VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\, y_1 + y_2 - 5)$$
$$c \odot (x, y) = (cx,\, cy)\,.$$

(a) Show that vector addition is associative, that is:

$$((x_1, y_1) \oplus (x_2, y_2)) \oplus (x_3, y_3) = (x_1, y_1) \oplus ((x_2, y_2) \oplus (x_3, y_3))\,.$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (4\,x_1 x_2,\; y_1 + 2\,y_2)$$
$$c \odot (x, y) = (cx,\; 0)\,.$$

(a) Show that there exists an additive identity element, that is:

$$\text{There exists } (w, z) \in V \text{ such that } (x, y) \oplus (w, z) = (x, y).$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2 + 3,\ y_1 + y_2)$$
$$c \odot (x, y) = (cx,\ y^c)\,.$$

(a) Show that vector addition is associative, that is:

$$((x_1, y_1) \oplus (x_2, y_2)) \oplus (x_3, y_3) = (x_1, y_1) \oplus ((x_2, y_2) \oplus (x_3, y_3))\,.$$

(b) Explain why V nonetheless is not a vector space.

Version 0123

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (3\,x_1 + x_2,\, y_1 + y_2)$$
$$c \odot (x, y) = (cx,\, cy)\,.$$

(a) Show that scalar multiplication distributes over vector addition, that is:

$$c \odot ((x_1, y_1) \oplus (x_2, y_2)) = c \odot (x_1, y_1) \oplus c \odot (x_2, y_2).$$

(b) Explain why V nonetheless is not a vector space.

Version 0264

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\, y_1 + y_2)$$
$$c \odot (x, y) = (cx,\, cy - 7\,c + 7)\,.$$

(a) Show that scalar multiplication is associative, that is:

$$a \odot (b \odot (x, y)) = (ab) \odot (x, y).$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (2\,x_1 + 2\,x_2,\, 5\,y_1 + 5\,y_2)$$
$$c \odot (x, y) = (cx,\, cy)\,.$$

(a) Show that scalar multiplication distributes over vector addition, that is:

$$c \odot ((x_1, y_1) \oplus (x_2, y_2)) = c \odot (x_1, y_1) \oplus c \odot (x_2, y_2).$$

(b) Explain why V nonetheless is not a vector space.

Version 0140

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\, y_1 + y_2 - 6)$$
$$c \odot (x, y) = (cx,\, cy)\,.$$

(a) Show that vector addition is associative, that is:

$$((x_1, y_1) \oplus (x_2, y_2)) \oplus (x_3, y_3) = (x_1, y_1) \oplus ((x_2, y_2) \oplus (x_3, y_3))\,.$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\, y_1 + y_2)$$
$$c \odot (x, y) = (4\,cx,\, 3\,cy)\,.$$

(a) Show that scalar multiplication distributes over scalar addition, that is:

$$(c + d) \odot (x, y) = c \odot (x, y) \oplus d \odot (x, y).$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\, y_1 + y_2)$$
$$c \odot (x, y) = (cx,\, cy - 6\,c + 6)\,.$$

(a) Show that scalar multiplication is associative, that is:

$$a \odot (b \odot (x, y)) = (ab) \odot (x, y).$$

(b) Explain why V nonetheless is not a vector space.

VS1
Vector spaces

Let V be the set of all pairs (x, y) of real numbers together with the following operations:

$$(x_1, y_1) \oplus (x_2, y_2) = (x_1 + x_2,\ y_1 + y_2)$$
$$c \odot (x, y) = (3\,cx,\ 4\,cy)\,.$$

(a) Show that scalar multiplication distributes over scalar addition, that is:

$$(c + d) \odot (x, y) = c \odot (x, y) \oplus d \odot (x, y).$$

(b) Explain why V nonetheless is not a vector space.

VS2
Linear combinations

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- $\begin{bmatrix} 1 \\ -2 \\ -1 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}$, $\begin{bmatrix} -2 \\ 2 \\ -4 \end{bmatrix}$, $\begin{bmatrix} 4 \\ -3 \\ 4 \end{bmatrix}$, and $\begin{bmatrix} 5 \\ -4 \\ 6 \end{bmatrix}$.
- $\begin{bmatrix} 2 \\ -1 \\ 0 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}$, $\begin{bmatrix} -2 \\ 2 \\ -4 \end{bmatrix}$, $\begin{bmatrix} 4 \\ -3 \\ 4 \end{bmatrix}$, and $\begin{bmatrix} 5 \\ -4 \\ 6 \end{bmatrix}$.

(b) Use these statements to determine if each vector is or is not a linear combination. If it is, give an example of such a linear combination.

