CS m51A: Logic Design of Digital Systems
UCLA Computer Science Department
Winter 2010
Midterm 1

Time: 100 minutes
Note: Closed book, closed notes, no electronic computing or communications devices.

Name: Angelina Huang

Student ID: 803657204

Question	Points	Grades
1	15	15
2	15	15
3	15	14
4	20	20
5	20	18
6	15	15
Total	100	97

"The best way to predict the future is to invent it."
-Alan Kay

Question 1: Number System Conversion

Find the value of x in the following equations. Show your work for credit.

a) $BCE0_{16} = x_4$

11 12 14

1011 1100 1110 0000 → $BCE0_{16}$

$x_4 = 23303200_4$ ✓

$11 \times 16^3 + 12 \times 16^2 + 14 \times 16 + 0 \times 16^0$

45056 + 3072 + 224 + 0

= 48352

48352 ÷ 4 = 12088; 12088 ÷ 4 = 3022; 3022 ÷ 4 = 755 r 2; 755 ÷ 4 = 188 r 3; 188 ÷ 4 = 47 r 0; 47 ÷ 4 = 11 r 3; 11 ÷ 4 = 2 r 3; 2 ÷ 4 = 0 r 2

b) $251_8 = x_6$

251_8

$2 \times 8^2 + 5 \times 8^1 + 1 \cdot 8^0$

128 + 40 + 1

= 169

169 ÷ 6 = 28 r 1; 28 ÷ 6 = 4 r 4; 4 ÷ 6 = 0 r 4

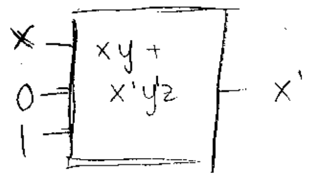
$x_6 = 441_6$ ✓

Question 2: Universal Set

Prove that the operation represented by the switching expression xy+x'yż is universal. You can use the constants 1 and 0.

$(a+b)' = a'b'$

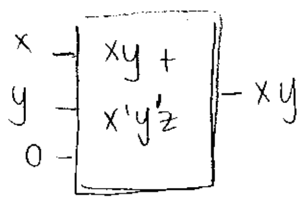
$xy + x'y\dot{z}$ is universal



NOT

$x \cdot 0 + x' \cdot 1 \cdot 1 =$

$0 + x' = x'$



AND

$x \cdot y + x' \cdot y' \cdot 0 = xy$

since {AND, NOT}, which is a universal set, can be formed from $xy + x'y\dot{z}$, then the switching expression $xy + x'y\dot{z}$ must be universal as well.

Question 3: Boolean Algebra

a) Simplify the following switching expression, using Boolean algebra. Show your work for credit.

f = ((a'+b)'(c+ab'+ad')'+d')'

$f = ((a'+b)'(c+ab'+ad')'+d')'$

$c + a(b'+d)$

$= ((ab')(c+ab'+ad')'+d')'$

$= [(ab')[c+a(b'+d')]'+d']'$

$[(ab')[c' \cdot [a(b'+d')]']+d']$

$= [(ab')[c' \cdot [a'+(b'+d')']]+d']$

$= [(ab')[c' \cdot (a'+bd)]+d']$

$= [(ab')(a'c'+bc'd)+d']$

$= (aa'b'c'+ab'bc'd+d')$

$a \cdot a' = 0$

$b' \cdot b = 0$

$= 0 \cdot b'c' + a \cdot 0 \cdot c'd + d'$

$= 0+0+d'$

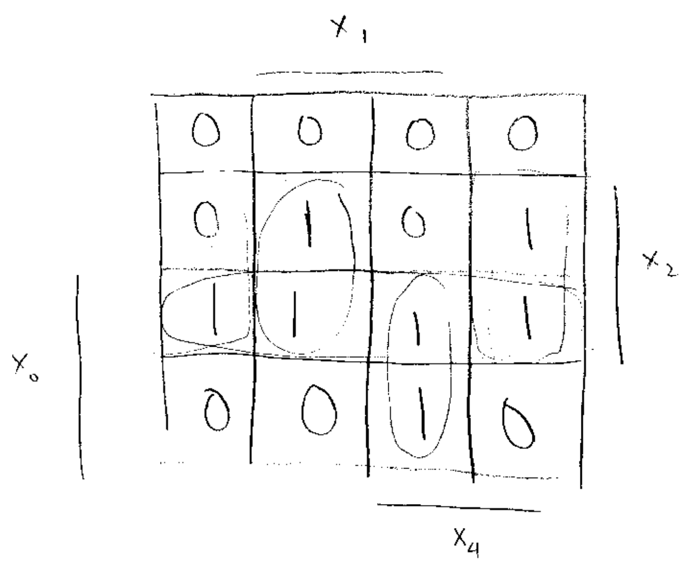
$\boxed{= d'}$

Complement Missed

(−1)

Question 4:
Give an example of a function of four variables with four prime implicants and seven minterms. For credit, provide the K-map, showing the prime implicants.

