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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)	12 → 20
4 (20)	18
5 (20)	20
Total (100)	90 → 98

$2^5 = 32$

Problem 1 (20 points)

32/16 8 4 2 1

$32 = 100000_2$

Find x and y:

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

| 00011 | 01011 | 00110 | 00010 | 01010 | 01000 | 00111 | 00001

1 2 2 3 0 3 0 0 2 1 1 0 2 0 0 3 2 0 1

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

(a) $3B62A871_{32}$

00011 | 01011 | 00110 | 00010 | 01010 | 01000 | 00111 | 00001 $_2$

$x_4 = 1223030021102003201_4$

13
9
117

(b) $46_7 = 28 + 6 = 34$

46_7

$28 + 6 = 34$

$99_{13} = 13 \times 9 + 9 = 117 + 9 = 126$

99_{13} $117 + 9 = 126$

34
160

$126 + 34 = 160$

121 11 1
1 3 6

160
121
39
33
6

1 160
121
39
3 33
6 6

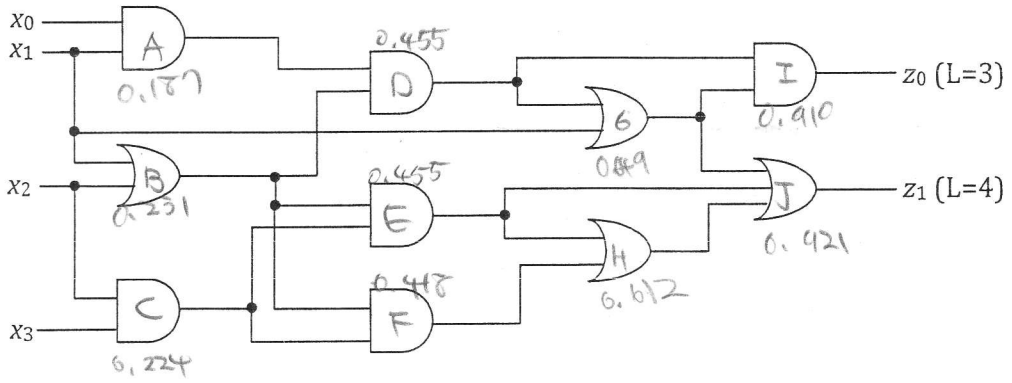
$y_{11} = 136_{11}$

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: 2 Fan-in , 1 Fan-out → 0.15+0.037 = 0.187

B: 2 Fan-in, 3 Fan-out → 0.12+0.037×3 = 0.231

C: 2 Fan-in, 2 Fan-out → 0.15+0.074 = 0.224

D: 2 Fan-in, 2-Fan-out → 0.15+0.074 = 0.224 → 0.455

E: 2 Fan-in, 2-Fan-out → 0.224 → 0.455

F: 2 Fan-in, 1-Fan-out → 0.187 → 0.418

G: 2 Fan-in, 2-Fan-out → 0.12+0.074 = 0.194 → 0.649

H: 2-Fan-in, 1-Fan-out → 0.12+0.037 = 0.157 → 0.612

I: 2-Fan-in, L=3 → 0.15+0.037×3 = 0.261 → 0.910

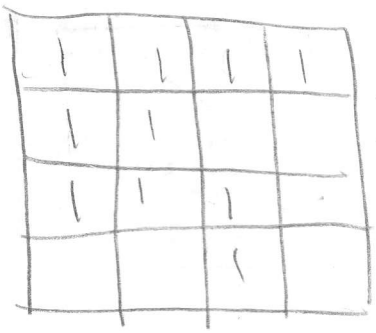
J: 3-Fan-in, L=4 → 0.12+0.038×4 = 0.272 → 0.921

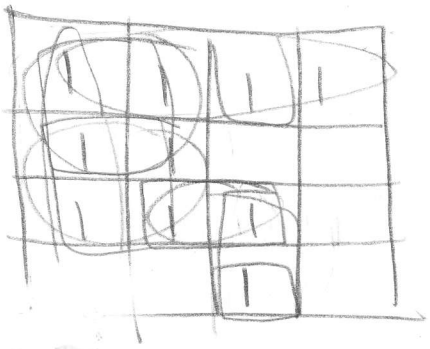
critical path delay = 0.921

critical path = B → D → G → J → z1

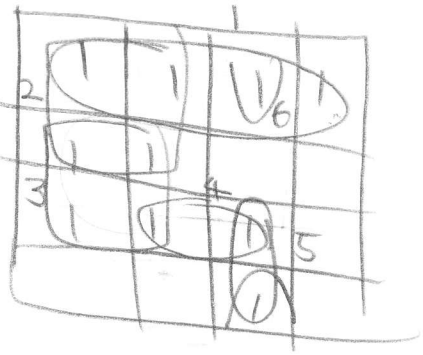
Problem 3 (20 points)

