Seminari 9

MATEMATIČKE METODE ZA INFORMATIČARE

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Sadržaj

prvi zadatak

Zadatak 1

U vektorskom prostoru $\mathbb{R}^3$ *zadane su dvije baze*

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\},$$

$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}.$$

Vektor $\vec{v} \in \mathbb{R}^3$ *u bazi* $\mathcal{B}_1$ *ima koordinate* $(3,-1,2)$.

a) *Odredite koordinate vektora* $\vec{v}$ *u kanonskoj bazi vektorskog prostora* $\mathbb{R}^3$.

b) *Odredite matricu prijelaza iz baze* $\mathcal{B}_2$ *u bazu* $\mathcal{B}_1$ *i pomoću nje odredite koordinate vektora* $\vec{v}$ *u bazi* $\mathcal{B}_2$.

Rješenje

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$

a)

$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$

Rješenje

$$\mathcal{B}_1 = \{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\}$$

$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

a) $\vec{v} = (3, -1, 2)$

Rješenje

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$

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a) $\vec{v} = (3,-1,2)_{\mathcal{B}_1}$

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1. način

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1. način

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1} = 3 \cdot (1, 2, -1)$$

Rješenje

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1. način

$$\vec{v} = (3,-1,2)_{\mathcal{B}_1} = 3\cdot(1,2,-1) +$$

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2. način

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2. način

$$X_{\mathcal{B}_{\text{kan}}} = MX_{\mathcal{B}_1}$$

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2. način

$$X_{\mathcal{B}_{\text{kan}}} = MX_{\mathcal{B}_1}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{M} \mathcal{B}_1$$

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$$X_{\mathcal{B}_{\text{kan}}} = MX_{\mathcal{B}_1}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{M} \mathcal{B}_1$$

$$M = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

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$$X_{\mathcal{B}_{\text{kan}}} = MX_{\mathcal{B}_1}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{M} \mathcal{B}_1$$

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$$M = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad X_{\mathcal{B}_1} = \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix}$$

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$$X_{\mathcal{B}_{\text{kan}}} = M X_{\mathcal{B}_1}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{M} \mathcal{B}_1$$

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a) $\vec{v} = (3,-1,2)_{\mathcal{B}_1}$

$$\mathcal{B}_2 = \{(0,2,1),\ (2,2,0),\ (1,-1,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0,0),\ (0,1,0),\ (0,0,1)\}$$

1. način

$$\vec{v} = (3,-1,2)_{\mathcal{B}_1} = 3\cdot(1,2,-1) + (-1)\cdot(0,2,0) + 2\cdot(1,1,1) =$$

$$= (5,6,-1)_{\mathcal{B}_{\text{kan}}} \rightsquigarrow 5\cdot(1,0,0) + 6\cdot(0,1,0) + (-1)\cdot(0,0,1)$$

2. način

$$X_{\mathcal{B}_{\text{kan}}} = MX_{\mathcal{B}_1}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{M} \mathcal{B}_1$$

$$M = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad X_{\mathcal{B}_1} = \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix}$$

$$X_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \\ -1 \end{bmatrix}$$

b)

$$\mathcal{B}_1 = \{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\}$$

$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

b)

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$
$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$

$$\mathcal{B}_2 \xrightarrow{\quad T \quad} \mathcal{B}_1$$

b)

$$\mathcal{B}_1 = \{(1,2,-1),\ (0,2,0),\ (1,1,1)\}$$

$$\mathcal{B}_2 = \{(0,2,1),\ (2,2,0),\ (1,-1,1)\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad T = \begin{bmatrix} \quad & \quad & \quad \\ & & \\ & & \end{bmatrix}$$

b) $(1, 2, -1) =$

$$\mathcal{B}_1 = \left\{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\right\}$$

$$\mathcal{B}_2 = \left\{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\right\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1)$

$$\mathcal{B}_1 = \{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\}$$

$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \quad & \quad & \quad \\ & & \\ & & \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) +$

$$\mathcal{B}_1 = \{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\}$$

$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \quad & \quad & \quad \\ \quad & \quad & \quad \\ \quad & \quad & \quad \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0)$

$$\mathcal{B}_1 = \{(1, 2, -1),\ (0, 2, 0),\ (1, 1, 1)\}$$

$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \quad & \quad & \quad \\ \quad & \quad & \quad \\ \quad & \quad & \quad \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) +$

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$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$

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$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad T = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$2\alpha_2 + \alpha_3 = 1$$

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$

$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$2\alpha_2 + \alpha_3 = 1$$

$$2\alpha_1 + 2\alpha_2 - \alpha_3 = 2$$

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$

$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$

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$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

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$$\boxed{\begin{aligned} \mathcal{B}_1 &= \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\} \\ \mathcal{B}_2 &= \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\} \end{aligned}}$$

$(0,2,0) =$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1} \qquad T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}$$

$$\boxed{\begin{aligned} \mathcal{B}_1 &= \{(1,2,-1),\ (0,2,0),\ (1,1,1)\} \\ \mathcal{B}_2 &= \{(0,2,1),\ (2,2,0),\ (1,-1,1)\} \end{aligned}}$$

$$(0,2,0) = \beta_1 \cdot (0,2,1)$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1} \qquad T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

b) $$(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$$

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$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$
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$$(0,2,0) = \beta_1 \cdot (0,2,1) +$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

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$(0,2,0) = \beta_1 \cdot (0,2,1) + \beta_2 \cdot (2,2,0)$

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$(0,2,0) = \beta_1 \cdot (0,2,1) + \beta_2 \cdot (2,2,0) +$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

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b) $$(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$$

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$$2\beta_2 + \beta_3 = 0$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1} \qquad T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$

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$$T = \begin{bmatrix} \alpha_1 & & \\ \alpha_2 & & \\ \alpha_3 & & \end{bmatrix}$$

b) $$(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$$

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$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

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$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$(1,1,1) =$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$

$$\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}$$

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$$\mathcal{B}_2 = \{(0, 2, 1),\ (2, 2, 0),\ (1, -1, 1)\}$$

$$(0, 2, 0) = \beta_1 \cdot (0, 2, 1) + \beta_2 \cdot (2, 2, 0) + \beta_3 \cdot (1, -1, 1)$$

$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$$(1, 1, 1) = \gamma_1 \cdot (0, 2, 1)$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

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$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$$(1,1,1) = \gamma_1 \cdot (0,2,1) +$$

b) $(1, 2, -1) = \alpha_1 \cdot (0, 2, 1) + \alpha_2 \cdot (2, 2, 0) + \alpha_3 \cdot (1, -1, 1)$

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$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

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b) $$(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$$

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$$(1,1,1) = \gamma_1 \cdot (0,2,1) + \gamma_2 \cdot (2,2,0) +$$

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$$\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}$$

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$$(0, 2, 0) = \beta_1 \cdot (0, 2, 1) + \beta_2 \cdot (2, 2, 0) + \beta_3 \cdot (1, -1, 1)$$

$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$$(1, 1, 1) = \gamma_1 \cdot (0, 2, 1) + \gamma_2 \cdot (2, 2, 0) + \gamma_3 \cdot (1, -1, 1)$$

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$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

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$$(1,1,1) = \gamma_1 \cdot (0,2,1) + \gamma_2 \cdot (2,2,0) + \gamma_3 \cdot (1,-1,1)$$

$$2\gamma_2 + \gamma_3 = 1$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$2\alpha_2 + \alpha_3 = 1$$
$$2\alpha_1 + 2\alpha_2 - \alpha_3 = 2$$
$$\alpha_1 + \alpha_3 = -1$$

$$\mathcal{B}_1 = \{(1,2,-1),\ (0,2,0),\ (1,1,1)\}$$
$$\mathcal{B}_2 = \{(0,2,1),\ (2,2,0),\ (1,-1,1)\}$$

$$(0,2,0) = \beta_1 \cdot (0,2,1) + \beta_2 \cdot (2,2,0) + \beta_3 \cdot (1,-1,1)$$

$$2\beta_2 + \beta_3 = 0$$
$$2\beta_1 + 2\beta_2 - \beta_3 = 2$$
$$\beta_1 + \beta_3 = 0$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$$(1,1,1) = \gamma_1 \cdot (0,2,1) + \gamma_2 \cdot (2,2,0) + \gamma_3 \cdot (1,-1,1)$$

$$2\gamma_2 + \gamma_3 = 1$$
$$2\gamma_1 + 2\gamma_2 - \gamma_3 = 1$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}$$

$$\boxed{\begin{aligned} \mathcal{B}_1 &= \{(1,2,-1),\ (0,2,0),\ (1,1,1)\} \\ \mathcal{B}_2 &= \{(0,2,1),\ (2,2,0),\ (1,-1,1)\} \end{aligned}}$$

$(0,2,0) = \beta_1 \cdot (0,2,1) + \beta_2 \cdot (2,2,0) + \beta_3 \cdot (1,-1,1)$

$$\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}$$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1} \qquad T = \begin{bmatrix} \alpha_1 & \beta_1 & \\ \alpha_2 & \beta_2 & \\ \alpha_3 & \beta_3 & \end{bmatrix}$$

$(1,1,1) = \gamma_1 \cdot (0,2,1) + \gamma_2 \cdot (2,2,0) + \gamma_3 \cdot (1,-1,1)$

$$\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}$$

b) $(1,2,-1) = \alpha_1 \cdot (0,2,1) + \alpha_2 \cdot (2,2,0) + \alpha_3 \cdot (1,-1,1)$

$$
\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}
$$

$$
\begin{aligned}
\mathcal{B}_1 &= \{(1,2,-1),\ (0,2,0),\ (1,1,1)\} \\
\mathcal{B}_2 &= \{(0,2,1),\ (2,2,0),\ (1,-1,1)\}
\end{aligned}
$$

$$(0,2,0) = \beta_1 \cdot (0,2,1) + \beta_2 \cdot (2,2,0) + \beta_3 \cdot (1,-1,1)$$

$$
\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}
$$

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 \\ \alpha_2 & \beta_2 & \gamma_2 \\ \alpha_3 & \beta_3 & \gamma_3 \end{bmatrix}$$

$$(1,1,1) = \gamma_1 \cdot (0,2,1) + \gamma_2 \cdot (2,2,0) + \gamma_3 \cdot (1,-1,1)$$

$$
\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}
$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

0	2	1	

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

0	2	1	
2	2	-1	

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

0	2	1	
2	2	-1	
1	0	1	

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

0	2	1	1
2	2	−1	2
1	0	1	−1

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i
0	2	1	1
2	2	-1	2
1	0	1	-1

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	
0	2	1	1	0
2	2	-1	2	2
1	0	1	-1	0

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	β_i
0	2	1	1	0
2	2	-1	2	2
1	0	1	-1	0

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	β_i	
0	2	1	1	0	1
2	2	-1	2	2	1
1	0	1	-1	0	1

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	β_i	γ_i
0	2	1	1	0	1
2	2	-1	2	2	1
1	0	1	-1	0	1

$$\left.\begin{array}{r} 2\alpha_2 + \alpha_3 = 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 = 2 \\ \alpha_1 + \alpha_3 = -1 \end{array}\right\}$$

$$\left.\begin{array}{r} 2\beta_2 + \beta_3 = 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 = 2 \\ \beta_1 + \beta_3 = 0 \end{array}\right\}$$

$$\left.\begin{array}{r} 2\gamma_2 + \gamma_3 = 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 = 1 \\ \gamma_1 + \gamma_3 = 1 \end{array}\right\}$$

			α_i	β_i	γ_i
0	2	1	1	0	1
2	2	-1	2	2	1
1	0	1	-1	0	1

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	β_i	γ_i
0	2	1	1	0	1
2	2	-1	2	2	1
①	0	1	-1	0	1

