ECE 462 Logic Design (Spring 2005) Name: Solutions
Total Points: 25
Duration: 50 minutes

This test is worth 23% of the final grade.
The test is printed on 6 pages.

You may bring 1 double-sided sheet of handwritten notes to this test.
If you need to make additional assumptions to answer a question, please state your assumptions clearly.

1. (4 points) For the functions f(w,x,y,z) = Σ (0,1,5,7,13), and g(w,x,y,z) = Σ (5,9,13), using Quine-McCluskey tabulation procedure, determine all the multiple-output prime implicants.

   Determine which of the MOPIs are implicants of function g but not implicants of function f.

   You may use the table below if you like.

	Identifier				Tag f	Tag g	
0	0	0	0	0	1	0	✓
1	0	0	0	1	1	0	✓
5	0	1	0	1	1	1	✓
9	1	0	0	1	0	1	✓
7	0	1	1	1	1	0	✓
13	1	1	0	1	1	1	✓
* (0,1)	0	0	0	–	1	0	$\bar{w}\bar{x}\bar{y}$
* (1,5)	0	–	0	1	1	0	$\bar{w}\bar{y}z$
~~(1,9)~~	~~–~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	
* (5,7)	0	1	–	1	1	0	$\bar{w}xz$
* (5,13)	–	1	0	1	1	1	$x\bar{y}z$
* (9,13)	1	–	0	1	0	1	$w\bar{y}z$
~~(1,5,9,13)~~	~~–~~	~~–~~	~~0~~	~~1~~	~~0~~	~~0~~	

* MOPI's

f:

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

g:

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

f · g:

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

2. (4 points) Consider function f(w,x,y,z) = Σ (0,3,5,7,8,10,11,12,13). The prime implicant table for function f(w,x,y,z) is shown below. This function has eight prime implicants, labelled A through H in the prime implicant table.

(i) Identify all distinguished columns and essential rows in the prime implicant table.

(ii) Using the prime implicant method, find all minimal sums for function f(w,x,y,z). Show your work.

You may denote each minimal sum as a sum of the letters (A through H) representing the desired prime implicants.

→ distinguishing column

essential row

		0	3	5	7	8	10	11	12	13
*	A = (0,8)	X				X				
**	B = (3,7)		X		X					
CcD	~~C = (5,7)~~			X	X					
**	D = (5,13)			X						X
	E = (8,12)					X			X	
FcG	~~F = (8,10)~~					X	X			
→ **	~~G = (10,11)~~						X	X		
Secondary essential	H = (12,13)								X	X
IcB	I = (3,11)		X					X		

Minimal Sum = A + G + B + D + E

or A + G + B + D + H

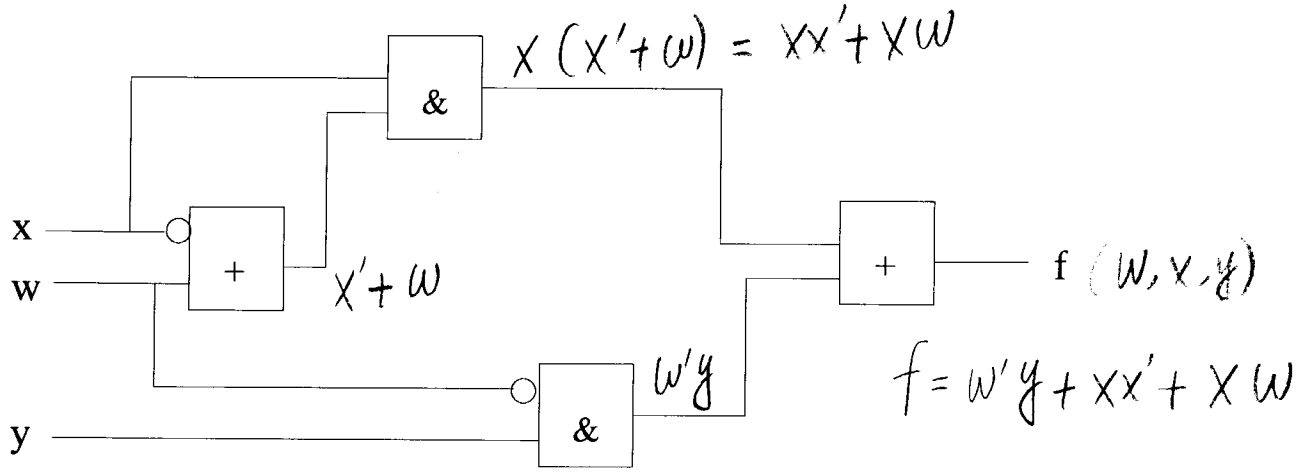
or A + G + B + C + H

or A + [illegible] + H + C + I

or A + C + F + H + I

(any one minimal sum is an adequate answer)

3. (4 points) Determine all the static logic hazards in the circuit shown below. Show your work.



