Thinh Nguyen
CSC 137
H.W #2

Problem 2.1

+> $f = x\bar{y} + yz$ for $x=1, y=0, z=1$

$f = 1.\bar{0} + 0.1$

$= 1.1 + 0 = 1+0 = \boxed{1}$

+> $f = x\bar{y} + yz$ for $x=1, y=1, z=0$

$f = 1.\bar{1} + 1.0$

$= 0 + 0 = \boxed{0}$

Problem 2.2

+> $y = \overline{\_c}\,\bar{x} + \_c\,x$ for $\_c=0, x=1$

$y = \bar{0}.\bar{1} + 0.1$

$= 1.0 + 0.1 = 0+0 = \boxed{0}$

+> $y = \overline{\_c}\,\bar{x} + \_c\,x$ for $\_c=1, x=1$

$y = \bar{1}.\bar{1} + 1.1$

$= 0.0 + 1.1$

$= 0 + 1$

$= \boxed{1}$

Problem 2.3

+> $f = \overline{xy}$

$x=0$ and $y=0 \rightarrow f = \overline{0.0} = \bar{0} = 1$
$x=0, y=1 \rightarrow f = \overline{0.1} = \bar{0} = 1$
$x=1, y=0 \rightarrow f = \overline{1.0} = \bar{0} = 1$
$x=1, y=1 \rightarrow f = \overline{1.1} = \bar{1} = 0$

x	y	f
0	0	1
0	1	1
1	0	1
1	1	0

(1)

+> $g = \bar{x} + \bar{y}$

$x=0, y=0 \rightarrow g = \bar{0} + \bar{0} = 1+1 = 1$
$x=0, y=1 \rightarrow g = \bar{0} + \bar{1} = 1+0 = 1$
$x=1, y=0 \rightarrow g = \bar{1} + \bar{0} = 0+1 = 1$
$x=1, y=1 \rightarrow g = \bar{1} + \bar{1} = 0+0 = 0$

x	y	g
0	0	1
0	1	1
1	0	1
1	1	0

(2)

From truth tables (1) and (2) $\rightarrow$ $\boxed{\overline{xy} = \bar{x} + \bar{y}}$

Problem 2.4

+> $f = \overline{x+y}$

$x=0, y=0 \rightarrow f = \overline{0+0} = \bar{0} = 1$
$x=0, y=1 \rightarrow f = \overline{0+1} = \bar{1} = 0$
$x=1, y=0 \rightarrow f = \overline{1+0} = \bar{1} = 0$
$x=1, y=1 \rightarrow f = \overline{1+1} = \bar{1} = 0$

x	y	f
0	0	1
0	1	0
1	0	0
1	1	0

(1)

+> $g = \bar{x}\,\bar{y}$

$x=0, y=0 \rightarrow g = \bar{0}.\bar{0} = 1.1 = 1$
$x=0, y=1 \rightarrow g = \bar{0}.\bar{1} = 1.0 = 0$
$x=1, y=0 \rightarrow g = \bar{1}.\bar{0} = 0.1 = 0$
$x=1, y=1 \rightarrow g = \bar{1}.\bar{1} = 0.0 = 0$

