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First Last

Student ID # [redacted]

University of California

Los Angeles

Computer Science Department

CSM51A/EEM16 Midterm Exam #1

Fall Quarter 2012

October 24th 2012

This is a closed book exam. Absolutely nothing is permitted except pen, pencil and eraser to write your solutions. Any academic dishonesty will be prosecuted to the full extent permissible by university regulations.

Time allowed 100 minutes.

Problem (possible points)	Points
1 (20)	20
2 (20)	20
3 (20)	20
4 (20)	20
5 (20)	20
Total (100)	100

Problem 1 (10+10 points)

Find x and y such that the following conditions are satisfied:

a) $3874638058_9 = x_{27}$

b) $23_7 + 43_9 = y_{12}$

367_8

011 110 111

a) $3^1 = 3 \quad 3^2 = 9 \quad 3^3 = 27$

$[10|222|111|201|022|001|222]_3$

3 26 13 19 8 1 26

$x_{27} = 3QDJ81Q_{27}$

b) $y_{10} = 2 \cdot 7 + 3 \cdot 7^0 + 4 \cdot 9 + 3 \cdot 9^0 = 14 + 3 + 36 + 3 = 56_{10}$

56

4 (8

0 (4

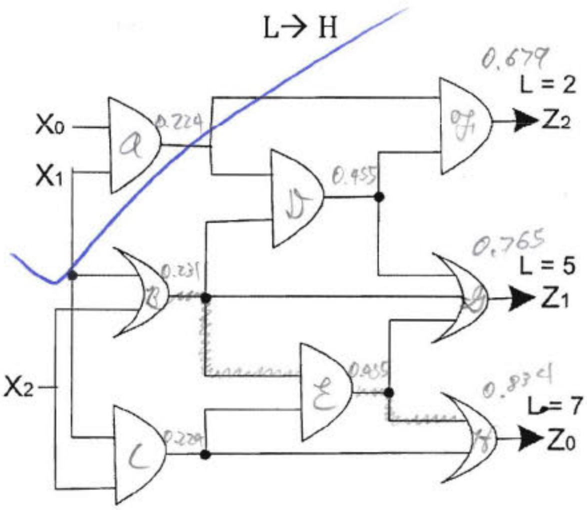
$y_{12} = 48_{12}$

20

Problem 2 (20 points)

Given the network below, calculate the critical path. Consider L → H delay while calculating the critical path. Use appropriate figure to show your work.

Gate	Fan-in	T_{pLH}
AND	2	0.15 + 0.037 L
OR	2	0.12 + 0.037 L
OR	3	0.12 + 0.038 L



a = 0.15 + 0.037·2 = 0.224
b = 0.12 + 0.037·3 = 0.231
c = 0.15 + 0.037·2 = 0.224

d = b + 0.15 + 0.037·2 = 0.231 + 0.224 = 0.455
e = b + 0.15 + 0.037·2 = 0.455

f = d + 0.15 + 0.037·2 = 0.455 + 0.224 = 0.679
g = d + 0.12 + 0.038·5 = 0.455 + 0.31 = 0.765
h = e + 0.12 + 0.037·7 = 0.455 + 0.379 = 0.834

critical path: b → e → h
delay: 0.834

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Problem 3 (20 points)

Function A, B, C, and D are defined in the following way. Which of these functions are equivalent?

A = x'z + x'y + zy' + yz'
B = x' + ((xy')' + (z + y)')'
C = xz + zy' + xyz + x'
D = x' + zy' + x'y

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

$a = x'z + x'y + y'z + yz'$

$= x'y'z + (x'yz + x'yz) + x'yz' + xy'z + x'y'z + xyz' + x'yz'$

$= x'y'z + (x'yz + x'yz') + xy'z + x'yz' = y'z(x'+x) + x'y(z+z') + yz'(x+x')$

$= y'z + x'y + yz'$ ✓

$B = x' + (xy')''(z+y)'' = x' + xy'z + xy'y \to 0 = x' + xy'z$

$= x'y + x'y' + xy'z = x'y + x'y' + y'(x' + xz)$, with $x' + xz \to x' + z$

$= x'y + x'y' + x'y' + y'z = x'(y + y') + y'z = x' + y'z$ ✓ (with $x'y' + x'y' \to x'y'$)

$C = xz + xyz + y'z + x' = xz(1+y) + y'z + x' = x' + z + y'z$ ✓ (with $x' + xz = x' + z$)

$= x' + z(1 + y') = x' + z$

$D = x' + y'z + x'y = x'(y+1) + y'z = x' + y'z$ ✓

Should be B = D

$B = a$ ✓

OK

20

Problem 4 (20 points)

Consider the following functions X, Y, and Z. Which subsets of X, Y, and Z form universal sets? (Constant 0 and 1 are NOT given.)