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

			α_i	β_i	γ_i	
0	2	1	1	0	1	
2	2	-1	2	2	1	
①	0	1	-1	0	1	$/\cdot(-2)$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\enclose{circle}{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline
\end{array}$$

$$\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}$$

$$\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}$$

$$\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
 & & & & & & \\
 & & & & & & \\
1 & 0 & 1 & -1 & 0 & 1 &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|cccl} & & & \alpha_i & \beta_i & \gamma_i & \\ \hline 0 & 2 & 1 & 1 & 0 & 1 & \\ 2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\ \textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline & & & & & & \\ 0 & & & & & & \\ 1 & 0 & 1 & -1 & 0 & 1 & \end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl} & & & \alpha_i & \beta_i & \gamma_i & \\ \hline 0 & 2 & 1 & 1 & 0 & 1 & \\ 2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\ \textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline & & & & & & \\ 0 & 2 & & & & & \\ 1 & 0 & 1 & -1 & 0 & 1 & \end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl} & & & \alpha_i & \beta_i & \gamma_i & \\ \hline 0 & 2 & 1 & 1 & 0 & 1 & \\ 2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\ \textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline & & & & & & \\ 0 & 2 & -3 & & & & \\ 1 & 0 & 1 & -1 & 0 & 1 & \end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\
\hline
0 & 2 & 1 & 1 & 0 & 1 \\
2 & 2 & -1 & 2 & 2 & 1 \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 \; /\cdot(-2) \\
\hline
 & & & & & \\
0 & 2 & -3 & 4 & & \\
1 & 0 & 1 & -1 & 0 & 1
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
 & & & & & & \\
0 & 2 & -3 & 4 & 2 & & \\
1 & 0 & 1 & -1 & 0 & 1 &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl} & & & \alpha_i & \beta_i & \gamma_i & \\ \hline 0 & 2 & 1 & 1 & 0 & 1 & \\ 2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\ \textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline & & & & & & \\ 0 & 2 & -3 & 4 & 2 & -1 & \\ 1 & 0 & 1 & -1 & 0 & 1 & \end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{\;+\;} \\
\text{①} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\cline{1-6}
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\cline{1-6}
0 & 2 & 1 & 1 & 0 & 1 & \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\cline{1-6}
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \overset{+}{\longleftarrow} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\ \hline
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\enclose{circle}{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \enclose{circle}{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
 & & & & & & \\
0 & 2 & -3 & 4 & 2 & -1 &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & & & & & & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & & & & & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & 4 & & & & \\
0 & 2 & -3 & 4 & 2 & -1 &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\enclose{circle}{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \enclose{circle}{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & 4 & -3 & & & \\
0 & 2 & -3 & 4 & 2 & -1 &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\ \hline
0 & 0 & 4 & -3 & -2 & & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
 & & & & & & \\
 & & & & & &
\end{array}$$

$$\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}$$

$$\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}$$

$$\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & -3 & 4 & 2 & -1 &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\ \hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 & \\ \hline
 & & & & & &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

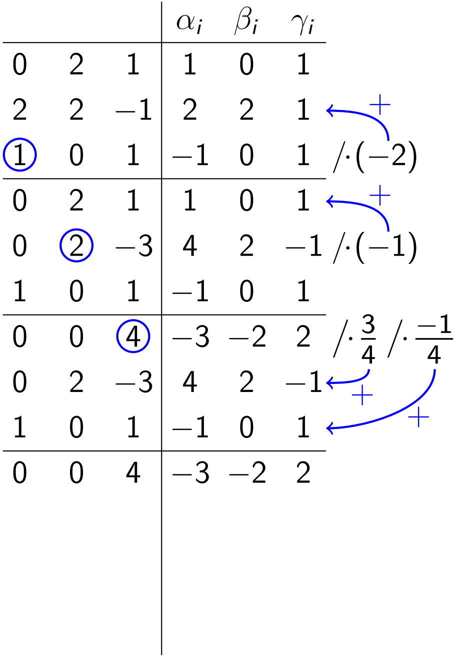
$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$



$$
\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \;\; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \quad /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \xleftarrow{+} \\
1 & 0 & 1 & -1 & 0 & 1 & \xleftarrow{+} \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \;/\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & & & \\
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & & \\
 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \;\; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & & & & & & \\
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1\\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2\\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0\\
2\beta_1 + 2\beta_2 - \beta_3 &= 2\\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1\\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1\\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \xleftarrow{+} \\
1 & 0 & 1 & -1 & 0 & 1 & \xleftarrow{+} \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & -\frac{1}{4} & & & \\
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \quad /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \xleftarrow{+} \\
1 & 0 & 1 & -1 & 0 & 1 & \xleftarrow{+} \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & &
\end{array}$$

$$\left.\begin{aligned} 2\alpha_2+\alpha_3&=1\\ 2\alpha_1+2\alpha_2-\alpha_3&=2\\ \alpha_1+\alpha_3&=-1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2+\beta_3&=0\\ 2\beta_1+2\beta_2-\beta_3&=2\\ \beta_1+\beta_3&=0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2+\gamma_3&=1\\ 2\gamma_1+2\gamma_2-\gamma_3&=1\\ \gamma_1+\gamma_3&=1 \end{aligned}\right\}$$

$$
\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1\\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2\\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0\\
2\beta_1 + 2\beta_2 - \beta_3 &= 2\\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1\\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1\\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|ccc l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \; /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

$$
\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \xleftarrow{+} \\
1 & 0 & 1 & -1 & 0 & 1 & \xleftarrow{+} \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
\end{array}
$$

$$
\left.\begin{aligned}
2\alpha_2 + \alpha_3 &= 1 \\
2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\
\alpha_1 + \alpha_3 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\beta_2 + \beta_3 &= 0 \\
2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\
\beta_1 + \beta_3 &= 0
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
2\gamma_2 + \gamma_3 &= 1 \\
2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\
\gamma_1 + \gamma_3 &= 1
\end{aligned}\right\}
$$

			α_i	β_i	γ_i	
0	2	1	1	0	1	
2	2	−1	2	2	1	+
①	0	1	−1	0	1	$/\cdot(-2)$
0	2	1	1	0	1	+
0	②	−3	4	2	−1	$/\cdot(-1)$
1	0	1	−1	0	1	
0	0	④	−3	−2	2	$/\cdot\frac{3}{4}$ $/\cdot\frac{-1}{4}$
0	2	−3	4	2	−1	+
1	0	1	−1	0	1	+
0	0	4	−3	−2	2	$/:4$
0	2	0	$\frac{7}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$/:2$
1	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	

	α_i	β_i	γ_i

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}$$

$$\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\
\hline
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2}
\end{array}$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \quad /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}
$$

$$
\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\
\hline
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\
0 & 1 & 0 & \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\
 & & & & &
\end{array}
$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4} \quad /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}
$$

$$
\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\
\hline
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\
0 & 1 & 0 & \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\
0 & 0 & 1 & -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2}
\end{array}
$$

$$\begin{array}{ccc|cccl}
 & & & \alpha_i & \beta_i & \gamma_i & \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \xleftarrow{+} \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\ \hline
0 & 2 & 1 & 1 & 0 & 1 & \xleftarrow{+} \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\ \hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \xleftarrow{+} \\
1 & 0 & 1 & -1 & 0 & 1 & \xleftarrow{+} \\ \hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\ \hline
 & & & & & &
\end{array}$$

$$\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\ \hline
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\
0 & 1 & 0 & \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\
0 & 0 & 1 & -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2}
\end{array}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 \\ \alpha_2 & \beta_2 & \gamma_2 \\ \alpha_3 & \beta_3 & \gamma_3 \end{bmatrix}$$

$$\left.\begin{aligned} 2\alpha_2+\alpha_3&=1\\ 2\alpha_1+2\alpha_2-\alpha_3&=2\\ \alpha_1+\alpha_3&=-1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2+\beta_3&=0\\ 2\beta_1+2\beta_2-\beta_3&=2\\ \beta_1+\beta_3&=0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2+\gamma_3&=1\\ 2\gamma_1+2\gamma_2-\gamma_3&=1\\ \gamma_1+\gamma_3&=1 \end{aligned}\right\}$$

			α_i	β_i	γ_i
1	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$
0	1	0	$\frac{7}{8}$	$\frac{1}{4}$	$\frac{1}{4}$
0	0	1	$-\frac{3}{4}$	$-\frac{1}{2}$	$\frac{1}{2}$

0	2	0	$\frac{}{4}$	$\frac{}{2}$	$\frac{}{2}$	$/\cdot 2$
1	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	

$$T=\begin{bmatrix}\alpha_1 & \beta_1 & \gamma_1\\ \alpha_2 & \beta_2 & \gamma_2\\ \alpha_3 & \beta_3 & \gamma_3\end{bmatrix}$$

$$\left.\begin{aligned} 2\alpha_2 + \alpha_3 &= 1 \\ 2\alpha_1 + 2\alpha_2 - \alpha_3 &= 2 \\ \alpha_1 + \alpha_3 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\beta_2 + \beta_3 &= 0 \\ 2\beta_1 + 2\beta_2 - \beta_3 &= 2 \\ \beta_1 + \beta_3 &= 0 \end{aligned}\right\}$$

$$\left.\begin{aligned} 2\gamma_2 + \gamma_3 &= 1 \\ 2\gamma_1 + 2\gamma_2 - \gamma_3 &= 1 \\ \gamma_1 + \gamma_3 &= 1 \end{aligned}\right\}$$

$-2)$

$-1)$

$/\cdot \frac{-1}{4}$

$/\cdot 2$

1	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$

			α_i	β_i	γ_i
1	0	0	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$
0	1	0	$\frac{7}{8}$	$\frac{1}{4}$	$\frac{1}{4}$
0	0	1	$-\frac{3}{4}$	$-\frac{1}{2}$	$\frac{1}{2}$

$$T = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

$$T = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 \\ \alpha_2 & \beta_2 & \gamma_2 \\ \alpha_3 & \beta_3 & \gamma_3 \end{bmatrix}$$

$$
\begin{array}{ccc|ccc|l}
 & & & \alpha_i & \beta_i & \gamma_i & \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \\
2 & 2 & -1 & 2 & 2 & 1 & \leftarrow + \\
\textcircled{1} & 0 & 1 & -1 & 0 & 1 & /\cdot(-2) \\
\hline
0 & 2 & 1 & 1 & 0 & 1 & \leftarrow + \\
0 & \textcircled{2} & -3 & 4 & 2 & -1 & /\cdot(-1) \\
1 & 0 & 1 & -1 & 0 & 1 & \\
\hline
0 & 0 & \textcircled{4} & -3 & -2 & 2 & /\cdot\frac{3}{4}\ /\cdot\frac{-1}{4} \\
0 & 2 & -3 & 4 & 2 & -1 & \leftarrow + \\
1 & 0 & 1 & -1 & 0 & 1 & \leftarrow + \\
\hline
0 & 0 & 4 & -3 & -2 & 2 & /:4 \\
0 & 2 & 0 & \frac{7}{4} & \frac{1}{2} & \frac{1}{2} & /:2 \\
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} & \\
\hline
 & & & & & &
\end{array}
$$

$$
\begin{array}{ccc|ccc}
 & & & \alpha_i & \beta_i & \gamma_i \\
\hline
1 & 0 & 0 & -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\
0 & 1 & 0 & \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\
0 & 0 & 1 & -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2}
\end{array}
$$

$$
T = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix}
$$

$$
T = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 \\ \alpha_2 & \beta_2 & \gamma_2 \\ \alpha_3 & \beta_3 & \gamma_3 \end{bmatrix}
$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} =$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix}$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix}$$

$$X_{\mathcal{B}_2} =$$

$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$

$\boxed{\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1}$

$$X_{\mathcal{B}_2} = T_{\mathcal{B}_2 \to \mathcal{B}_1} X_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{2} & \frac{1}{2} \\ \frac{7}{8} & \frac{1}{4} & \frac{1}{4} \\ -\frac{3}{4} & -\frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} 3 \\ -1 \\ 2 \end{bmatrix}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} \\ \frac{23}{8} \\ -\frac{3}{4} \end{bmatrix}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1$$