x	y	g
0	0	1
0	1	0
1	0	0
1	1	0

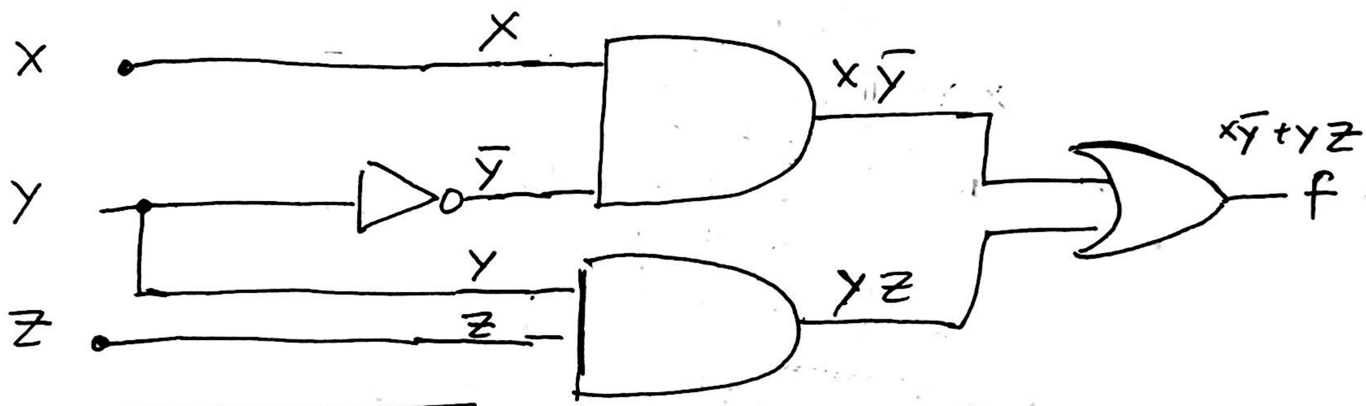
(2)

From (1) and (2) $\rightarrow$ $\boxed{\overline{x+y} = \bar{x}\,\bar{y}}$

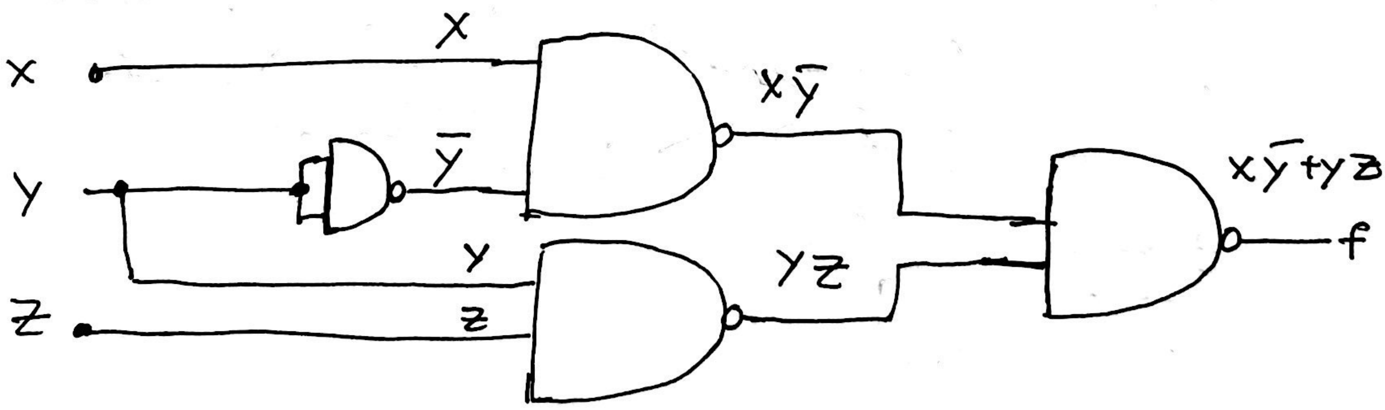
Problem 2.5

$f = x\bar{y} + yz$

The circuit schematic:



The NAND Gates:



Problem 2.6

+) $f = (x+y)(\bar{y}+z)$ for $x=1, y=0, z=1$

$f = (1+0)(\bar{0}+1)$

$= 1 \cdot (1+1) = 1 \cdot 1 = \boxed{1}$

+) $f = (x+y)(\bar{y}+z)$ for $x=1, y=1, z=0$

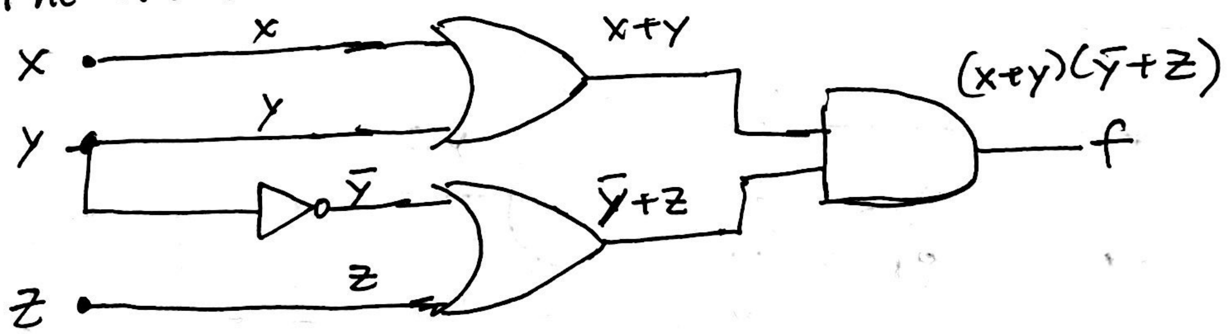
$f = (1+1)(\bar{1}+0)$

$= 1 \cdot (0+0) = 1 \cdot 0 = \boxed{0}$

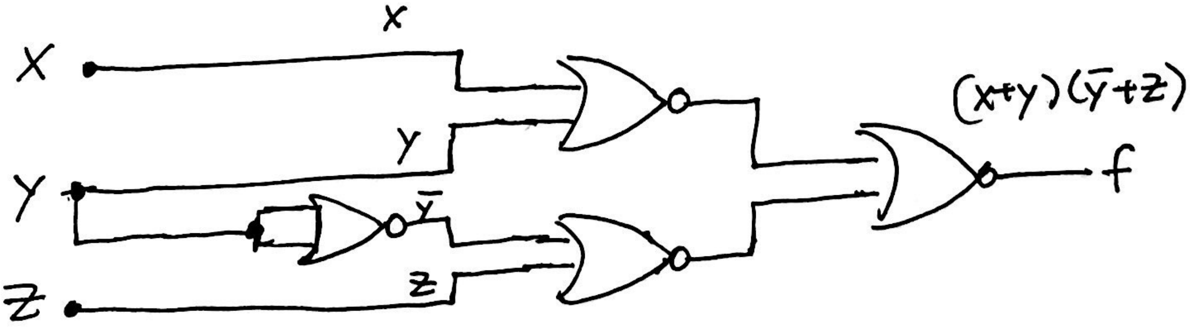
Problem 2.7

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

The circuit schematic:



The NOR gates



Problem 2.8

$f = x\bar{y} + yz$ (SOP expression)

$\bar{f} = \overline{x\bar{y} + yz}$

$= (\overline{x\bar{y}}) \cdot (\overline{yz})$

Applying Theorem 1 $\Rightarrow$ $\bar{f} = (\bar{x}+y) \cdot (\bar{y}+\bar{z})$

SOP of $\bar{f}$ $= \bar{x}\cdot\bar{y} + \bar{x}\cdot\bar{z} + \underbrace{y\cdot\bar{y}}_{0} + y\cdot\bar{z}$

SOP of $\bar{f}$ $= \bar{x}\cdot\bar{y} + \bar{x}\cdot\bar{z} + y\cdot\bar{z}$

$f = \overline{\text{SOP of } \bar{f}} = \overline{\bar{x}\cdot\bar{y} + \bar{x}\cdot\bar{z} + y\cdot\bar{z}}$

Applying Theorem 2 $\Rightarrow$ $f = (\overline{\bar{x}\cdot\bar{y}})(\overline{\bar{x}\cdot\bar{z}})(\overline{y\cdot\bar{z}})$

Applying Theorem 1 $\Rightarrow$ $f = (x+y)(x+z)(\bar{y}+z)$

$$\boxed{\begin{aligned}\text{So, POS of } f &= (x+y)(x+z)(\bar{y}+z)\\ &= (x+y)(\bar{y}+z)\end{aligned}}$$

