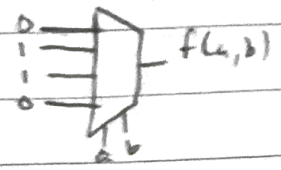
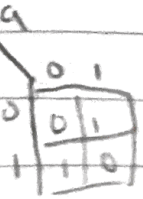
Homework 3

1a. 4:1 MUX $s1=a$ $s0=b$ $w0=0$, $w1=1$, $w2=1$, $w3=0$

a	b	f(a,b)
0	0	0
0	1	1
1	0	1
1	1	0

$f(a,b) = a'b + ab'$

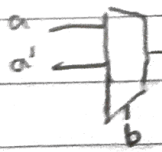


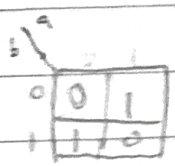


1b. 2:1 MUX $s = b$ $w0=a$ $w1=a'$

a	b	f(a,b)
0	0	0
0	1	1
1	0	1
1	1	0

$f(a,b) = ab' + a'b$

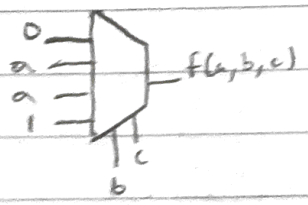


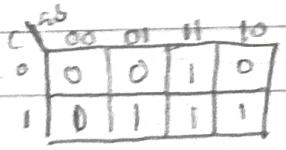


1c. $f(a,b,c)$ 4:1 MUX $s1=b$, $s0=c$, $w0=0$, $w1=a$, $w2=a$, $w3=1$

a	b	c	f(a,b,c)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$f(a,b,c) = ab'c + abc' + bc$

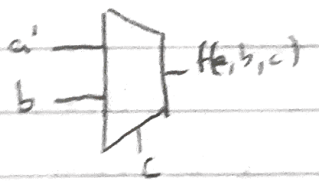


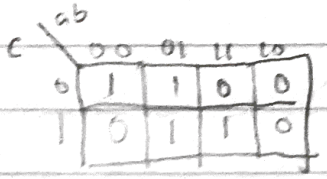


1d. $f(a,b,c)$ 2:1 MUX $s=c$, $w0=a'$ $w1=b$

a	b	c	f(a,b,c)
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

$f(a,b,c) = a'c' + bc$

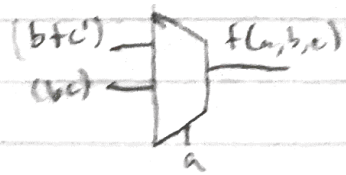


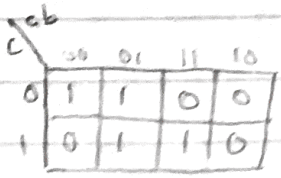


1e. $f(a,b,c)$ 2:1 MUX $s=a$ $w0=(b+c')$, $w1=(bc)$

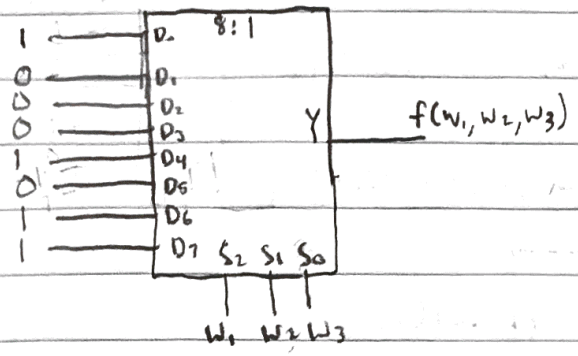
a	b	c	f(a,b,c)
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

$f(a,b,c) = a'(b+c') + abc$





2a. $f(W_1, W_2, W_3) = \Sigma m(0,4,6,7)$



2b.

