Digital Electronics (EEEN20050)

Fergal Lonergan (13456938) Homework 1 Problem Set

1 a $(123.17)_{10}$ * Fraction repeats infinitely in Binary

Decimal to Binary

Integer	Remainder
123/2	1
~~61~~ 61/2	1
30/2	0
15/2	1
7/2	1
3/2	1
1/2	1 ↑
0	

Fraction	Integer
0.17 x2	0 ↓
0.34 x2	0
0.68 x2	1
0.36 x2	0
0.72 x2	1
0.44 x2	0
0.88 x2	1
0.76 x2	1
0.52 x2	1 ...

Decimal	Binary
$(123.17)_{10}$	$=(1111011.001010111...)_2$

Decimal to Hexadecimal

Integer	Remainder
123/16	B
7/16	7 ↑
0	

Fraction	Integer
0.17x16	2 ↓
0.72x16	B
0.52x16	8
0.32 x16	5
0.12 x16	1
...	

Decimal	Hexadecimal
$(123.17)_{10}$	$=(7B.2B851......)_{16}$

Fraction repeats infinitely in Hexadecimal

$(1063.5)_{10}$

Decimal to Binary

Integer	Remainder	Fraction	Integer
1063/2	1	0.5x2	1 ↓
531/2	1		
265/2	1		
132/2	0		
66/2	0		
33/2	1		
16/2	0		
8/2	0		
4/2	0		
2/2	0		
1/2	1 ↑		
0			

$$\boxed{\begin{array}{cc} \text{Decimal} & \text{Binary} \\ (1063.5)_{10} & =(10000100111.1)_2 \end{array}}$$

Decimal to Hexadecimal

Integer	Remainder	Fraction	Integer
1063/16	7	0.5x16	8 ↓
66/16	2		
4/16	4 ↑		
0			

$$\boxed{\begin{array}{cc} \text{Decimal} & \text{Hexadecimal} \\ (1063.5)_{10} & =(427.8)_{16} \end{array}}$$

b $(111010110001.011)_2$

Binary to Decimal

1	1	1	0	1	0	1	1	0	0	0	1	.	0	1	1
2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}

No need to multiply 0's.

$2^{11} + 2^{10} + 2^{9} + 2^{7} + 2^{5} + 2^{4} + 2^{0} + 2^{-2} + 2^{-3}$

$2048 + 1024 + 512 + 128 + 32 + 16 + 1 + 0.25 + 0.125 = 3761.375$

$(111010110001.011)_2 = (3761.375)_{10}$

Binary to Hexadecimal

Binary	1110	1011	0001	.	0110
Decimal	14	11	1	.	6
Hexadecimal	E	B	1	.	6

$(111010110001.011)_2 = (EB1.6)_{16}$

2a 011011010

One's compliment 100100101
for one's compliment change 1's to 0's and 0's to 1's

Two's Compliment 100100110
for two's compliment add 1 to one's compliment

b 010000101

One's compliment 10111010

Two's compliment 10111011
Similarly two's compliment can be found by taking the 1's compliment after the LSB.

3 $F(A,B,C,D) = B'D + A'D + BD$

Sum of minterms.

	A	B	C	D	F(A,B,C,D)	F'(A,B,C,D)
0	0	0	0	0	0	1
1	0	0	0	1	1	0
2	0	0	1	0	0	1
3	0	0	1	1	1	0
4	0	1	0	0	0	1
5	0	1	0	1	1	0
6	0	1	1	0	0	1
7	0	1	1	1	1	0
8	1	0	0	0	0	1
9	1	0	0	1	1	0
10	1	0	1	0	0	1
11	1	0	1	1	1	0
12	1	1	0	0	0	1
13	1	1	0	1	1	0
14	1	1	1	0	0	1
15	1	1	1	1	1	0

