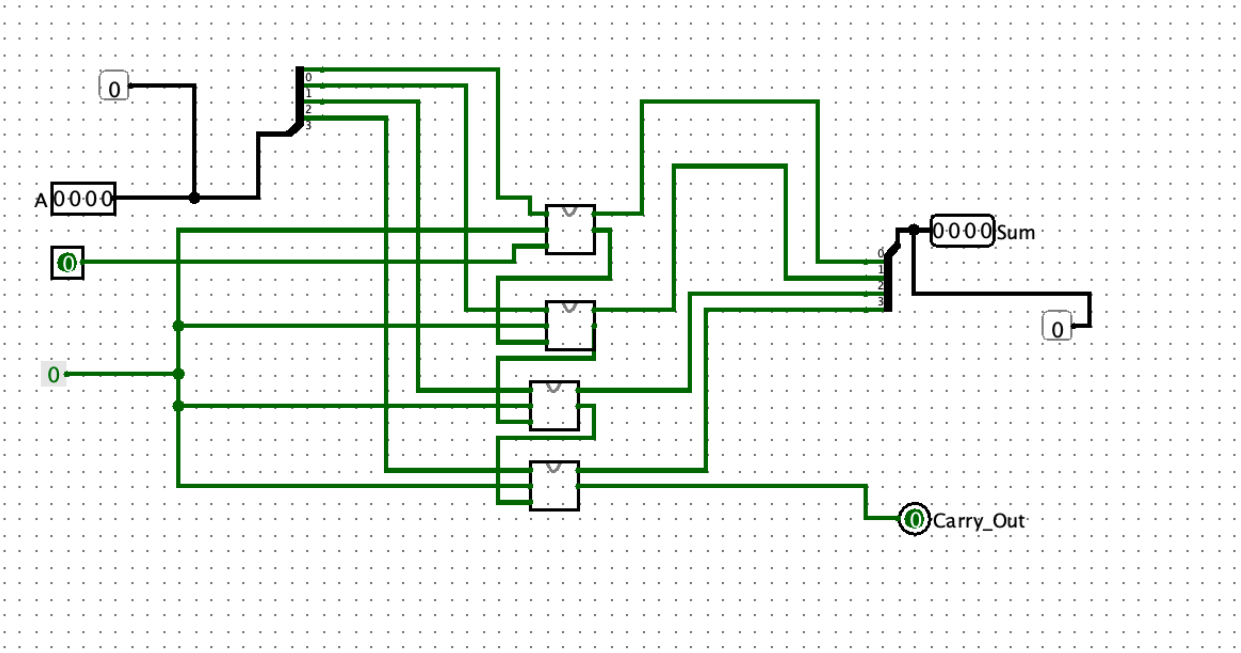


2. Any Block that has not been designed previously

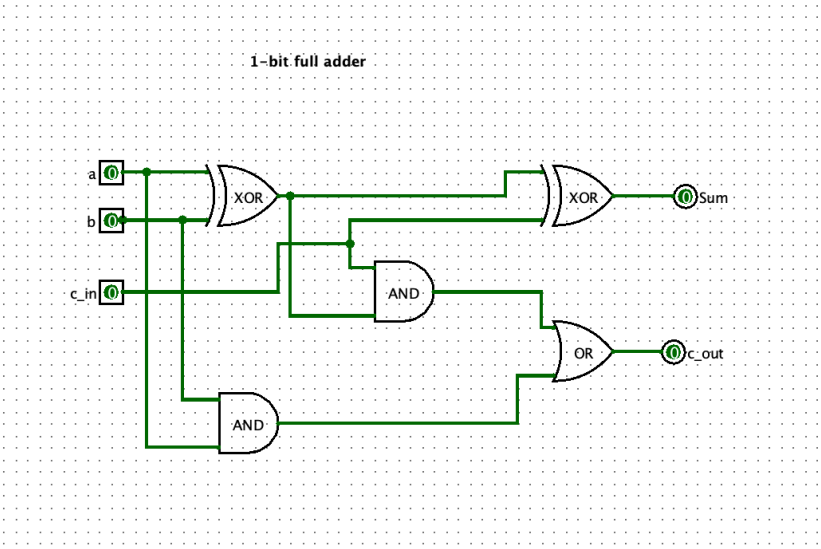
a) 4-bit adder-subtractor with overflow detection