W_1	W_2	W_3	$f(W_1, W_2, W_3)$
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

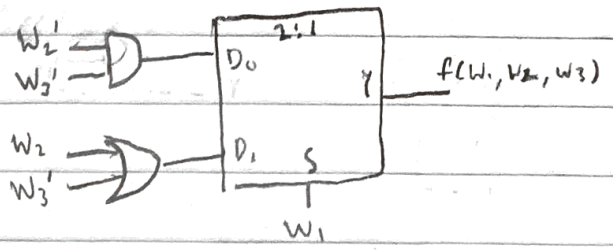
$f(0, W_2, W_3) = W_2'W_3'$

$f(1, W_2, W_3) = W_2'W_3' + W_2W_3' + W_2W_3$

$= W_2 + W_3'$

$f(W_1, W_2, W_3) = W_1' \cdot W_2'W_3' + W_1 \cdot (W_2 + W_3')$

$= W_1'W_2'W_3' + W_1(W_2 + W_3')$



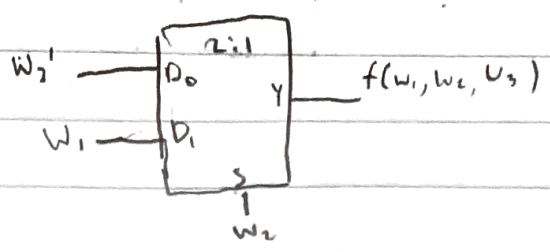
2c.

W_1	W_2	W_3	f
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

$f(W_1, 0, W_3) = W_1'W_3' + W_1W_3' = W_3'$

$f(W_1, 1, W_3) = W_1W_3' + W_1W_3 = W_1$

$f(W_1, W_2, W_3) = W_2' \cdot W_3' + W_1W_2$



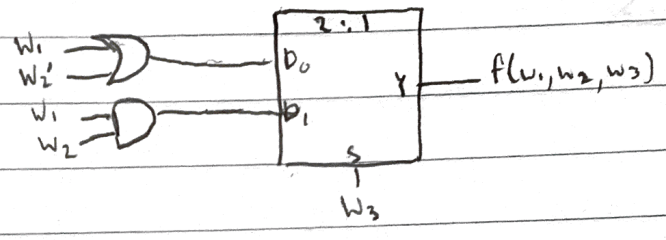
2d.

W_1	W_2	W_3	f
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

$f(W_1, W_2, 0) = W_1'W_2' + W_1W_2' + W_1W_2 = W_1 + W_2'$

$f(W_1, W_2, 1) = W_1W_2$

$f(W_1, W_2, W_3) = W_3' \cdot (W_1 + W_2') + W_3 \cdot W_1W_2$



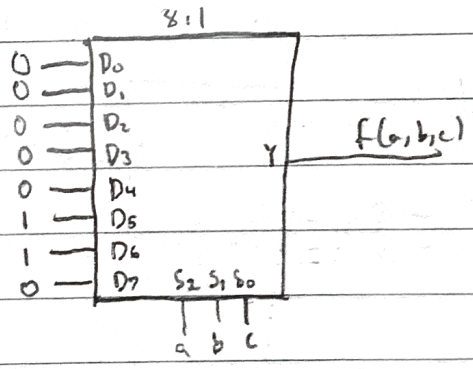
2e. b: 2 gates, 1 multiplexer, 7 inputs

c: 0 gates, 1 multiplexer, 3 inputs

d: 2 gates, 1 multiplexer, 7 inputs

3a. $f(a,b,c) = (ab) \oplus (ac)$

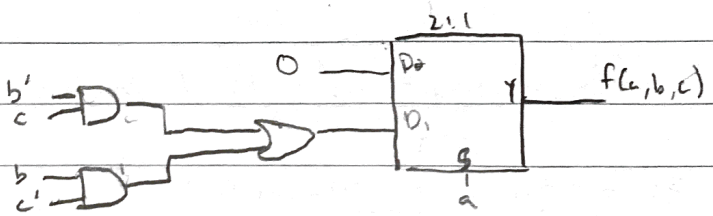
a	b	c	f(a,b,c)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0



