

SANTA CLARA UNIVERSITY
Electrical Engineering Department

ELEN 21/COEN 21 Introduction to Logic Design – Spring 2014

Midterm Exam 1 solution
Total time: 60 minutes Total points: 25

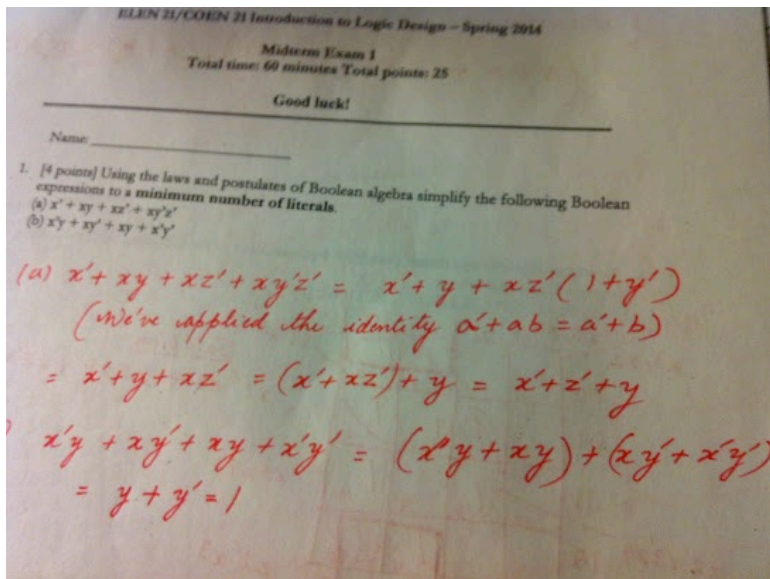
Good luck!

Name: _____

1. [4 points] Using the laws and postulates of Boolean algebra simplify the following Boolean expressions to a **minimum number of literals**.

(a) $x' + xy + xz' + xy'z'$

(b) $x'y + xy' + xy + x'y'$



2. [4 points] Express the following function in **sum of minterms** and **product of maxterms**.

$$F(x, y, z) = (xy + z)(xz + y)$$

Handwritten solution for problem 2:

(b) $x'y + xy' + xz + x'y' = (x'y + xy') + (xz + x'y')$
 $= y + y' = 1$

2. [4 points] Express the following function in sum of minterms and product of maxterms.
 $F(x, y, z) = (xy + z)(xz + y)$
 $= xyz + xz + xy + yz$

x	y	z	F	Minterms	Maxterms
0	0	0	0		$(x+y+z)$
0	0	1	0		$(x+y+z')$
0	1	0	0		$(x'+y+z')$
0	1	1	1	$x'y z$	$(x'+y+z)$
1	0	0	0		
1	0	1	1	$xy' z$	
1	1	0	1	xyz'	
1	1	1	1	xyz	$(x'+y'+z')$

Solution:
 $F = x'y z + xy' z + xyz' + xyz$
 $F = (x+y+z)(x+y+z')(x'+y+z)(x'+y+z')$

3. [2 points] Find the **complement** of the following expression using DeMorgan's theorem:

$$AB(C'D + CD') + A'B'(C' + D)(C + D')$$

3. [2 points] Find the **complement** of the following expression using DeMorgan's theorem:
 $[AB(C'D + CD') + A'B'(C' + D)(C + D')]'$
 $= (A' + B' + (C + D')(C' + D)) \cdot (A + B)(C'D')(C'D)$

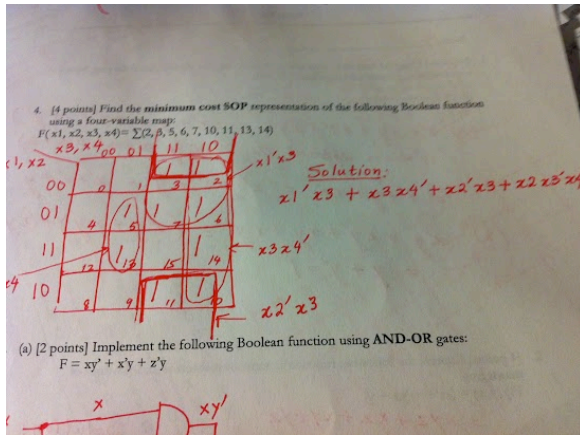
4. [4 points] Find the **minimum cost SOP** representation of the following Boolean function using a four-variable map:
 $F(x_1, x_2, x_3, x_4) = \sum(2, 3, 5, 6, 7, 10, 11, 13, 14)$

