INTRODUCTION TO DIGITAL SYSTEMS

SYSC2310 (Fall 2020)

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Lab 3: Answer Sheet

Exercise 1: Design an Arbitrary Function.

$P = \overline{A2}\,A1\,A0 + \overline{A3}\,\overline{A2}\,A1 + \overline{A3}\,A2\,A0 + A2\,\overline{A1}\,A0$

$D = \overline{A3}\,A2\,A0 + A3\,\overline{A2}\,\overline{A1} + A3\,\overline{A1}\,\overline{A0} + \overline{A3}\,\overline{A2}\,A1\,A0 + A3\,A2\,A1\,A0$

The total number of AND and OR gates is:

3-pin AND: 7 4-pin AND: 2 4-pin OR: 1 5-pin OR: 1

Exercise 2: BCD to 7-Segment Decoder (IC 7447)

$S_a = \overline{D2}\,\overline{D0} + D3 + D1 + D2\,D0$

$S_b = \overline{D2} + \overline{D1}\,\overline{D0} + D1\,D0$

$S_c = \overline{D1} + D0 + D2$

$S_d = \overline{D2}\,D0 + \overline{D2}\,D1 + D1\,\overline{D0} + D3 + D2\,\overline{D1}\,D0$

$S_e = \overline{D0}\,(\overline{D2} + D1)$

$S_f = \overline{D1}\,\overline{D0} + D2\,\overline{D0} + D2\,\overline{D1} + D3$

$S_g = D2\,\overline{D1} + D3 + \overline{D2}\,D1 + D1\,\overline{D0}$

The total number of AND and OR gates is:

2-pin AND: 14 3-pin AND: 1 4-pin OR: 3 3-pin OR: 2 5-pin OR: 1 2-pin OR: 1

Part 1A

SPSC2310 Lab 3 – Exercise 1 : PART 1A

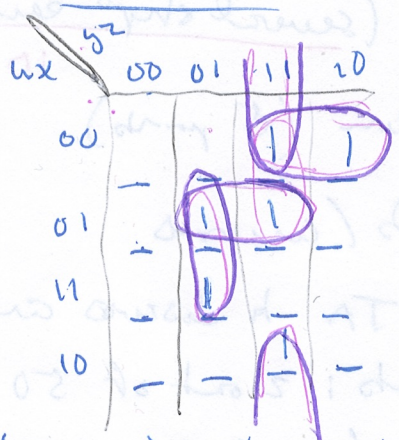
- Four inputs, 2 outputs
- let A3, A2, A1, A0 be w, x, y, z respectively

P { true, number is PRIME
  { false, if not PRIME

D { true, # divisible by 3 or 4
  { false, "

A3 w	A2 x	A1 y	A0 z	P	D
0	0	0	1	0	0
0	0	1	0	1	0
0	0	1	1	1	1
0	1	0	0	0	1
0	1	0	1	1	0
0	1	1	0	0	1
0	1	1	1	1	0
1	0	0	0	0	1
1	0	0	1	0	1
1	0	1	0	0	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	0	1	1	0
1	1	1	0	0	0
1	1	1	1	0	1

Function P

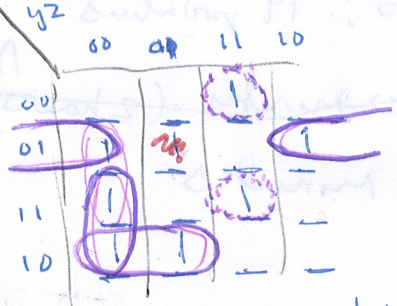


~~double pair~~
4 ~~2-terms~~ implicants
↳ 4 3-terms
Using SoP:

Using PoS:
- 2 terms
- 4 3 terms

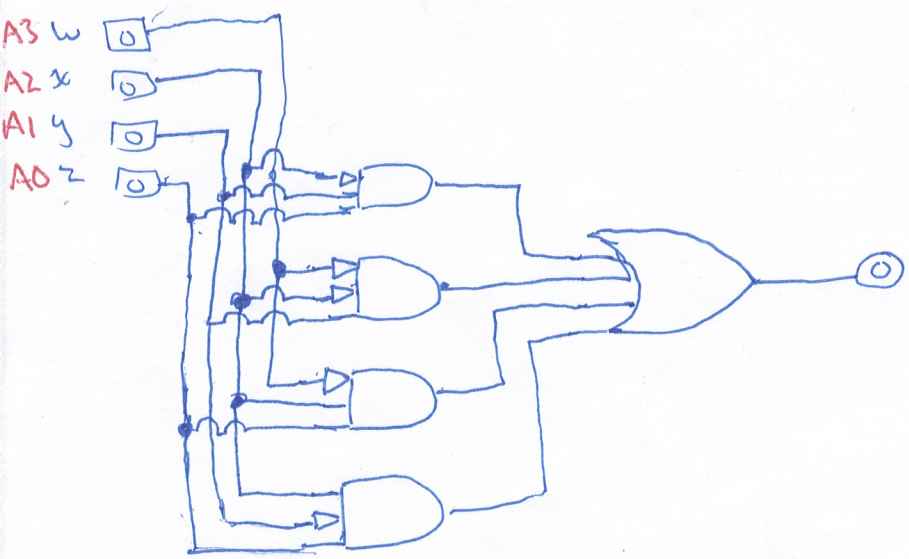
$P(w,x,y,z) = x'yz + w'x'y + w'xz + xy'z$

Function D



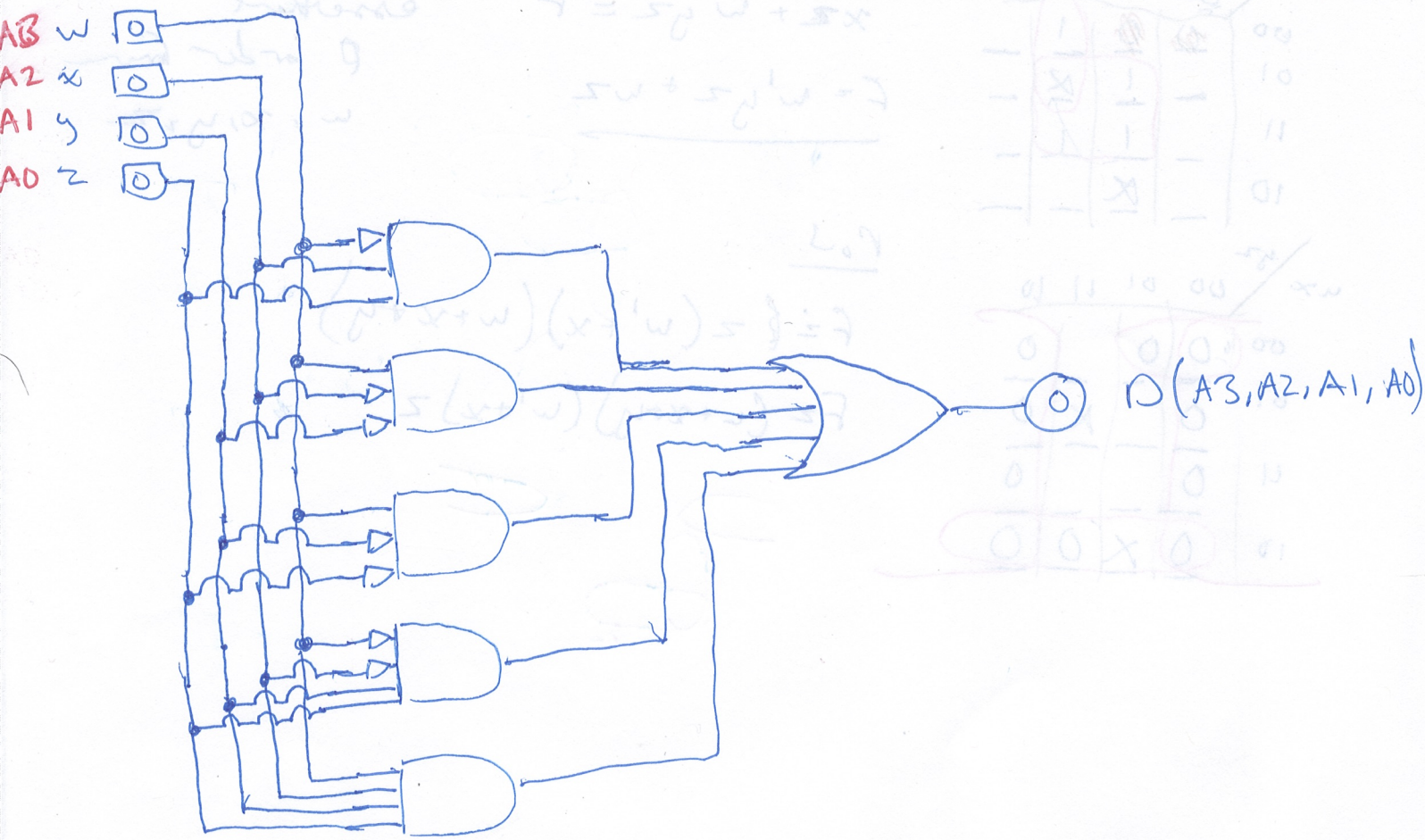
$D(w,x,y,z) = w'xz + wx'y' + wy'z' + w'x'yz + wxyz$