3b. $f(0,b,c) = \emptyset$

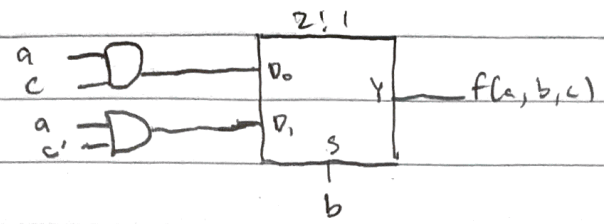
$f(1,b,c) = b'c + bc'$

$f(a,b,c) = a' \cdot 0 + a(b'c + bc')$



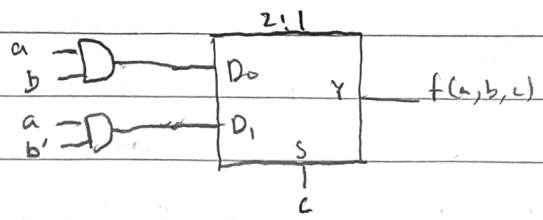
3c. $f(a, 0, c) = ac$

$f(a, 1, c) = ac'$ $\quad f(a,b,c) = ab'c + abc'$



3d. $f(a, b, 0) = ab$

$f(a, b, 1) = ab'$ $\quad f(a,b,c) = abc' + ab'c$

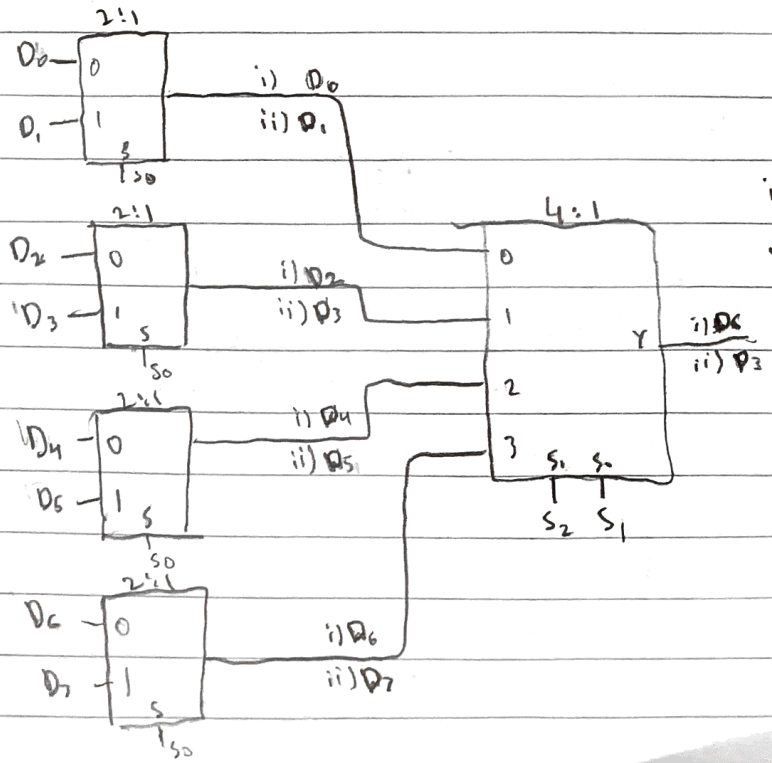


3e. b: 3 gates, 1 MUX, 8 inputs

c: 2 gates, 1 MUX, 7 inputs

d: 2 gates, 1 MUX, 7 inputs

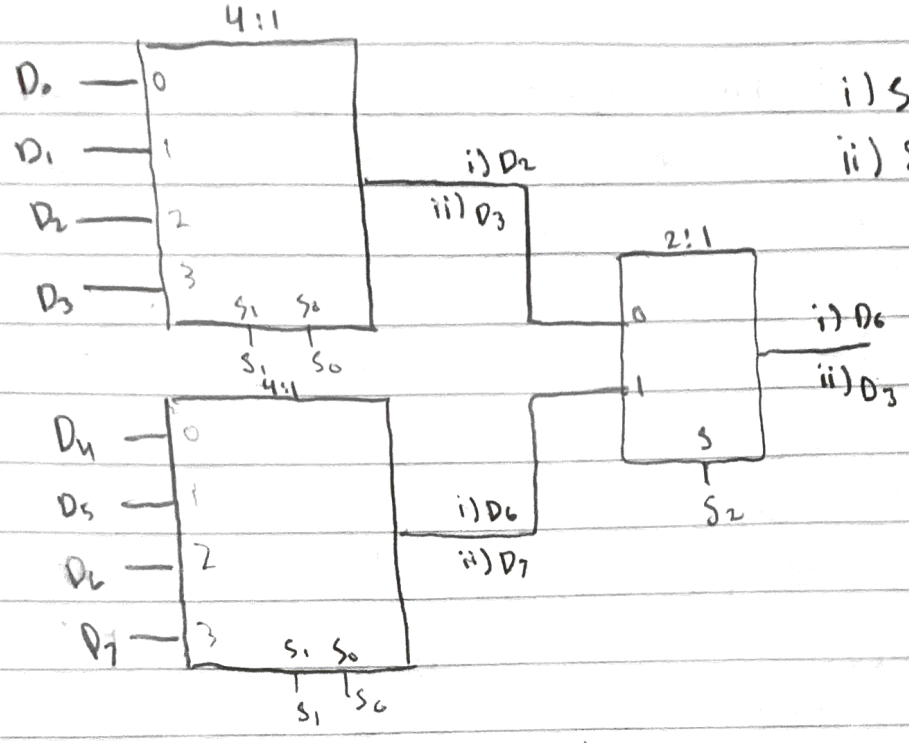
4a.



