UCLA
Department of Electrical Engineering
EEM16 – Fall 2012
Midterm
October 30, 2012
(The midterm contains 6 problems)

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Solution.

1. Exam is closed book. You are allowed **one 8 ½ x 11" double-sided cheat sheet.**
2. Calculators are allowed.
3. Show the intermediate steps leading to your final solution for each problem.
4. You can use both sides of the sheets to answer questions.

Problem	Points	Your Score	Comments
1a	5		
1b	5		
2	10		
3	10		
4	10		
5a	2		
5b	3		
5c	5		
6a	3		
6b	3		
6c	4		
	Total: 60		

1. Find X, Y such that the following conditions are satisfied:
   a) $(2303031022)_4 = X_8$ (5pt)
   b) $(236)_7 - (104)_6 = Y_{11}$ (5pt)

a) $LHS = 10110011001101001010$

$= (2631512)_8$

b). $(236)_7 = 2 \cdot 7^2 + 3 \cdot 7^1 + 6 \cdot 7^0$

$= 98 + 21 + \cancel{42}6$

$= \cancel{(161)_{10}}\ (125)_{10}$

$(104)_6 = 1 \cdot 6^2 + 4 \cdot 6^0$

$= 36 + 4 = (40)_{10}$

$(125)_{10} - (40)_{10} = (85)_{10} = (78)_{11}$

$11 \,|\underline{85}$ ---- 8

$11 \,|\underline{7}$ --- 7

0

2. Which of the following functions are equivalent: (10pt)

$A = x'y' + x'z'$
$B = x'z' + x'y'z$
$C = x'y'z' + x'z' + y'z$

A

x \ yz	00	01	11	10
0	1	1	0	1
1	0	0	0	0

B

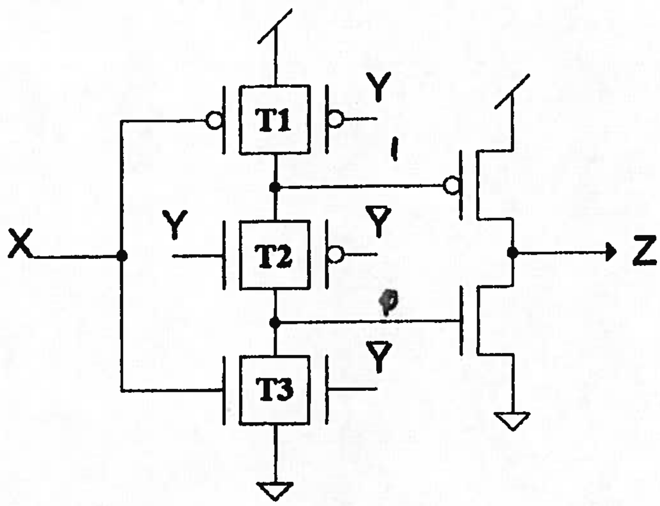
x \ yz	00	01	11	10
0	1	1	0	1
1	0	0	0	0

C

x \ yz	00	01	11	10
0	1	1	0	1
1	0	1	0	0

$\Rightarrow A = B.$

3. For the two-input gate given by the following (10pt)



complete the table (for T_i = on/off) provided below:

(Note that only T_2 is a transmission gate.)

X	Y	T_1	T_2	T_3	Z
0	0	ON	OFF	ON	Z
0	1	ON	ON	OFF	0
1	0	ON	OFF	ON	Z
1	1	OFF	ON	ON	1

2.5 each

4. Use a * gate that implements the following logic: (10pt)

X Y	X * Y
0 0	1
0 1	1
1 0	0
1 1	1

to implement the gate network of the function:

$$f\ \cancel{z} = (((x+y)'+z)'+y+z)'+x'$$

Hint: Simplify first and then draw the gate network.