Function P Diagram

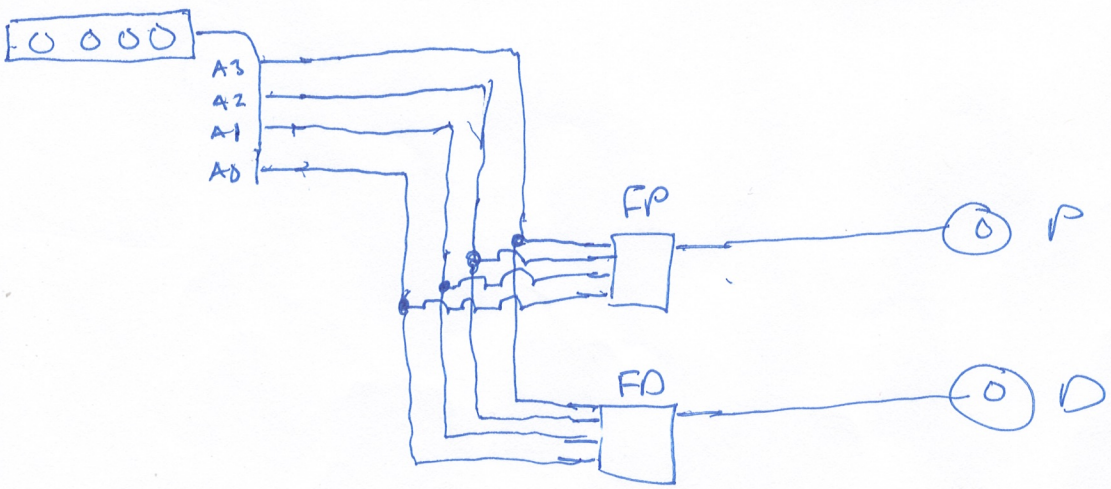


PART 1A

Function D diagram



Main Diagram



PART IA page 2

Counting the # of gates

3-pin input AND: 7

4-input AND: 2

4-input OR: 1

5-input OR: 1

PART 1A

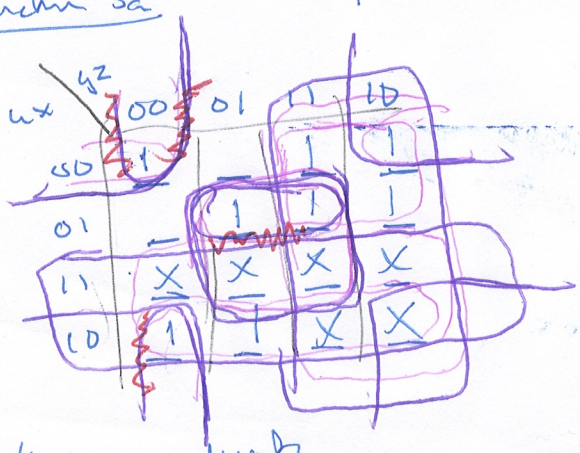
PART 2A

SYSC2310 - LAB3 - Exercise 2: PART 2A

- let w,x,y,z be D3, D2, D1, D0

D3 w	D2 x	D1 y	D0 z	Sa	Sb	Sc	Sd	Se	Sf	Sg
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1
1	0	1	0	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X
1	1	0	1	X	X	X	X	X	X	X
1	1	1	0	X	X	X	X	X	X	X
1	1	1	1	X	X	X	X	X	X	X

