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Computer Science Department

CSM51A/EEM16 Midterm Exam #1

Winter Quarter 2014

January 30th 2014

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

20

Problem 1 (20 points)

Find x and y:

(a) $3B62A871_{32} = x_4$

(b) $46_7 + 99_{13} = y_{11}$

a) $3B62A871_{32}$

$= 00011101011001100010.01010.01000.00111.00001_2$

$= 01223030021102003201_4$

$\therefore x = 01223030021102003201$ ✓

b) $46_7 + 99_{13}$

$= (4 \times 7 + 6) + (9 \times 13 + 9)$

$= 34 + 126$

$= 160$

$= 1 \times 121 + 3 \times 11 + 6$

$= 136_{11}$

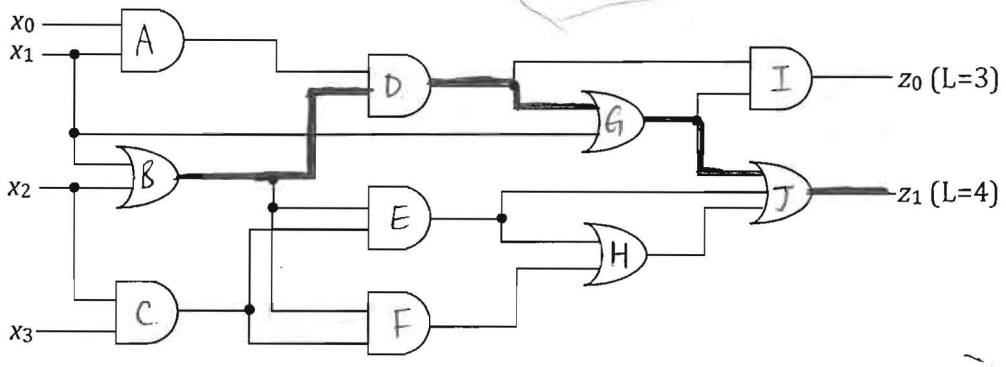
$\therefore y = 136$ ✓

20

Problem 2 (20 points)

Given the network below, calculate the critical path delay. Consider L → H delay when calculating the critical path.

Gate	Fan-in	t_{pLH}	t_{pHL}
AND	2	$0.15 + 0.037L$	$0.16 + 0.017L$
AND	3	$0.20 + 0.038L$	$0.18 + 0.018L$
OR	2	$0.12 + 0.037L$	$0.20 + 0.019L$
OR	3	$0.12 + 0.038L$	$0.34 + 0.022L$



A: $0.15+0.037(1) = 0.187$

B: $0.12+0.037(3) = 0.231$

C: $0.15+0.037(2) = 0.224$

D: $0.15+0.037(2) = 0.224$, B+D : $0.231+0.224 = 0.455$

E: $0.15+0.037(2) = 0.224$, B+E : $0.231+0.224 = 0.455$

F: $0.15+0.037(1) = 0.187$, B+F : $0.231+0.187 = 0.418$

G: $0.12+0.037(2) = 0.194$, B+D+G : $0.455+0.194 = 0.649$

H: $0.12+0.037(1) = 0.157$, B+E+H : $0.455+0.157 = 0.612$

I: $0.15+0.037(3) = 0.261$, B+D+G+I : $0.649+0.261 = 0.910$

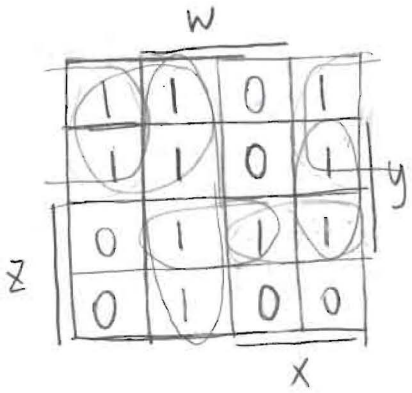
J: $0.12+0.038(4) = 0.272$, B+D+G+J : $0.649+0.272 = 0.921$

∴ Critical path delay : 0.921 ✓

20

Problem 3 (20 points)

Draw a K-map that contains 10 minterms, 6 prime implicants, and 2 essential prime implicants.