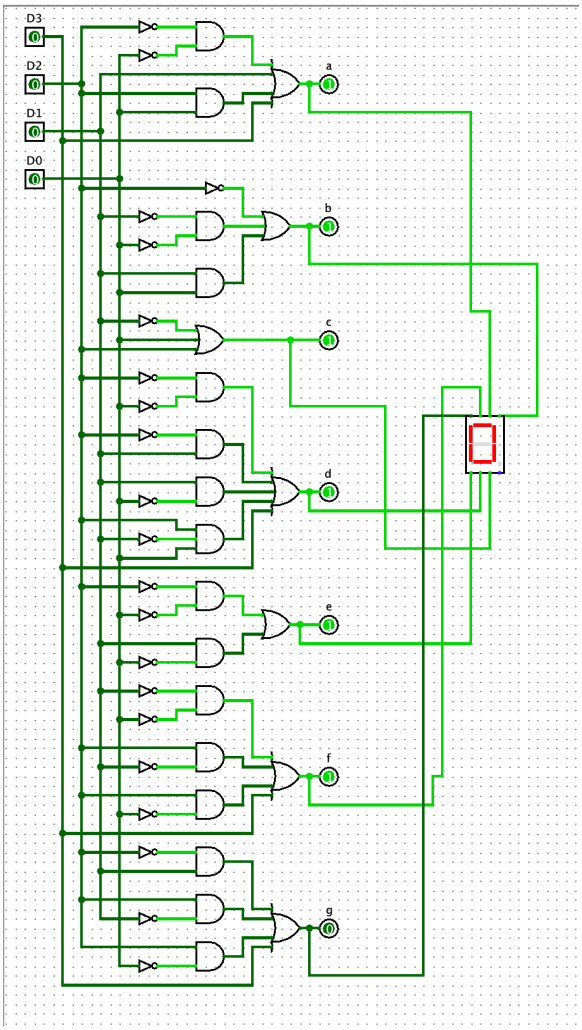
b) 4-bit A+1 adder



c) 1-bit full adder



d)7 Segment Decoder



3. Computer the total number of gates

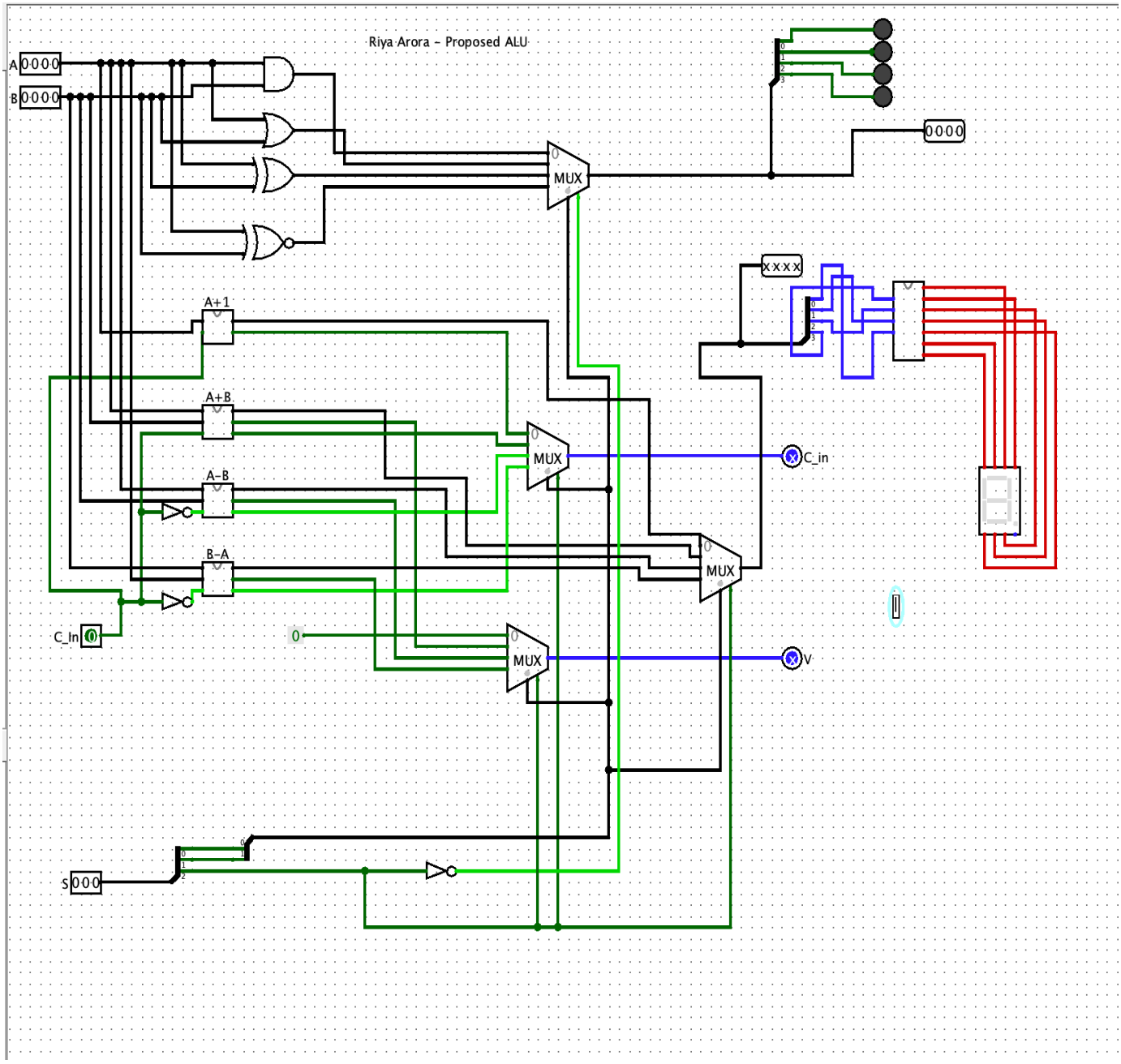
Assuming the hates have the same implementation area, the total number of gates in the proposed ALU design is 150 gates.