Scanned with CamScanner

$$\boxed{\text{Problem } 2.9}$$

$$f = x\bar{y} + yz \ (\text{SOP})$$

$$\bar{f} = \overline{x\bar{y} + yz}$$

$$= (\overline{x\bar{y}}) . (\overline{yz})$$

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

$$\text{SOP of } \bar{f} = \bar{x}\bar{y} + \bar{x}\bar{z} + \underbrace{y\bar{y}}_{0} + y\bar{z}$$

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

$$\text{Dual of } \bar{f} = (\bar{x} + \bar{y})(\bar{x} + \bar{z})(y + \bar{z})$$

$$\boxed{\begin{aligned} \text{POS of } f &= (x+y)(x+z)(\bar{y}+z) \\ &= (x+y)(\bar{y}+z) \end{aligned}}$$

Problem 2.12

$Y = 2X + 3$

a)

	X_2	X_1	X_0	Y_4	Y_3	Y_2	Y_1	Y_0	
0	0	0	0	0	0	0	1	1	3
1	0	0	1	0	0	1	0	1	5
2	0	1	0	0	0	1	1	1	7
3	0	1	1	0	1	0	0	1	9
4	1	0	0	0	1	0	1	1	11
5	1	0	1	0	1	1	0	1	13
6	1	1	0	0	1	1	1	1	15
7	1	1	1	1	0	0	0	1	17

Canonical SOP expression y2:

$$\boxed{Y_2 = (\bar{x}\bar{y}z) + (\bar{x}y\bar{z}) + (x\bar{y}z) + (xy\bar{z})}$$

b)

	X_2	X_1	X_0	Y_4	Y_3	Y_2	Y_1	Y_0	
0	0	0	0	0	0	0	1	1	3
1	0	0	1	0	0	1	0	1	5
2	0	1	0	0	0	1	1	1	7
3	0	1	1	0	1	0	0	1	9
-4	1	0	0	1	1	0	1	1	-5
-3	1	0	1	1	1	1	0	1	-3
-2	1	1	0	1	1	1	1	1	-1
-1	1	1	1	0	0	0	0	1	1

Min-terms for Y_4:

$$\boxed{Y_4\ f(x,y,z) = \sum\left((100)_2, (101)_2, (110)_2\right)}$$

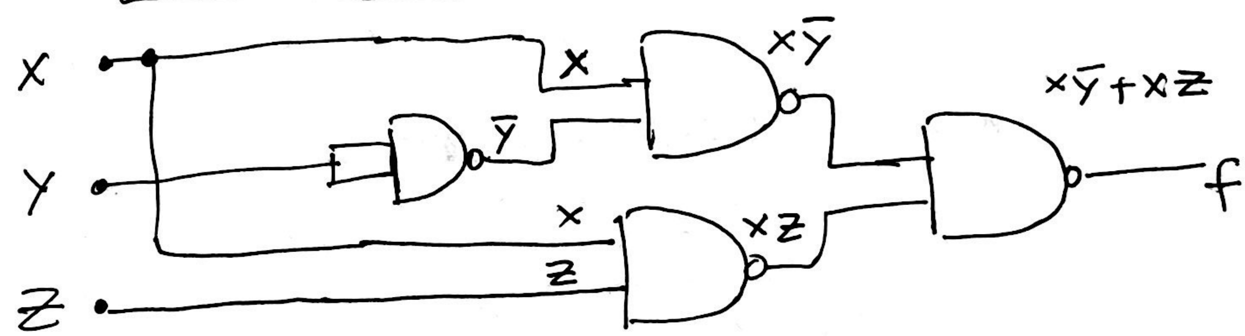
c) K-map

z \ xy	00	01	10	11
0	0	0	1	1
1	0	0	1	0

Minimal SOP expression for y_4:

$$\boxed{y_4 = x\bar{y} + xz}$$

d) NAND circuit for y_4:



e) Since the minimal SOP requires less number of transistors than the canonical

$\Rightarrow$ $\text{transistors}_{\text{Canonical}} > \text{transistors}_{\text{minimal SOP}}$