ECE 362 Homework 1 Solutions

1.1 **2.1** Function is true for binary 0101010101 and 1010101010

$\Sigma(341, 682)$

2.2

e1	x1	e2	x2	f
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	X
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	X
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

1.2 **2.3**

x	y	z	fa	fb
0	0	0	1	1
0	0	1	0	0
0	1	0	0	0
0	1	1	1	1
1	0	0	0	1
1	0	1	0	1
1	1	0	1	1
1	1	1	0	0

fa = x'y'z' + x'yz + xyz' (canonical sum)
= (x+y+z')(x+y'+z)(x'+y+z)(x'+y+z')(x'+y'+z') (canonical product)

fb = x'y'z' + x'yz + xy'z' + xy'z + xyz' (canonical sum)
= (x+y+z')(x+y'+z)(x'+y'+z') (canonical product)

2.4 b'c + acd' + a'c + eb' + e(a+c)(a'+d')
b'(c+e) + c(ad'+a') + e(a+c)(ad)'
b'(c+e) + c(a'+d') + e(a+c)(ad)'
b'(c+e) + c(ad)' + e(a+c)(ad)'
b'(c+e) + (c+ea+ec)(ad)'
b'(c+e) + (c+ea)(ad)'

1.3 2.6 **a** Prove by expanding to canonical sum and showing that they are equal

ab’ + bc’ + ca’
= ab’c + ab’c’ + abc’ + a’bc’ + a’bc + a’b’c

a’b + b’c + c’a
= a’bc + a’bc’ + ab’c + a’b’c + abc’ + ab’c’

b Show by derivation

ab + a’c + bcd
abc + abc’ + a’bc + a’b’c + bcd
bc(a+a’) + abc’ + a’b’c + bcd
bc + abc’ + a’b’c + ~~bcd~~
bc(a+a’) + abc’ + a’b’c
abc + abc’ + a’bc + a’b’c
ab + a’c

2.7 **a** f’ = (a+bc)’
= a’(bc)’
= a’(b’ + c’)
= a’b’ + a’c’

ff’ = (a+bc)(a’b’+a’c’)
= ~~aa’b’~~ + ~~aa’c’~~ + ~~a’bb’c~~ + ~~a’bcc’~~
= 0

b f’ = ((a+b)(a’c+d))’
= (a+b)’ + (a’c+d)’
= a’b’ + (a’c)’d’
= a’b’ + (a+c’)d’
= a’b’ + ad’ + c’d’

ff’ = (a+b)(a’c+d)(a’b’+ad’+c’d’)
= (~~aa’c~~+ad+a’bc+bd)(a’b’+ad’+c’d’)
= ~~aa’b’d~~ + ~~add’~~ + ~~ac’dd’~~ + ~~a’bb’c~~ + ~~aa’bcd’~~ + ~~a’bcc’d’~~ + ~~a’bb’d~~ + ~~abdd’~~ + ~~bc’dd’~~
= 0

c f’ = (ab+b’c+ca’d)’
= (ab)’(b’c)’(ca’d)’
= (a’+b’)(b+c’)(c’+a+d’)
= (a’b+a’c’+~~bb’~~+b’c’)(c’+a+d’)
= ~~a’bc’~~ + ~~aa’b~~ + a’bd’ + a’c’ + ~~aa’c’~~ + ~~a’c’d’~~ + b’c’ + ~~ab’c’~~ + ~~b’c’d’~~ (absorbtion)
= a’bd’ + a’c’ + b’c’

ff’ = (ab+b’c+ca’d)(a’bd’+a’c’+b’c’)
= ~~aa’bd’~~ + ~~aa’bc’~~ + ~~abb’c’~~ + ~~a’bb’cd’~~ + ~~a’b’cc’~~ + ~~b’cc’~~ + ~~a’bcdd’~~ + ~~a’cc’d~~ + ~~a’b’cc’d~~
= 0

1.4 **2.9** **a**

z1	z2	z3	w
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

b $\Sigma(3, 5, 6, 7)$

c w = z1z2 + z1z3 + z2z3

2.11 **a** f = x'y + xy'

b
(x⊕y)⊕z
(x'y+xy')⊕z
(x'y+xy')'z + (x'y+xy')z'
(x'y)'(xy')'z + x'yz' + xy'z'
(x+y')(x'+y)z + x'yz' + xy'z'
(~~xx'~~+xy+x'y'+~~yy'~~)z + x'yz' + xy'z'
xyz + x'y'z + x'yz' + xy'z'
x'(y'z+yz') + x(yz+y'z')
x'(y⊕z) + x((yz)'(y'z')')'
x'(y⊕z) + x((y'+z')(y+z))'
x'(y⊕z) + x(~~yy'~~+y'z+yz'+~~zz'~~)'
x'(y⊕z) + x(y⊕z)'
x⊕(y⊕z)

