

Banta ner och fyll ut till bas i \mathbb{R}^4 .

$$\mathbb{U} = \left[\underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \end{pmatrix} \right] \subset \mathbb{R}^4.$$

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$$\mathbb{U} = \left[\underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \\ \hline \mathbf{u}_1 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \\ \hline \mathbf{u}_2 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \\ \hline \mathbf{u}_3 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \\ \hline \mathbf{u}_4 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \\ \hline \mathbf{u}_5 \end{pmatrix} \right] \subset \mathbb{R}^4.$$

Ställ upp beroendeekvationen *och* L.K. = godtycklig vektor

$$\lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 = \mathbf{0}, \mathbf{x}.$$

$$\begin{aligned} \lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 &= \lambda_1 \underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \end{pmatrix} + \lambda_2 \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \end{pmatrix} + \lambda_3 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \end{pmatrix} + \lambda_4 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \end{pmatrix} + \lambda_5 \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 \\ \lambda_1 \\ \lambda_1 \\ 0 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 0 \\ \lambda_2 \\ 0 \\ \lambda_2 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_3 \\ 0 \\ -\lambda_3 \\ \lambda_3 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_4 \\ 2\lambda_4 \\ \lambda_4 \\ -3\lambda_4 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 2\lambda_5 \\ \lambda_5 \\ 0 \\ -3\lambda_5 \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 \\ \lambda_1 + \lambda_2 + 2\lambda_4 + \lambda_5 \\ \lambda_1 - \lambda_3 + \lambda_4 \\ \lambda_2 + \lambda_3 - 3\lambda_4 - 3\lambda_5 \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -1 & 0 & 1 & 1 & 2 \\ 1 & 1 & 0 & 2 & 1 \\ 1 & 0 & -1 & 1 & 0 \\ 0 & 1 & 1 & -3 & -3 \end{pmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \end{aligned}$$

Banta ner och fyll ut till bas i \mathbb{R}^4 .

$$\mathbb{U} = \left[\underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \\ \hline \mathbf{u}_1 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \\ \hline \mathbf{u}_2 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \\ \hline \mathbf{u}_3 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \\ \hline \mathbf{u}_4 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \\ \hline \mathbf{u}_5 \end{pmatrix} \right] \subset \mathbb{R}^4.$$

Ställ upp beroendeekvationen och L.K. = godtycklig vektor

$$\lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 = \mathbf{0}, \mathbf{x}.$$

$$\begin{aligned} \lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 &= \lambda_1 \underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \\ \hline \end{pmatrix} + \lambda_2 \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \\ \hline \end{pmatrix} + \lambda_3 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \\ \hline \end{pmatrix} + \lambda_4 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \\ \hline \end{pmatrix} + \lambda_5 \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \\ \hline \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 \\ \lambda_1 \\ \lambda_1 \\ 0 \\ \hline \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 0 \\ \lambda_2 \\ 0 \\ \lambda_2 \\ \hline \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_3 \\ 0 \\ -\lambda_3 \\ \lambda_3 \\ \hline \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_4 \\ 2\lambda_4 \\ \lambda_4 \\ -3\lambda_4 \\ \hline \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 2\lambda_5 \\ \lambda_5 \\ 0 \\ -3\lambda_5 \\ \hline \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 \\ \lambda_1 + \lambda_2 + 2\lambda_4 + \lambda_5 \\ \lambda_1 - \lambda_3 + \lambda_4 \\ \lambda_2 + \lambda_3 - 3\lambda_4 - 3\lambda_5 \\ \hline \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -1 & 0 & 1 & 1 & 2 \\ 1 & 1 & 0 & 2 & 1 \\ 1 & 0 & -1 & 1 & 0 \\ 0 & 1 & 1 & -3 & -3 \\ \hline \end{pmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \\ \hline \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \hline \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ \hline \end{pmatrix}. \end{aligned}$$

Banta ner och fyll ut till bas i \mathbb{R}^4 .

$$\mathbb{U} = \left[\underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \\ \hline \mathbf{u}_1 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \\ \hline \mathbf{u}_2 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \\ \hline \mathbf{u}_3 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \\ \hline \mathbf{u}_4 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \\ \hline \mathbf{u}_5 \end{pmatrix} \right] \subset \mathbb{R}^4.$$

