EECS 140/141 HW3 S'20

1. a. CPoS from T.T

$$a = (e+d+k+w)\cdot(e+d+k+\bar{w})(e+d+\bar{k}+w)\cdot(e+d+\bar{k}+\bar{w})\cdot$$
$$\cdot(e+\bar{d}+k+w)\cdot(e+\bar{d}+k+\bar{w})(e+\bar{d}+\bar{k}+w)\cdot(e+\bar{d}+\bar{k}+\bar{w})\cdot$$
$$\cdot(\bar{e}+d+k+w)(\bar{e}+d+\bar{k}+w)\cdot(\bar{e}+\bar{d}+\bar{k}+w)$$

b. CPoS cost: $(i+2)M+1 = (4+2)(11)+1 = 67$

CSoP cost: $(i+2)m+1 = (4+2)(5)+1 = 31$

"Word description" implementation cost = 9.

2. a)

x_1	x_0	y_1	y_0	f
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

b) $f = \sum m(0, 5, 10, 15)$

3. From lecture notes for AND/OR Ckt

s	x_1	x_2	y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

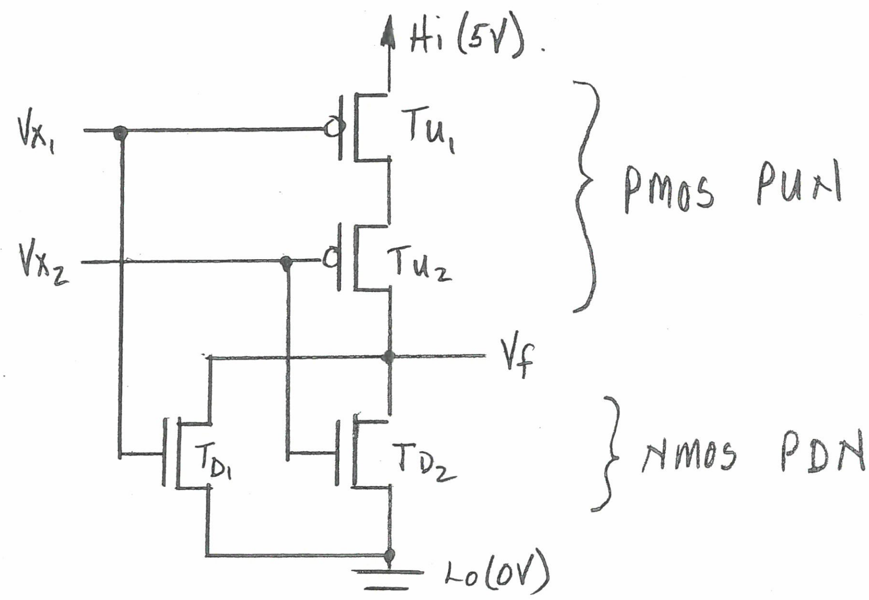
CPoS:

$$y = (s+x_1+x_2)(\bar{s}+x_1+x_2)\cdot(\bar{s}+x_1+\bar{x}_2)\cdot(\bar{s}+\bar{x}_1+x_2)$$

Note that we can use the combining property (14b) to combine maxterm $(\bar{s}+x_1+x_2)$ with any other maxterm. Using 7b first (and twice) to create 3 instances of $(\bar{s}+x_1+x_2)$, we can combine it with every other maxterm.

Simplest PoS: $(x_1+x_2)(\bar{s}+x_1)\cdot(\bar{s}+x_2)$ cost = 13.

4a.



b.

