

1

Linear Equations in Linear Algebra

1.1 SOLUTIONS

Notes: The key exercises are 7 (or 11 or 12), 19–22, and 25. For brevity, the symbols R_1, R_2, \dots stand for row 1 (or equation 1), row 2 (or equation 2), and so on. Additional notes are at the end of the section.

$$1. \quad \begin{aligned} x_1 + 5x_2 &= 7 \\ -2x_1 - 7x_2 &= -5 \end{aligned} \quad \begin{bmatrix} 1 & 5 & 7 \\ -2 & -7 & -5 \end{bmatrix}$$

Replace R_2 by $R_2 + (2)R_1$ and obtain:

$$\begin{aligned} x_1 + 5x_2 &= 7 \\ 3x_2 &= 9 \end{aligned} \quad \begin{bmatrix} 1 & 5 & 7 \\ 0 & 3 & 9 \end{bmatrix}$$

Scale R_2 by $1/3$:

$$\begin{aligned} x_1 + 5x_2 &= 7 \\ x_2 &= 3 \end{aligned} \quad \begin{bmatrix} 1 & 5 & 7 \\ 0 & 1 & 3 \end{bmatrix}$$

Replace R_1 by $R_1 + (-5)R_2$:

$$\begin{aligned} x_1 &= -8 \\ x_2 &= 3 \end{aligned} \quad \begin{bmatrix} 1 & 0 & -8 \\ 0 & 1 & 3 \end{bmatrix}$$

The solution is $(x_1, x_2) = (-8, 3)$, or simply $(-8, 3)$.

$$2. \quad \begin{aligned} 2x_1 + 4x_2 &= -4 \\ 5x_1 + 7x_2 &= 11 \end{aligned} \quad \begin{bmatrix} 2 & 4 & -4 \\ 5 & 7 & 11 \end{bmatrix}$$

Scale R_1 by $1/2$ and obtain:

$$\begin{aligned} x_1 + 2x_2 &= -2 \\ 5x_1 + 7x_2 &= 11 \end{aligned} \quad \begin{bmatrix} 1 & 2 & -2 \\ 5 & 7 & 11 \end{bmatrix}$$

Replace R_2 by $R_2 + (-5)R_1$:

$$\begin{aligned} x_1 + 2x_2 &= -2 \\ -3x_2 &= 21 \end{aligned} \quad \begin{bmatrix} 1 & 2 & -2 \\ 0 & -3 & 21 \end{bmatrix}$$

Scale R_2 by $-1/3$:

$$\begin{aligned} x_1 + 2x_2 &= -2 \\ x_2 &= -7 \end{aligned} \quad \begin{bmatrix} 1 & 2 & -2 \\ 0 & 1 & -7 \end{bmatrix}$$

Replace R_1 by $R_1 + (-2)R_2$:

$$\begin{aligned} x_1 &= 12 \\ x_2 &= -7 \end{aligned} \quad \begin{bmatrix} 1 & 0 & 12 \\ 0 & 1 & -7 \end{bmatrix}$$

The solution is $(x_1, x_2) = (12, -7)$, or simply $(12, -7)$.

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Anthony S. Fauci



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