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Chapter 2 Homework

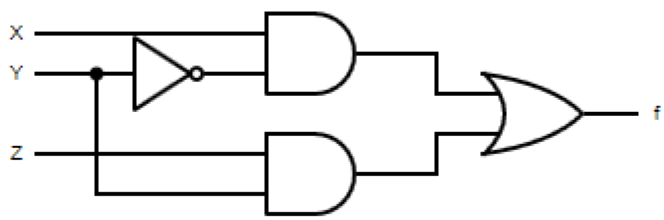
2.1 Evaluate $f = x\overline{y} + yz$ for $x = 1$, $y = 0$, and $z = 1$ and for $x = 1$, $y = 1$, and $z = 0$.

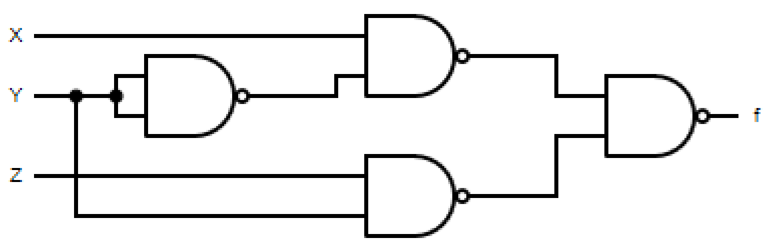
x=1, y=0, z=1 → 1.1 + 0.1 → 1 + 0 = **1**
x=1, y=1, z=0 → 1.0 + 1.0 → 0 + 0 = **0**

2.2 Evaluate $y = \overline{\_c}\,\overline{x} + \_cx$ for $\_c = 0$ and $x = 1$ and for $\_c = 1$ and $x = 1$ where $\_c$ is an active-low signal.

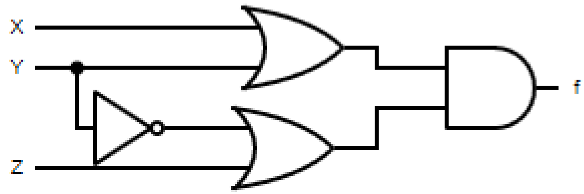
_c = active-low signal inverter therefore 0=on 1=off
_c=0, x=1 → 1.0 + 0.1 → 0 + 0 = **0**
_c=1, x=1 → 0.0 + 1.1 → 1 + 1 = **1**

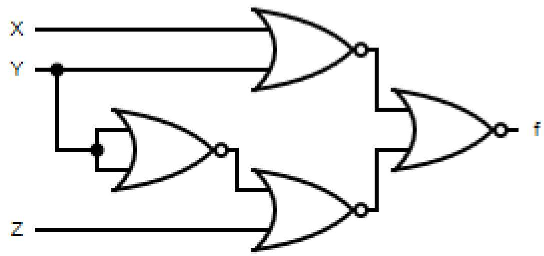
2.5 Draw the circuit schematic for $f = x\overline{y} + yz$ and then convert the schematic to NAND gates using the steps illustrated in the textbook.





2.7 Draw the circuit schematic for $f = (x + y)(\bar{y} + z)$ and then convert the schematic to NOR gates using the steps illustrated in the textbook.





2.8 Given $f = x\bar{y} + yz$ (an SOP expression) determine its equivalent POS expression. Hint: First find the SOP of $\bar{f}$ and then use the rule "POS expression of f = Complement of the SOP expression of $\bar{f}$".

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

$\overline{\text{SOP of } \bar{f}}$ $\quad \bar{f} = \overline{(\bar{x} + y)(\bar{y} + \bar{z})}$

POS of $\quad \mathbf{f = (x + \bar{y})(y + z)}$

2.9 Obtain the POS expression of f by applying the Dual Principle to the SOP of $\bar{f}$ where $f = x\bar{y} + yz$.

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

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

POS of $\quad \mathbf{f = (x + \bar{y})(y + z)}$

2.10 Suppose we would like to build function Y = 2X + 3 where X denotes a 3-bit unsigned value $(x2x1x0)_2$ and Y = $y4..y0$ is a 5-bit value in hardware. Construct its truth table where input bits are $x2$, $x1$, and $x0$ and output bits are $y4$ through $y0$. Then do the following for output $y2$ (you may repeat this for the other outputs):

x_2	x_1	x_0	y_4	y_3	y_2	y_1	y_0
0	0	0	0	0	0	1	1
0	0	1	0	0	1	0	1
0	1	0	0	0	1	1	1
0	1	1	0	1	0	0	1
1	0	0	0	1	0	1	1
1	0	1	0	1	1	0	1
1	1	0	0	1	1	1	1
1	1	1	1	0	0	0	1

a. Determine the canonical SOP expression for output bit $y2$.