Prime Implicants: $z'w'$, $z'x'$, $x'w$, zyw, zyx, yxw'

Essential Prime Implicants: $z'w'$, $x'w$

Problem 4 (20 points)

One 2-bit number, A, and two 1-bit numbers, B and C, are given. Design a system that outputs the product of the largest two inputs. Use only the star (*) gate defined below to implement your circuit. You may also use constants 0 and 1.

x	y	x*y
0	0	1
0	1	1
1	0	0
1	1	1

$x*y = x'+y$

$x*0 = x'$

$(x*0)*y = x+y$

$x*(y*0) = x'+y'$

$(x*(y*0))*0 = (x'+y')' = xy$

Inputs: a_1a_0, b_0, C_0 Output: z_1z_0

z_1

a_1 \ a_0	C_0b_0 = 00	01	11	10
0	0	0	0	0
1	0	1	1	1

z_0

a_1 \ a_0	C_0b_0 = 00	01	11	10
0	0	1	1	0
1	0	1	1	1

$\therefore z_1 = a_1C_0 + a_1b_0$

$= (a_1)(b_0 + C_0)$

$z_0 = a_0C_0 + a_0b_0 + a_1'b_0C_0$

$= (b_0+C_0)(a_1'+a_0)(a_0+b_0)(a_0+C_0)$

$z_1 = a_1(C_0+b_0) = a_1((C_0*0)*b_0) = (a_1*(((C_0*0)*b_0)*0))*0$

$z_0 = a_0(C_0+b_0) + b_0C_0a_1'$

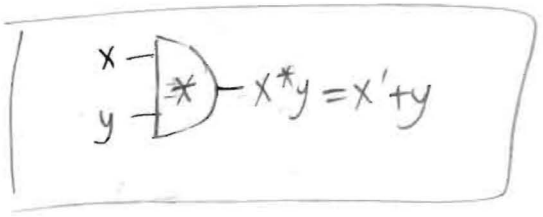
$= (a_0*(((C_0*0)*b_0)*0))*0 + (b_0'+C_0'+a_1)'$

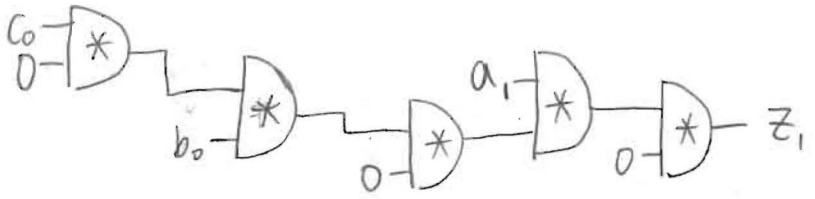
$= (a_0*(((C_0*0)*b_0)*0))*0 + (b_0*(C_0*a_1))'$

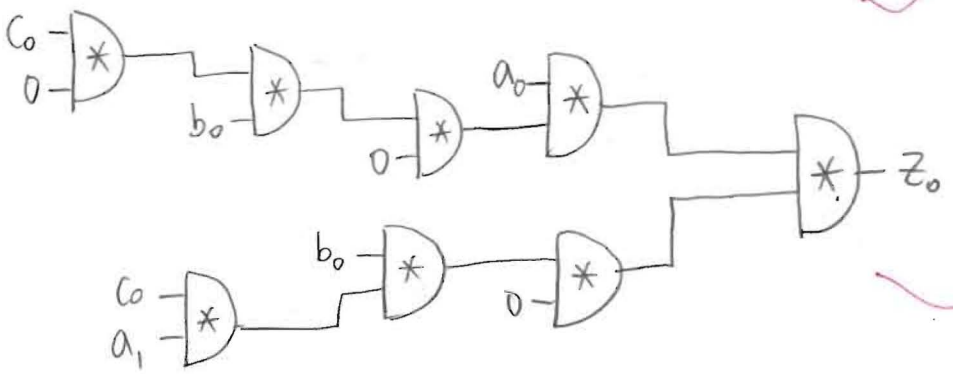
$= (a_0*(((C_0*0)*b_0)*0))*((b_0*(C_0*a_1))*0)$

back

Problem 4) Extra Page







Problem 5 (20 points)

Four 1-bit numbers (A, B, C, and D) are given. Design a system that outputs the difference between the sum of the two largest numbers and the sum of the two smallest numbers. For example, say A and B are the largest and C and D are the smallest, the output should be Z = (A+B) – (C+D).

(a) Implement this system using only minimal NAND-NAND networks.
(b) Implement this system using only minimal NOR-NOR networks.

Inputs: a_0 (A), b_0 (B), c_0 (C), d_0 (D), Output: $z_1 z_0$

z_1

$a_0 b_0$ \ $c_0 d_0$	00	01	11	10
00	0	0	1	0
01	0	1	0	1
11	1	0	0	0
10	0	1	0	1

z_0

$a_0 b_0$ \ $c_0 d_0$	00	01	11	10
00	0	1	0	1
01	1	0	1	0
11	0	1	0	1
10	1	0	1	0

$$z_1 = a_0 b_0 c_0' d_0' + a_0 b_0' c_0' d_0 + a_0' b_0 c_0' d_0 + a_0' b_0' c_0 d_0 + a_0' b_0 c_0 d_0' + a_0 b_0' c_0 d_0'$$