Napomena

$$\mathcal{B}_2 \xrightarrow{\quad T \quad} \mathcal{B}_1 \qquad\qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{\quad T_1 \quad} \mathcal{B}_1$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \left[\begin{array}{c} \\ \\ \\ \end{array} \right]$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$

$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & & \\ 2 & & \\ -1 & & \end{bmatrix}$$

$$\begin{aligned} \mathcal{B}_1 &= \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\} \\ \mathcal{B}_2 &= \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\} \\ \mathcal{B}_{\text{kan}} &= \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\} \end{aligned}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & \\ 2 & 2 & \\ -1 & 0 & \end{bmatrix}$$

$$\begin{aligned} \mathcal{B}_1 &= \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\} \\ \mathcal{B}_2 &= \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\} \\ \mathcal{B}_{\text{kan}} &= \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\} \end{aligned}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

$$\mathcal{B}_1 = \{(1,2,-1),\ (0,2,0),\ (1,1,1)\}$$

$$\mathcal{B}_2 = \{(0,2,1),\ (2,2,0),\ (1,-1,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0,0),\ (0,1,0),\ (0,0,1)\}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

$$\begin{aligned} \mathcal{B}_1 &= \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\} \\ \mathcal{B}_2 &= \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\} \\ \mathcal{B}_{\mathsf{kan}} &= \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\} \end{aligned}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & & \\ 2 & & \\ 1 & & \end{bmatrix}$$

$$\mathcal{B}_1 = \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\}$$
$$\mathcal{B}_2 = \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\}$$
$$\mathcal{B}_{\text{kan}} = \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & \\ 2 & 2 & \\ 1 & 0 & \end{bmatrix}$$

$$\begin{aligned} \mathcal{B}_1 &= \{(1,2,-1),\ (0,2,0),\ (1,1,1)\} \\ \mathcal{B}_2 &= \{(0,2,1),\ (2,2,0),\ (1,-1,1)\} \\ \mathcal{B}_{\text{kan}} &= \{(1,0,0),\ (0,1,0),\ (0,0,1)\} \end{aligned}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{aligned} \mathcal{B}_1 &= \big\{(1,2,-1),\ (0,2,0),\ (1,1,1)\big\} \\ \mathcal{B}_2 &= \big\{(0,2,1),\ (2,2,0),\ (1,-1,1)\big\} \\ \mathcal{B}_{\mathsf{kan}} &= \big\{(1,0,0),\ (0,1,0),\ (0,0,1)\big\} \end{aligned}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\mathsf{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\mathcal{B}_2 \xrightarrow{\hspace{2cm}} \mathcal{B}_{\mathsf{kan}} \xrightarrow{\hspace{2cm}} \mathcal{B}_1$$

Napomena

$$\begin{tikzcd} \mathcal{B}_2 \arrow[r, "T"] & \mathcal{B}_1 \end{tikzcd} \qquad \begin{tikzcd} \mathcal{B}_{\text{kan}} \arrow[r, "T_1"] & \mathcal{B}_1 \end{tikzcd} \qquad \begin{tikzcd} \mathcal{B}_{\text{kan}} \arrow[r, "T_2"] & \mathcal{B}_2 \end{tikzcd}$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{tikzcd} \mathcal{B}_2 \arrow[r, "T_2^{-1}"] & \mathcal{B}_{\text{kan}} \arrow[r] & \mathcal{B}_1 \end{tikzcd}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\mathcal{B}_2 \xrightarrow{T_2^{-1}} \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1$$

Napomena

$$\mathcal{B}_2 \xrightarrow{\ T\ } \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{\ T_1\ } \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{\ T_2\ } \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{tikzcd}
\mathcal{B}_2 \arrow[r, "T_2^{-1}"] \arrow[rr, bend right, "T_2^{-1} T_1"'] & \mathcal{B}_{\text{kan}} \arrow[r, "T_1"] & \mathcal{B}_1
\end{tikzcd}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{tikzcd}
\mathcal{B}_2 \arrow[r, "T_2^{-1}"] \arrow[rr, bend right, "T_2^{-1}T_1"'] & \mathcal{B}_{\text{kan}} \arrow[r, "T_1"] & \mathcal{B}_1
\end{tikzcd}$$

$$\boxed{T = T_2^{-1}T_1}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{tikzcd}
\mathcal{B}_2 \arrow[r, "T_2^{-1}"] \arrow[rr, bend right, "T_2^{-1}T_1"'] & \mathcal{B}_{\text{kan}} \arrow[r, "T_1"] & \mathcal{B}_1
\end{tikzcd}$$

$$\boxed{T = T_2^{-1} T_1}$$

$$T_2^{-1} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & \frac{1}{2} \\ \frac{3}{8} & \frac{1}{8} & -\frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{bmatrix}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$T_1 = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad T_2 = \begin{bmatrix} 0 & 2 & 1 \\ 2 & 2 & -1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{tikzcd}
\mathcal{B}_2 \arrow[r, "T_2^{-1}"] \arrow[rr, bend right, "T_2^{-1}T_1"'] & \mathcal{B}_{\text{kan}} \arrow[r, "T_1"] & \mathcal{B}_1
\end{tikzcd}$$

$$\boxed{T = T_2^{-1} T_1}$$

$\boxed{\text{DZ}}$

$$T_2^{-1} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & \frac{1}{2} \\ \frac{3}{8} & \frac{1}{8} & -\frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{bmatrix}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1 X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2 X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

$$\vec{v} = (5, 6, -1)_{\mathcal{B}_{\text{kan}}}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1 X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2 X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

$$X_{\mathcal{B}_2} = T_2^{-1} X_{\mathcal{B}_{\text{kan}}}$$

$$\vec{v} = (5, 6, -1)_{\mathcal{B}_{\text{kan}}}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

$$\vec{v} = (5, 6, -1)_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} = T_2^{-1}X_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} =$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

$$\vec{v} = (5, 6, -1)_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} = T_2^{-1}X_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & \frac{1}{2} \\ \frac{3}{8} & \frac{1}{8} & -\frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{bmatrix}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

$$\vec{v} = (3, -1, 2)_{\mathcal{B}_1}$$

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$$X_{\mathcal{B}_2} = T_2^{-1}X_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & \frac{1}{2} \\ \frac{3}{8} & \frac{1}{8} & -\frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} 5 \\ 6 \\ -1 \end{bmatrix}$$

Napomena

$$\mathcal{B}_2 \xrightarrow{T} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_1} \mathcal{B}_1 \qquad \mathcal{B}_{\text{kan}} \xrightarrow{T_2} \mathcal{B}_2$$

$$X_{\mathcal{B}_2} = TX_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_1X_{\mathcal{B}_1} \qquad X_{\mathcal{B}_{\text{kan}}} = T_2X_{\mathcal{B}_2}$$

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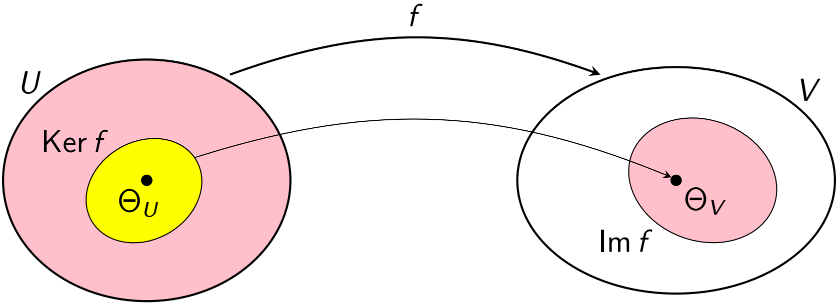
$$X_{\mathcal{B}_2} = T_2^{-1}X_{\mathcal{B}_{\text{kan}}}$$

$$X_{\mathcal{B}_2} = \begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & \frac{1}{2} \\ \frac{3}{8} & \frac{1}{8} & -\frac{1}{4} \\ \frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} 5 \\ 6 \\ -1 \end{bmatrix} = \begin{bmatrix} -\frac{1}{4} \\ \frac{23}{8} \\ -\frac{3}{4} \end{bmatrix}$$

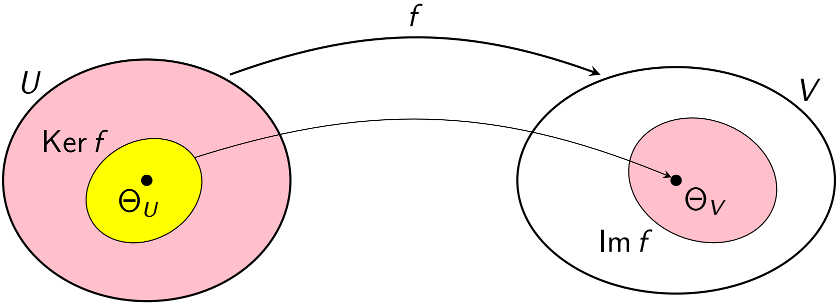
Linearni operator

Linearni operator



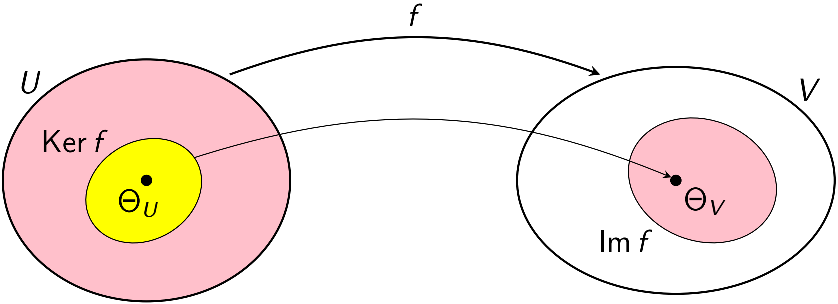
- $f(\alpha a + \beta b) = \alpha f(a) + \beta f(b), \quad \alpha, \beta \in F,\ a, b, \in U$

Linearni operator



- $f(\alpha a + \beta b) = \alpha f(a) + \beta f(b), \quad \alpha, \beta \in F, \ a, b, \in U$
- $r(f) = \dim(\mathrm{Im}\, f), \quad d(f) = \dim(\mathrm{Ker}\, f), \quad r(f) + d(f) = \dim U$

Linearni operator



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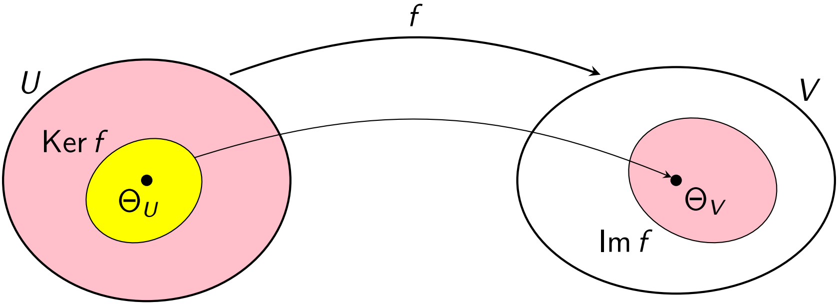
- $f : U \to V$ je injekcija $\iff d(f) = 0$

Linearni operator



- $f(\alpha a + \beta b) = \alpha f(a) + \beta f(b), \quad \alpha, \beta \in F, \ a, b, \in U$
- $r(f) = \dim(\mathrm{Im}\, f), \quad d(f) = \dim(\mathrm{Ker}\, f), \quad r(f) + d(f) = \dim U$
- $f : U \to V$ je injekcija $\iff d(f) = 0$
- $f : U \to V$ je surjekcija $\iff r(f) = \dim V \quad (\dim V < \infty)$

drugi zadatak

Zadatak 2

Zadano je preslikavanje $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ *s*