VS2
Linear combinations

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- $\begin{bmatrix} 13 \\ -4 \\ 13 \\ -19 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} -4 \\ 1 \\ -4 \\ 5 \end{bmatrix}$, $\begin{bmatrix} -2 \\ 2 \\ 0 \\ 3 \end{bmatrix}$, and $\begin{bmatrix} 4 \\ 2 \\ 8 \\ -4 \end{bmatrix}$.
- $\begin{bmatrix} 14 \\ -5 \\ 12 \\ -18 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} -4 \\ 1 \\ -4 \\ 5 \end{bmatrix}$, $\begin{bmatrix} -2 \\ 2 \\ 0 \\ 3 \end{bmatrix}$, and $\begin{bmatrix} 4 \\ 2 \\ 8 \\ -4 \end{bmatrix}$.

(b) Use these statements to determine if each vector is or is not a linear combination. If it is, give an example of such a linear combination.

VS2
Linear combinations

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- $\begin{bmatrix} 0 \\ 0 \\ 3 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} 1 \\ 2 \\ -4 \end{bmatrix}$, $\begin{bmatrix} -3 \\ -6 \\ 12 \end{bmatrix}$, $\begin{bmatrix} 1 \\ 3 \\ -4 \end{bmatrix}$, and $\begin{bmatrix} 2 \\ 5 \\ -8 \end{bmatrix}$.
- $\begin{bmatrix} -1 \\ -1 \\ 4 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} 1 \\ 2 \\ -4 \end{bmatrix}$, $\begin{bmatrix} -3 \\ -6 \\ 12 \end{bmatrix}$, $\begin{bmatrix} 1 \\ 3 \\ -4 \end{bmatrix}$, and $\begin{bmatrix} 2 \\ 5 \\ -8 \end{bmatrix}$.

(b) Use these statements to determine if each vector is or is not a linear combination. If it is, give an example of such a linear combination.

VS2
Linear combinations

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- $\begin{bmatrix} -1 \\ 2 \\ -5 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} -2 \\ 3 \\ 0 \end{bmatrix}$, $\begin{bmatrix} 3 \\ -5 \\ 5 \end{bmatrix}$, $\begin{bmatrix} 0 \\ -1 \\ 10 \end{bmatrix}$, and $\begin{bmatrix} 5 \\ -9 \\ 15 \end{bmatrix}$.
- $\begin{bmatrix} 0 \\ 1 \\ -4 \end{bmatrix}$ is a linear combination of the vectors $\begin{bmatrix} -2 \\ 3 \\ 0 \end{bmatrix}$, $\begin{bmatrix} 3 \\ -5 \\ 5 \end{bmatrix}$, $\begin{bmatrix} 0 \\ -1 \\ 10 \end{bmatrix}$, and $\begin{bmatrix} 5 \\ -9 \\ 15 \end{bmatrix}$.

(b) Use these statements to determine if each vector is or is not a linear combination. If it is, give an example of such a linear combination.

VS3
Spanning sets

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{\begin{bmatrix}1\\0\\0\\5\end{bmatrix}, \begin{bmatrix}0\\1\\-2\\1\end{bmatrix}, \begin{bmatrix}-1\\0\\1\\-4\end{bmatrix}, \begin{bmatrix}0\\-3\\3\\-5\end{bmatrix}\right\}$ **spans** $\mathbb{R}^4$.
- The set of vectors $\left\{\begin{bmatrix}1\\0\\0\\5\end{bmatrix}, \begin{bmatrix}0\\1\\-2\\1\end{bmatrix}, \begin{bmatrix}-1\\0\\1\\-4\end{bmatrix}, \begin{bmatrix}0\\-3\\3\\-5\end{bmatrix}\right\}$ does **not** span $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS3
Spanning sets

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} -3 \\ -5 \\ 4 \\ -4 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ -2 \\ -2 \end{bmatrix}, \begin{bmatrix} 15 \\ 18 \\ -18 \\ 6 \end{bmatrix}, \begin{bmatrix} 0 \\ -7 \\ 2 \\ -14 \end{bmatrix}, \begin{bmatrix} -8 \\ -11 \\ 10 \\ -6 \end{bmatrix} \right\}$ **spans** $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} -3 \\ -5 \\ 4 \\ -4 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ -2 \\ -2 \end{bmatrix}, \begin{bmatrix} 15 \\ 18 \\ -18 \\ 6 \end{bmatrix}, \begin{bmatrix} 0 \\ -7 \\ 2 \\ -14 \end{bmatrix}, \begin{bmatrix} -8 \\ -11 \\ 10 \\ -6 \end{bmatrix} \right\}$ does **not** span $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS3
Spanning sets

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} 5 \\ 2 \\ 4 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 5 \\ 2 \\ 5 \\ 1 \end{bmatrix}, \begin{bmatrix} 5 \\ 3 \\ -1 \\ 4 \end{bmatrix} \right\}$ **spans** $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} 5 \\ 2 \\ 4 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 5 \\ 2 \\ 5 \\ 1 \end{bmatrix}, \begin{bmatrix} 5 \\ 3 \\ -1 \\ 4 \end{bmatrix} \right\}$ does **not** span $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS3
Spanning sets