0 $(1\cdot 0)+(1\cdot 0)+(0\cdot 0)=0$

1 $(1\cdot 1)+(1\cdot 1)+(0\cdot 1)=1$

2 $(1\cdot 0)+(1\cdot 0)+(0\cdot 0)=0$

3 $(1\cdot 1)+(1\cdot 1)+(0\cdot 1)=1$

4 $(0\cdot 0)+(1\cdot 0)+(1\cdot 0)=0$

5 $(0\cdot 1)+(1\cdot 1)+(1\cdot 1)=1$

6 $(0\cdot 0)+(1\cdot 0)+(1\cdot 0)=0$

7 $(0\cdot 1)+(1\cdot 1)+(1\cdot 1)=1$

8 $(1\cdot 0)+(0\cdot 0)+(0\cdot 0)=0$

9 $(1\cdot 1)+(0\cdot 1)+(0\cdot 1)=1$

10 $(1\cdot 0)+(0\cdot 0)+(0\cdot 0)=0$

11 $(1\cdot 1)+(0\cdot 1)+(0\cdot 1)=1$

12 $(0\cdot 0)+(0\cdot 0)+(1\cdot 0)=0$

13 $(0\cdot 1)+(0\cdot 1)+(1\cdot 1)=1$

14 $(0\cdot 0)+(0\cdot 0)+(1\cdot 0)=0$

15 $(0\cdot 1)+(0\cdot 1)+(1\cdot 1)=1$

$f=(A'B'C'D)+(A'B'CD)+(A'BC'D)+(A'BCD)+(AB'C'D)+(AB'CD)+(ABC'D)+(ABCD)$

$f=\Sigma m(1,3,5,7,9,11,13,15)$

3 $F(A,B,C,D) = (B'D) + (A'D) + (BD)$

Sum of Maxterms

	A	B	C	D	F(A,B,C,D)	F'(A,B,C,D)
0	0	0	0	0	0	1
1	0	0	0	1	1	0
2	0	0	1	0	0	1
3	0	0	1	1	1	0
4	0	1	0	0	0	1
5	0	1	0	1	1	0
6	0	1	1	0	0	1
7	0	1	1	1	1	0
8	1	0	0	0	0	1
9	1	0	0	1	1	0
10	1	0	1	0	0	1
11	1	0	1	1	1	0
12	1	1	0	0	0	1
13	1	1	0	1	1	0
14	1	1	1	0	0	1
15	1	1	1	1	1	0

0	$(1\cdot 0)+(1\cdot 0)+(0\cdot 0)=0$	8	$(1\cdot 0)+(0\cdot 0)+(0\cdot 0)=0$
1	$(1\cdot 1)+(1\cdot 1)+(0\cdot 1)=1$	9	$(1\cdot 1)+(0\cdot 1)+(0\cdot 1)=1$
2	$(1\cdot 0)+(1\cdot 0)+(0\cdot 0)=0$	10	$(1\cdot 0)+(0\cdot 0)+(0\cdot 0)=0$
3	$(1\cdot 1)+(1\cdot 1)+(0\cdot 1)=1$	11	$(1\cdot 1)+(0\cdot 1)+(0\cdot 1)=1$
4	$(0\cdot 0)+(1\cdot 0)+(1\cdot 0)=0$	12	$(0\cdot 0)+(0\cdot 0)+(1\cdot 0)=0$
5	$(0\cdot 1)+(1\cdot 1)+(1\cdot 1)=1$	13	$(0\cdot 1)+(0\cdot 1)+(1\cdot 1)=1$
6	$(0\cdot 0)+(1\cdot 0)+(1\cdot 0)=0$	14	$(0\cdot 0)+(0\cdot 0)+(1\cdot 0)=0$
7	$(0\cdot 1)+(1\cdot 1)+(1\cdot 1)=1$	15	$(0\cdot 1)+(0\cdot 1)+(1\cdot 1)=1$

