Due: Tuesday, Jan 28

College of Charleston
Computer Science Department

CSCI 350 Digital Logic and Computer Organization
G. Pothering
Assignment 1
Spring 2020- Due January 28, 2020

Course Outcomes being addressed:

1. Understand the relationship between logic circuits, Boolean functions, Boolean expressions, truth tables.

Assignment Problems

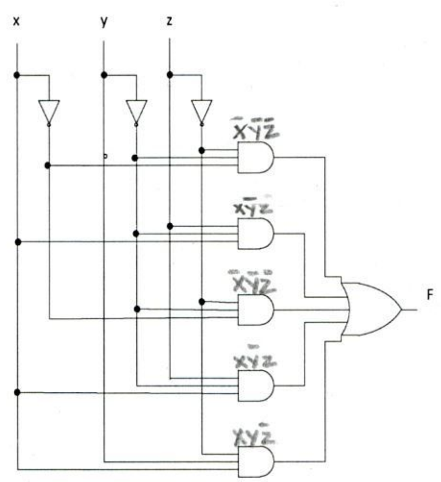
1. Give a truth table and both canonical SOP and POS expressions for each of the following logic functions:

   a. `f(x,y,z) = Σ(0,1,5,7)`
   b. `f(x,y,z,w) = Π(0,2,3,5,8,10,11,12,15)`

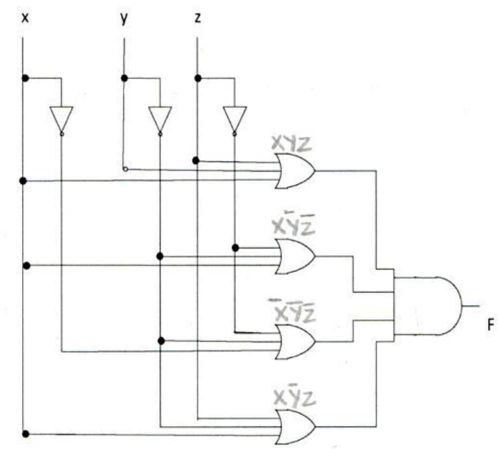
2. For both of the expressions in problem 1a. draw an associated logic circuit.

3. Given the following logic circuits, determine both the canonical SOP expressions and the canonical POS expression associated with each

   a.



   b.



4. For each circuit of problem 3 express the function each one implements using both logic function notations (that is use both the Σ and Π representations for each part.) .

5. Give a canonical POS expression for the majority function, whose truth table is on page 151 of your textbook.

6. Give a canonical SOP expression for an odd parity bit P for three given signals S2, S1, S0. That is among a given set input signals and P there must be an odd number of 1s in total. For example P(1,0,1) = 1, while P(0,1,0) = 0.

7. Give canonical SOP and POS expressions for the function whose truth table is given in Figure 3.5 on page 155. Note, the last columns in both tables are the same, so this is what you are going to base your canonical expressions on.

8. On page 238, problem 6, your author notes that there are four Boolean functions of a single variable. Express each of these functions as a logic function.

CSCI 350: Assignment 1

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January 28, 2020

1. Give a truth table and both canonical SOP and POS expressions for each of the following logic functions.

all 1's

a. f(x,y,z) = Σ(0,1,5,7)

$$SOP = \underset{000}{\bar{x}\bar{y}\bar{z}} + \underset{001}{\bar{x}\bar{y}z} + \underset{101}{x\bar{y}z} + \underset{111}{xyz}$$