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} -1 \\ 0 \\ 2 \\ 1 \end{bmatrix}, \begin{bmatrix} -5 \\ -4 \\ 3 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 4 \\ 3 \\ 4 \end{bmatrix}, \begin{bmatrix} -4 \\ -11 \\ -11 \\ -13 \end{bmatrix} \right\}$ **spans** $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} -1 \\ 0 \\ 2 \\ 1 \end{bmatrix}, \begin{bmatrix} -5 \\ -4 \\ 3 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 4 \\ 3 \\ 4 \end{bmatrix}, \begin{bmatrix} -4 \\ -11 \\ -11 \\ -13 \end{bmatrix} \right\}$ does **not** span $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS3
Spanning sets

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} -1 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 3 \\ 1 \\ -2 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 3 \\ 5 \\ -3 \\ 1 \end{bmatrix} \right\}$ **spans** $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} -1 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 3 \\ 1 \\ -2 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 3 \\ 5 \\ -3 \\ 1 \end{bmatrix} \right\}$ does **not** span $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 7\,x + 6\,y = 0 \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 7\,xy^2 = 0 \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^2$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \\ z \\ w \end{array}\right] \middle|\, 2\,w + 3\,x = 5\,z \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \\ z \\ w \end{array}\right] \middle|\, 5\,x = z^2 - 2\,w + 2\,y \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^4$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 5\,x = 3\,y \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, x^2 + 5\,y = 0 \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^2$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \\ z \end{array}\right] \middle|\, x^3 + 3\,y + 5\,z = 0 \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \\ z \end{array}\right] \middle|\, 4\,x + 5\,y = 5\,z \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^3$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 3\,xy^2 = 0 \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 5\,x + 4\,y = 0 \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^2$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 3\,x = 3\,y \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 6\,xy^2 = 0 \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^2$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix} \middle| -6\,w + 6\,y = 4\,x - 4\,z \right\} \qquad W = \left\{ \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix} \middle| x^3 + 4\,y + 4\,z = 2\,w \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^4$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \\ z \\ w \end{array} \right] \middle| x + 4\,y + 2\,z = 5\,w \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \\ z \\ w \end{array} \right] \middle| 6\,x = z^2 - 5\,w + 5\,y \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^4$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 5\,xy^2 = 0 \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \end{array} \right] \middle| \, 7\,x + 6\,y = 0 \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^2$ and one is not.

VS4
Subspaces

Consider the following two sets of Euclidean vectors:

$$U = \left\{ \left[\begin{array}{c} x \\ y \\ z \end{array} \right] \middle| \, 4\,x^3 y + 5\,z = 0 \right\} \qquad W = \left\{ \left[\begin{array}{c} x \\ y \\ z \end{array} \right] \middle| \, 2\,x + y = 4\,z \right\}$$

Explain why one of these sets is a subspace of $\mathbb{R}^3$ and one is not.

VS5
Linear independence

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} 0 \\ 1 \\ 0 \\ 1 \end{bmatrix}, \begin{bmatrix} -1 \\ 5 \\ -1 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ -11 \\ 2 \\ -1 \end{bmatrix} \right\}$ is linearly **independent**.
- The set of vectors $\left\{ \begin{bmatrix} 0 \\ 1 \\ 0 \\ 1 \end{bmatrix}, \begin{bmatrix} -1 \\ 5 \\ -1 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ -11 \\ 2 \\ -1 \end{bmatrix} \right\}$ is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS5
Linear independence

(a) Write a statement involving the solutions of a vector equation that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} -3 \\ 1 \\ 3 \\ -2 \end{bmatrix}, \begin{bmatrix} -5 \\ 4 \\ 5 \\ -4 \end{bmatrix}, \begin{bmatrix} -8 \\ 5 \\ 8 \\ -6 \end{bmatrix} \right\}$ is linearly **independent**.
- The set of vectors $\left\{ \begin{bmatrix} -3 \\ 1 \\ 3 \\ -2 \end{bmatrix}, \begin{bmatrix} -5 \\ 4 \\ 5 \\ -4 \end{bmatrix}, \begin{bmatrix} -8 \\ 5 \\ 8 \\ -6 \end{bmatrix} \right\}$ is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS6
Basis identification

(a) Write a statement involving spanning and independence properties that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} 0 \\ -3 \\ -1 \\ -2 \end{bmatrix}, \begin{bmatrix} 0 \\ -9 \\ -3 \\ -6 \end{bmatrix}, \begin{bmatrix} -2 \\ 1 \\ -2 \\ 3 \end{bmatrix}, \begin{bmatrix} 4 \\ 4 \\ 6 \\ -2 \end{bmatrix} \right\}$ is a **basis** of $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} 0 \\ -3 \\ -1 \\ -2 \end{bmatrix}, \begin{bmatrix} 0 \\ -9 \\ -3 \\ -6 \end{bmatrix}, \begin{bmatrix} -2 \\ 1 \\ -2 \\ 3 \end{bmatrix}, \begin{bmatrix} 4 \\ 4 \\ 6 \\ -2 \end{bmatrix} \right\}$ is **not** a basis of $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS6
Basis identification

(a) Write a statement involving spanning and independence properties that's equivalent to each claim below.