$f=(A+B+C+D)(A+B+C'+D)(A+B'+C+D)(A+B'+C'+D)(A'+B+C+D)(A'+B+C'+D)(A'+B'+C+D)(A'+B'+C'+D)$

$f=\prod M(0,2,4,6,8,10,12,14)$

4a $F(x,y,z) = \Sigma(0,2,6,7)$

This yields

$$F(x,y,z) = x'y'z' + x'yz' + xyz' + xyz$$

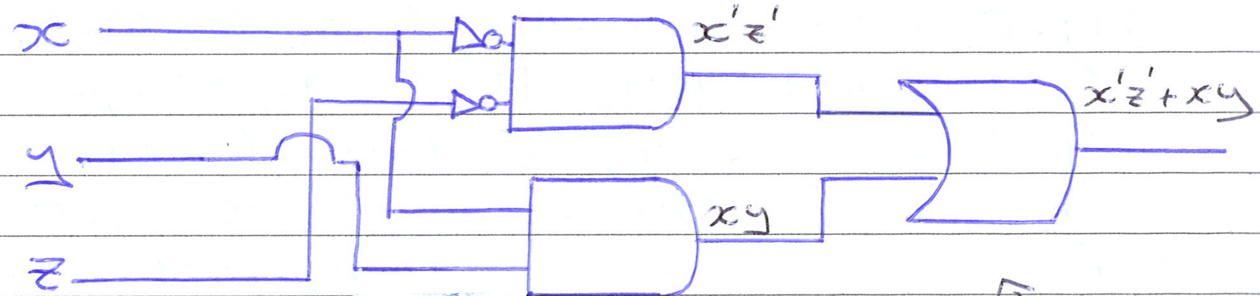
Karnaugh Map

$xy \backslash z$	0	1
00	① 1	0
01	1 ②	0
11	1	1
10	0	0

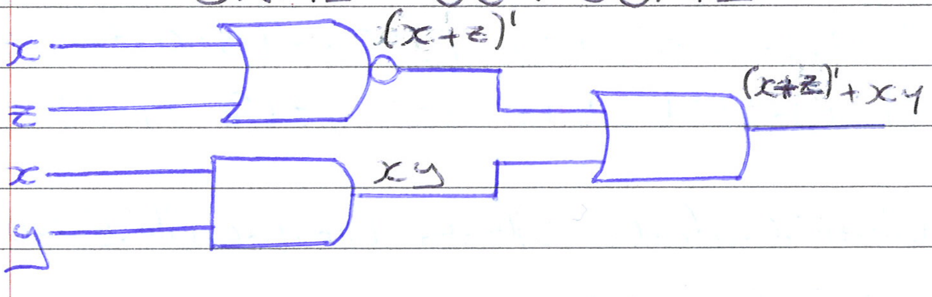
① $x'\cancel{y'}z'$
$x'\cancel{y}z'$
$x'z'$

② $xy\cancel{z'}$
$xy\cancel{z}$
xy

Therefore $F(x,y,z) = x'z' + xy$



SAME OUTCOME



b $F(A,B,C,D) = \Pi(1,3,6,9,11,12,14)$

	A	B	C	D		A	B	C	D
M_0	0	0	0	0	M_8	1	0	0	0
$\boxed{M_1}$	0	0	0	1	$\boxed{M_9}$	1	0	0	1
M_2	0	0	1	0	M_{10}	1	0	1	0
$\boxed{M_3}$	0	0	1	1	$\boxed{M_{11}}$	1	0	1	1
M_4	0	1	0	0	$\boxed{M_{12}}$	1	1	0	0
M_5	0	1	0	1	M_{13}	1	1	0	1
$\boxed{M_6}$	0	1	1	0	$\boxed{M_{14}}$	1	1	1	0
M_7	0	1	1	1	M_{15}	1	1	1	1