$X = a'b' + ac$
$Y = b'c + bc'$
$Z = ab' + ac'$

X | 1: a = a, b = a, c = a $X = a' \cdot a' + a \cdot a = a' + a = 1$ AND: a = a, b = 1, c = c $X = a' \cdot 1' + ac = ac$

- any other inputs of a, b, c, or 1 doesn't create an inverter (not)

X: {1, AND}

✓

Y | 0: b = b, c = b $Y = b'b + bb' = 0$ - any other inputs of b, c, or 0 doesn't create any other functions

Y: {0}

✓

Z | 0: a = a, b = a, c = a $Z = aa' + aa' = 0$ - any other inputs of a, b, c, or 0 doesn't create any other function

Z: {0}

✓

X, Y or X, Z or X, Y, Z | - right now, 0 and 1 are available as inputs

NOT (X): a = 0, b = b $X = 0'b' + 0 \cdot c = b'$ ✓

- with {NOT, AND}, OR can be created ✓
- this leads to the known universal set of {AND, OR, NOT} ✓

subsets (X, Y), (X, Z), and (X, Y, Z) form a universal set ✓

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Problem 5 (20 points)

One 2-bit number A, and two 1-bit numbers B and C are given. Design a minimal NOR-NOR network that outputs the product of the largest two inputs.

largest output = 3·1 = 3 (2 bits)

z_1:

CB \ a_1a_0	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	0	0	1	1
10	0	0	1	1

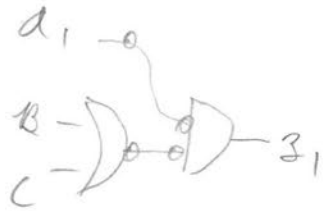
z_0:

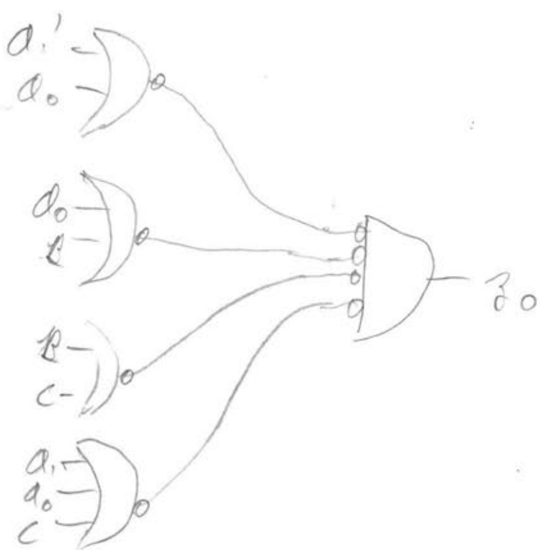
CB \ a_1a_0	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	1	1	1	0
10	0	1	1	0

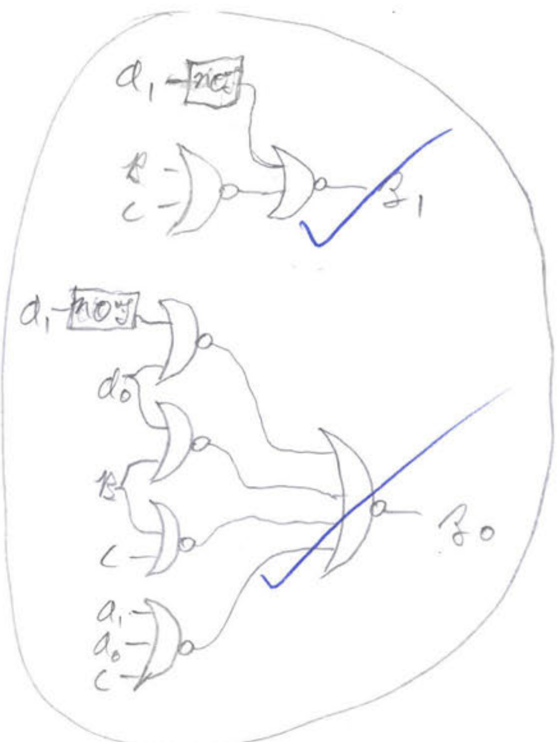
$z_1 = (a_1)(B+C)$

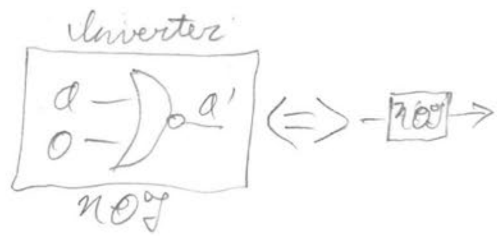
$z_0 = (a_1'+a_0)(B+C)(a_0+B)(a_1+a_0+C)$

There's a smaller solution.
(the last sum doesn't need A_1)









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