$f = w'y + xx' + xw$

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

$w'y$ wx

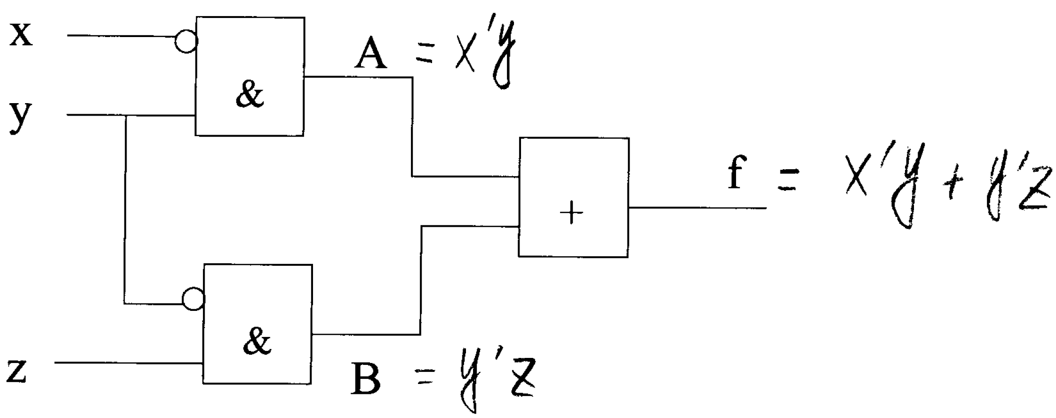
logic static 1 hazard

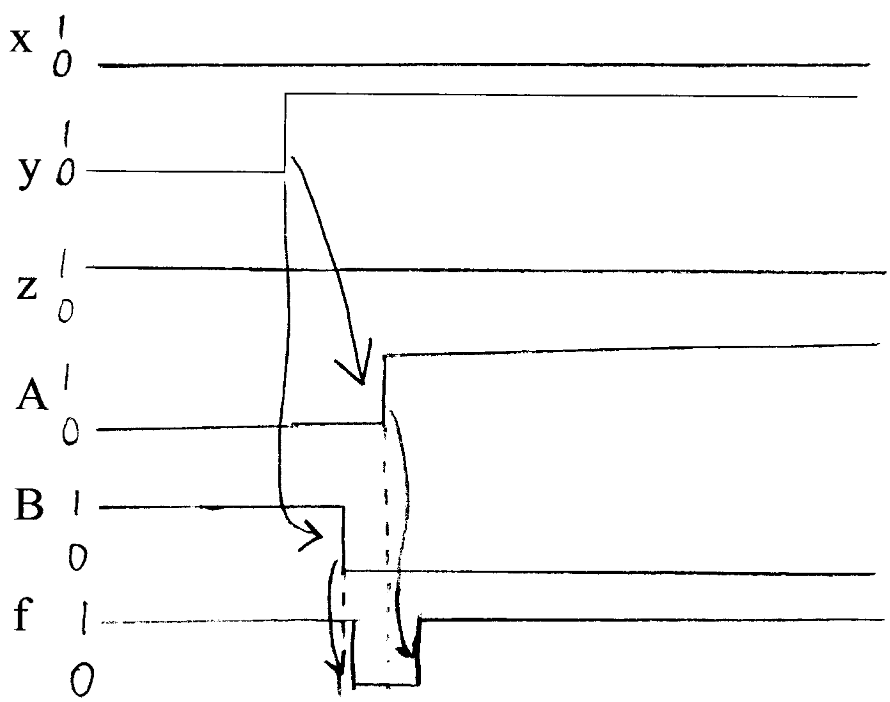
$\langle wxy \rangle$: $011 \leftrightarrow 111$

logic static 0 hazard

$\langle wxy \rangle$ $000 \leftrightarrow 010$

4. (4 points) The circuit shown below implements the function f(x,y,z) = x'y + y'z. There exists a static logic hazard for the transition from xyz = 001 to xyz = 011. Complete the timing diagram below to show how this hazard may occur. Outputs of the AND gates in the circuit are labelled A and B as shown in the figure.





5. (5 points) Karnaugh map for a function f(w,x,y,z) is shown below.

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

(a) For the above function, determine whether there exists a simple disjoint decomposition of the form F(g(y,z),w,x). If such a decomposition exists, determine the appropriate functions g and F used for the decomposition.

Yes. $g(y,z) = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} = y'z'$

$F(g,w,x) = w'x'g + wxg' + wx'g = x'g + wxg'$

Alternatively, $g(y,z) = \begin{pmatrix} 0 \\ 1 \\ 1 \\ 1 \end{pmatrix} = y+z$

$F(g,w,x) = w'x'g' + wxg + wx'g'$

(b) Determine whether the function is positive or negative or mixed in variable w.

$f_{w'} \rightarrow$

1	0
0	0
0	0
0	0

$f_{w} \rightarrow$

1	0
0	1
0	1
0	1

Since $f_{w'} \Rightarrow f_w$, f is positive

6. (4 points) Use the first Tison method to determine all the prime implicants for the function g(w,x,y) = y' + w'y + wx'y

$L = \{y', w'y, wx'y\}$

w $\quad$ $w'y$, $wx'y$ $\Rightarrow$ concensus $x'y$

$\Rightarrow L = \{y', w'y, \cancel{wx'y}, x'y\}$

x no concensus

y $\quad$ y', $w'y$ > concensus w'

y', $x'y$ > concensus x'

$L = \{y', \cancel{w'y}, \cancel{x'y}, w', x'\}$

$\Downarrow$

$L = \underbrace{\{y', w', x'\}}_{\downarrow}$

P.I.'s

Alternate Method

y $\quad$ y', $w'y$ > concensus w'

y', $wx'y$ > concensus wx'

$L = \{y', \cancel{w'y}, \cancel{wx'y}, w', wx'\}$

$= \{y', w', wx'\}$

w $\quad$ w', wx' > concensus x'

$L = \{y', w', \cancel{wx'}, x'\}$

$= \{y', w', x'\}$

x no concensus

$L = \underbrace{\{y', w', x'\}}_{\downarrow}$

P.I.'s