$\Sigma m: (3, 6, 10, 11, 13, 14, 15)$



$Z = X_0X_2 + X_1X_2X_4' + X_0X_1X_4 + X_1'X_2X_4$

minterms:

0110	6
0011	3
1010	10
1110	14
1111	15
1011	11
1101	13

Question 5: NOR-NOR network

Give a minimal NOR-NOR network that implements the subtraction of x from y,

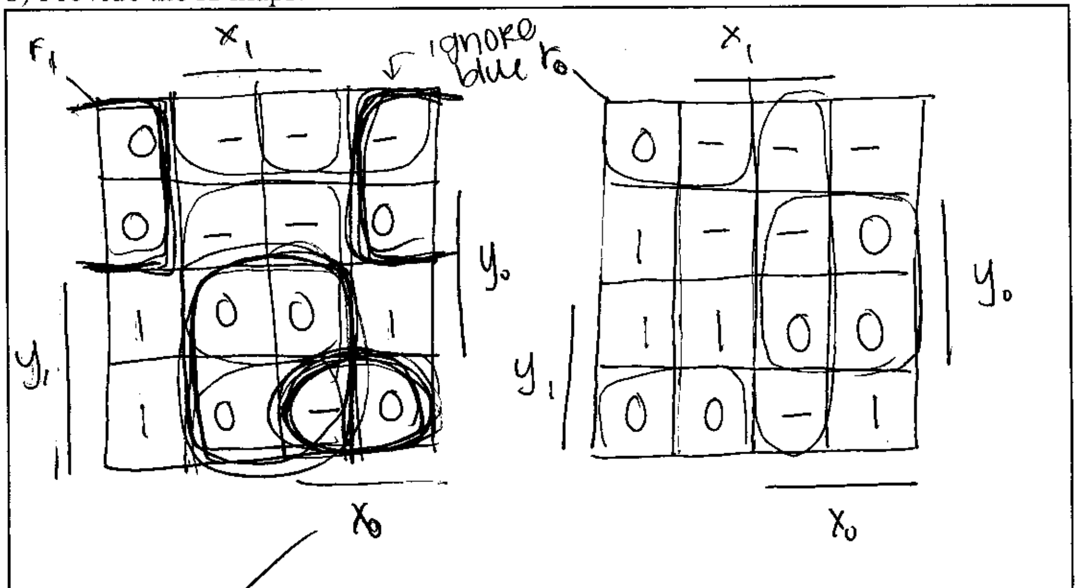
y(y1,y0) - x(x1,x0) = r(r1,r0).

For example if x=10 and y=11, then r=01. Assume that an input where x is greater than y is never given.

a) Provide the truth table.

$y_1 y_0$	$x_1 x_0$	$r_1 r_0$	
00	00	00	0-0=0
01	00	01	1-0=1
01	01	00	1-1=0
10	00	10	2-0=2
10	01	01	2-1=1
10	10	00	2-2=0
11	00	11	3-0=3
11	01	10	3-1=2
11	10	01	3-2=1
11	11	00	3-3=0

b) Provide the K-maps.



c) Provide the switching expressions.