This yields

$$F(A,B,C,D) = (A+B+C+D')(A+B+C'+D')(A+B'+C'+D)(A'+B+C+D') + (A'+B+C'+D')(A'+B'+C+D)(A'+B'+C'+D)$$

Karnaugh map

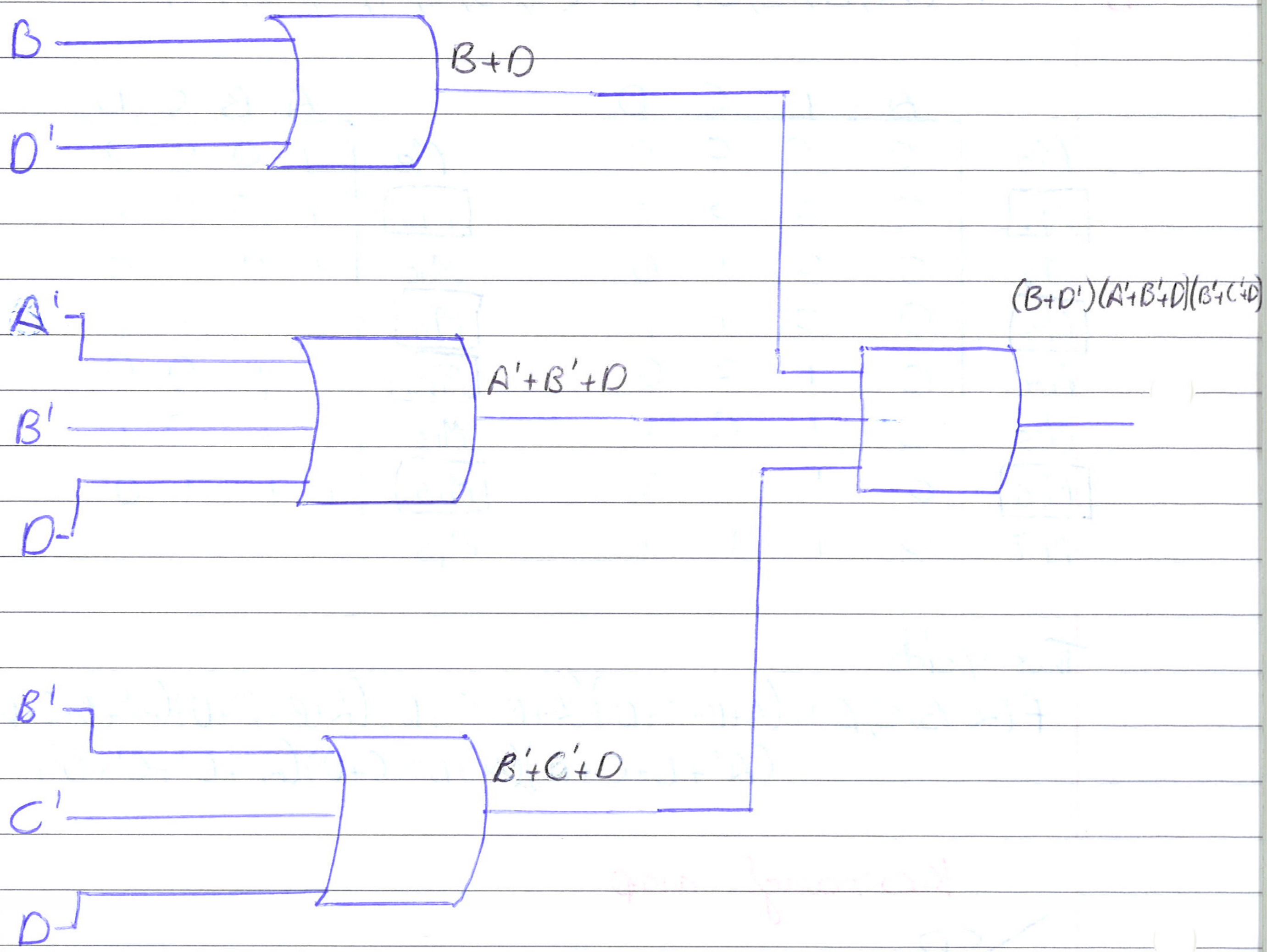
AB \ CD	00	01	11	10
00	1	0	0	1
01	1	1	1	0
11	0	1	1	0
10	1	0	0	1

(1)
$$\cancel{A}+B+\cancel{C}+D'$$
$$\cancel{A}+B+\cancel{C'}+D'$$
$$\cancel{A'}+B+\cancel{C}+D'$$
$$\underline{\cancel{A'}+B+\cancel{C'}+D'}$$
$$B+D'$$