4. Compute the Critical Path Delay (CPD)

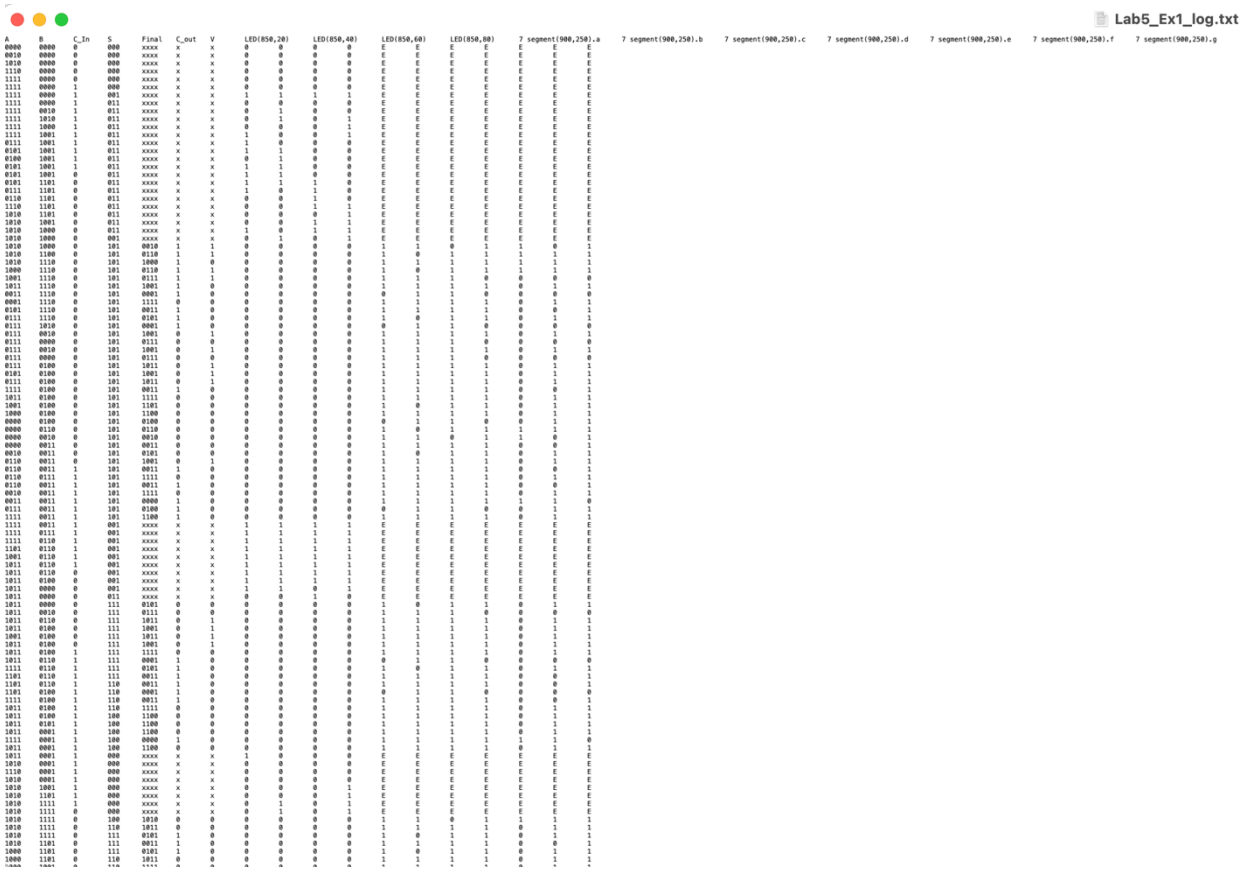
Assuming all of the gates have the same delay, the CPD of the proposed ALU design is 9 gates.