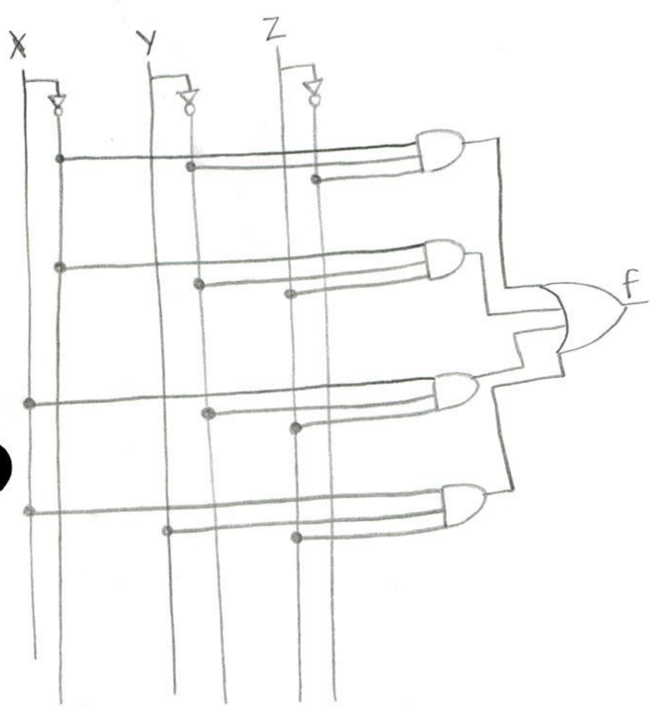
all 0's

$= \Pi(2,3,4,6)$

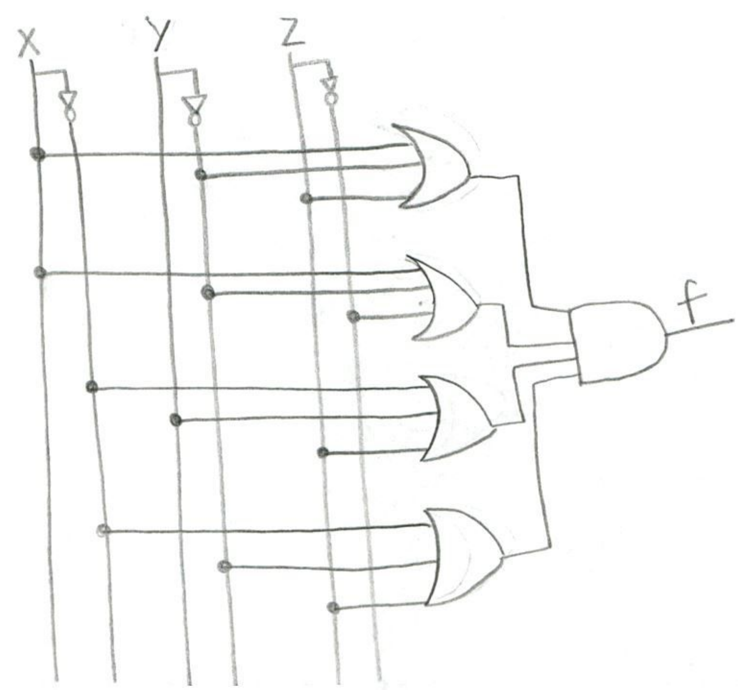
$$POS = \underset{010}{(x+\bar{y}+z)}\underset{011}{(x+\bar{y}+\bar{z})}\underset{100}{(\bar{x}+y+z)}\underset{110}{(\bar{x}+\bar{y}+z)}$$

	x	y	z	f
0	0	0	0	1
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	0
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1

1a SOP



1a POS



b. $f(x,y,z,w) = \Pi(0,2,3,5,8,10,11,12,15)$ —all 0's

POS= $(x+y+z+w)(x+y+\bar{z}+w)(x+y+\bar{z}+\bar{w})(x+\bar{y}+z+\bar{w})(\bar{x}+y+z+w)$

0 0000 2 0010 3 0011 5 0101 8 1000

$(\bar{x}+y+\bar{z}+w)(\bar{x}+y+\bar{z}+\bar{w})(\bar{x}+\bar{y}+z+w)(\bar{x}+\bar{y}+\bar{z}+\bar{w})$