V_{x_1}	V_{x_2}	T_{u_1}	T_{u_2}	PUN	T_{D_1}	T_{D_2}	PDN	V_f	Current
Lo(0)	Lo(0)	Cl	Cl	Cl	Op	Op	Op	Hi (1)	0
Lo(0)	Hi(1)	Cl	Op	Op	Op	Cl	Cl	Lo (0)	0
Hi(1)	Lo(0)	Op	Cl	Op	Cl	Op	Cl	Lo (0)	0
Hi(1)	Hi(1)	Op	Op	Op	Cl	Cl	Cl	Lo (0)	0

5. a). Reading directly from logic diagram (CSoP form):

$f = \bar{x}_1 \bar{x}_2 x_3 + \bar{x}_1 x_2 \bar{x}_3 + x_1 \bar{x}_2 \bar{x}_3 + x_1 x_2 x_3$

$f = m_1 + m_2 + m_4 + m_7$

x_1	x_2	x_3	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

b). NOT gates: 2 transistors

AND & OR gates: $2 \times (\#\text{inputs}) + 2 = 2 \times (\#\text{inputs} + 1)$

for inversion of NAND or NOR.

Here: 3 NOT, 4, 3-input AND, 1 4-input OR

$3(2) + (4)(3+1)(2) + (1)(4+1)(2) = 6 + 32 + 10 = \underline{\underline{48}}$

6. $A = x_1 \oplus x_2$, $h = A \oplus x_3 = (x_1 \oplus x_2) \oplus x_3$.

x_1	x_2	x_3	A	h
0	0	0	0	0
0	0	1	0	1
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	0	1

This matches the T.T. for the network of Figure P3.1 as given in previous solutions.

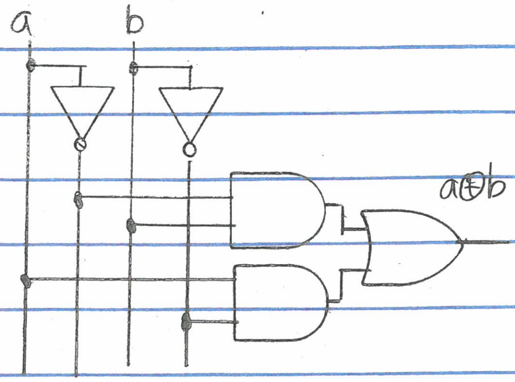
7.

a	b	$a \oplus b$
0	0	0
0	1	1
1	0	1
1	1	0

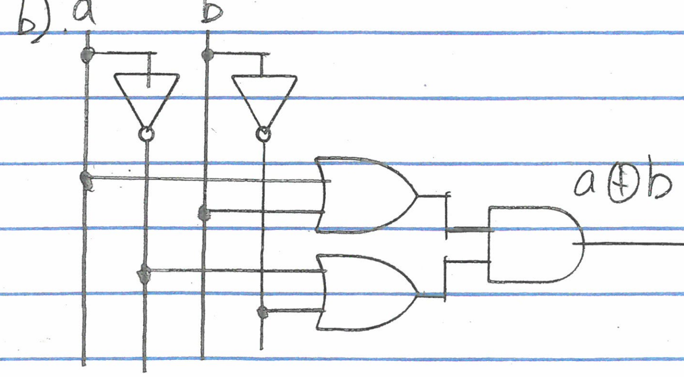
(a) SoP: $a \oplus b = \bar{a}b + a\bar{b}$

(b) PoS: $a \oplus b = (a+b) \cdot (\bar{a} + \bar{b})$.

a)



b)



8. Label NOR output as X and XOR output as y.
f is then NAND of X and y.

				$\overline{(a+b)}$	$c \oplus d$	
a	b	c	d	X	y	$f = \overline{(X \cdot y)}$
0	0	0	0	1	0	1
0	0	0	1	1	1	0
0	0	1	0	1	1	0
0	0	1	1	1	0	1
0	1	0	0	0	0	1
0	1	0	1	0	1	1
0	1	1	0	0	1	1
0	1	1	1	0	0	1
1	0	0	0	0	0	1
1	0	0	1	0	1	1
1	0	1	0	0	1	1
1	0	1	1	0	0	1
1	1	0	0	0	0	1
1	1	0	1	0	1	1
1	1	1	0	0	1	1
1	1	1	1	0	0	1