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**Dualidade - Exercícios**

Escreva o dual dos seguintes PPL:

1)  $\max Z = x_1 + 2x_2 + 3x_3$

Sujeito a:

$$\begin{aligned}x_1 + x_2 + x_3 &\leq 10 \\2x_1 + x_2 + 4x_3 &\leq 12 \\x_1 + 3x_2 - x_3 &\leq 9 \\x_1, x_2, x_3 &\geq 0\end{aligned}$$

2)  $\max Z = 3x_1 + 5x_2$

Sujeito a:

$$\begin{aligned}x_1 &\leq 4 \\x_2 &\leq 6 \\3x_1 + x_2 &= 18 \\x_1 &\geq 0, x_2 \in \Re\end{aligned}$$

3)  $\min Z = 4x_1 + 3x_2 + x_3$

Sujeito a:

$$\begin{aligned}2x_1 + 2x_2 + 5x_3 &\geq 7 \\3x_1 + 5x_2 + x_3 &\geq 4 \\x_1, x_2, x_3 &\geq 0\end{aligned}$$

4)  $\max Z = 2x_1 + 3x_2 + x_3$

Sujeito a:

$$\begin{aligned}x_1 + x_2 &\leq 10 \\2x_1 + 4x_2 - x_3 &= 20 \\x_1, x_2, x_3 &\geq 0\end{aligned}$$

5)  $\min Z = 16x_1 + 25x_2$

Sujeito a:

$$\begin{aligned}x_1 + 7x_2 &\geq 4 \\x_1 + 5x_2 &\geq 5 \\2x_1 + 3x_2 &\geq 9 \\x_1, x_2 &\geq 0\end{aligned}$$

6)  $\min Z = 20x_1 + 12x_2$

Sujeito a:

$$\begin{aligned}2x_1 + 4x_2 &\geq 48 \\x_1 - 3x_2 &\leq 10 \\3x_1 + x_2 &\geq 24 \\x_1, x_2 &\geq 0\end{aligned}$$

7)  $\max Z = 5x_1 + 4x_2 + 3x_3$

Sujeito a:

$$\begin{aligned}4x_1 + 2x_2 - x_3 &\leq 50 \\2x_1 + 3x_2 - 4x_3 &\geq 40 \\x_1 + 2x_2 - 2x_3 &\leq 30 \\x_1, x_2 &\geq 0 \text{ e } x_3 \text{ livre}\end{aligned}$$

**Respostas:**

1)  $\min Y = 10y_1 + 12y_2 + 9y_3$

Sujeito a:

$$\begin{aligned}y_1 + 2y_2 + y_3 &\geq 1 \\y_1 + y_2 + 3y_3 &\geq 2 \\y_1 + 4y_2 - y_3 &\geq 3 \\y_1, y_2, y_3 &\geq 0\end{aligned}$$

2)  $\min Y = 4y_1 + 6y_2 + 18y_3$

Sujeito a:

$$\begin{aligned}y_1 + 3y_3 &\geq 3 \\y_2 + y_3 &= 5 \\y_1, y_2 &\geq 0, y_3 \in \mathbb{R}\end{aligned}$$

3)  $\max Y = 7y_1 + 4y_2$

Sujeito a:

$$\begin{aligned}2y_1 + 3y_2 &\leq 4 \\2y_1 + 5y_2 &\leq 3 \\5y_1 + y_2 &\leq 1 \\y_1, y_2 &\geq 0\end{aligned}$$

4)  $\min Y = 10y_1 + 20y_2$

Sujeito a:

$$\begin{aligned}y_1 + 2y_2 &\geq 2 \\y_1 + 4y_2 &\geq 3 \\-y_2 &\geq 1 \\y_1 &\geq 0 \text{ e } y_2 \in \mathbb{R}\end{aligned}$$

5)  $\max Y = 4y_1 + 5y_2 + 9y_3$

Sujeito a:

$$\begin{aligned}y_1 + y_2 + 2y_3 &\leq 16 \\7y_1 + 5y_2 + 3y_3 &\leq 25 \\y_1, y_2, y_3 &\geq 0\end{aligned}$$

6)  $\max Y = 48y_1 - 10y_2 + 24y_3$

Sujeito a:

$$\begin{aligned}2y_1 - y_2 + 3y_3 &\leq 20 \\4y_1 + 3y_2 + y_3 &\leq 12 \\y_1, y_2, y_3 &\geq 0\end{aligned}$$

7)  $\min Y = 50y_1 - 40y_2 + 30y_3$

Sujeito a:

$$\begin{aligned}4y_1 - 2y_2 + y_3 &\geq 5 \\2y_1 - 3y_2 + 2y_3 &\geq 4 \\-y_1 + 4y_2 - 2y_3 &= 3 \\y_1, y_2, y_3 &\geq 0\end{aligned}$$