$$X*Y = (XY')' = X'+Y = E(X,Y).$$

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

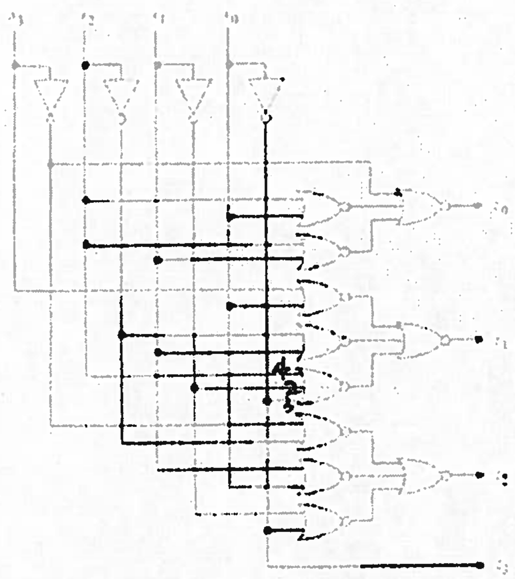
$$= ((x'y')' \cdot z' + y + z)'+x'$$

$$= (x+y+\cancel{y}+z)'+x'$$

$$= x'y'z'+x' = x'$$

$$f = E(x,0).$$

5. Analyzing gate networks



Gate type	Fan-in	Propagation delays t_{pLH} [ns]	Propagation delays t_{pHL} [ns]	Load factor [standard loads]	Size [equiv. gates]
AND	2	$0.15 + 0.037L$	$0.16 + 0.017L$	1.0	2
AND	3	$0.20 + 0.038L$	$0.18 + 0.018L$	1.0	2
AND	4	$0.28 + 0.039L$	$0.21 + 0.019L$	1.0	3
OR	2	$0.12 + 0.037L$	$0.20 + 0.019L$	1.0	2
OR	3	$0.12 + 0.038L$	$0.34 + 0.022L$	1.0	2
OR	4	$0.13 + 0.038L$	$0.45 + 0.025L$	1.0	3
NOT	1	$0.02 + 0.035L$	$0.05 + 0.017L$	1.0	1
NAND	2	$0.05 + 0.038L$	$0.08 + 0.027L$	1.0	1
NAND	3	$0.07 + 0.038L$	$0.09 + 0.039L$	1.0	2
NAND	4	$0.10 + 0.037L$	$0.12 + 0.051L$	1.0	2
NAND	5	$0.21 + 0.038L$	$0.34 + 0.019L$	1.0	4
NAND	6	$0.24 + 0.037L$	$0.36 + 0.019L$	1.0	5
NAND	8	$0.24 + 0.038L$	$0.42 + 0.019L$	1.0	6
NOR	2	$0.06 + 0.075L$	$0.07 + 0.016L$	1.0	1
NOR	3	$0.16 + 0.111L$	$0.08 + 0.017L$	1.0	2
NOR	4	$0.23 + 0.149L$	$0.08 + 0.017L$	1.0	4
NOR	5	$0.18 + 0.038L$	$0.23 + 0.018L$	1.0	4
NOR	6	$0.16 + 0.037L$	$0.24 + 0.018L$	1.0	5
NOR	8	$0.54 + 0.038L$	$0.23 + 0.018L$	1.0	6
XOR	2*	$0.30 + 0.036L$	$0.30 + 0.021L$	1.1	3
		$0.16 + 0.036L$	$0.15 + 0.020L$	2.0	

Using the table above, find the:

a) Load factor of each primary input of the gate network (2pt)

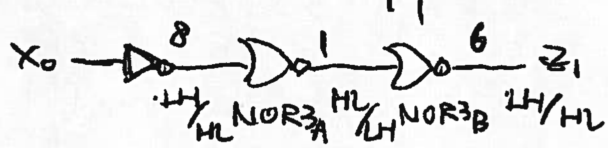
b) Network size in equivalent gates (Hint: See last column) (3pt)

c) Show the critical path of the gate network and calculate the corresponding delays t_{pLH} and t_{pHL}. Assume the load on each primary output of the gate network is $L = 6$. (5pt)

a. X_3 2 ; X_2 4 ; X_1 4 ; X_0 4

b NOT × 4   1×4 = 4
NOR2 × 7   1×7 = 7
NOR3 × 4   2×4 = 8
+
19

c



$t_{pLH}(X_0, Z_1) = t_{pLH}(\text{NOR3B}) + t_{pHL}(\text{NOR3A}) + t_{pLH}(\text{NOT})$

$= 0.16 + 0.111 \cdot 6 + 0.08 + 0.017 \cdot 1 + 0.02 + 0.038 \times 8$

1.247

$= \cancel{2.831}$ 10 ns

$\cancel{1.469}$

$$t_{pHL}(X_0, Z_1) = t_{pHL}(NOR3B) + t_{pLH}(NOR3A) + t_{pHL}(NOT)$$

$$= 0.08 + 0.017 \cdot 6 + 0.16 + 0.111 \cdot 1 + 0.05 + 0.017 \cdot 8$$

$$= 0.639 \text{ ns}$$

6. For $f(w,x,y,z) = one\text{-}set(0,1,2,3,5,7,8,10,11,15)$

a) Find all the prime implicants. (3pt)

b) Indicate which of these prime implicants are essential. (3pt)

c) Obtain a minimal sum of products for f. Is it unique? (4pt)

wx \ yz	00	01	11	10
00	1	1	1	1
01	0	1	1	0
11	0	0	1	0
10	1	0	1	1

$y x'$

$x'y$

PI

a. $w'x'$, yz, $w'z$, $x'z'$, , $x'y$

1 2 3 4 5

b. EPI. yz, $w'z$, $x'z'$

c. $f = yz + w'z + x'z'$

unique.

a) $x_3'x_2'$, x_1x_0, $x_3'x_0$, $x_2'x_0'$, $x_2'x_1$

b) x_1x_0, $x_3'x_0$, $x_2'x_0'$