Exercise 1.B

1. Implement Circuit in Logisim



2. Logging File for ALU



A	B	C_In	S	Final	C_out	V	LED(850,20)	LED(850,40)	LED(850,60)	LED(850,80)	7 segment(900,250).a	7 segment(900,250).b	7 segment(900,250).c	7 segment(900,250).d	7 segment(900,250).e	7 segment(900,250).f	7 segment(900,250).g
0000	0000	0	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
0010	0000	0	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1010	0000	0	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1110	0000	0	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1111	0000	0	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1111	0000	1	000	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1111	0000	1	001	xxxx	x	x	1	1	E	E	E	E	E	E	E	E	E
1111	0000	1	011	xxxx	x	x	0	0	E	E	E	E	E	E	E	E	E
1111	0010	1	011	xxxx	x	x	0	1	0	0	E	E	E	E	E	E	E
1111	1010	1	011	xxxx	x	x	0	1	0	1	E	E	E	E	E	E	E
1111	1000	1	011	xxxx	x	x	0	0	0	1	E	E	E	E	E	E	E
1111	1001	1	011	xxxx	x	x	1	0	0	1	E	E	E	E	E	E	E
0111	1001	1	011	xxxx	x	x	1	0	0	0	E	E	E	E	E	E	E
0101	1001	1	011	xxxx	x	x	1	1	0	0	E	E	E	E	E	E	E
0100	1001	1	011	xxxx	x	x	0	1	0	0	E	E	E	E	E	E	E
0101	1001	1	011	xxxx	x	x	1	1	0	0	E	E	E	E	E	E	E
0101	1001	0	011	xxxx	x	x	1	1	0	0	E	E	E	E	E	E	E
0101	1101	0	011	xxxx	x	x	1	1	1	0	E	E	E	E	E	E	E
0111	1101	0	011	xxxx	x	x	1	0	1	0	E	E	E	E	E	E	E
0110	1101	0	011	xxxx	x	x	0	0	1	0	E	E	E	E	E	E	E
1110	1101	0	011	xxxx	x	x	0	0	1	1	E	E	E	E	E	E	E
1010	1101	0	011	xxxx	x	x	0	0	0	1	E	E	E	E	E	E	E
1010	1001	0	011	xxxx	x	x	0	0	1	1	E	E	E	E	E	E	E
1010	1000	0	011	xxxx	x	x	1	0	1	1	E	E	E	E	E	E	E
1010	1000	0	001	xxxx	x	x	0	1	0	1	E	E	E	E	E	E	E
1010	1000	0	101	0010	1	1	0	0	0	1	1	1	0	1	1	0	1
1010	1100	0	101	0110	1	1	0	0	0	0	1	1	0	1	1	1	1
1010	1110	0	101	1000	1	0	0	0	0	0	1	1	1	1	1	1	1
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1001	1110	0	101	0111	1	1	0	0	0	0	1	1	1	0	0	0	0
1011	1110	0	101	1001	1	0	0	0	0	0	1	1	1	1	0	1	1
0011	1110	0	101	0001	1	0	0	0	0	0	0	1	1	1	0	0	0
0001	1110	0	101	1111	0	0	0	0	0	0	1	1	1	1	0	1	1
0101	1110	0	101	0011	1	0	0	0	0	0	1	1	1	1	0	0	1
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0111	1010	0	101	0001	1	0	0	0	0	0	0	1	1	1	0	0	0
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0000	0011	0	101	0011	0	0	0	0	0	0	1	1	1	1	0	0	1
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0110	0011	1	101	0011	1	0	0	0	0	0	1	1	1	1	0	0	1
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0011	0011	1	101	0000	1	0	0	0	0	0	1	1	1	1	0	1	0
0111	0011	1	101	0100	1	0	0	0	0	0	1	1	0	1	1	0	1
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1111	0100	1	110	0011	1	0	0	0	0	0	1	1	1	1	0	0	1
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1010	0001	1	000	xxxx	x	x	0	0	0	0	E	E	E	E	E	E	E
1110	0001	1	000	xxxx	x	x	0	0	0	0	E	E	E	E	E	E	E
1010	0001	1	000	xxxx	x	x	0	0	0	0	E	E	E	E	E	E	E
1010	1001	1	000	xxxx	x	x	0	0	0	1	E	E	E	E	E	E	E
1010	1101	1	000	xxxx	x	x	0	0	0	1	E	E	E	E	E	E	E
1010	1111	1	000	xxxx	x	x	0	1	0	1	E	E	E	E	E	E	E
1010	1111	0	000	xxxx	x	x	0	1	0	1	E	E	E	E	E	E	E
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1000	1101	0	111	0101	1	0	0	0	0	0	1	0	1	1	0	1	1
1000	1101	0	110	1011	0	0	0	0	0	0	1	1	1	1	0	1	1