c If x⊕y = z,

x⊕z = x⊕(x⊕y) = (x⊕x)⊕y = 0⊕y = y

x⊕y⊕z = x⊕y⊕(x⊕y) = (x⊕x)⊕(y⊕y) = 0⊕0 = 0

d If xy = 0,

x⊕y
x'y + xy'
((x'y)'(xy')')'
((x+y')(x'+y))'
(~~xx'~~+xy+x'y'+~~yy'~~)'
(0+x'y')'
(x'y')'
x + y

e (a+b)⊕(a+c)
(a+b)'(a+c) + (a+b)(a+c)'
a'b'(a+c) + (a+b)a'c'
~~aa'b'~~ + a'b'c + ~~aa'c'~~ + a'bc'
a'(b'c+bc')
a'(b⊕c)

f x⊕y⊕xy
x'(y⊕xy) + x(y⊕xy)'
x'(~~y'xy~~+y(xy)') + x(~~y'xy~~+y(xy)')'
x'y(x'+y') + x(y'+xy)
x'y + ~~x'yy'~~ + xy' + xy
x + y

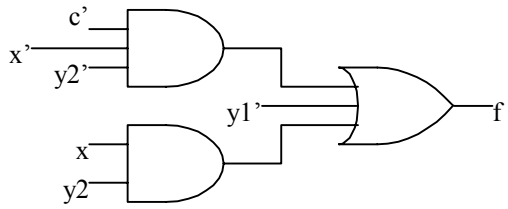
x⊕x'y
x'x'y + x(x'y)'
x'y + x(x+y')
x'y + x + xy'
x + y

1.5 3.1 **a** f = ((c+x+y2)y1(xy2)')'

Using DeMorgan's,

f = (c+x+y2)' + y1' + xy2
= c'x'y2' + y1' + xy2

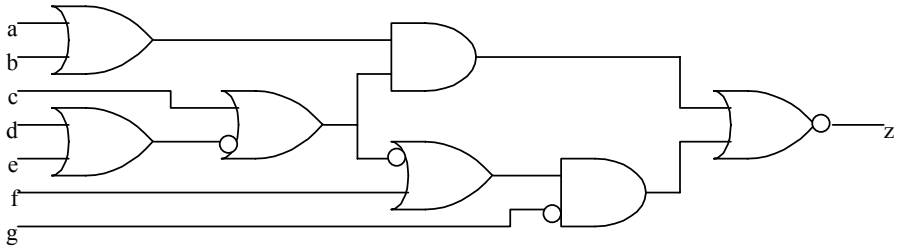
b There are several ways of interpreting this problem. Here is one possible solution:



c For the schematic in part b,

f = c'x'y2' + y1' + xy2

3.2 **a** There are several ways of interpreting this problem. Here is one possible solution:



b z = ((a'b')'(c'(d'e')')')'(((c'(d'e')')'f')'g')'

c (a'b'+c'(d'e')')((c'(d'e')')'f'+g)
(a'b'+c'(d+e))((c+d'e')f'+g)
(a'b'+c'd+c'e)(cf'+d'e'f'+g)
a'b'cf' + a'b'd'e'f' + a'b'g + ~~ce'df'~~ + ~~c'dd'e'f'~~ + c'dg + ~~ce'ef'~~ + ~~c'd'ee'f'~~ + c'eg
a'b'cf' + a'b'd'e'f' + a'b'g + c'dg + c'eg

d ((a'+b')'+(c'+(d'+e')')')' + (((c'+(d'+e')')'+f')'+g')'

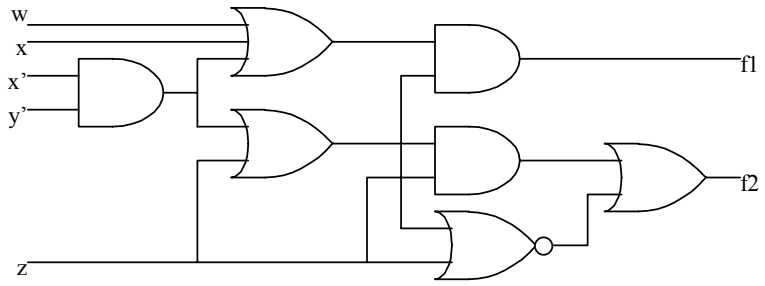
e ... skipping lots of algebra ...

a'c' + a'de + b'c' + b'de + cd'g + ce'g + f'g

Take the dual:

(a'+c')(a'+d+e)(b'+c')(b'+d+e)(c+d'+g)(c+e'+g)(f'+g)

1.6 3.5 There are several ways of interpreting this problem. Here is one possible solution:



f1 = (w+x+x'y')(z+x'y')

f2 = ((x+y)'+z)'⊕z
= ((x+y)'+z)'z' + (x'y'+z)z
= ((x+y)'+z)'z' + x'y'z + z
= z + (z+(x+y)')'
= z + (x+y)z'
= x + y + z

3.7 **a** (x1x2+x3)(x2+x4+x5) + x5 + x3x4

b x1x2 + x2x3 + x3x4 + ~~x3x5~~ + x5 + ~~x3x4~~
x1x2 + x2x3 + x3x4 + x5