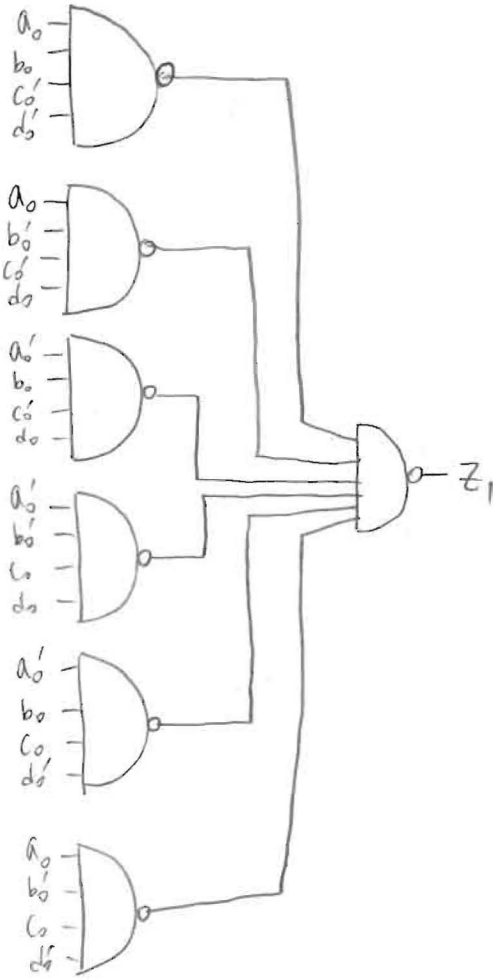
$$= (a_0 + b_0 + c_0)(a_0 + b_0 + d_0)(a_0 + c_0 + d_0)(b_0 + c_0 + d_0)(a_0' + b_0' + d_0') \cdot (a_0' + c_0' + d_0')(a_0' + b_0' + c_0')(b_0' + c_0' + d_0')$$

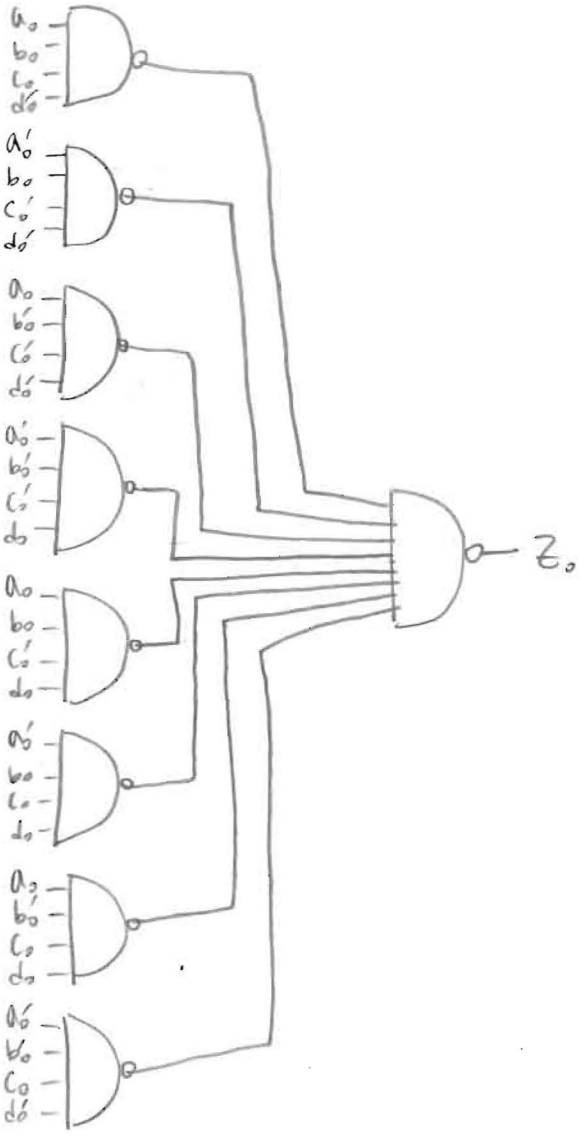
$$z_0 = a_0' b_0 c_0' d_0' + a_0 b_0' c_0' d_0' + a_0' b_0' c_0' d_0 + a_0 b_0 c_0' d_0 + a_0' b_0 c_0 d_0 + a_0 b_0' c_0 d_0 + a_0' b_0' c_0 d_0' + a_0 b_0 c_0 d_0'$$

$$= (a_0 + b_0 + c_0 + d_0)(a_0 + b_0 + c_0' + d_0')(a_0 + b_0' + c_0 + d_0')(a_0 + b_0' + c_0' + d_0) \cdot (a_0' + b_0' + c_0 + d_0)(a_0' + b_0' + c_0' + d_0')(a_0' + b_0 + c_0 + d_0')(a_0' + b_0 + c_0' + d_0)$$

Problem 5) Extra Page

a)





b)