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





10 minterms
6 prime implicants
2 EPIs



6 Prime implicants,
1 and 3 are EPIs

18

Problem 4 (20 points) 3×1

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

maxterm

$x*y = x'+y$

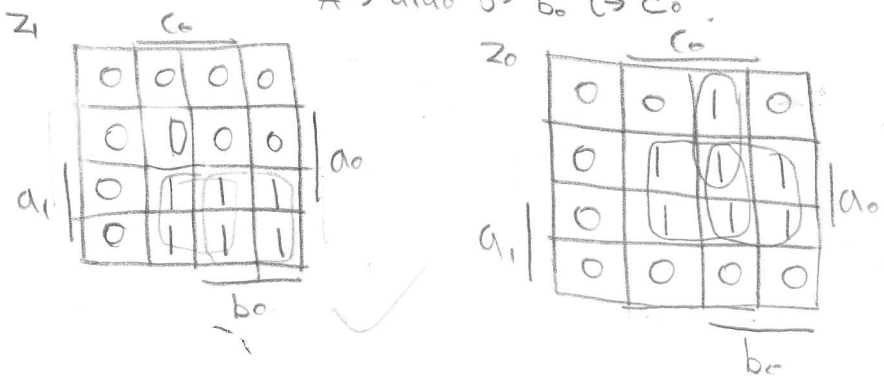
$a_1'b_0 =$

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

max: $3 \rightarrow 11_2$

2 k-maps needed

$A \rightarrow a_1a_0$ $B \rightarrow b_0$ $C \rightarrow c_0$



$z_1 = a_1c_0 + a_1b_0 = a_1(b_0+c_0)$

$z_0 = a_0b_0 + a_0c_0 + a_1'b_0c_0 = a_0(b_0+c_0) + a_1'b_0c_0$

with $x*y = x'+y$

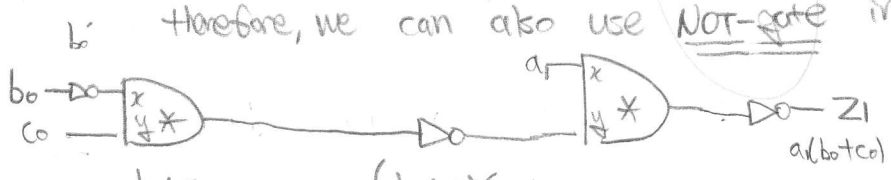
if $x = x$

$y = 0$

$x*y = x'$

z_1 gate network

b' therefore, we can also use NOT-gate in our network



$a_1' + (b_0+c_0)' = (a_1(b_0+c_0))'$

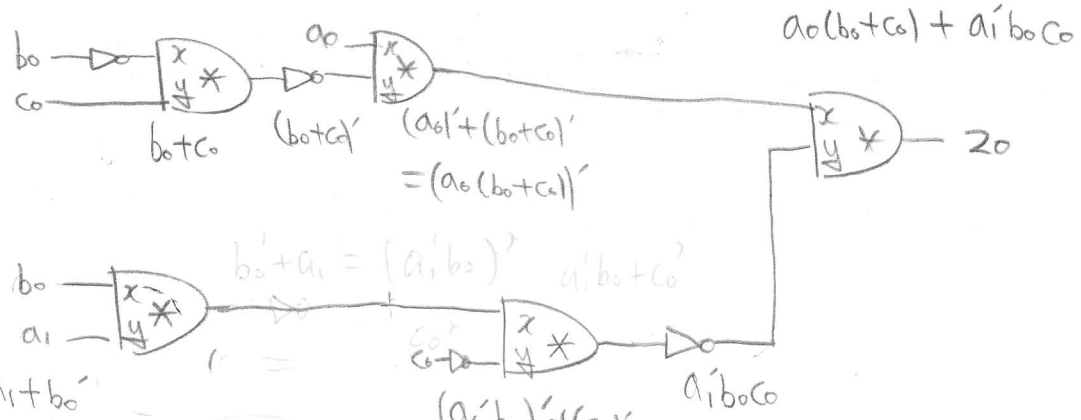
$a'+b' = (ab)'$