Ställ upp beroendeekvationen *och* L.K. = godtycklig vektor

$$\lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 = \mathbf{0}, \mathbf{x}.$$

$$\begin{aligned} \lambda_1 \mathbf{u}_1 + \lambda_2 \mathbf{u}_2 + \lambda_3 \mathbf{u}_3 + \lambda_4 \mathbf{u}_4 + \lambda_5 \mathbf{u}_5 &= \lambda_1 \underline{\mathbf{e}} \begin{pmatrix} -1 \\ 1 \\ 1 \\ 0 \end{pmatrix} + \lambda_2 \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \end{pmatrix} + \lambda_3 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 0 \\ -1 \\ 1 \end{pmatrix} + \lambda_4 \underline{\mathbf{e}} \begin{pmatrix} 1 \\ 2 \\ 1 \\ -3 \end{pmatrix} + \lambda_5 \underline{\mathbf{e}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ -3 \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 \\ \lambda_1 \\ \lambda_1 \\ 0 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 0 \\ \lambda_2 \\ 0 \\ \lambda_2 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_3 \\ 0 \\ -\lambda_3 \\ \lambda_3 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} \lambda_4 \\ 2\lambda_4 \\ \lambda_4 \\ -3\lambda_4 \end{pmatrix} + \underline{\mathbf{e}} \begin{pmatrix} 2\lambda_5 \\ \lambda_5 \\ 0 \\ -3\lambda_5 \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 \\ \lambda_1 + \lambda_2 + 2\lambda_4 + \lambda_5 \\ \lambda_1 - \lambda_3 + \lambda_4 \\ \lambda_2 + \lambda_3 - 3\lambda_4 - 3\lambda_5 \end{pmatrix} = \\ &= \underline{\mathbf{e}} \begin{pmatrix} -1 & 0 & 1 & 1 & 2 \\ 1 & 1 & 0 & 2 & 1 \\ 1 & 0 & -1 & 1 & 0 \\ 0 & 1 & 1 & -3 & -3 \end{pmatrix} \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \underline{\mathbf{e}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \underline{\mathbf{e}} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}. \end{aligned}$$

Lös som vanligt!

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right)$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right)$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_4-r_2]{}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right)$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right)$$

Vi får systemen

$$\begin{array}{cc}
 \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) & \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \\
 & \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \\
 & \sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)
 \end{array}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{} \\ \sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right)$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right.$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ -\lambda_5 \end{pmatrix}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{} \\ \sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff \\ \iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -\lambda_5 \\ t \end{pmatrix}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -\lambda_5 \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s + 3t \\ s \\ -t \\ t \end{pmatrix}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -\lambda_5 \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s + 3t \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -\lambda_5 \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s - 3t \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix} = s \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{pmatrix} + t \begin{pmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \quad s, t \in \mathbb{R}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s + 3t \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix} = s \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{pmatrix} + t \begin{pmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \quad s, t \in \mathbb{R}$$

Låt först $s = 1$ och $t = 0$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s - 3t \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix} = s \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{pmatrix} + t \begin{pmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \quad s, t \in \mathbb{R}$$

Låt först $s = 1$ och $t = 0$ så att $\lambda_1 = 1, \lambda_2 = -1, \lambda_3 = 1, \lambda_4 = 0, \lambda_5 = 0$ och sätt in i beroendeekvationen.

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s - 3t - 3t = -s \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix} = s \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{pmatrix} + t \begin{pmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \quad s, t \in \mathbb{R}$$

Låt först $s = 1$ och $t = 0$ så att $\lambda_1 = 1, \lambda_2 = -1, \lambda_3 = 1, \lambda_4 = 0, \lambda_5 = 0$ och sätt in i beroendeekvationen.
Då fås

$$1 \cdot \mathbf{u}_1 - 1 \cdot \mathbf{u}_2 + 1 \cdot \mathbf{u}_3 + 0 \cdot \mathbf{u}_4 + 0 \cdot \mathbf{u}_5 = \mathbf{u}_1 - \mathbf{u}_2 + \mathbf{u}_3 = \mathbf{0}$$

Vi får systemen

$$\left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 1 & 1 & 0 & 2 & 1 & 0 & x_2 \\ 1 & 0 & -1 & 1 & 0 & 0 & x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow[r_3+r_1]{r_2+r_1} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 1 & 1 & -3 & -3 & 0 & x_4 \end{array} \right) \xrightarrow{r_4-r_2} \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & -6 & -6 & 0 & -x_1 - x_2 + x_4 \end{array} \right) \xrightarrow[r_4+3r_3]{r_4+3r_3}$$

$$\sim \left(\begin{array}{ccccc|cc} -1 & 0 & 1 & 1 & 2 & 0 & x_1 \\ 0 & 1 & 1 & 3 & 3 & 0 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & 0 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Vi löser först beroendeekvationen