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right).$$

a) *Dokažite da je* h *linearni operator.*

b) *Odredite jezgru, sliku, rang i defekt operatora* h*.*

c) *Odredite matrični zapis operatora* h *u paru kanonskih baza.*

Rješenje $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

a)

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

Rješenje

$h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a+d,\ a-b+c\right)$$

a)

$h(\alpha A + \beta B)$

Rješenje

$h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

a)

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

a)

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h(\alpha A + \beta B) =$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

a)

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h(\alpha A + \beta B) = h\Bigg($$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

a)

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h(\alpha A + \beta B) = h\left(\alpha \cdot \begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix}\right.$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

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$$h(\alpha A + \beta B) = h\left(\alpha \cdot \begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix} + \right.$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

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$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

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Rješenje

$h : M_2(\mathbb{R}) \to \mathbb{R}^2$

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$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

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$$= h\Bigg($$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

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$$= h\left(\begin{bmatrix} & \\ & \end{bmatrix}\right.$$

Rješenje

a) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \\ & \end{bmatrix}\right.$$

Rješenje

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ & \end{bmatrix}\right.$$

Rješenje

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$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \end{bmatrix}\right.$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right)$$

Rješenje

$h : M_2(\mathbb{R}) \to \mathbb{R}^2$

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$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right)$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

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Rješenje

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right) =$$

$= \big($

Rješenje

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$$= \big((\alpha a_1 + \beta a_2)$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

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Rješenje

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$$= \big((\alpha a_1 + \beta a_2) + (\alpha d_1 + \beta d_2),\ (\alpha a_1 + \beta a_2)$$

Rješenje

$h : M_2(\mathbb{R}) \to \mathbb{R}^2$

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$$= \big((\alpha a_1 + \beta a_2) + (\alpha d_1 + \beta d_2),\ (\alpha a_1 + \beta a_2) -$$

Rješenje

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$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

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$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right) =$$

$$= \Big((\alpha a_1 + \beta a_2) + (\alpha d_1 + \beta d_2),\ (\alpha a_1 + \beta a_2) - (\alpha b_1 + \beta b_2)$$

Rješenje $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

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$$= \alpha \cdot \big(a_1 + d_1,\ a_1 - b_1 + c_1\big) + \beta \cdot \big(a_2 + d_2,\ a_2 - b_2 + c_2\big) =$$

$$= \alpha \cdot h\left(\begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix}\right) + \beta \cdot$$

Rješenje

a)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h(\alpha A + \beta B) = h\left(\alpha \cdot \begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix} + \beta \cdot \begin{bmatrix} a_2 & b_2 \\ c_2 & d_2 \end{bmatrix}\right) =$$

$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right) =$$

$$= \left((\alpha a_1 + \beta a_2) + (\alpha d_1 + \beta d_2),\, (\alpha a_1 + \beta a_2) - (\alpha b_1 + \beta b_2) + (\alpha c_1 + \beta c_2)\right) =$$

$$= \left(\alpha(a_1 + d_1) + \beta(a_2 + d_2),\, \alpha(a_1 - b_1 + c_1) + \beta(a_2 - b_2 + c_2)\right) =$$

$$= \alpha \cdot \left(a_1 + d_1,\ a_1 - b_1 + c_1\right) + \beta \cdot \left(a_2 + d_2,\ a_2 - b_2 + c_2\right) =$$

$$= \alpha \cdot h\left(\begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix}\right) + \beta \cdot h\left(\begin{bmatrix} a_2 & b_2 \\ c_2 & d_2 \end{bmatrix}\right)$$

Rješenje

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

a)

$$h(\alpha A + \beta B) \overset{?}{=} \alpha h(A) + \beta h(B)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

$$h(\alpha A + \beta B) = h\left(\alpha \cdot \begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix} + \beta \cdot \begin{bmatrix} a_2 & b_2 \\ c_2 & d_2 \end{bmatrix}\right) =$$

$$= h\left(\begin{bmatrix} \alpha a_1 + \beta a_2 & \alpha b_1 + \beta b_2 \\ \alpha c_1 + \beta c_2 & \alpha d_1 + \beta d_2 \end{bmatrix}\right) =$$

$$= \big((\alpha a_1 + \beta a_2) + (\alpha d_1 + \beta d_2),\ (\alpha a_1 + \beta a_2) - (\alpha b_1 + \beta b_2) + (\alpha c_1 + \beta c_2)\big) =$$

$$= \big(\alpha(a_1 + d_1) + \beta(a_2 + d_2),\ \alpha(a_1 - b_1 + c_1) + \beta(a_2 - b_2 + c_2)\big) =$$

$$= \alpha \cdot \left(a_1 + d_1,\ a_1 - b_1 + c_1\right) + \beta \cdot \left(a_2 + d_2,\ a_2 - b_2 + c_2\right) =$$

$$= \alpha \cdot h\left(\begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix}\right) + \beta \cdot h\left(\begin{bmatrix} a_2 & b_2 \\ c_2 & d_2 \end{bmatrix}\right) = \alpha h(A) + \beta h(B)$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a+d,\ a-b+c\right)$$

Ker h

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a + d,\ a - b + c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$(a+d,\ a-b+c)$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left(a + d,\ a - b + c\right) = (0, 0)$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$a + d = 0$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\begin{aligned} a + d &= 0 \\ a - b + c &= 0 \end{aligned}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left(a + d,\ a - b + c\right) = (0, 0)$$

$$\left.\begin{aligned} a + d &= 0 \\ a - b + c &= 0 \end{aligned}\right\}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \rightsquigarrow d = -a$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a + d,\ a - b + c\right)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left(a + d,\ a - b + c\right) = (0, 0)$$

$$\left.\begin{aligned} a + d &= 0 \\ a - b + c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a + b \end{aligned}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

Ker h =

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a + d = 0 \\ a - b + c = 0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d = -a \\ \rightsquigarrow c = -a + b \end{array}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

$$\mathrm{Ker}\, h = \left\{ \begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix} \right.$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & \\ & \end{bmatrix} \right.$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\text{Ker}\, h = \left\{ \begin{bmatrix} \quad a \quad & \quad b \quad \\ & \end{bmatrix} \right.$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a+d,\ a-b+c\right)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$\left(a+d,\ a-b+c\right) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & \end{bmatrix} \right.$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} \right.$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a + d = 0 \\ a - b + c = 0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d = -a \\ \rightsquigarrow c = -a + b \end{array}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a + d = 0 \\ a - b + c = 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a + b \end{aligned}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} =$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a + d &= 0 \\ a - b + c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a + b \end{aligned}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & \\ & \end{bmatrix}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ & \end{bmatrix}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \left(a+d,\ a-b+c\right)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$\left(a+d,\ a-b+c\right) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} +$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} & \\ & \end{bmatrix}$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & \\ & \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2} \qquad \left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow\ d=-a \\ \rightsquigarrow\ c=-a+b \end{array}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ & \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a + d = 0 \\ a - b + c = 0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d = -a \\ \rightsquigarrow c = -a + b \end{array}$$

$$\big(a + d,\ a - b + c\big) = (0, 0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

$$\boxed{\text{Ker } h}$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$\big(a+d,\ a-b+c\big) = (0,0)$$

$$\text{Ker } h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\mathcal{B}_{\text{Ker}\,h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\text{Ker}\,h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

b)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\text{Ker}\, h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\text{Ker}\, h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{array}{r} a+d=0 \\ a-b+c=0 \end{array}\right\} \begin{array}{l} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{array}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$d(h) = 2 \neq 0$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

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Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

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$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

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$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

Im h

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\mathrm{Ker}\, h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\mathrm{Ker}\, h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$\downarrow$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a + d,\ a - b + c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a + d &= 0 \\ a - b + c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a + b \end{aligned}$$

$$(a + d,\ a - b + c) = (0, 0)$$

$$\text{Ker } h = \left\{ \begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\text{Ker } h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a + b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$r(h) =$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2 = 2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$d(h) = 2 \ne 0$$

$$\downarrow$$

h nije injekcija

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2 = 2 \qquad r(h) = 2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d&=0 \\ a-b+c&=0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d=-a \\ &\rightsquigarrow c=-a+b \end{aligned}$$

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$$\text{Ker}\,h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$d(h) = 2 \neq 0$$

$$\downarrow$$

h nije injekcija

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2 = 2 \qquad r(h) = 2 = \dim \mathbb{R}^2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\mathrm{Ker}\, h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\mathrm{Ker}\, h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$\downarrow$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2 = 2 \qquad r(h) = 2 = \dim \mathbb{R}^2$$

$\hookrightarrow$ h je surjekcija

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{matrix} a+d=0 \\ a-b+c=0 \end{matrix}\right\} \begin{matrix} \rightsquigarrow d=-a \\ \rightsquigarrow c=-a+b \end{matrix}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\text{Ker } h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\text{Ker } h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$\downarrow$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$r(h) = 4 - 2 = 2$$

$$r(h) = 2 = \dim \mathbb{R}^2$$

$\hookrightarrow$ h je surjekcija

$$\text{Im } h = \mathbb{R}^2$$

b) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = (a+d,\ a-b+c)$$

Ker h

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \Theta_{\mathbb{R}^2}$$

$$\left.\begin{aligned} a+d &= 0 \\ a-b+c &= 0 \end{aligned}\right\} \begin{aligned} &\rightsquigarrow d = -a \\ &\rightsquigarrow c = -a+b \end{aligned}$$

$$(a+d,\ a-b+c) = (0,0)$$

$$\operatorname{Ker} h = \left\{ \begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} : a, b \in \mathbb{R} \right\}$$

$$\mathcal{B}_{\operatorname{Ker} h} = \left\{ \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right\}$$

$$\begin{bmatrix} a & b \\ -a+b & -a \end{bmatrix} = a \cdot \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} + b \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$$d(h) = 2 \neq 0$$

$\downarrow$

h nije injekcija

Im h

$$r(h) + d(h) = \dim M_2(\mathbb{R})$$

$$\mathcal{B}_{\operatorname{Im} h} = \{(1,0),(0,1)\}$$

$$r(h) = 4 - 2 = 2$$

$$r(h) = 2 = \dim \mathbb{R}^2$$

$\hookrightarrow$ h je surjekcija

$$\operatorname{Im} h = \mathbb{R}^2$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\}$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

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$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) =$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1)$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0)$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $\qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0) +$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0) + 1 \cdot (0,1)$$

c) $h: M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1\cdot(1,0) + 1\cdot(0,1) \qquad H = \begin{bmatrix} \quad & \quad & \quad & \quad \\ & & & \end{bmatrix}$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0), (0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0) + 1 \cdot (0,1) \qquad H = \begin{bmatrix} 1 & & & \\ 1 & & & \end{bmatrix}$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $\quad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1\cdot(1,0) + 1\cdot(0,1) \qquad H = \begin{bmatrix} 1 & & & \\ 1 & & & \end{bmatrix}$$

$$h\left(\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}\right) =$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0) + 1 \cdot (0,1) \qquad H = \begin{bmatrix} 1 & & & \\ 1 & & & \end{bmatrix}$$

$$h\left(\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}\right) = (0,-1)$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$

$$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0),(0,1)\big\}$$

$$h\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}\right) = (1,1) = 1 \cdot (1,0) + 1 \cdot (0,1) \qquad H = \begin{bmatrix} 1 & & & \\ 1 & & & \end{bmatrix}$$

$$h\left(\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}\right) = (0,-1) = 0 \cdot (1,0)$$

c) $h : M_2(\mathbb{R}) \to \mathbb{R}^2$ $$h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a + d,\ a - b + c\big)$$

$$\mathcal{B}_1 = \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix} \right\} \qquad \mathcal{B}_2 = \big\{(1,0), (0,1)\big\}$$

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c)

$$h : M_2(\mathbb{R}) \to \mathbb{R}^2 \qquad h\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = \big(a+d,\ a-b+c\big)$$

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treći zadatak

Zadatak 3

Zadano je preslikavanje $f : \mathbb{R}^4 \to \mathbb{R}^2$ *s*

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v).$$

a) *Dokažite da je* f *linearni operator.*

b) *Odredite jezgru, sliku, rang i defekt operatora* f*.*

c) *Odredite matrični prikaz operatora* f *u paru kanonskih baza.*

d) *Odredite matrični prikaz operatora* f *u paru baza*

$$\mathcal{A} = \big\{(1, 0, 0, 0),\ (1, 2, 0, 0),\ (1, 2, 3, 0),\ (1, 2, 3, 4)\big\},$$

$$\mathcal{B} = \big\{(1, 10),\ (1, 11)\big\}.$$

e) *Odredite sliku vektora* $(1, 0, -1, 8)$.