z_0 gate network

next page→

Problem 4) Extra Page

$$z_0 = a_0(b_0 + c_0) + a_1' b_0 c_0$$



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

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

$(a_1' b_0)' + (c_0)' = (a_1' b_0 c_0)'$

0 0 0 0 0
0 0 0 1 1
0 0 1 0 1
0 0 1 1 2

0 1 0 0 1
0 1 0 1 2
0 1 1 0 2
0 1 1 1 1

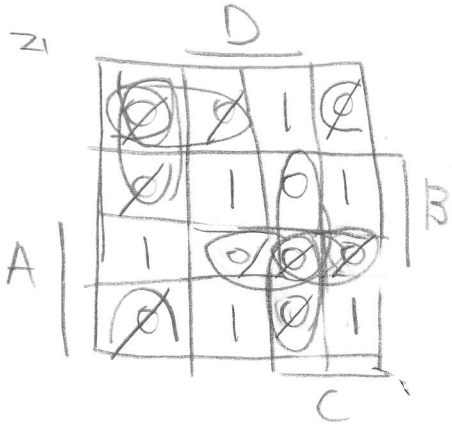
1 0 0 0 1
1 0 0 1 2
1 0 1 0 2
1 0 1 1 1

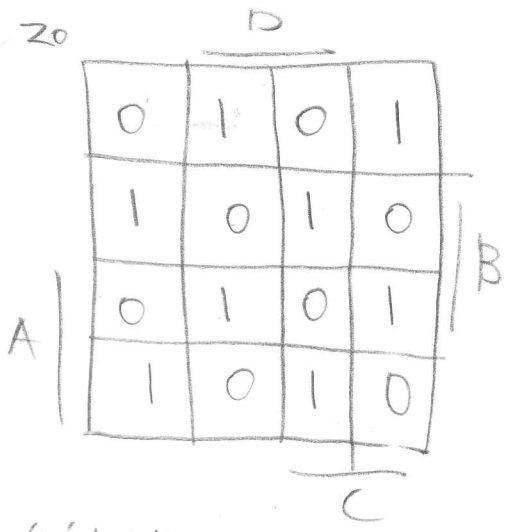
1 1 0 0 2
1 1 0 1 1
1 1 1 0 1
1 1 1 1 0

Problem 5 (20 points)

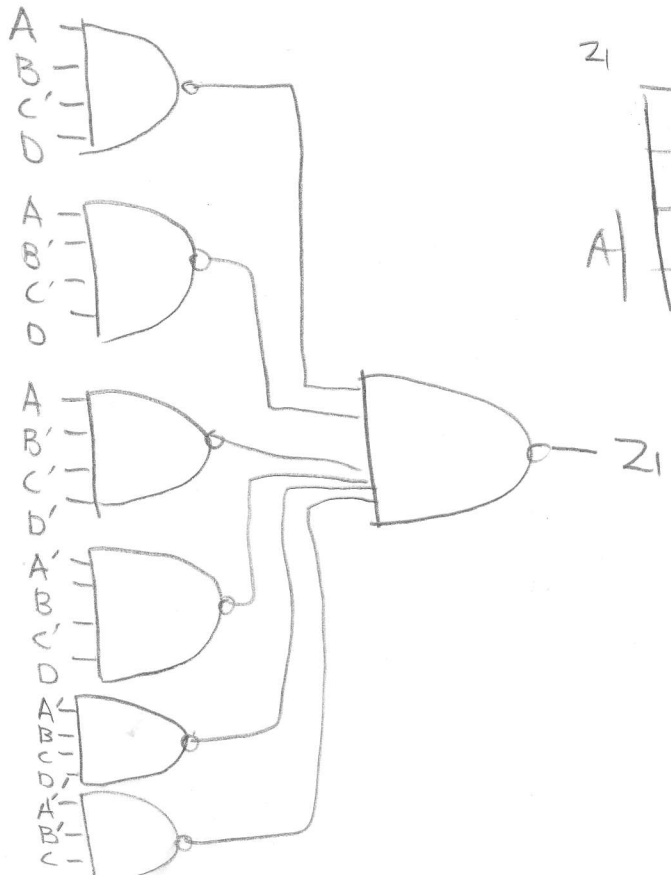
Four 1-bit numbers (A, B, C, and D) are given. Design a system that outputs the difference between the sum of the two largest numbers and the sum of the two smallest numbers. For example, say A and B are the largest and C and D are the smallest, the output should be Z = (A+B) – (C+D).