(2)
$$A'+B'+\cancel{C}+D$$
$$\underline{A'+B'+\cancel{C'}+D}$$
$$A'+B'+D$$

(3)
$$A+B'+C'+D$$
$$\underline{A'+B'+C'+D}$$
$$B'+C'+D$$

$$\Rightarrow F(A,B,C,D) = (B+D')(A'+B'+D)(B'+C'+D)$$


B
D'
B+D
A'
B'
D
A'+B'+D
B'
C'
D
B'+C'+D
(B+D')(A'+B'+D)(B'+C'+D)

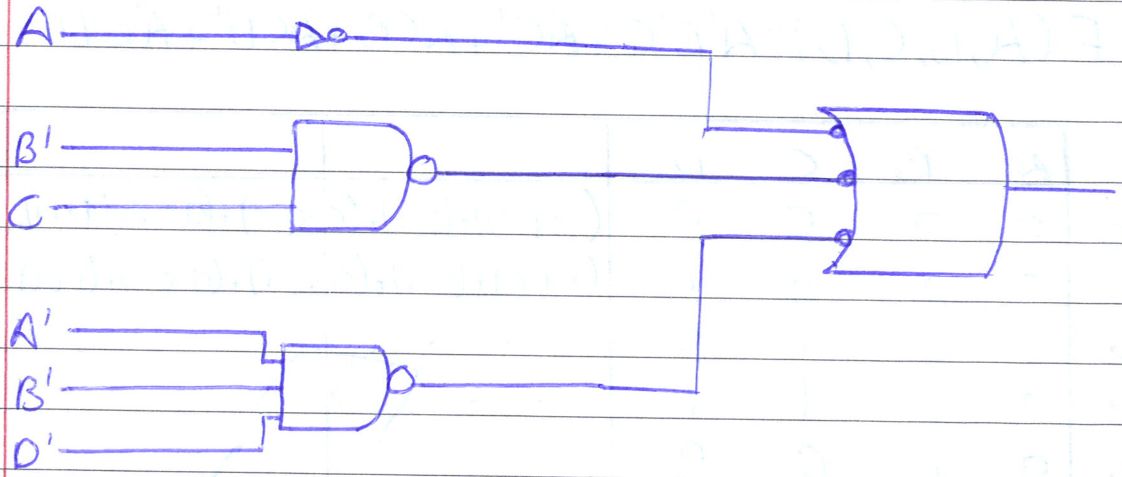
5a

$$F(A,B,C,D) = A'B'C + AC' + ACD + ACD' + A'B'D'$$

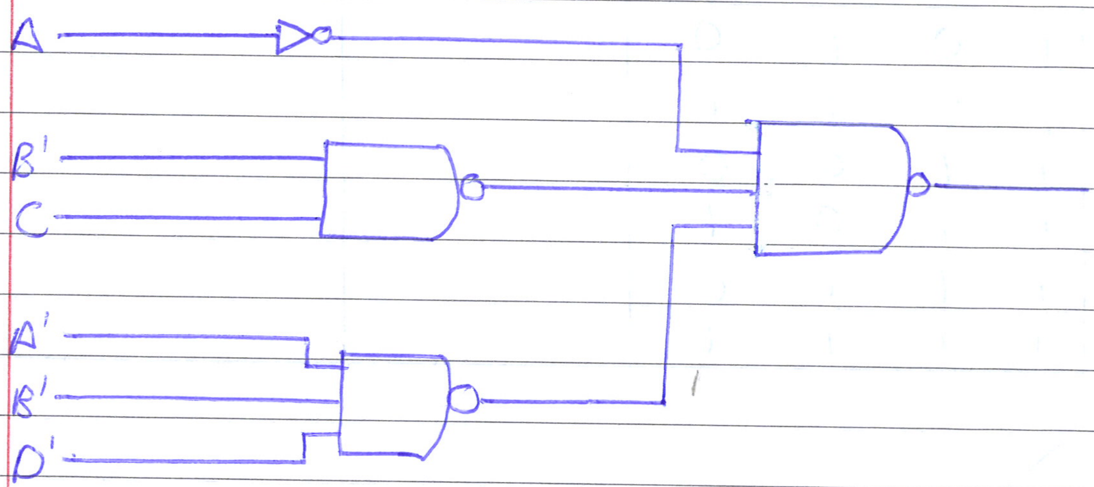
	A	B	C	D		F(A,B,C,D)
0	0	0	0	0	$(1\cdot1\cdot0)+(0\cdot1)+(0\cdot0\cdot0)+(0\cdot0\cdot1)+(1\cdot1\cdot1)$	1
1	0	0	0	1	$(1\cdot1\cdot0)+(0\cdot1)+(0\cdot0\cdot1)+(0\cdot0\cdot0)+(1\cdot1\cdot0)$	0
2	0	0	1	0	. . .	1
3	0	0	1	1	. . . ETC.	1
4	0	1	0	0		0
5	0	1	0	1		0
6	0	1	1	0		0
7	0	1	1	1		0
8	1	0	0	0		1
9	1	0	0	1		1
10	1	0	1	0		1
11	1	0	1	1		1
12	1	1	0	0		1
13	1	1	0	1		1
14	1	1	1	0		1
15	1	1	1	1		1