A	B	C_In	S	Final	C_out	V	LED(850,20)	LED(850,40)	LED(850,60)	LED(850,80)	7 segment(900,250).a
0000	0000	0	000	xxxx	x	x	0	0	E	E	E
0010	0000	0	000	xxxx	x	x	0	0	E	E	E
1010	0000	0	000	xxxx	x	x	0	0	E	E	E
1110	0000	0	000	xxxx	x	x	0	0	E	E	E
1111	0000	0	000	xxxx	x	x	0	0	E	E	E
1111	0000	1	000	xxxx	x	x	0	0	E	E	E
1111	0000	1	001	xxxx	x	x	1	1	E	E	E
1111	0000	1	011	xxxx	x	x	0	0	E	E	E
1111	0010	1	011	xxxx	x	x	0	1	0	0	E
1111	1010	1	011	xxxx	x	x	0	1	0	1	E
1111	1000	1	011	xxxx	x	x	0	0	0	1	E
1111	1001	1	011	xxxx	x	x	1	0	0	1	E
0111	1001	1	011	xxxx	x	x	1	0	0	0	E
0101	1001	1	011	xxxx	x	x	1	1	0	0	E
0100	1001	1	011	xxxx	x	x	0	1	0	0	E
0101	1001	1	011	xxxx	x	x	1	1	0	0	E
0101	1001	0	011	xxxx	x	x	1	1	0	0	E
0101	1101	0	011	xxxx	x	x	1	1	1	0	E
0111	1101	0	011	xxxx	x	x	1	0	1	0	E
0110	1101	0	011	xxxx	x	x	0	0	1	0	E
1110	1101	0	011	xxxx	x	x	0	0	1	1	E
1010	1101	0	011	xxxx	x	x	0	0	0	1	E
1010	1001	0	011	xxxx	x	x	0	0	1	1	E
1010	1000	0	011	xxxx	x	x	1	0	1	1	E
1010	1000	0	001	xxxx	x	x	0	1	0	1	E
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1011	1110	0	101	1001	1	0	0	0	0	0	1
0011	1110	0	101	0001	1	0	0	0	0	0	0
0001	1110	0	101	1111	0	0	0	0	0	0	1
0101	1110	0	101	0011	1	0	0	0	0	0	1
0111	1110	0	101	0101	1	0	0	0	0	0	1
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0111	0010	0	101	1001	0	1	0	0	0	0	1
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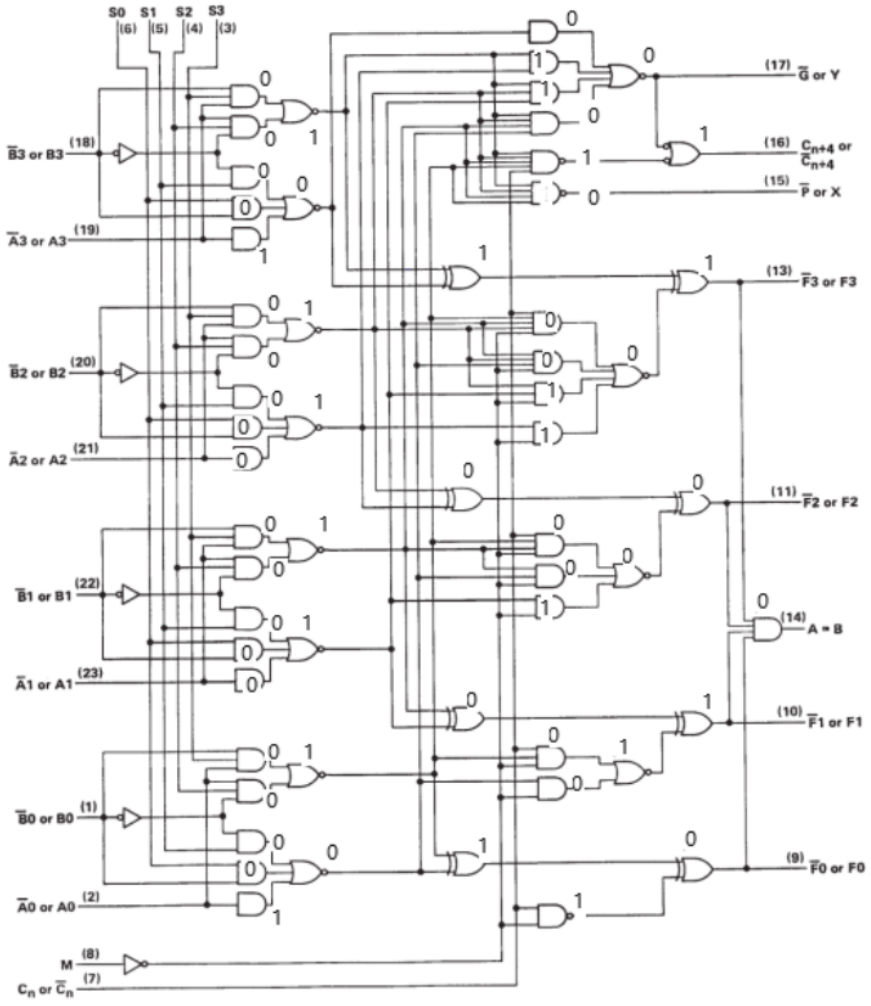
0111	0100	0	101	1011	0	1	0	0	0	0	1
1111	0100	0	101	0011	1	0	0	0	0	0	1
1011	0100	0	101	1111	0	0	0	0	0	0	1
1001	0100	0	101	1101	0	0	0	0	0	0	1
1000	0100	0	101	1100	0	0	0	0	0	0	1