$$\mathbf{y_2 = x_2 x_1 \overline{x_0} + x_2 \overline{x_1} x_0 + \overline{x_2} x_1 \overline{x_0} + \overline{x_2 x_1} x_0}$$

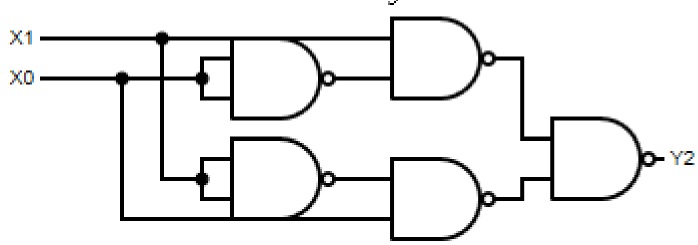
b. Write the min-terms for $y2$.

$$\mathbf{f(x_1, x_0) = \sum(2, 1)}$$

c. Use K-map and find a minimal SOP expression for $y2$.

$$\mathbf{y_2 = x_1 \overline{x_0} + \overline{x_1} x_0}$$

d. Draw a minimal NAND circuit for $y2$.



e. Compare the number of transistors required to implement the canonical and the minimal SOP expressions.

5 Transistors for minimal vs… upwards of 20 for canonical. Seems like minimal is a lot better

2.14 Find a minimal SOP expression for each of the following functions using K-maps:

a. $f(w, x, y, z) = \Sigma(0, 2, 8, 10) + \Sigma_d(12, 14)$

Canonical SOP: $f = (\overline{wxyz} + \overline{wx}\,y\,\overline{z} + w\,\overline{xyz} + w\,\overline{x}\,y\,\overline{z}) + (wx\,\overline{yz} + wxy\,\overline{z})$

$((\overline{wxz})(\overline{y} + y) + (w\,\overline{xz})(\overline{y} + y)) + ((wx\,\overline{z})(\overline{y} + y))$

$((\overline{wxz}) + (w\,\overline{xz})) + (wx\,\overline{z}) \rightarrow (\overline{xz}) + (wx\,\overline{z})$

Minimal SOP: $f = (\overline{xz}) + (wx\,\overline{z})$Error! Bookmark not defined.

b. $g(a, b, c, d) = \Sigma(5, 7, 13, 15) + \Sigma_d(6, 14)$

Canonical SOP: $g = (\overline{a}\,b\,\overline{c}\,d + \overline{a}\,bcd + ab\,\overline{c}\,d + abcd) + (\overline{a}\,bc\,\overline{d} + abc\,\overline{d})$

$((\overline{a}\,bd)(c + \overline{c}) + (abd)(c + \overline{c})) + ((bc\,\overline{d})(a + \overline{a}))$

$(\overline{a}\,bd) + (abd) + (bc\,\overline{d}) \rightarrow (bd) + (bc\,\overline{d})$

Minimal SOP: $g = (bd) + (bc\,\overline{d})$

c. $h(w, x, y, z) = \Pi(0, 2, 8, 10) + \Pi_d(12, 14)$

Canonical SOP: $h = (\overline{wxyz} + \overline{wx}\,y\,\overline{z} + w\,\overline{xyz} + w\,\overline{x}\,y\,\overline{z}) + (wx\,\overline{yz} + wxy\,\overline{z})$

$((\overline{wxz})(\overline{y} + y) + (w\,\overline{xz})(\overline{y} + y)) + ((wx\,\overline{z})(\overline{y} + y))$

$((\overline{wxz}) + (w\,\overline{xz})) + (wx\,\overline{z}) \rightarrow (\overline{xz}) + (wx\,\overline{z})$

Minimal SOP: $h = (\overline{xz}) + (wx\,\overline{z})$Error! Bookmark not defined.

d. $t(a, b, c, d) = \Pi(5, 7, 13, 15) + \Pi_d(6, 14)$

Canonical SOP: $t = (\overline{a}\,b\,\overline{c}\,d + \overline{a}\,bcd + ab\,\overline{c}\,d + abcd) + (\overline{a}\,bc\,\overline{d} + abc\,\overline{d})$

$((\overline{a}\,bd)(c + \overline{c}) + (abd)(c + \overline{c})) + ((bc\,\overline{d})(a + \overline{a}))$

$(\overline{a}\,bd) + (abd) + (bc\,\overline{d}) \rightarrow (bd) + (bc\,\overline{d})$

Minimal SOP: $t = (bd) + (bc\,\overline{d})$

2.15 Find minimal POS expressions for each of the functions given in Problem 2.14.

a. Minimal POS: **$f = (w+y+z)(w+\overline{x + y} + z)(\overline{z})$**

b. Minimal POS: **$g = (a+\overline{b}+d)(\overline{d})$**

c. Minimal POS: **$h = (w+y+z)(w+\overline{x + y} + z)(\overline{z})$**

d. Minimal POS: **$t = (a+\overline{b}+d)(\overline{d})$**