10 1010 11 1011 12 1100 15 1111

—all 1's

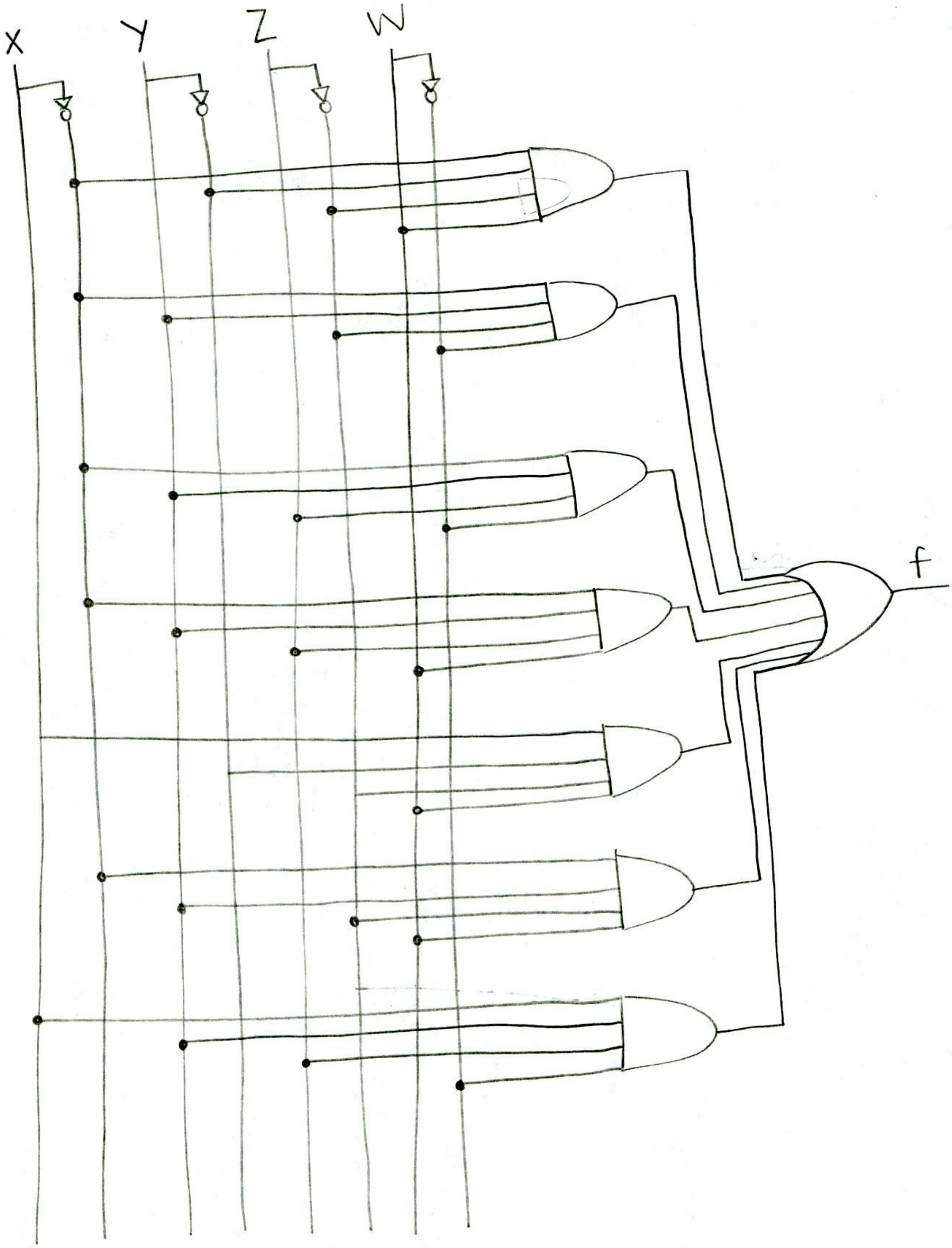
$= \Sigma(1,4,6,7,9,13,14)$

SOP= $\bar{x}\bar{y}\bar{z}w + \bar{x}y\bar{z}\bar{w} + \bar{x}yz\bar{w} + \bar{x}yzw + x\bar{y}\bar{z}w + xy\bar{z}w + xyz\bar{w}$

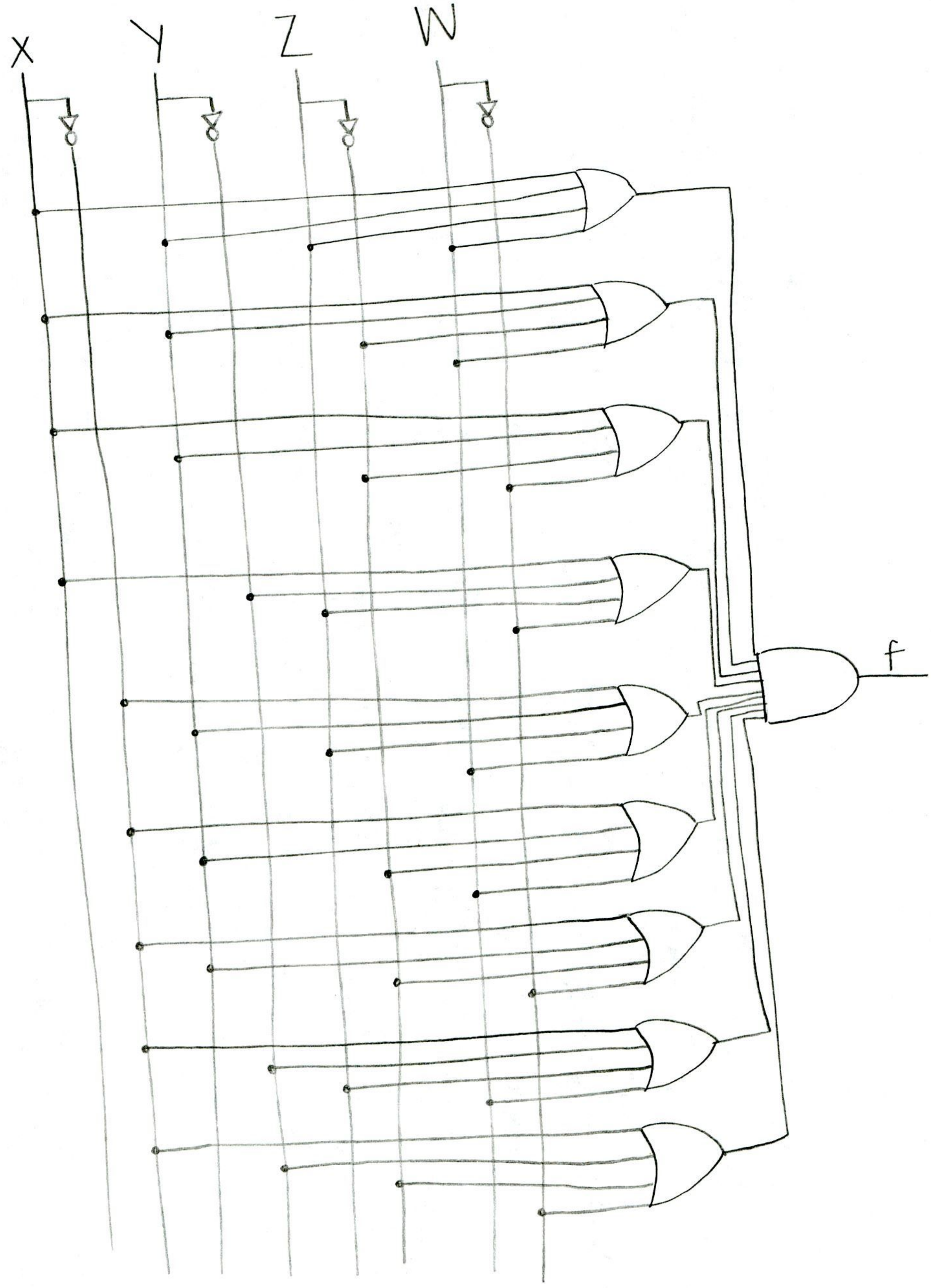
1 0001 4 0100 6 0110 7 0111 9 1001 13 1101 14 1110