Exercise 2: Study an Industrial ALU

1. A = [1001] A = [1100]
   F = A + 1 F = A + 1
   F = [1010] F = [1101]

Solution of 2.1 $A = [1001]$



2. A = [1001] F = A + B
   B = [1100] F = [10101]
3. A = [1001] F = A' + B
   B = [1100] F = [10010]

Part2

① $A = [1001]$ $A = [1100]$

$F = 1001 + 0001 = 1010$

$F = 1100 + 0001 = 1101$

② $A = [1001]$ $B = [1100]$

$\bar{A} = [0110]$

$F = A + B \longrightarrow 1001 + 1100 = 10101$

③ $F = 0110 + 1100 = 10010$

④ total number is 63 gates

⑤ max delay is 7 gates

Exercise 3: Describe the Circuit (BONUS)

Circuit Name: 4-bit ALU
8 Different Functions

1. Logic Functions (Only occur when S2 is equal to zero)

Output: LED's
Input: 4 bits
Uses a MUX

a) A AND B
    Occurs when S1 = 0
    Occurs when S0 = 0
b) A OR B
    Occurs when S1 = 0
    Occurs when S0 = 1
c) A XOR B
    Occurs when S1 = 1
    Occurs when S0 = 0
d) A XNOR B
    Occurs when S1 = 1
    Occurs when S0 = 1

2. Arithmetic Functions (Only occur when S2 is equal to one)

Output: 7 Segment Decoder
Input: 4 bits
Uses a MUX, C-Out and Overflow Indicator Included

a) A+1
    Occurs when S1 = 0
    Occurs when S0 = 0
    Occurs when C_in= 0
b) A+B
    Occurs when S1 = 0
    Occurs when S0 = 1
    Occurs when C_in = 0
c) A-B
    Occurs when S1 = 1
    Occurs when S0 = 0
    Occurs when C_in = 1
d) B-A
    Occurs when S1 = 1
    Occurs when S0 = 1
    Occurs when C_in = 1