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a)

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b)$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(\alpha a + \beta b) =$$

Rješenje $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\big($$

Rješenje $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\Big(\alpha \cdot (x_1, y_1, u_1, v_1)$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\Big(\alpha \cdot (x_1, y_1, u_1, v_1) +$$

Rješenje $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\big(\alpha \cdot (x_1, y_1, u_1, v_1) + \beta \cdot (x_2, y_2, u_2, v_2)$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $$f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(\alpha a + \beta b) = f\big(\alpha \cdot (x_1, y_1, u_1, v_1) + \beta \cdot (x_2, y_2, u_2, v_2)\big)$$

Rješenje

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$$= f($$

Rješenje

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

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$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\left(\alpha \cdot (x_1, y_1, u_1, v_1) + \beta \cdot (x_2, y_2, u_2, v_2)\right) =$$

$$= f(\alpha x_1 + \beta x_2,$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\big(\alpha \cdot (x_1, y_1, u_1, v_1) + \beta \cdot (x_2, y_2, u_2, v_2)\big) =$$

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Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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Rješenje

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$$= f(\alpha x_1 + \beta x_2,\ \alpha y_1 + \beta y_2,\ \alpha u_1 + \beta u_2,\ \alpha v_1 + \beta v_2)$$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

a) $f(\alpha a + \beta b) \overset{?}{=} \alpha f(a) + \beta f(b)$ $\qquad f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\alpha a + \beta b) = f\big(\alpha \cdot (x_1, y_1, u_1, v_1) + \beta \cdot (x_2, y_2, u_2, v_2)\big) =$$

$$= f(\alpha x_1 + \beta x_2,\ \alpha y_1 + \beta y_2,\ \alpha u_1 + \beta u_2,\ \alpha v_1 + \beta v_2) =$$

$$= ($$

Rješenje

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$= f(\alpha x_1 + \beta x_2,\ \alpha y_1 + \beta y_2,\ \alpha u_1 + \beta u_2,\ \alpha v_1 + \beta v_2) =$$

$$= \big((\alpha x_1 + \beta x_2)$$

Rješenje

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$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

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b) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

Ker f

$f : \mathbb{R}^4 \to \mathbb{R}^2$

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x	y	u	v	

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$$\begin{array}{cccc|c} x & y & u & v & \\ \hline 1 & 2 & -1 & -1 & 0 \end{array}$$

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x	y	u	v	
1	2	−1	−1	0
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x & y & u & v & & \\
\hline
\textcircled{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\
-1 & -2 & 1 & 1 & 0 & \curvearrowleft + \\
\hline
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\hline
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\hline
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-1 & -2 & 1 & 1 & 0 & \leftarrow + \\
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$$x+2y-u-v=0 \rightsquigarrow x=-2y+u+v$$

b) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$(-2y+u+v, y, u, v) = y\cdot(-2,1,0,0) + u\cdot(1,0,1,0) + v\cdot(1,0,$$

b) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Ker f

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$f(x,y,u,v) = \Theta_{\mathbb{R}^2}$$

$$(x+2y-u-v,\ -x-2y+u+v) = (0,0)$$

$$\left.\begin{aligned} x+2y-u-v &= 0 \\ -x-2y+u+v &= 0 \end{aligned}\right\}$$

$$\begin{array}{cccc|cl}
x & y & u & v & & \\
\hline
\textcircled{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\
-1 & -2 & 1 & 1 & 0 & \leftarrow + \\
\hline
1 & 2 & -1 & -1 & 0 & \\
0 & 0 & 0 & 0 & 0 & \\
\hline
1 & 2 & -1 & -1 & 0 &
\end{array}$$

$$x+2y-u-v = 0 \rightsquigarrow x = -2y+u+v$$

$$\operatorname{Ker} f = \{(-2y+u+v, y, u, v) : y,u,v \in \mathbb{R}\}$$

$$(-2y+u+v, y, u, v) = y\cdot(-2,1,0,0) + u\cdot(1,0,1,0) + v\cdot(1,0,0,$$

b) $$f(x,y,u,v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Ker f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

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$$(x + 2y - u - v,\ -x - 2y + u + v) = (0,0)$$

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$$\begin{array}{cccc|cl}
x & y & u & v & & \\ \hline
\enclose{circle}{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\
-1 & -2 & 1 & 1 & 0 & \hookleftarrow + \\ \hline
1 & 2 & -1 & -1 & 0 & \\
0 & 0 & 0 & 0 & 0 & \\ \hline
1 & 2 & -1 & -1 & 0 &
\end{array}$$

$$x + 2y - u - v = 0 \rightsquigarrow x = -2y + u + v$$

$$\text{Ker}\, f = \{(-2y + u + v, y, u, v) : y, u, v \in \mathbb{R}\}$$

$$(-2y + u + v, y, u, v) = y \cdot (-2,1,0,0) + u \cdot (1,0,1,0) + v \cdot (1,0,0,1)$$

b) $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

$\boxed{\operatorname{Ker} f}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(x,y,u,v) = \Theta_{\mathbb{R}^2}$$

$$(x+2y-u-v,\ -x-2y+u+v) = (0,0)$$

$$\left.\begin{aligned} x+2y-u-v &= 0 \\ -x-2y+u+v &= 0 \end{aligned}\right\}$$

$$\begin{array}{cccc|cl} x & y & u & v & & \\ \hline \textcircled{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\ -1 & -2 & 1 & 1 & 0 & \hookleftarrow + \\ \hline 1 & 2 & -1 & -1 & 0 & \\ 0 & 0 & 0 & 0 & 0 & \\ \hline 1 & 2 & -1 & -1 & 0 & \end{array}$$

$$x+2y-u-v = 0 \rightsquigarrow x = -2y+u+v$$

$$\operatorname{Ker} f = \{(-2y+u+v, y, u, v) : y, u, v \in \mathbb{R}\}$$

$$(-2y+u+v, y, u, v) = y \cdot (-2,1,0,0) + u \cdot (1,0,1,0) + v \cdot (1,0,0,1)$$

$$\mathcal{B}_{\operatorname{Ker} f} = \{(-2,1,0,0),\ (1,0,1,0),\ (1,0,0,1)\}$$

b) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Ker f

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

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$$\begin{array}{cccc|cl} x & y & u & v & & \\ \hline \textcircled{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\ -1 & -2 & 1 & 1 & 0 & \hookleftarrow + \\ \hline 1 & 2 & -1 & -1 & 0 & \\ 0 & 0 & 0 & 0 & 0 & \\ \hline 1 & 2 & -1 & -1 & 0 & \end{array}$$

$$x+2y-u-v=0 \rightsquigarrow x=-2y+u+v$$

$$\operatorname{Ker} f = \{(-2y+u+v, y, u, v) : y,u,v \in \mathbb{R}\}$$

$$(-2y+u+v, y, u, v) = y\cdot(-2,1,0,0) + u\cdot(1,0,1,0) + v\cdot(1,0,0,1)$$

$$\mathcal{B}_{\operatorname{Ker} f} = \{(-2,1,0,0),\ (1,0,1,0),\ (1,0,0,1)\}$$

$$d(f) = 3$$

b) $$f(x,y,u,v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Ker f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(x,y,u,v) = \Theta_{\mathbb{R}^2}$$

$$(x + 2y - u - v,\ -x - 2y + u + v) = (0,0)$$

$$\left.\begin{aligned} x + 2y - u - v &= 0 \\ -x - 2y + u + v &= 0 \end{aligned}\right\}$$

$$\begin{array}{cccc|cl} x & y & u & v & & \\ \hline \textcircled{1} & 2 & -1 & -1 & 0 & / \cdot 1 \\ -1 & -2 & 1 & 1 & 0 & \leftarrow + \\ \hline 1 & 2 & -1 & -1 & 0 & \\ 0 & 0 & 0 & 0 & 0 & \\ \hline 1 & 2 & -1 & -1 & 0 & \end{array}$$

$$x + 2y - u - v = 0 \rightsquigarrow x = -2y + u + v$$

$$\operatorname{Ker} f = \{(-2y + u + v, y, u, v) : y, u, v \in \mathbb{R}\}$$

$$(-2y + u + v, y, u, v) = y \cdot (-2,1,0,0) + u \cdot (1,0,1,0) + v \cdot (1,0,0,1)$$

$$\mathcal{B}_{\operatorname{Ker} f} = \{(-2,1,0,0),\ (1,0,1,0),\ (1,0,0,1)\}$$

$$d(f) = 3 \neq 0$$

b) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Ker f

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$f(x,y,u,v) = \Theta_{\mathbb{R}^2}$$

$$(x+2y-u-v,\ -x-2y+u+v) = (0,0)$$

$$\left.\begin{aligned} x+2y-u-v &= 0 \\ -x-2y+u+v &= 0 \end{aligned}\right\}$$

$$\begin{array}{cccc|cl} x & y & u & v & & \\ \hline \textcircled{1} & 2 & -1 & -1 & 0 & /\cdot 1 \\ -1 & -2 & 1 & 1 & 0 & \leftarrow + \\ \hline 1 & 2 & -1 & -1 & 0 & \\ 0 & 0 & 0 & 0 & 0 & \\ \hline 1 & 2 & -1 & -1 & 0 & \end{array}$$

$$x+2y-u-v=0 \rightsquigarrow x = -2y+u+v$$

$$\operatorname{Ker} f = \{(-2y+u+v, y, u, v) : y, u, v \in \mathbb{R}\}$$

$$(-2y+u+v, y, u, v) = y\cdot(-2,1,0,0) + u\cdot(1,0,1,0) + v\cdot(1,0,0,1)$$

$$\mathcal{B}_{\operatorname{Ker} f} = \{(-2,1,0,0),\ (1,0,1,0),\ (1,0,0,1)\}$$

$d(f) = 3 \neq 0$ → f nije injekcija

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$\operatorname{Im} f$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4 \qquad r(f) \neq \dim \mathbb{R}^2$$

$$r(f) = 1$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot ($$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1,$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1)$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) +$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$
$$r(f) + 3 = 4$$
$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$
$$= x \cdot (1,-1) + y \cdot ($$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2,$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$
$$r(f) + 3 = 4$$
$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$
$$= x \cdot (1, -1) + y \cdot (2, -2)$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$r(f) = 1$$

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) +$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow$ f nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot ($$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$
$$r(f) + 3 = 4$$
$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$
$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1)$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) +$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$r(f) = 1$$

