Chapter 4

4.1. SOP form: $f = \overline{x}_1 x_2 + \overline{x}_2 x_3$
POS form: $f = (\overline{x}_1 + \overline{x}_2)(x_2 + x_3)$

4.2. SOP form: $f = x_1\overline{x}_2 + x_1 x_3 + \overline{x}_2 x_3$
POS form: $f = (x_1 + x_3)(x_1 + \overline{x}_2)(\overline{x}_2 + x_3)$

4.3. SOP form: $f = \overline{x}_1 x_2 x_3 \overline{x}_4 + x_1 x_2 \overline{x}_3 x_4 + \overline{x}_2 x_3 x_4$
POS form: $f = (\overline{x}_1 + x_4)(x_2 + x_3)(\overline{x}_2 + \overline{x}_3 + \overline{x}_4)(x_2 + x_4)(x_1 + x_3)$

4.4. SOP form: $f = \overline{x}_2\overline{x}_3 + \overline{x}_2\overline{x}_4 + x_2 x_3 x_4$
POS form: $f = (\overline{x}_2 + x_3)(x_2 + \overline{x}_3 + \overline{x}_4)(\overline{x}_2 + x_4)$

4.5. SOP form: $f = \overline{x}_3\overline{x}_5 + \overline{x}_3 x_4 + x_2 x_4 \overline{x}_5 + \overline{x}_1 x_3 \overline{x}_4 x_5 + x_1 x_2 \overline{x}_4 x_5$
POS form: $f = (\overline{x}_3 + x_4 + x_5)(\overline{x}_3 + \overline{x}_4 + \overline{x}_5)(x_2 + \overline{x}_3 + \overline{x}_4)(x_1 + x_3 + x_4 + \overline{x}_5)(\overline{x}_1 + x_2 + x_4 + \overline{x}_5)$

4.7. SOP form: $f = x_3\overline{x}_4\overline{x}_5 + \overline{x}_3\overline{x}_4 x_5 + x_1 x_4 x_5 + x_1 x_2 x_4 + x_3 x_4 x_5 + \overline{x}_2 x_3 x_4 + x_2\overline{x}_3 x_4\overline{x}_5$
POS form: $f = (x_3 + x_4 + x_5)(\overline{x}_3 + x_4 + \overline{x}_5)(x_1 + \overline{x}_2 + \overline{x}_3 + \overline{x}_4 + x_5)$

4.9. $f = x_1 x_2 x_3 + x_1 x_2 x_4 + x_1 x_3 x_4 + x_2 x_3 x_4$

4.10. SOP form: $f = x_1 x_2 \overline{x}_3 + x_1 \overline{x}_2 x_4 + x_1 x_3 \overline{x}_4 + \overline{x}_1 x_2 x_3 + \overline{x}_1 x_3 x_4 + x_2 \overline{x}_3 x_4$
POS form: $f = (x_1 + x_2 + x_3)(x_1 + x_2 + x_4)(x_1 + x_3 + x_4)(x_2 + x_3 + x_4)(\overline{x}_1 + \overline{x}_2 + \overline{x}_3 + \overline{x}_4)$
The POS form has lower cost.

4.12. The first 3 product terms are shared, hence the total cost is 31.

4.14. $f = (x_3 \uparrow g) \uparrow ((g \uparrow g) \uparrow x_4)$ where $g = (x_1 \uparrow (x_2 \uparrow x_2)) \uparrow ((x_1 \uparrow x_1) \uparrow x_2)$

4.15. $\overline{f} = (((x_3 \downarrow x_3) \downarrow g) \downarrow ((g \downarrow g) \downarrow (x_4 \downarrow x_4))$, where
$g = ((x_1 \downarrow x_1) \downarrow x_2) \downarrow (x_1 \downarrow (x_2 \downarrow x_2))$. Then, $f = \overline{f} \downarrow \overline{f}$.

4.21 $f = g \cdot h + \overline{g} \cdot \overline{h}$, where $g = x_1 x_2$ and $h = x_3 + x_4$

4.22.
$g = x_5(\overline{x}_1 + x_2)$
$f = (\overline{x}_3\overline{x}_4 + x_3 x_4)g + \overline{x}_3 x_4 \overline{g} = x_3 x_4 g + \overline{x}_3\overline{x}_4 g + \overline{x}_3 x_4 \overline{g}$
Cost $= 9 + 18 = 27$