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & 0 \\ 0 & 1 & 1 & 3 & 3 & 0 \\ 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right) \iff \left\{ \begin{array}{l} -\lambda_1 + \lambda_3 + \lambda_4 + 2\lambda_5 = 0 \\ \lambda_2 + \lambda_3 + 3\lambda_4 + 3\lambda_5 = 0 \\ 2\lambda_4 + 2\lambda_5 = 0 \\ 0 = 0 \end{array} \right. \iff$$

$$\iff \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -\lambda_3 - 3\lambda_4 - 3\lambda_5 \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} \lambda_3 + \lambda_4 + 2\lambda_5 \\ -s - 3t \\ s \\ -t \\ t \end{pmatrix} = \begin{pmatrix} s - t + 2t = s + t \\ -s \\ s \\ -t \\ t \end{pmatrix} = s \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{pmatrix} + t \begin{pmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \quad s, t \in \mathbb{R}$$

Låt först $s = 1$ och $t = 0$ så att $\lambda_1 = 1, \lambda_2 = -1, \lambda_3 = 1, \lambda_4 = 0, \lambda_5 = 0$ och sätt in i beroendeekvationen.
Då fås

$$1 \cdot \mathbf{u}_1 - 1 \cdot \mathbf{u}_2 + 1 \cdot \mathbf{u}_3 + 0 \cdot \mathbf{u}_4 + 0 \cdot \mathbf{u}_5 = \mathbf{u}_1 - \mathbf{u}_2 + \mathbf{u}_3 = \mathbf{0} \iff \mathbf{u}_3 = -\mathbf{u}_1 + \mathbf{u}_2$$

Därefter, på samma sätt, $s = 0$ och $t = 1$ så att $\lambda_1 = 1, \lambda_2 = 0, \lambda_3 = 0, \lambda_4 = -1, \lambda_5 = 1$ och därmed

$$\mathbf{u}_1 - \mathbf{u}_4 + \mathbf{u}_5 = \mathbf{0} \iff \mathbf{u}_5 = -\mathbf{u}_1 + \mathbf{u}_4$$

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, dvs

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, dvs

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Återstår att utreda systemet linjärkombination = godtycklig vektor.

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, dvs

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Återstår att utreda systemet linjärkombination = godtycklig vektor. Från tidigare kalkyl hade vi

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & x_1 \\ 0 & 1 & 1 & 3 & 3 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, dvs

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Återstår att utreda systemet linjärkombination = godtycklig vektor. Från tidigare kalkyl hade vi

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & x_1 \\ 0 & 1 & 1 & 3 & 3 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Detta system är lösbart omm $2x_1 - x_2 + 3x_3 + x_4 = 0$.

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, dvs

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Återstår att utreda systemet linjärkombination = godtycklig vektor. Från tidigare kalkyl hade vi

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & x_1 \\ 0 & 1 & 1 & 3 & 3 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Detta system är lösbart omm $2x_1 - x_2 + 3x_3 + x_4 = 0$. Det betyder att endast de vektorer \mathbf{x} vars koordinater uppfyller att $2x_1 - x_2 + 3x_3 + x_4 = 0$ kan skrivas som linjärkombinationer av $\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4, \mathbf{u}_5$

Detta visar då att \mathbf{u}_3 och \mathbf{u}_5 kan utses till löjliga element och satsen om löjliga element, sats 5.3.16, sid 111 ger då att \mathbf{u}_3 och \mathbf{u}_5 kan strykas, d v s

$$\mathbb{U} = [\mathbf{u}_1, \mathbf{u}_2, \cancel{\mathbf{u}_3}, \mathbf{u}_4, \cancel{\mathbf{u}_5}] = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4]$$

Återstår att utreda systemet linjärkombination = godtycklig vektor. Från tidigare kalkyl hade vi

$$\left(\begin{array}{ccccc|c} -1 & 0 & 1 & 1 & 2 & x_1 \\ 0 & 1 & 1 & 3 & 3 & x_1 + x_2 \\ 0 & 0 & 0 & 2 & 2 & x_1 + x_3 \\ 0 & 0 & 0 & 0 & 0 & 2x_1 - x_2 + 3x_3 + x_4 \end{array} \right)$$

Detta system är lösbart omm $2x_1 - x_2 + 3x_3 + x_4 = 0$. Det betyder att endast de vektorer \mathbf{x} vars koordinater uppfyller att $2x_1 - x_2 + 3x_3 + x_4 = 0$ kan skrivas som linjärkombinationer av $\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3, \mathbf{u}_4, \mathbf{u}_5$, d v s

$$\mathbb{U} = \{\mathbf{x} \in \mathbb{R}^4: 2x_1 - x_2 + 3x_3 + x_4 = 0\} = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_4].$$