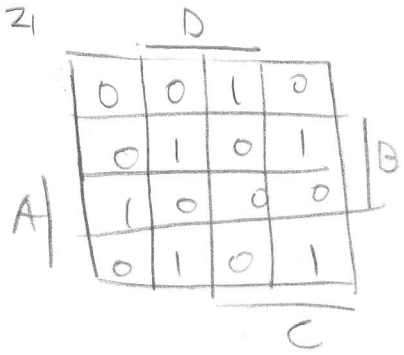
(a) Implement this system using only minimal NAND-NAND networks. sum of products
(b) Implement this system using only minimal NOR-NOR networks. product of sums





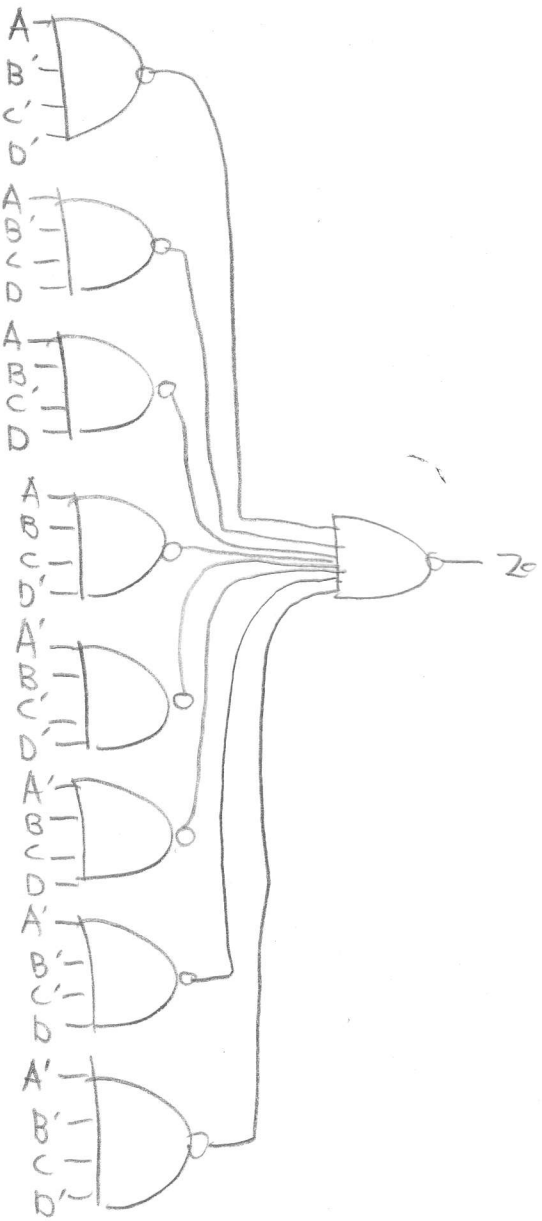
(a) $Z_1 = ABC'D + AB'C'D + AB'C'D' + A'BC'D + A'BCD' + A'B'CD$





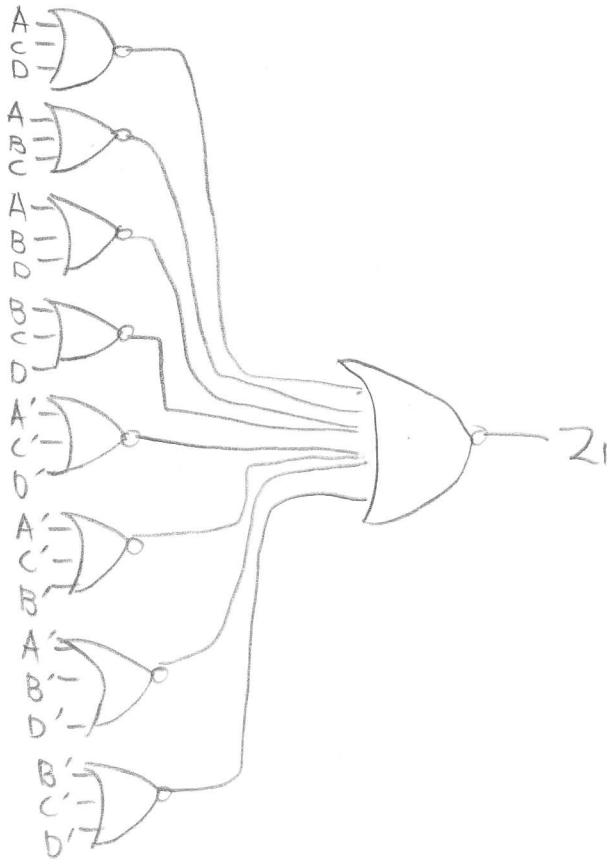
Problem 5) Extra Page

$$Z_0 = AB'C'D' + AB'CD + ABC'D + ABCD' + A'BC'D' + A'BCD + A'B'C'D + A'B'CD'$$



part (b) → next page

$Z_1 = (A+C+D)(A+B+C)(A+B+D)(B+C+D)(A'+C'+D')(A'+C'+B')$
$(A'D'B')(B'C'D')$



$Z_0 = (A+B+C+D)(A+B+C'+D')(A+B'+C+D')(A+B'+C'+D)(A'+B'+C+D)(A'+B'+C'+D')$
$(A'+B+C+D')(A'+B+C'+D)$