2.12

Decision variables. Let

\[ g_1, g_2, g_3 = \text{amount of gas 1, 2, and 3 produced, respectively} \]
\[ c_1, c_2, c_3 = \text{amount of crude 1, 2, and 3 purchased, respectively} \]
\[ x_{11}, x_{21}, x_{31} = \text{amount of crude 1, 2, and 3 in gas 1, respectively} \]
\[ x_{12}, x_{22}, x_{32} = \text{amount of crude 1, 2, and 3 in gas 2, respectively} \]
\[ x_{13}, x_{23}, x_{33} = \text{amount of crude 1, 2, and 3 in gas 3, respectively} \]

Objective function and constraints.

\[
\begin{align*}
\text{min} & \quad 55c_1 + 65c_2 + 75c_3 + 4(g_1 + g_2 + g_3) \\
\text{s.t.} & \quad c_1 = x_{11} + x_{12} + x_{13} \\
& \quad c_2 = x_{21} + x_{22} + x_{23} \\
& \quad c_3 = x_{31} + x_{32} + x_{33} \\
& \quad g_1 = x_{11} + x_{21} + x_{31} \\
& \quad g_2 = x_{12} + x_{22} + x_{32} \\
& \quad g_3 = x_{13} + x_{23} + x_{33} \\
& \quad 85x_{11} + 90x_{21} + 94x_{31} \geq 87g_1 \\
& \quad 85x_{12} + 90x_{22} + 94x_{32} \geq 89g_2 \\
& \quad 85x_{13} + 90x_{23} + 94x_{33} \geq 91g_3 \\
& \quad 50x_{11} + 65x_{21} + 85x_{31} \geq 60g_1 \\
& \quad 50x_{12} + 65x_{22} + 85x_{32} \geq 70g_2 \\
& \quad 50x_{13} + 65x_{23} + 85x_{33} \geq 80g_3 \\
& \quad g_1 + g_2 + g_3 \leq 14000 \\
& \quad g_1 \geq 4000 \\
& \quad g_2 \geq 3000 \\
& \quad g_3 \geq 2000 \\
& \quad 0 \leq c_1 \leq 5000 \\
& \quad 0 \leq c_2 \leq 5000 \\
& \quad 0 \leq c_3 \leq 5000
\end{align*}
\]

(minimize cost) (crude 1 purchased = used) (crude 2 purchased = used) (crude 3 purchased = used) (gas 1 produced) (gas 2 produced) (gas 3 produced) (minimum octane for gas 1) (minimum octane for gas 2) (minimum octane for gas 3) (minimum quality for gas 1) (minimum quality for gas 2) (minimum quality for gas 3) (refinery limit) (demand obligation for gas 1) (demand obligation for gas 2) (demand obligation for gas 3) (crude 1 lower and upper bounds) (crude 2 lower and upper bounds) (crude 3 lower and upper bounds)