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) + u \cdot (-1, 1) + v \cdot ($$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) + u \cdot (-1, 1) + v \cdot (-1, 1)$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$\operatorname{Im} f$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1) + v\cdot(-1,1)$$

$$\left[\qquad\qquad \right]$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,1)$$

$$\begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,1)$$

$$\begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1) + v\cdot(-1,1)$$

$$\begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow$ f nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1) + v\cdot(-1,1)$$

$$\begin{bmatrix} 1 & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

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$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1) + v\cdot(-1,1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) + u \cdot (-1, 1) + v \cdot (-1, 1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{array}{l} / \cdot 1 \\ \\ \end{array}$$

$$f(x,y,u,v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$\boxed{\operatorname{Im} f}$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,1)$$

$$\begin{array}{l} \begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \end{array} \begin{array}{l} / \cdot 1 \\ \curvearrowleft + \end{array}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$\operatorname{Im} f$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x\cdot(1,-1) + y\cdot(2,-2) + u\cdot(-1,1) + v\cdot(-1,1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{matrix} /\cdot 1 \\ + \end{matrix} \sim \begin{bmatrix} \quad & \quad & \quad & \quad \\ \quad & \quad & \quad & \quad \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$r(f) + d(f) = \dim \mathbb{R}^4$$

$$r(f) + 3 = 4$$

$$r(f) = 1$$

$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f$ nije surjekcija

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) + u \cdot (-1, 1) + v \cdot (-1, 1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{matrix} / \cdot 1 \\ \curvearrowleft + \end{matrix} \sim \begin{bmatrix} 1 & 2 & -1 & -1 \\ & & & \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$\operatorname{Im} f$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{matrix} /\cdot 1 \\ \hookleftarrow + \end{matrix} \sim \begin{bmatrix} 1 & 2 & -1 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

Im f

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x + 2y - u - v,\ -x - 2y + u + v) =$$

$$= x \cdot (1, -1) + y \cdot (2, -2) + u \cdot (-1, 1) + v \cdot (-1, 1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{matrix} / \cdot 1 \\ + \end{matrix} \sim \begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$\boxed{\operatorname{Im} f}$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\begin{aligned} r(f) + d(f) &= \dim \mathbb{R}^4 \\ r(f) + 3 &= 4 \\ r(f) &= 1 \end{aligned}$$

$$r(f) \neq \dim \mathbb{R}^2 \longrightarrow f \text{ nije surjekcija}$$

$$(x+2y-u-v,\ -x-2y+u+v) =$$

$$= x \cdot (1,-1) + y \cdot (2,-2) + u \cdot (-1,1) + v \cdot (-1,1)$$

$$\begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{matrix} / \cdot 1 \\ + \end{matrix} \sim \begin{bmatrix} \textcircled{1} & 2 & -1 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\mathcal{B}_{\operatorname{Im} f} = \{(1,-1)\}$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

c) $$f(x,y,u,v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A}_{\mathsf{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

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c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A}_{\mathsf{kan}} = \big\{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\big\}$$

$$\mathcal{B}_{\mathsf{kan}} = \big\{(1, 0), (0, 1)\big\}$$

$$f(1, 0, 0, 0) =$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$\mathcal{A}_{\mathsf{kan}} = \big\{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\big\}$$

$$\mathcal{B}_{\mathsf{kan}} = \big\{(1, 0), (0, 1)\big\}$$

$$f(1, 0, 0, 0) = (1, -1)$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$\mathcal{A}_{\mathsf{kan}} = \left\{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\right\}$$

$$\mathcal{B}_{\mathsf{kan}} = \left\{(1, 0), (0, 1)\right\}$$

$$f(1, 0, 0, 0) = (1, -1) = 1 \cdot (1, 0)$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) +$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\big\}$$
$$\mathcal{B}_{\text{kan}} = \big\{(1,0), (0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

c)

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} \qquad\qquad\qquad\qquad \\ \\ \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0), (0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

c)

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\mathsf{kan}}, \mathcal{B}_{\mathsf{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\mathsf{kan}} = \big\{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\big\}$$

$$\mathcal{B}_{\mathsf{kan}} = \big\{(1,0), (0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$F_{(\mathcal{A}_{\text{kan}},\, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0), (0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) =$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0), (0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) +$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & & & \\ -1 & & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) + (-2) \cdot (0,1)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1, 0), (0, 1)\}$$

$$f(1, 0, 0, 0) = (1, -1) = 1 \cdot (1, 0) + (-1) \cdot (0, 1)$$

$$f(0, 1, 0, 0) = (2, -2) = 2 \cdot (1, 0) + (-2) \cdot (0, 1)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) + (-2) \cdot (0,1)$$

$$f(0,0,1,0) =$$

c) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\,\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0),(0,1)\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$

$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$

$$f(0,0,1,0) = (-1,1)$$

c)
$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\,\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

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$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$
$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$
$$f(0,0,1,0) = (-1,1) = -1\cdot(1,0)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

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$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) + (-2) \cdot (0,1)$$

$$f(0,0,1,0) = (-1,1) = -1 \cdot (1,0) +$$

c) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & & \\ -1 & -2 & & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$

$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$

$$f(0,0,1,0) = (-1,1) = -1\cdot(1,0) + 1\cdot(0,1)$$

c) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$

$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$

$$f(0,0,1,0) = (-1,1) = -1\cdot(1,0) + 1\cdot(0,1)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0),(0,1)\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) + (-2) \cdot (0,1)$$

$$f(0,0,1,0) = (-1,1) = -1 \cdot (1,0) + 1 \cdot (0,1)$$

$$f(0,0,0,1) =$$

c) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$

$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$

$$f(0,0,1,0) = (-1,1) = -1\cdot(1,0) + 1\cdot(0,1)$$

$$f(0,0,0,1) = (-1,1)$$

c) $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$f(1,0,0,0) = (1,-1) = 1 \cdot (1,0) + (-1) \cdot (0,1)$$

$$f(0,1,0,0) = (2,-2) = 2 \cdot (1,0) + (-2) \cdot (0,1)$$

$$f(0,0,1,0) = (-1,1) = -1 \cdot (1,0) + 1 \cdot (0,1)$$

$$f(0,0,0,1) = (-1,1) = -1 \cdot (1,0)$$

c) $$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1,0),(0,1)\big\}$$

$$f(1,0,0,0) = (1,-1) = 1\cdot(1,0) + (-1)\cdot(0,1)$$

$$f(0,1,0,0) = (2,-2) = 2\cdot(1,0) + (-2)\cdot(0,1)$$

$$f(0,0,1,0) = (-1,1) = -1\cdot(1,0) + 1\cdot(0,1)$$

$$f(0,0,0,1) = (-1,1) = -1\cdot(1,0) +$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & \\ -1 & -2 & 1 & \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1, 0), (0, 1)\big\}$$

$$f(1, 0, 0, 0) = (1, -1) = 1 \cdot (1, 0) + (-1) \cdot (0, 1)$$

$$f(0, 1, 0, 0) = (2, -2) = 2 \cdot (1, 0) + (-2) \cdot (0, 1)$$

$$f(0, 0, 1, 0) = (-1, 1) = -1 \cdot (1, 0) + 1 \cdot (0, 1)$$

$$f(0, 0, 0, 1) = (-1, 1) = -1 \cdot (1, 0) + 1 \cdot (0, 1)$$

c) $$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$F_{(\mathcal{A}_{\text{kan}},\, \mathcal{B}_{\text{kan}})} = \begin{bmatrix} 1 & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} = \big\{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\big\}$$

$$\mathcal{B}_{\text{kan}} = \big\{(1, 0), (0, 1)\big\}$$

$$f(1, 0, 0, 0) = (1, -1) = 1 \cdot (1, 0) + (-1) \cdot (0, 1)$$

$$f(0, 1, 0, 0) = (2, -2) = 2 \cdot (1, 0) + (-2) \cdot (0, 1)$$

$$f(0, 0, 1, 0) = (-1, 1) = -1 \cdot (1, 0) + 1 \cdot (0, 1)$$

$$f(0, 0, 0, 1) = (-1, 1) = -1 \cdot (1, 0) + 1 \cdot (0, 1)$$

d) **1. način**

$$f(x,y,u,v)=(x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4\to\mathbb{R}^2$$

d) **1. način** $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

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$\mathcal{B} = \{(1, 10), (1, 11)\}$

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$f(1,0,0,0) =$

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$f(1,0,0,0) = (1, -1)$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

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$\mathcal{B} = \{(1, 10), (1, 11)\}$

$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10)$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

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$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) +$

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$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$ $\mathcal{B} = \{(1, 10), (1, 11)\}$

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$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$ $\mathcal{B} = \{(1, 10), (1, 11)\}$

$$\alpha_1 + \alpha_2 = 1$$

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$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$ $\mathcal{B} = \{(1,10),(1,11)\}$

$$\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}$$

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$f(1,2,0,0) =$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & & & \\ \alpha_2 & & & \end{bmatrix}$$

d) 1. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1,10),(1,11)\}$$

$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

$$\alpha_1 + \alpha_2 = 1$$

$$10\alpha_1 + 11\alpha_2 = -1$$

$$f(1,2,0,0) = (5,-5)$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & & & \\ \alpha_2 & & & \end{bmatrix}$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

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$$\alpha_1 + \alpha_2 = 1$$

$$10\alpha_1 + 11\alpha_2 = -1$$

$$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10)$$

$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & & & \\ \alpha_2 & & & \end{bmatrix}$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

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$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10) +$

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d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

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$f(1,2,0,0) = (5,-5) = \beta_1 \cdot (1,10) + \beta_2 \cdot (1,11)$

$$\beta_1 + \beta_2 = 5$$

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$$f(1,2,0,0) = (5,-5) = \beta_1 \cdot (1,10) + \beta_2 \cdot (1,11)$$

$$\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}$$

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$\mathcal{B} = \{(1, 10), (1, 11)\}$

$$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$$

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$$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10) + \beta_2 \cdot (1, 11)$$

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$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & & \\ \alpha_2 & \beta_2 & & \end{bmatrix}$$

$$f(1, 2, 3, 0) = (2, -2)$$

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$\mathcal{B} = \{(1,10), (1,11)\}$

$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

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$$f(1,2,0,0) = (5,-5) = \beta_1 \cdot (1,10) + \beta_2 \cdot (1,11)$$

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$$10\beta_1 + 11\beta_2 = -5$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & & \\ \alpha_2 & \beta_2 & & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10)$$

d) **1. način** $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

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$$10\beta_1 + 11\beta_2 = -5$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & & \\ \alpha_2 & \beta_2 & & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

$$\gamma_1 + \gamma_2 = 2$$

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$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

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$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

$$\gamma_1 + \gamma_2 = 2$$
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d) 1. način $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

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$\mathcal{B} = \{(1, 10), (1, 11)\}$

$$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$$

$$\alpha_1 + \alpha_2 = 1$$
$$10\alpha_1 + 11\alpha_2 = -1$$

$$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10) + \beta_2 \cdot (1, 11)$$

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$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1, 2, 3, 0) = (2, -2) = \gamma_1 \cdot (1, 10) + \gamma_2 \cdot (1, 11)$$

$$\gamma_1 + \gamma_2 = 2$$
$$10\gamma_1 + 11\gamma_2 = -2$$

$$f(1, 2, 3, 4) =$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

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$$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$$

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$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1, 2, 3, 0) = (2, -2) = \gamma_1 \cdot (1, 10) + \gamma_2 \cdot (1, 11)$$

$$\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}$$

$$f(1, 2, 3, 4) = (-2, 2)$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v, \ -x - 2y + u + v)$

$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$\mathcal{B} = \{(1, 10), (1, 11)\}$

$$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$$

$$\alpha_1 + \alpha_2 = 1$$
$$10\alpha_1 + 11\alpha_2 = -1$$

$$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10) + \beta_2 \cdot (1, 11)$$

$$\beta_1 + \beta_2 = 5$$
$$10\beta_1 + 11\beta_2 = -5$$

$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1, 2, 3, 0) = (2, -2) = \gamma_1 \cdot (1, 10) + \gamma_2 \cdot (1, 11)$$

$$\gamma_1 + \gamma_2 = 2$$
$$10\gamma_1 + 11\gamma_2 = -2$$

$$f(1, 2, 3, 4) = (-2, 2) = \delta_1 \cdot (1, 10)$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$\mathcal{B} = \{(1,10), (1,11)\}$

