Problem #07

Write the following set of equations in matrix form.

$$V_1 = 5I_y, \qquad V_3 = 100, \qquad V_4 = \frac{V_y}{5}, \qquad \frac{V_2 - V_1}{45} - \frac{V_x}{50} + \frac{V_2 - V_3}{30} + \frac{V_2 - V_4}{50} = 0, \qquad V_x = V_4 - V_3,$$

$$V_y = V_4 - V_2, \qquad I_y = \frac{V_4 - V_2}{50}$$

Rearranging terms, we have:

$$V_1 - 5I_y = 0 \qquad\qquad V_3 = 100 \qquad\qquad V_4 - \frac{1}{5}V_y = 0$$

$$-\frac{1}{45}V_1 + \frac{17}{225}V_2 - \frac{1}{30}V_3 - \frac{1}{50}V_4 - \frac{1}{50}V_x = 0$$

$$V_3 - V_4 + V_x = 0 \qquad\qquad V_2 - V_4 + V_y = 0 \qquad\qquad \frac{1}{50}V_2 - \frac{1}{50}V_4 + I_y = 0$$

In matrix form:

$$
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & -5 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & -\frac{1}{5} & 0 \\
-\frac{1}{45} & \frac{17}{225} & -\frac{1}{30} & -\frac{1}{50} & -\frac{1}{50} & 0 & 0 \\
0 & 0 & 1 & -1 & 1 & 0 & 0 \\
0 & 1 & 0 & -1 & 0 & 1 & 0 \\
0 & \frac{1}{50} & 0 & -\frac{1}{50} & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_x \\ V_y \\ I_y
\end{bmatrix}
=
\begin{bmatrix}
0 \\ 100 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0
\end{bmatrix}
$$