

EC262 Problem Set 4 (Solutions)

Due: Friday 7 September 2012

Complete the following problems from the textbook *Digital Design with an Introduction to the Verilog HDL*, Mano and Ciletti, Fifth Edition.

Chapter 2

Problems: 2(bcd), 3(a,c,d), 9(a,b), 15, 17(c), 18, 22(a).

Problem 2: Simplify expressions

b. $(x + y)(x + y') = x$ P9b

c. $\begin{aligned} xyz + x'y + xyz' &= xy(z + z') + x'y \\ &= xy + x'y \\ &= y \end{aligned}$ P8a
P5a, P3b
P9a

d. $\begin{aligned} (A + B)'(A' + B')' &= (A'B')(AB) \\ &= (A'A)(B'B) = 0 \end{aligned}$ P11a

Problem 3: Simplify expressions

a. $\begin{aligned} ABC + A'B + ABC' &= AB(C + C') + A'B \\ &= AB + A'B \\ &= B \end{aligned}$ P8a
P5a, P3b
P9a

c. $\begin{aligned} (x + y)'(x' + y') &= x'y'(x' + y') \\ &= x'y'x' + x'y'y' \\ &= x'y' + x'y' \\ &= x'y' \end{aligned}$ P11a
P8a
P6b, P6b
P6a

d. $\begin{aligned} xy + x(wz + wz') &= xy + x(w(z + z')) \\ &= xy + wx \\ &= x(w+y) \end{aligned}$ P8a
P5a, P3b
P8a

Problem 9: Find the complement of

a. $\begin{aligned} F &= (xy' + x'y) \\ F' &= (xy' + x'y)' = (xy')'(x'y)' \\ &= (x' + y)(x + y') \\ &= x'y' + xy \end{aligned}$ P11a
P11b
P14a

$$b. F = (a + c)(a + b')(a' + b + c')$$

$$F' = [(a + c)(a + b')(a' + b + c')]' = (a + c)' + (a + b')' + (a' + b + c)'$$

$$= a'c' + a'b + ab'c$$

P11b

P11a

Problem 15: Simplify T_1 and T_2 from the truth table.

ABC	T1	T2
000	1	0
001	1	0
010	1	0
011	0	1
100	0	1
101	0	1
110	0	1
111	0	1

$$T_1 = A'B'C' + A'B'C + A'BC' = A'B'(C' + C) + A'C'(B' + B) \quad P8a$$

$$= A'B' + A'C'$$

$$= A'(B' + C') \quad P8a$$

$$T_2 = A'BC + AB'C' + AB'C + ABC' + ABC = BC(A' + A) + AB'(C' + C) + AB(C' + C) \quad P8a$$

$$= BC + AB' + AB$$

$$= BC + A(B' + B) \quad P8a$$

$$= A + BC$$

Problem 17: Obtain the truth table and express the function in sum of minterms and product of maxterms.

$$c. F = (c' + d)(b + c') = bc' + c' + bd + c'd$$

$$= (c' + c'd + bd)$$

$$= c' + bd$$

P8a

P 12a

P 12a

a b c d	F
0 0 0 0	1
0 0 0 1	1
0 0 1 0	0
0 0 1 1	0
0 1 0 0	1
0 1 0 1	1
0 1 1 0	0
0 1 1 1	1
1 0 0 0	1
1 0 0 1	1
1 0 1 0	0
1 0 1 1	0
1 1 0 0	1
1 1 0 1	1
1 1 1 0	0
1 1 1 1	1

Sum of minterms:

$$F = a'b'c'd' + a'b'c'd + a'bc'd' + a'bc'd + a'bcd + ab'c'd' + ab'c'd + abc'd' + abc'd + abcd$$

Product of maxterms:

$$F' = a'b'cd' + a'b'cd + a'bcd' + ab'cd' + ab'cd + abcd'$$

$$F = (a'b'cd' + a'b'cd + a'bcd' + ab'cd' + ab'cd + abcd)'$$

$$F = (a+b+c'+d) (a+b+c+d') (a+b+c'+d) (a'+b+c'+d) (a'+b'+c+d)$$

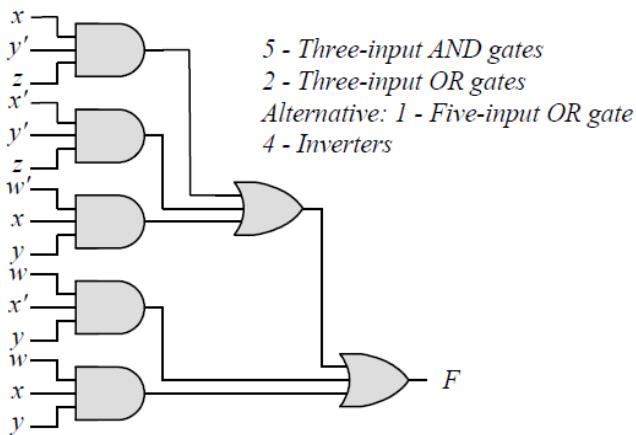
Problem 18:

$$F = xy'z + x'y'z + w'xy + wx'y + wxy$$

- a. Obtain a truth table

w x y z	F
0 0 0 0	0
0 0 0 1	1
0 0 1 0	0
0 0 1 1	0
0 1 0 0	0
0 1 0 1	1
0 1 1 0	1
0 1 1 1	1
1 0 0 0	0
1 0 0 1	1
1 0 1 0	1
1 0 1 1	1
1 1 0 0	0
1 1 0 1	1
1 1 1 0	1
1 1 1 1	1

- b. Draw the logic diagram



c. Simplify the function

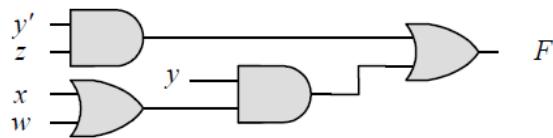
$$\begin{aligned}
 F &= xy'z + x'y'z + w'xy + wx'y + wxy = xy'z + x'y'z + w'xy + wx'y + wxy + wxy \quad P6a \\
 &= y'z(x + x') + xy(w + w') + wy(x + x') \quad P8a \\
 &= y'z + xy + wy \\
 &= y'z + y(w + x) \quad P8a
 \end{aligned}$$

d. Using truth table to show the simplified and the original expressions are the same.

$$F = y'z + xy + wy$$

w x y z	F
0 0 0 0	0
0 0 0 1	1
0 0 1 0	0
0 0 1 1	0
0 1 0 0	0
0 1 0 1	1
0 1 1 0	1
0 1 1 1	1
1 0 0 0	0
1 0 0 1	1
1 0 1 0	1
1 0 1 1	1
1 1 0 0	0
1 1 0 1	1
1 1 1 0	1
1 1 1 1	1

e. Draw the logic diagram for the simplified expression.



1 – Inverter, 2 – Two-input AND gates, 2 – Two-input OR gates

Problem 22: Convert each of the following expressions into SOP and POS.

$$\begin{aligned}
 a. (u + xw)(x + u'v) &= ux + uu'v + xxw + xwu'v \quad P8a \\
 &= ux + xw + xwu'v
 \end{aligned}$$

SOP	= ux + xw	P12a
POS	= x(u + w)	