i) $S_2\ S_1\ S_0 = 110 \rightarrow D_6$

ii) $S_2\ S_1\ S_0 = 011 \rightarrow D_3$

4b.



i) $S_2S_1S_0 = 110 \rightarrow D_6$

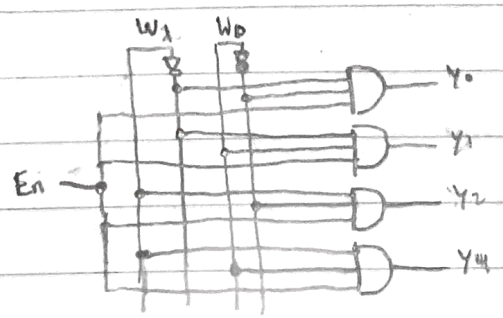
ii) $S_2S_1S_0 = 011 \rightarrow D_3$

4c. 4b & 4c both get the same final output.

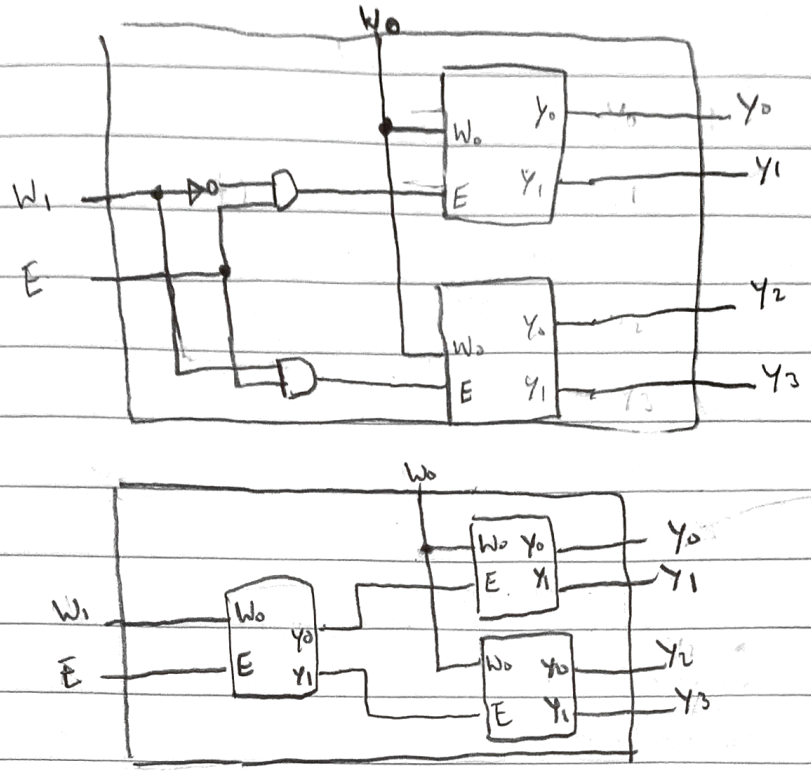
The number of inputs in the each systems is different. For 2:1 MUX in one 4:1 MUX has 12 inputs, while two 4:1 MUX to 2:1 MUX only has 10 inputs. The two 4:1 MUX to 2:1 MUX is better because less inputs which makes it easier to find the output of the system.

5a.