	x	y	z	w	f
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	0

1b SOP



10 POS



#3

(a) $SOP = \bar{x}\bar{y}\bar{z} + x\bar{y}z + \bar{x}\bar{y}\bar{z} + x\bar{y}z + xy\bar{z}$

$\quad\quad\quad\ 000 \quad\ 101 \quad\ 000 \quad\ 101 \quad\ 110$

all 1's

$f(x,y,z) = \sum(0,5,0,5,6) = \sum(0,5,6)$

all 0's

$= \prod(1,2,3,4,7)$

$(\bar{x}+y+z)$ $\ 1\ 0\ 0$

$POS = (x+y+\bar{z})(x+\bar{y}+z)(x+\bar{y}+\bar{z})(\bar{x}+\bar{y}+\bar{z})$

$\quad 001 \quad 010 \quad 011 \quad 111$

(b) $POS = (x+y+z)(x+\bar{y}+\bar{z})(\bar{x}+\bar{y}+\bar{z})(x+\bar{y}+z)$

$\quad 000 \quad 011 \quad 111 \quad 010$

all 0's

$f(x,y,z) = \prod(0,3,7,2) = \prod(0,2,3,7)$

all 1's

$= \sum(1,4,5,6)$

$SOP = \bar{x}\bar{y}z + x\bar{y}\bar{z} + x\bar{y}z + xy\bar{z}$

$\quad 001 \quad 100 \quad 101 \quad 110$

#5 $m(a,b,c) = \prod(0,1,2,4)$ all 0's

$POS = (a+b+c)(a+b+\bar{c})(a+\bar{b}+c)(\bar{a}+b+c)$

$\quad 000 \quad 001 \quad 010 \quad 100$

#6

	S2	S1	S0	P
0	0	0	0	1
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

all 1's

$P(S2,S1,S0) = \sum(0,3,5,6)$

$SOP = \overline{S2}\,\overline{S1}\,\overline{S0} + \overline{S2}\,S1\,S0 + S2\,\overline{S1}\,S0 + S2\,S1\,\overline{S0}$

$\quad 000 \quad 011 \quad 101 \quad 110$

#7 $AB + AC = \overset{\text{all 1's}}{\sum}(5,6,7)$

$A(B+C)$ $SOP = \underset{101}{A\bar{B}C} + \underset{110}{AB\bar{C}} + \underset{111}{ABC}$

$= \overset{\text{all 0's}}{\prod}(0,1,2,3,4)$

$POS = \underset{000}{(A+B+C)}\underset{001}{(A+B+\bar{C})}\underset{010}{(A+\bar{B}+C)}\underset{011}{(A+\bar{B}+\bar{C})}\underset{100}{(\bar{A}+B+C)}$

#8 There exists 4 boolean functions of a single variable & 16 functions of 2 variables. How many functions of 4 variables are there? 256

express each of these 4 as logical functions.

① Inverter 

$X = \bar{A}$

② Buffer 

$X = A$

③ True 

$A = 1$

④ False 

$A = 0$