Brian Faure DCD Hw #3 Section #4 RUID: 150003563

#1) Implement the following circuits in a hazard-free manner

a.) $F(A,B,C) = B\bar{C} + \bar{A}C$

This is the prime implicant to include to eliminate timing hazards

New Minimal Sum → $\boxed{B\bar{C} + \bar{A}C + \bar{A}B}$

C\AB	00	01	11	10
0	0	1	1	0
1	1	1	0	0

b.) $F(A,B,C,D) = \Sigma(0,4,5,6,7,9,11,13,14)$

$\boxed{F = \bar{A}C\bar{D} + \bar{A}B + B\bar{C}D + A\bar{C}D + B\bar{C}D + A\bar{B}D}$

CD\AB	00	01	11	10
00	1	1	0	0
01	0	1	1	1
11	0	1	0	1
10	0	1	1	0

#2) Draw K-map, # of Prime Implicants, Distinguished One-Cells, essential primes, find minimal sum.

a.) $F = \Sigma_{WXYZ}(0,1,5,7,8,9,13)$
- 3 Prime Implicants
- 4 Distinguished One-Cells
- 3 Essential Primes

$\boxed{F = X'Y' + Y'Z + WXZ}$

YZ\WX	00	01	11	10
00	*1	0	0	1*
01	1	1	*1	1
11	0	1*	0	0
10	0	0	0	0

b.) $F = \Sigma_{WXYZ}(0,1,2,3,6,7,8,13,14,15)$
- 5 Prime Implicants
- 4 Distinguished One-Cells
- 4 Essential Prime Implicants

$\boxed{F = \bar{W}\bar{X} + XY + WXZ + \bar{X}Y\bar{Z}}$

YZ\WX	00	01	11	10
00	1	0	0	1*
01	*1	0	1*	0
11	1	1	1	0
10	1	1	*1	0

c.) $F = \sum_{W,X,Y,Z}(0,2,3,4,5,6,7,10,11,13)$

YZ\WX	00	01	11	10
00	1*	1	0	0
01	0	1	*1	0
11	1	1	0	1*
10	1	1	0	1*

- 4 Distinguished One-Cells
- 5 Prime Implicants
- 3 Essential Primes

$$F = \bar{W}X + \bar{X}Y + \bar{W}\bar{Y}\bar{Z} + X\bar{Y}Z$$

d.) $F = \sum_{WXYZ}(1,3,5,7,11,12,13,14,15)$

YZ\WX	00	01	11	10
00	0	0	*1	0
01	1*	1	1	0
11	1	1	1	*1
10	0	0	*1	0

- 4 Distinguished One-Cells
- 4 Prime Implicants
- 3 Essential Primes

$$F = WX + YZ + \bar{W}Z$$

#3) $F = \sum_{WXYZ}(3,4,6,7,8,10,11,12)$

a.) Use k-map to find minimum Product of Sums

YZ\WX	00	01	11	10
00	0	1	1	1
01	0	0	0	0
11	1	1	0	1
10	0	1	0	1

Product of sums
$$= (Y' + Z)(W' + X' + Z')(U + X + Y)$$
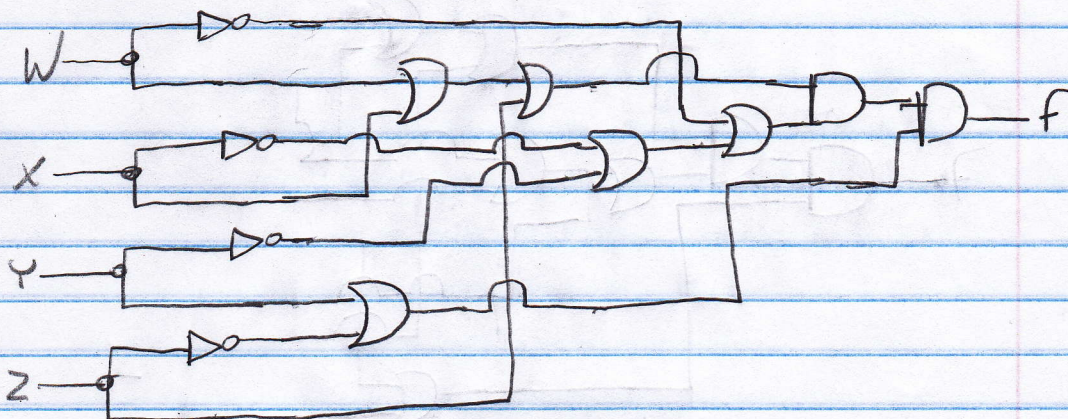
$$= (Y + Z')(W + X + Z)(W' + X' + Y')$$

b.) (Next Page)

$(Y+Z')(W+X'+Z)(W'+X+Y)$

b.) Draw logic diagram implementing product-of-sums

c.) Are there any static hazards? Static-1 or static-0?

Yes, two static-0 hazards, denoted by $\Diamond$

d.) To fix the design, need to add in two extra terms to the product-of-sums expression to cover the two hazards

→ These two expressions are found using Product of sums standard method for the diagrams I circled in the prior question

Original $f = (Y+Z')(W+X+Z)(W'+X'+Y')$

W/O Hazards $= (Y+Z')(W+X+Z)(W'+X'+Y')(W'+X'+Z')(W+X+Y) = f$