Handwritten solution for problem 4:

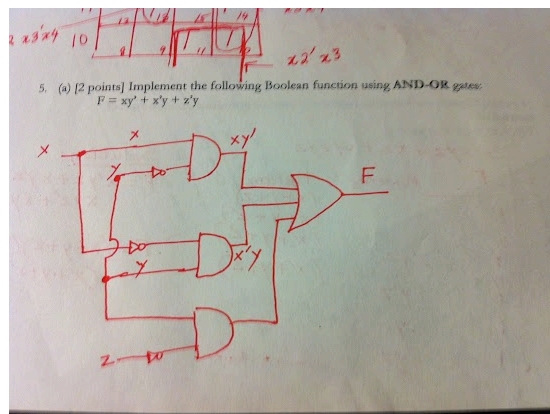
Solution:
 $x_1' x_3 + x_3 x_4' + x_2' x_3 + x_2 x_3'$

4. [4 points] Find the **minimum cost SOP** representation of the following Boolean function using a four-variable map:

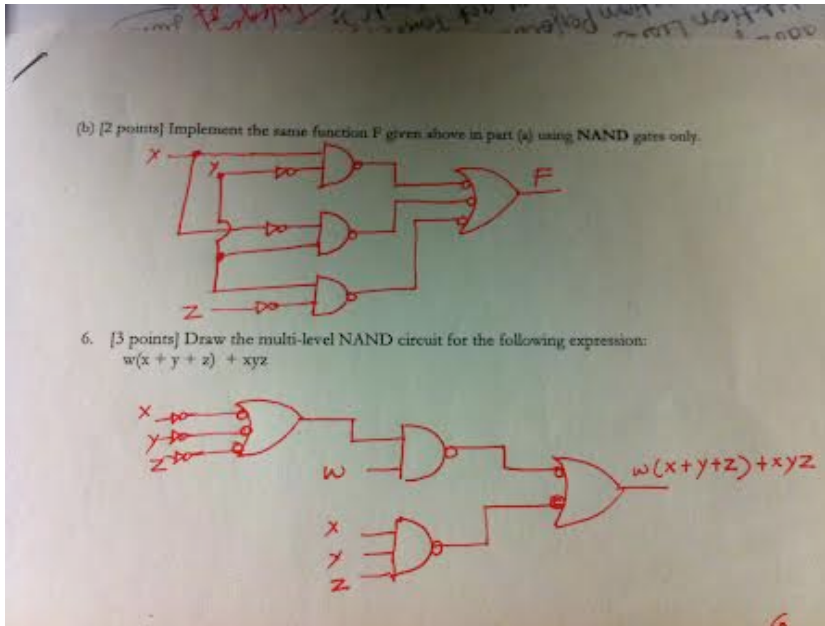
$$F(x_1, x_2, x_3, x_4) = \sum(2, 3, 5, 6, 7, 10, 11, 13, 14)$$



5. (a) [2 points] Implement the following Boolean function using **AND-OR** gates:
 $F = xy' + x'y + z'y$



- (b) [2 points] Implement the same function F given above in part (a) using **NAND** gates only.



6. [4 points] Implement the functions F and G shown in this table on a PLA:

A	B	C	D	F	G
0	0	0	0	1	0
0	0	0	1	0	0
0	0	1	0	0	1
0	0	1	1	0	0
0	1	0	0	0	0
0	1	0	1	1	0
0	1	1	0	1	1
0	1	1	1	1	1
1	0	0	0	0	0
1	0	0	1	0	0
1	0	1	0	X	X
1	0	1	1	X	X
1	1	0	0	X	X
1	1	0	1	X	X
1	1	1	0	X	X
1	1	1	1	X	X

7. [4 points] Implement the functions F and G shown in this table on a PLA:

A	B	C	D	F	G
0	0	0	0	1	0
0	0	0	1	0	0
0	0	1	0	0	1
0	0	1	1	0	0
0	1	0	0	0	0
0	1	0	1	1	0
0	1	1	0	1	1
0	1	1	1	1	1
1	0	0	0	0	0
1	0	0	1	0	0
1	0	1	0	X	X
1	0	1	1	X	X
1	1	0	0	X	X
1	1	0	1	X	X
1	1	1	0	X	X
1	1	1	1	X	X

F

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

G

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

$$F = A'B'C'D' + BD + BC \quad G = BC + CD'$$