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

① = A ② = B'C ③ = A'B'D'



On the first level we put the inverters on the output.
We put them on the input for the 2nd level
=> No change to find output



b $F(A,B,C) = (A'+B'+C')(A'+B')(A'+C')$

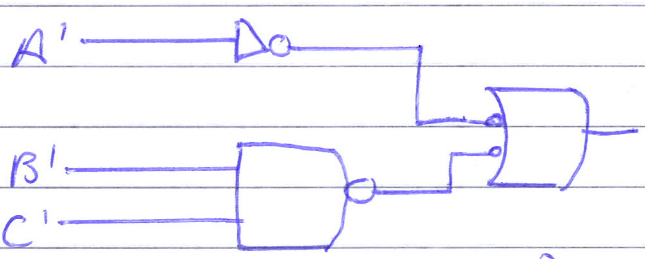
	A	B	C		
0	0	0	0	$(1+1+1)(1+1)(1+1)$	1
1	0	0	1	$(1+1+0)(1+1)(1+0)$	1
2	0	1	0	$(1+0+1)(1+0)(1+1)$	1
3	0	1	1	$(1+0+0)(1+0)(1+0)$	1
4	1	0	0	$(0+1+1)(0+1)(0+1)$	1
5	1	0	1	$(0+1+0)(0+1)(0+0)$	0
6	1	1	0	$(0+0+1)(0+0)(0+1)$	0
7	1	1	1	$(0+0+0)(0+0)(0+0)$	0

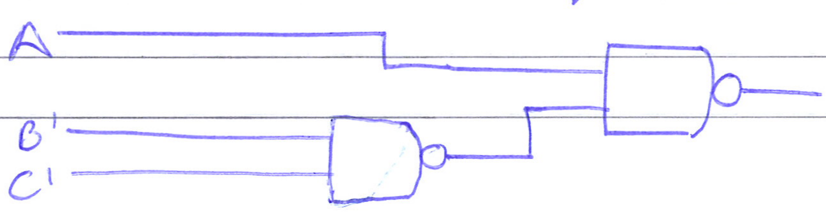
AB \ C	0	1
00	1	1
01	1	1
11	0	0
10	1	0

① $A'\cdot B'\cdot C'$
$A'\cdot B\cdot C'$
$A'\cdot B'\cdot C$
$A'\cdot B\cdot C$
A'