Finding Sa

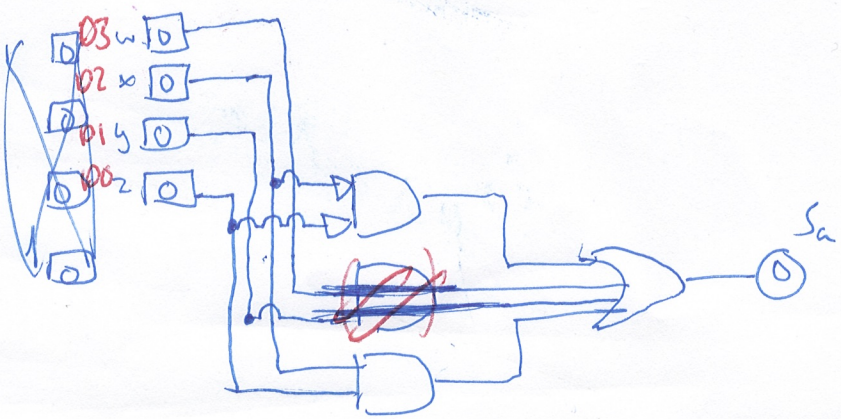


→ 4 prime implicants

Using SOP:

$S_a(w,x,y,z) = x'z' + w + y + xz$

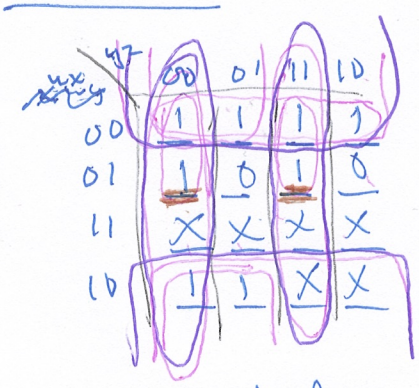
$S_a(D3,D2,D1,D0) = D2'D0' + D3 + D1 + D2D0$



PART 2A

page 1

Function S_b

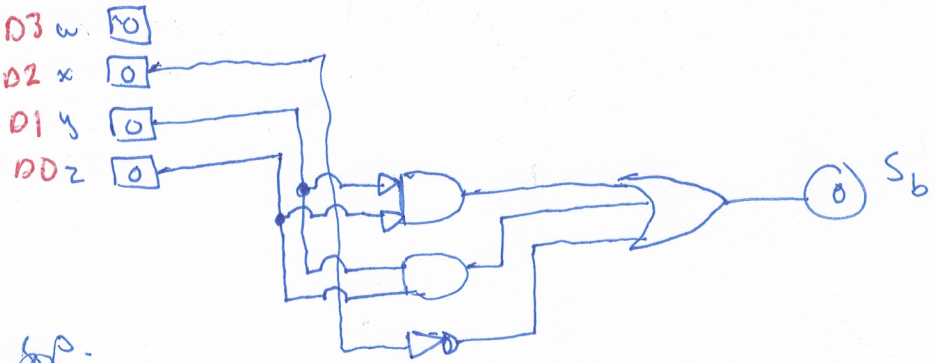


- 3 prime implicants

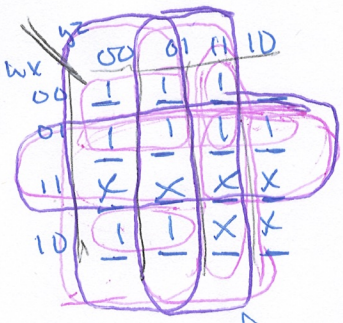
using SOP:

$S_b(w,x,y,z) = x' + y'z' + yz$

$S_b(D3,D2,D1,D0) = D2' + D1'D0' + D1D0$



Function S_c

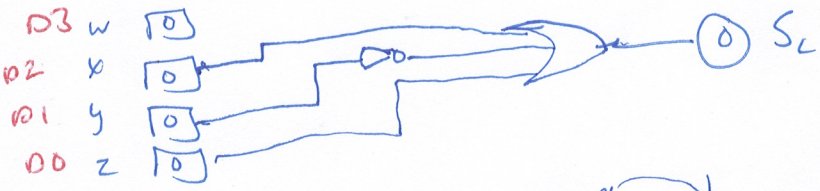


- 3 prime implicants

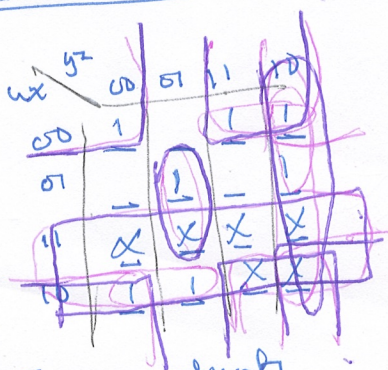
using SOP:

$S_c(w,x,y,z) = y' + z + x$

$S_c(D3,D2,D1,D0) = D1' + D0 + D2$



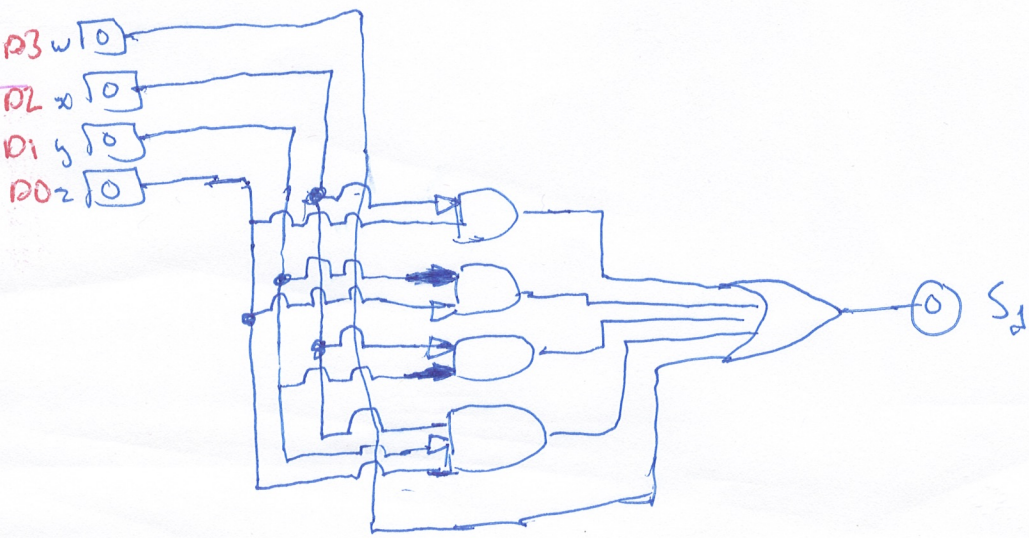
Function S_d



- 5 prime implicants

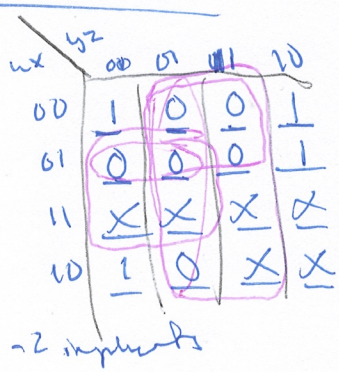
$S_d(w,x,y,z) = x'z + x'y + yz' + w + xy'z$

$S_d(D3,D2,D1,D0) = D2'D0 + D2'D1 + D1D0' + D3 + D2D1'D0$



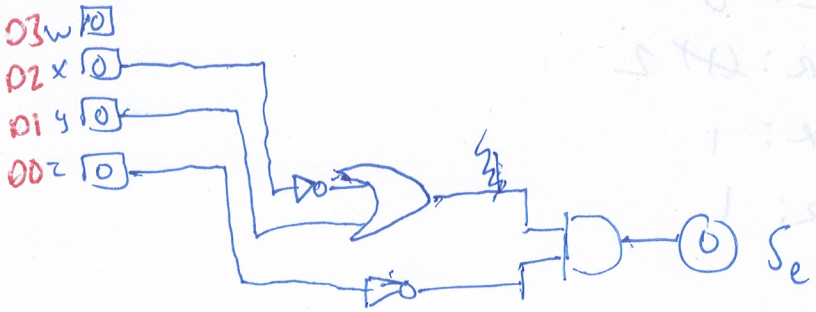
Function S_e

Using POS:

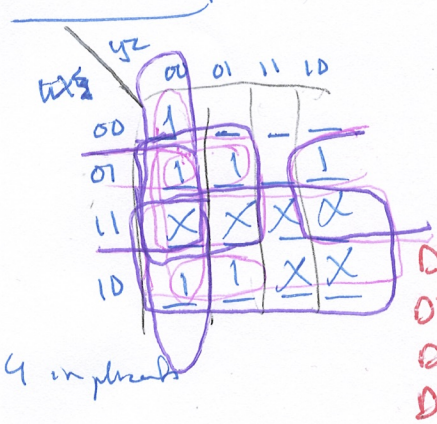


$S_e(w,x,y,z) = z'(x'+y)$

$S_e(D3,D2,D1,D0) = D0'(D2'+D1)$

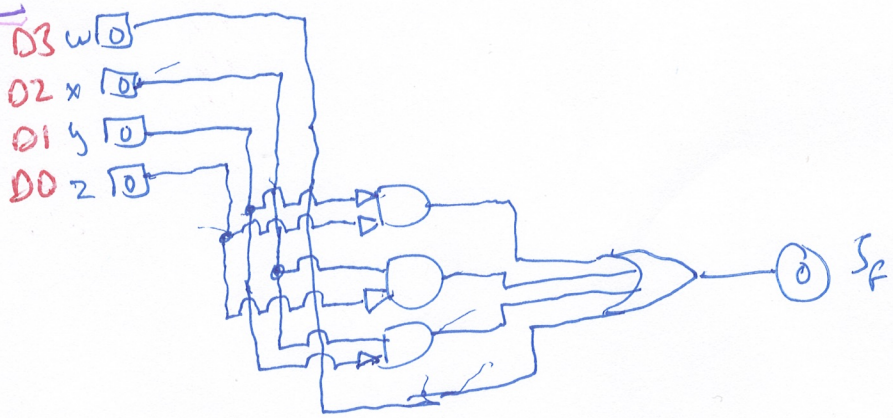


Function S_f

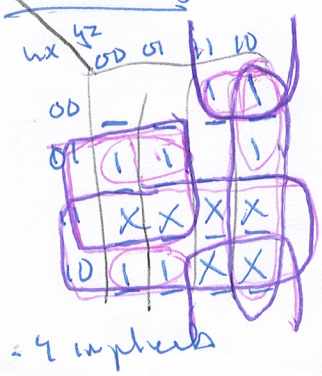


$S_f(w,x,y,z) = y'z' + xz' + xy' + w$

$S_F(D3,D2,D1,D0) = D1'D0' + D2D0' + D2D1' + D3$

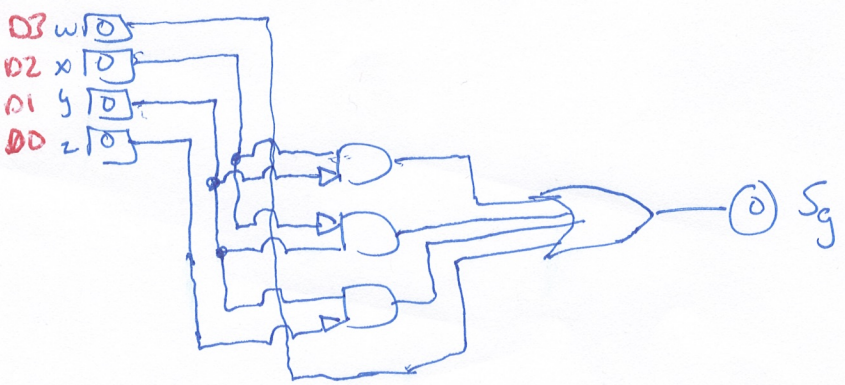


Function S_g



$S_g(w,x,y,z) = xy' + w + x'y + yz'$

$S_g(D3,D2,D1,D0) = D2D1' + D3 + D2'D1 + D1D0'$



PART 2 ✓ page 3

Counting # of gates:

2-input AND: 14

3-input AND: 1

4-input OR: 3

3-input OR: ~~1~~ 2

5-input OR: 1

2-input OR: 1