En	W_1	W_0	Y_0	Y_1	Y_2	Y_3
0	x	x	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1



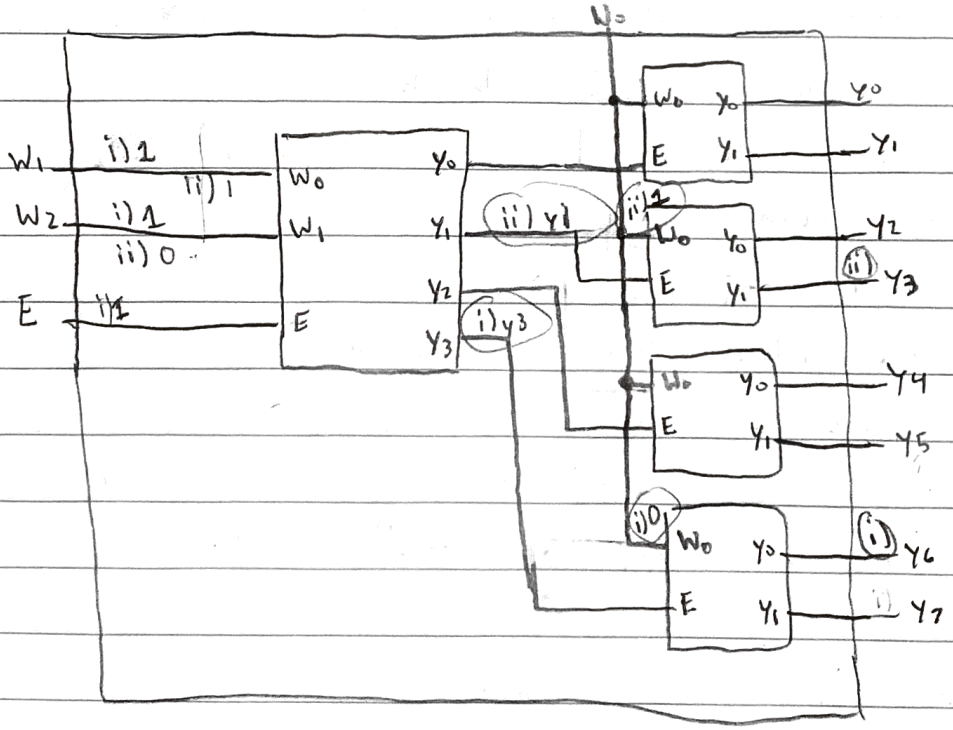
5b.



i) TW0 1:2 decoders are needed

ii) It is possible to create a 2:4 decoder using only 1:2 decoders. You will have three 1:2 decoders. The input for the enable for the second and third 1:2 decoders will be the output of the first 1:2 decoder.

5c.



i) $W_2 W_1 W_0 = 110 \rightarrow Y_6$

ii) $W_2 W_1 W_0 = 011 \rightarrow Y_3$

6a. $(101011)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$1 \times 32 + 0 \times 16 + 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 =$

$32 + 8 + 2 + 1 = (43)_{10}$

6b. $(0101011)_2$

6 5 4 3 2 1 0

64 32 16 8 4 2 1

$0\times64 + 1\times32 + 0\times16 + 1\times8 + 0\times4 + 1\times2 + 1\times1$

$32 + 8 + 3 = \boxed{(43)_{10}}$

6c. $(0011111)_2$

6 5 4 3 2 1 0

64 32 16 8 4 2 1

$0\times64 + 0\times32 + 1\times16 + 1\times8 + 1\times4 + 1\times2 + 1\times1$

$16 + 8 + 4 + 2 + 1 = \boxed{(31)_{10}}$

6d. $(1111100)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$1\times32 + 1\times16 + 1\times8 + 1\times4 + 0\times2 + 0\times1 = 32 + 16 + 8 + 4 = \boxed{(60)_{10}}$

6e. $(111110)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$1\times32 + 1\times16 + 1\times8 + 1\times4 + 1\times2 + 0\times1 = 32 + 16 + 8 + 4 + 2 = \boxed{(62)_{10}}$

7a. $(101011)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$-32 + 8 + 2 + 1 = \boxed{(-21)_{10}}$

7b. $(0101011)_2$

6 5 4 3 2 1 0

64 32 16 8 4 2 1

$32 + 8 + 2 + 1 = \boxed{(43)_{10}}$

7c. $(0\,0\,1\,1\,1\,1)_2$

6 5 4 3 2 1 0

64 32 16 8 4 2 1

$16 + 8 + 4 + 2 + 1 = \boxed{(31)_{10}}$

7d. $(1\,1\,1\,1\,0\,0)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$-32 + 16 + 8 + 4 = \boxed{(-4)_{10}}$

7e. $(1\,1\,1\,1\,1\,0)_2$

5 4 3 2 1 0

32 16 8 4 2 1

$-32 + 16 + 8 + 4 + 2 = \boxed{(-2)_{10}}$