② $A'+B'+C'$
$AB'C'$
$B'C'$

$\Rightarrow F(A,B,C) = A' + B'C'$



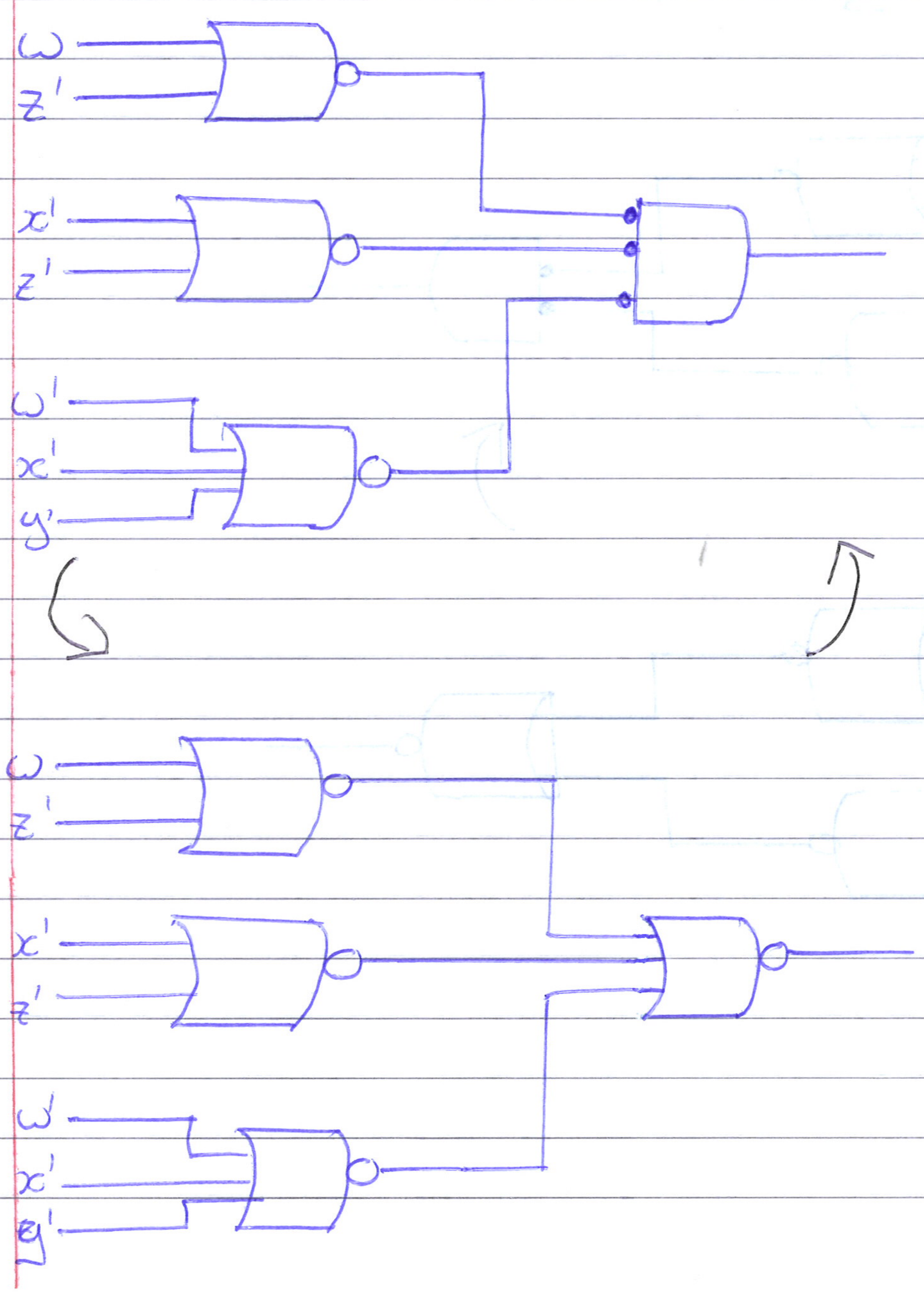


6a

$F = wx' + y'z' + w'yz'$

wx \ yz	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	0
10	1	1	1	1

① $(w + z')$ ② $(x' + z')$ ③ $(w' + x' + y')$



b

$F = [(x+y')(x'+z)]'$

$xy \backslash z$	0	1
00	1	1
01	0	0
11	1	0
10	1	0

① $x+y'$ ② $x'+z'$

$\Rightarrow F = (x+y')(x'+z')$