$r_1 = (y_1 + x_1)(x_1' + y_1')(y_1' + x_0' + y_0)$

$r_1 = (x_1 + y_1)(x_1' + y_1')(x_0' + y_0 + y_1')$ X -2

$r_0 = (y_0 + x_0)(x_0' + y_0')$

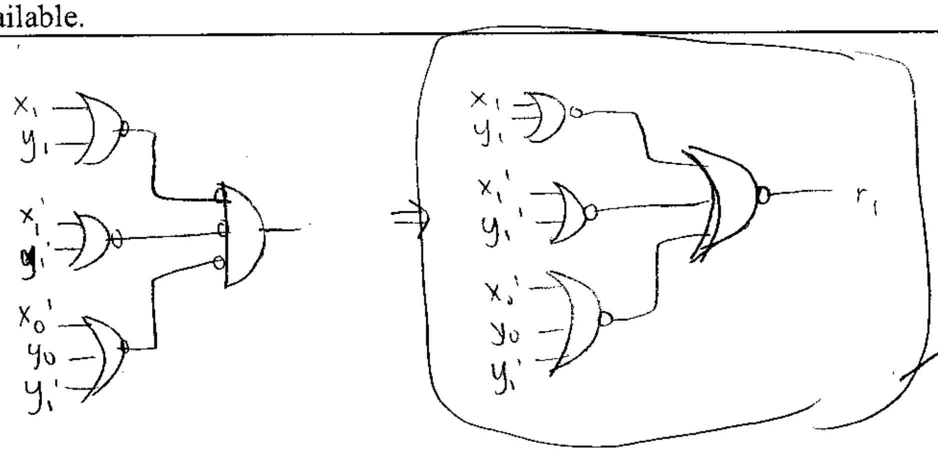
$r_0 = (x_0 + y_0)(x_0' + y_0')$ ✓

d) Provide a minimal NOR-NOR network. Assume you have the negation of the input bits available.

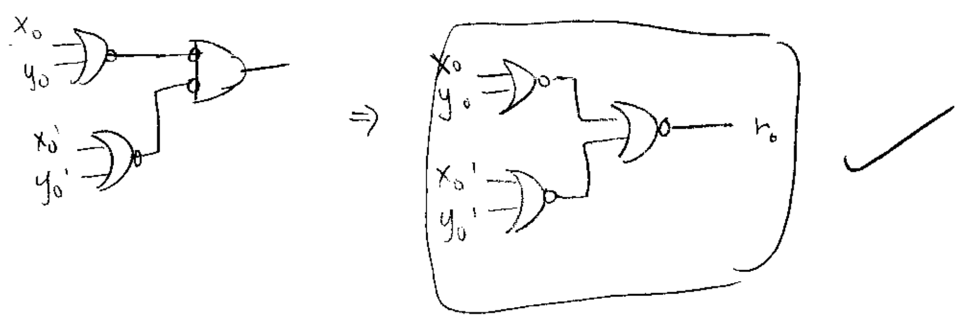
$a'b'c'$

$(a+b+c)'$

r_1



r_0



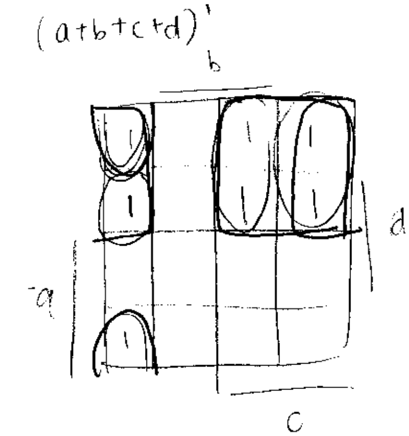
✓

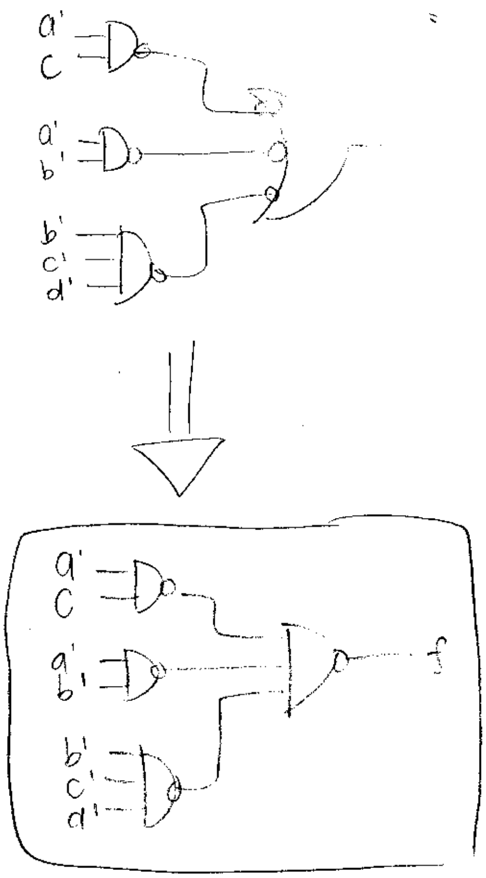
Question 6:

Give a minimal NAND-NAND implementation for the following function

f=a'b'c+b'c'd'+a'b'c'd+a'bc

For credit, show your work. Assume you have the negation of the input bits available.





minimal:

$a'c + a'b' + b'c'd'$