$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

$$\alpha_1 + \alpha_2 = 1$$
$$10\alpha_1 + 11\alpha_2 = -1$$

$$f(1,2,0,0) = (5,-5) = \beta_1 \cdot (1,10) + \beta_2 \cdot (1,11)$$

$$\beta_1 + \beta_2 = 5$$
$$10\beta_1 + 11\beta_2 = -5$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

$$\gamma_1 + \gamma_2 = 2$$
$$10\gamma_1 + 11\gamma_2 = -2$$

$$f(1,2,3,4) = (-2,2) = \delta_1 \cdot (1,10) +$$

d) **1. način** $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$\mathcal{B} = \{(1,10),(1,11)\}$

$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

$$\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}$$

$$f(1,2,0,0) = (5,-5) = \beta_1 \cdot (1,10) + \beta_2 \cdot (1,11)$$

$$\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

$$\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}$$

$$f(1,2,3,4) = (-2,2) = \delta_1 \cdot (1,10) + \delta_2 \cdot (1,11)$$

d) **1. način** $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$ $f:\mathbb{R}^4 \to \mathbb{R}^2$

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$$f(1,0,0,0) = (1,-1) = \alpha_1 \cdot (1,10) + \alpha_2 \cdot (1,11)$$

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$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

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$$\delta_1 + \delta_2 = -2$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

$\mathcal{B} = \{(1, 10), (1, 11)\}$

$$f(1, 0, 0, 0) = (1, -1) = \alpha_1 \cdot (1, 10) + \alpha_2 \cdot (1, 11)$$

$$\alpha_1 + \alpha_2 = 1$$

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$$f(1, 2, 0, 0) = (5, -5) = \beta_1 \cdot (1, 10) + \beta_2 \cdot (1, 11)$$

$$\beta_1 + \beta_2 = 5$$

$$10\beta_1 + 11\beta_2 = -5$$

$$F_{(\mathcal{A}, \mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \\ \alpha_2 & \beta_2 & \gamma_2 & \end{bmatrix}$$

$$f(1, 2, 3, 0) = (2, -2) = \gamma_1 \cdot (1, 10) + \gamma_2 \cdot (1, 11)$$

$$\gamma_1 + \gamma_2 = 2$$

$$10\gamma_1 + 11\gamma_2 = -2$$

$$f(1, 2, 3, 4) = (-2, 2) = \delta_1 \cdot (1, 10) + \delta_2 \cdot (1, 11)$$

$$\delta_1 + \delta_2 = -2$$

$$10\delta_1 + 11\delta_2 = 2$$

d) **1. način** $f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$

$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$ $f : \mathbb{R}^4 \to \mathbb{R}^2$

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$$\beta_1 + \beta_2 = 5$$

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$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \delta_1 \\ \alpha_2 & \beta_2 & \gamma_2 & \delta_2 \end{bmatrix}$$

$$f(1,2,3,0) = (2,-2) = \gamma_1 \cdot (1,10) + \gamma_2 \cdot (1,11)$$

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$$f(1,2,3,4) = (-2,2) = \delta_1 \cdot (1,10) + \delta_2 \cdot (1,11)$$

$$\delta_1 + \delta_2 = -2$$

$$10\delta_1 + 11\delta_2 = 2$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

1	1	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

1	1	
10	11	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

1	1	1
10	11	-1

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

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$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i
1	1	1
10	11	-1

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	
1	1	1	5
10	11	-1	-5

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

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$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i
1	1	1	5
10	11	-1	-5

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

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		α_i	β_i	
1	1	1	5	2
10	11	-1	-5	-2

$$\left.\begin{aligned}\alpha_1 + \alpha_2 &= 1\\ 10\alpha_1 + 11\alpha_2 &= -1\end{aligned}\right\}$$

$$\left.\begin{aligned}\beta_1 + \beta_2 &= 5\\ 10\beta_1 + 11\beta_2 &= -5\end{aligned}\right\}$$

$$\left.\begin{aligned}\gamma_1 + \gamma_2 &= 2\\ 10\gamma_1 + 11\gamma_2 &= -2\end{aligned}\right\}$$

$$\left.\begin{aligned}\delta_1 + \delta_2 &= -2\\ 10\delta_1 + 11\delta_2 &= 2\end{aligned}\right\}$$

		α_i	β_i	γ_i
1	1	1	5	2
10	11	-1	-5	-2

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

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$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	
1	1	1	5	2	-2
10	11	-1	-5	-2	2

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

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$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i
1	1	1	5	2	-2
10	11	-1	-5	-2	2

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$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i
1	1	1	5	2	-2
10	11	-1	-5	-2	2

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

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$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i
①	1	1	5	2	-2
10	11	-1	-5	-2	2

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc|l} & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline \textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\ 10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline \end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	+
1	1	1	5	2	-2	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc|l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \xleftarrow{+} \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \\
0 & & & & & & \\
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$\leftarrow +$
1	1	1	5	2	-2	
0	1					

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \\
0 & 1 & -11 & & & & \\
 & & & & & &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$+$
1	1	1	5	2	-2	
0	1	-11	-55			

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$+$
1	1	1	5	2	-2	
0	1	-11	-55	-22		

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc|l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \xleftarrow{+} \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1+\alpha_2&=1\\ 10\alpha_1+11\alpha_2&=-1\end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1+\beta_2&=5\\ 10\beta_1+11\beta_2&=-5\end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1+\gamma_2&=2\\ 10\gamma_1+11\gamma_2&=-2\end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1+\delta_2&=-2\\ 10\delta_1+11\delta_2&=2\end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$+$
1	1	1	5	2	-2	
0	1	-11	-55	-22	22	

$$\left.\begin{aligned}\alpha_1+\alpha_2&=1\\10\alpha_1+11\alpha_2&=-1\end{aligned}\right\}$$

$$\left.\begin{aligned}\beta_1+\beta_2&=5\\10\beta_1+11\beta_2&=-5\end{aligned}\right\}$$

$$\left.\begin{aligned}\gamma_1+\gamma_2&=2\\10\gamma_1+11\gamma_2&=-2\end{aligned}\right\}$$

$$\left.\begin{aligned}\delta_1+\delta_2&=-2\\10\delta_1+11\delta_2&=2\end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
$\textcircled{1}$	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$+$
1	1	1	5	2	-2	
0	$\textcircled{1}$	-11	-55	-22	22	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline
1 & 1 & 1 & 5 & 2 & -2 & \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\ \hline
 & & & & & & \\
 & & & & & &
\end{array}$$

$$\left.\begin{aligned}\alpha_1+\alpha_2&=1\\10\alpha_1+11\alpha_2&=-1\end{aligned}\right\}$$

$$\left.\begin{aligned}\beta_1+\beta_2&=5\\10\beta_1+11\beta_2&=-5\end{aligned}\right\}$$

$$\left.\begin{aligned}\gamma_1+\gamma_2&=2\\10\gamma_1+11\gamma_2&=-2\end{aligned}\right\}$$

$$\left.\begin{aligned}\delta_1+\delta_2&=-2\\10\delta_1+11\delta_2&=2\end{aligned}\right\}$$

$$\begin{array}{cc|cccc l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\ \hline
 & & & & & &
\end{array}$$

$$\left.\begin{aligned} \alpha_1+\alpha_2&=1\\ 10\alpha_1+11\alpha_2&=-1\end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1+\beta_2&=5\\ 10\beta_1+11\beta_2&=-5\end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1+\gamma_2&=2\\ 10\gamma_1+11\gamma_2&=-2\end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1+\delta_2&=-2\\ 10\delta_1+11\delta_2&=2\end{aligned}\right\}$$

$$\begin{array}{cc|cccc|l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\ \hline
 & & & & & & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	← +
1	1	1	5	2	-2	← +
0	①	-11	-55	-22	22	$/\cdot(-1)$
1						
0	1	-11	-55	-22	22	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|cccc|l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\
\hline
1 & 0 & & & & & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$
\begin{array}{cc|cccc l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\
\hline
1 & 0 & 12 & & & & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}
$$

$$
\left.\begin{aligned}
\alpha_1 + \alpha_2 &= 1 \\
10\alpha_1 + 11\alpha_2 &= -1
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
\beta_1 + \beta_2 &= 5 \\
10\beta_1 + 11\beta_2 &= -5
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
\gamma_1 + \gamma_2 &= 2 \\
10\gamma_1 + 11\gamma_2 &= -2
\end{aligned}\right\}
$$

$$
\left.\begin{aligned}
\delta_1 + \delta_2 &= -2 \\
10\delta_1 + 11\delta_2 &= 2
\end{aligned}\right\}
$$

$$\begin{array}{cc|cccc|l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\
\hline
1 & 0 & 12 & 60 & & & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

		α_i	β_i	γ_i	δ_i	
①	1	1	5	2	-2	$/\cdot(-10)$
10	11	-1	-5	-2	2	$\leftarrow +$
1	1	1	5	2	-2	$\leftarrow +$
0	①	-11	-55	-22	22	$/\cdot(-1)$
1	0	12	60	24		
0	1	-11	-55	-22	22	

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|ccccl}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\
\hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\
\hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\
\hline
1 & 0 & 12 & 60 & 24 & -24 & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$
\begin{array}{cc|cccc l}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\ \hline
1 & 0 & 12 & 60 & 24 & -24 & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}
$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \delta_1 \\ \alpha_2 & \beta_2 & \gamma_2 & \delta_2 \end{bmatrix}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$\begin{array}{cc|ccccl}
 & & \alpha_i & \beta_i & \gamma_i & \delta_i & \\ \hline
\textcircled{1} & 1 & 1 & 5 & 2 & -2 & /\cdot(-10) \\
10 & 11 & -1 & -5 & -2 & 2 & \leftarrow + \\ \hline
1 & 1 & 1 & 5 & 2 & -2 & \leftarrow + \\
0 & \textcircled{1} & -11 & -55 & -22 & 22 & /\cdot(-1) \\ \hline
1 & 0 & 12 & 60 & 24 & -24 & \\
0 & 1 & -11 & -55 & -22 & 22 &
\end{array}$$

$$\left.\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ 10\alpha_1 + 11\alpha_2 &= -1 \end{aligned}\right\}$$

$$\left.\begin{aligned} \beta_1 + \beta_2 &= 5 \\ 10\beta_1 + 11\beta_2 &= -5 \end{aligned}\right\}$$

$$\left.\begin{aligned} \gamma_1 + \gamma_2 &= 2 \\ 10\gamma_1 + 11\gamma_2 &= -2 \end{aligned}\right\}$$

$$\left.\begin{aligned} \delta_1 + \delta_2 &= -2 \\ 10\delta_1 + 11\delta_2 &= 2 \end{aligned}\right\}$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} \alpha_1 & \beta_1 & \gamma_1 & \delta_1 \\ \alpha_2 & \beta_2 & \gamma_2 & \delta_2 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

2. način

$$f(x,y,u,v)=(x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4\to\mathbb{R}^2$$

$$\mathcal{A}=\{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}}=\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B}=\{(1,10),(1,11)\} \qquad \mathcal{B}_{\text{kan}}=\{(1,0),(0,1)\}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

2. način

$$f(x,y,u,v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10),(1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0),(0,1)\}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\}$$

$$\mathcal{B} = \{(1, 10), (1, 11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1, 0), (0, 1)\}$$

$$F_{(\mathcal{A}, \mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$$

$$\mathcal{A}_{\mathrm{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\mathrm{kan}} = \{(1,0), (0,1)\}$$

$$S = \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\mathrm{kan}},\mathcal{B}_{\mathrm{kan}})} S$$

$$\mathcal{A}_{\mathrm{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\mathrm{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$S = \begin{bmatrix} 1 & & & \\ 0 & & & \\ 0 & & & \\ 0 & & & \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$S = \begin{bmatrix} 1 & 1 \\ 0 & 2 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$F_{(\mathcal{A}, \mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 2 \\ 0 & 0 & 3 \\ 0 & 0 & 0 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

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$$\mathcal{A}_{\mathrm{kan}} = \{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10),(1,11)\} \qquad \mathcal{B}_{\mathrm{kan}} = \{(1,0),(0,1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\mathrm{kan}},\mathcal{B}_{\mathrm{kan}})} S$$

$$\mathcal{A}_{\mathrm{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\mathrm{kan}} \xrightarrow{T} \mathcal{B}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\}$$

$$\mathcal{B} = \{(1, 10), (1, 11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1, 0), (0, 1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$F_{(\mathcal{A}, \mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

$$T = \begin{bmatrix} \qquad\qquad \\ \\ \end{bmatrix}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0), (1,2,0,0), (1,2,3,0), (1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10), (1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0), (0,1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

$$T = \begin{bmatrix} 1 & \\ 10 & \end{bmatrix}$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1, 0, 0, 0), (1, 2, 0, 0), (1, 2, 3, 0), (1, 2, 3, 4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1, 0, 0, 0), (0, 1, 0, 0), (0, 0, 1, 0), (0, 0, 0, 1)\}$$

$$\mathcal{B} = \{(1, 10), (1, 11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1, 0), (0, 1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$F_{(\mathcal{A}, \mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

$$T = \begin{bmatrix} 1 & 1 \\ 10 & 11 \end{bmatrix}$$

2. način

$$f(x,y,u,v)=(x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4\to\mathbb{R}^2$$

$$\mathcal{A}=\{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}}=\{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B}=\{(1,10),(1,11)\}\qquad\mathcal{B}_{\text{kan}}=\{(1,0),(0,1)\}$$

$$S=\begin{bmatrix}1&1&1&1\\0&2&2&2\\0&0&3&3\\0&0&0&4\end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})}=T^{-1}F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})}S$$

$$\mathcal{A}_{\text{kan}}\xrightarrow{S}\mathcal{A},\qquad\mathcal{B}_{\text{kan}}\xrightarrow{T}\mathcal{B}$$

$$T=\begin{bmatrix}1&1\\10&11\end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})}=$$

2. način

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{A} = \{(1,0,0,0),(1,2,0,0),(1,2,3,0),(1,2,3,4)\}$$

$$\mathcal{A}_{\text{kan}} = \{(1,0,0,0),(0,1,0,0),(0,0,1,0),(0,0,0,1)\}$$

$$\mathcal{B} = \{(1,10),(1,11)\} \qquad \mathcal{B}_{\text{kan}} = \{(1,0),(0,1)\}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}, \quad \mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}$$

$$T = \begin{bmatrix} 1 & 1 \\ 10 & 11 \end{bmatrix}$$

$$F_{(\mathcal{A},\mathcal{B})} = \frac{1}{\ }$$

2. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$F_{(\mathcal{A},\mathcal{B})} = T^{-1} F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})} S$$

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2. način

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$$T = \begin{bmatrix} 1 & 1 \\ 10 & 11 \end{bmatrix}$$

$$F_{(\mathcal{A}, \mathcal{B})} = \frac{1}{1} \begin{bmatrix} 11 & & & \\ & & & \end{bmatrix}$$

2. način

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$$F_{(\mathcal{A},\mathcal{B})} =$$

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$$F_{(\mathcal{A},\mathcal{B})} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix}$$

e) **1. način**

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

e) 1. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$f(1, 0, -1, 8) =$

e)

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$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = ($$

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$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = \big(1 + 2 \cdot 0 - (-1) - 8,$$

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$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = \big(1 + 2 \cdot 0 - (-1) - 8,\ -1 - 2 \cdot 0 + (-1) + 8\big)$$

$$f(1, 0, -1, 8) = (-6, 6)$$

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1. način

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2. način

e)

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

1. način

$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = \big(1 + 2 \cdot 0 - (-1) - 8,\ -1 - 2 \cdot 0 + (-1) + 8\big)$$

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2. način

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

e)

1. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = \big(1 + 2 \cdot 0 - (-1) - 8,\ -1 - 2 \cdot 0 + (-1) + 8\big)$$

$$f(1, 0, -1, 8) = (-6, 6)$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A}, \mathcal{B})} X_{\mathcal{A}}}$$

2. način

$$Y_{\mathcal{B}_{\text{kan}}} = F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} X_{\mathcal{A}_{\text{kan}}}$$

e) $f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$

1. način

$f : \mathbb{R}^4 \to \mathbb{R}^2$

$$f(\overset{x}{1}, \overset{y}{0}, \overset{u}{-1}, \overset{v}{8}) = \big(1+2\cdot 0-(-1)-8,\ -1-2\cdot 0+(-1)+8\big)$$

$$f(1,0,-1,8) = (-6,6)$$

$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})}X_{\mathcal{A}}}$

2. način

$$Y_{\mathcal{B}_{\text{kan}}} = F_{(\mathcal{A}_{\text{kan}},\mathcal{B}_{\text{kan}})}X_{\mathcal{A}_{\text{kan}}}$$

$$Y_{\mathcal{B}_{\text{kan}}} =$$

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$$f(1, 0, -1, 8) = (-6, 6)$$

2. način

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A}, \mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}_{\text{kan}}} = F_{(\mathcal{A}_{\text{kan}}, \mathcal{B}_{\text{kan}})} X_{\mathcal{A}_{\text{kan}}}$$

$$Y_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix}$$

e)

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2. način

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

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$$Y_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ -1 \\ 8 \end{bmatrix}$$

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2. način

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$$Y_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & 2 & -1 & -1 \\ -1 & -2 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ -1 \\ 8 \end{bmatrix} \qquad Y_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} -6 \\ 6 \end{bmatrix}$$

3. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

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$(1, 0, -1, 8)$

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$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

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$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

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$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A}, \mathcal{B})} X_{\mathcal{A}}}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

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$(1,0,-1,8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

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$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

3. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

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$(1, 0, -1, 8)$ ⇝ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

DZ

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

3. način

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$(1,0,-1,8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$\boxed{\text{DZ}}$

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$X_{\mathcal{A}} =$$

3. način

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$(1,0,-1,8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

DZ

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$X_{\mathcal{A}} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

3. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A}, \mathcal{B})} X_{\mathcal{A}}}$$

DZ

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$X_{\mathcal{A}} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ -1 \\ 8 \end{bmatrix}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

3. način

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$(1, 0, -1, 8) \rightsquigarrow$ moramo pronaći koordinate u bazi $\mathcal{A}$

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$\boxed{\text{DZ}}$

$$S^{-1} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix}$$

$$\mathcal{A}_{\text{kan}} \xrightarrow{S} \mathcal{A}$$

$$\mathcal{A} \xrightarrow{S^{-1}} \mathcal{A}_{\text{kan}}$$

$$X_{\mathcal{A}} = S^{-1} X_{\mathcal{A}_{\text{kan}}}$$

$$X_{\mathcal{A}} = \begin{bmatrix} 1 & -\frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & -\frac{1}{3} & 0 \\ 0 & 0 & \frac{1}{3} & -\frac{1}{4} \\ 0 & 0 & 0 & \frac{1}{4} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ -1 \\ 8 \end{bmatrix} = \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix}$$

$$S = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 2 & 2 & 2 \\ 0 & 0 & 3 & 3 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} =$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix}$$

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$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72, 66)_{\mathcal{B}} =$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1, 10),\ (1, 11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A}, \mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72, 66)_{\mathcal{B}} =$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1,10),\ (1,11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72, 66)_{\mathcal{B}} = -72 \cdot (1, 10)$$

$$f(x, y, u, v) = (x + 2y - u - v,\ -x - 2y + u + v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1, 10),\ (1, 11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72, 66)_{\mathcal{B}} = -72 \cdot (1, 10) +$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f : \mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1,10),\ (1,11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72, 66)_{\mathcal{B}} = -72 \cdot (1,10) + 66 \cdot (1,11)$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1,10),\ (1,11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})}X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72,66)_{\mathcal{B}} = -72\cdot(1,10) + 66\cdot(1,11) = (-6,6)$$

$$f(x,y,u,v) = (x+2y-u-v,\ -x-2y+u+v)$$

$$f:\mathbb{R}^4 \to \mathbb{R}^2$$

$$\mathcal{B} = \{(1,10),\ (1,11)\}$$

$$\boxed{Y_{\mathcal{B}} = F_{(\mathcal{A},\mathcal{B})} X_{\mathcal{A}}}$$

$$Y_{\mathcal{B}} = \begin{bmatrix} 12 & 60 & 24 & -24 \\ -11 & -55 & -22 & 22 \end{bmatrix} \begin{bmatrix} 1 \\ \frac{1}{3} \\ -\frac{7}{3} \\ 2 \end{bmatrix} = \begin{bmatrix} -72 \\ 66 \end{bmatrix}$$

$$(-72,66)_{\mathcal{B}} = -72\cdot(1,10) + 66\cdot(1,11) = (-6,6)_{\mathcal{B}_{\text{kan}}}$$

Domaća zadaća

Domaća zadaća

Zadatak 4

Zadano je preslikavanje $f : \mathbb{R}^3 \to \mathbb{R}^3$ *definirano s*

$$f(x, y, z) = (x - 2y,\ z,\ x + y).$$

a) *Dokažite da je* f *linearni operator.*

b) *Odredite jezgru, sliku, rang i defekt operatora* f.

c) *Odredite matrični prikaz operatora* f *u kanonskoj bazi.*

d) *Odredite matrični prikaz operatora* f *u bazi*

$$\mathcal{B} = \big\{(1, 0, 0),\ (1, 1, 0),\ (1, 1, 1)\big\}.$$

e) *Odredite sliku vektora* $(2, 1, -3)$.

Rješenje

b) $\operatorname{Ker} f = \{(0,0,0)\},\ d(f) = 0,\ \operatorname{Im} f = \mathbb{R}^3,\ r(f) = 3$

Baza za $\operatorname{Ker} f$ ne postoji jer je jezgra u ovom slučaju trivijalni vektorski prostor.

$\mathcal{B}_{\operatorname{Im} f} = \{(1,0,0),\ (0,1,0),\ (0,0,1)\}$

Linearni operator f je izomorfizam.

c)

$$F_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & -2 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

d) Zadatak riješite na dva načina: bez korištenja matrice prijelaza i pomoću matrice prijelaza.

$$F_{\mathcal{B}} = \begin{bmatrix} 1 & -1 & -2 \\ -1 & -2 & -1 \\ 1 & 2 & 2 \end{bmatrix} \qquad T = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \qquad T^{-1} = \begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\boxed{F_{\mathcal{B}} = T^{-1} F_{\mathcal{B}_{\text{kan}}} T} \qquad \boxed{\mathcal{B}_{\text{kan}} \xrightarrow{T} \mathcal{B}}$$

e) **1. način** (uvrštavanje u formulu kojom je zadan linearni operator)

$$f(2,1,-3) = (0,-3,3)$$

2. način $Y_{\mathcal{B}_{\text{kan}}} = F_{\mathcal{B}_{\text{kan}}} X_{\mathcal{B}_{\text{kan}}}$

$$Y_{\mathcal{B}_{\text{kan}}} = \begin{bmatrix} 1 & -2 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \\ -3 \end{bmatrix} = \begin{bmatrix} 0 \\ -3 \\ 3 \end{bmatrix}$$

3. način $Y_{\mathcal{B}} = F_{\mathcal{B}} X_{\mathcal{B}}, \quad X_{\mathcal{B}} = T^{-1} X_{\mathcal{B}_{\text{kan}}}$

$$Y_{\mathcal{B}} = \begin{bmatrix} 1 & -1 & -2 \\ -1 & -2 & -1 \\ 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 1 \\ 4 \\ -3 \end{bmatrix} = \begin{bmatrix} 3 \\ -6 \\ 3 \end{bmatrix}$$

$$(3,-6,3)_{\mathcal{B}} = 3 \cdot (1,0,0) + (-6) \cdot (1,1,0) + 3 \cdot (1,1,1) = (0,-3,3)_{\mathcal{B}_{\text{kan}}}$$