- The set of vectors $\left\{ \begin{bmatrix} 0 \\ -1 \\ 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \\ 3 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ -1 \\ -2 \\ -3 \end{bmatrix}, \begin{bmatrix} -1 \\ -6 \\ 6 \\ -7 \end{bmatrix} \right\}$ is a **basis** of $\mathbb{R}^4$.
- The set of vectors $\left\{ \begin{bmatrix} 0 \\ -1 \\ 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \\ 3 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ -1 \\ -2 \\ -3 \end{bmatrix}, \begin{bmatrix} -1 \\ -6 \\ 6 \\ -7 \end{bmatrix} \right\}$ is **not** a basis of $\mathbb{R}^4$.

(b) Explain how to determine which of these statements is true.

VS7
Basis of a subspace

Consider the following subspace W of $\mathbb{R}^4$:

$$W = \operatorname{span}\left\{ \begin{bmatrix} -2 \\ -1 \\ -3 \\ 3 \end{bmatrix}, \begin{bmatrix} 5 \\ 2 \\ 1 \\ -2 \end{bmatrix}, \begin{bmatrix} -6 \\ -2 \\ 4 \\ -2 \end{bmatrix} \right\}.$$

(a) Explain how to find a basis of W.

(b) Explain how to find the dimension of W.

VS7
Basis of a subspace

Consider the following subspace W of $\mathbb{R}^4$:

$$W = \operatorname{span}\left\{\begin{bmatrix} 0 \\ 2 \\ 2 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -5 \\ -2 \\ 4 \end{bmatrix}, \begin{bmatrix} 0 \\ -6 \\ -6 \\ 3 \end{bmatrix}, \begin{bmatrix} 3 \\ 5 \\ 3 \\ 0 \end{bmatrix}, \begin{bmatrix} 6 \\ -14 \\ -7 \\ 14 \end{bmatrix}\right\}.$$

(a) Explain how to find a basis of W.

(b) Explain how to find the dimension of W.

VS8 Polynomial and matrix spaces

(a) Given the set

$$\left\{x^3 - x^2 - x - 1, -x^3 - 2\,x^2 - 3\,x - 2, 4\,x^3 + 5\,x^2 + 8\,x + 5\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials is linearly **independent**.
- The set of polynomials is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8 Polynomial and matrix spaces

(a) Given the set

$$\left\{-2\,x^{2} + 1, 6\,x^{2} - 3, 2\,x^{2} - 1, -4\,x^{2} + 2, -2\,x^{3} + 3\,x^{2} + x - 5\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials **spans** $\mathcal{P}_3$
- The set of polynomials does **not** span $\mathcal{P}_3$

(b) Explain how to determine which of these statements is true.

VS8 Polynomial and matrix spaces

(a) Given the set

$$\left\{-2\,x^3 - 3\,x^2 - 4\,x + 4, 2\,x^3 + 3\,x^2 + x - 3, 12\,x^3 + 18\,x^2 + 15\,x - 21\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials is linearly **independent**.
- The set of polynomials is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8
Polynomial and matrix spaces

(a) Given the set

$$\left\{x^3 - 2\,x^2 + x + 2, 2\,x^2 - 1, -x^3 + 3\,x^2 + 3\,x - 2, x^3 - 6\,x^2 + 9\,x + 5\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials is linearly **independent**.
- The set of polynomials is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8
Polynomial and matrix spaces

(a) Given the set
$$\left\{-x+1, -x+1, 5\,x^{3}+4\,x^{2}-4\,x+5, 15\,x^{3}+12\,x^{2}-13\,x+16\right\}$$
write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials **spans** $\mathcal{P}_3$
- The set of polynomials does **not** span $\mathcal{P}_3$

(b) Explain how to determine which of these statements is true.

VS8 Polynomial and matrix spaces

(a) Given the set

$$\left\{x^3 - 2\,x^2 + x + 2, 2\,x^2 - 1, -x^3 + 3\,x^2 + 3\,x - 2, x^3 - 6\,x^2 + 9\,x + 5\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials is linearly **independent**.
- The set of polynomials is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8
Polynomial and matrix spaces

(a) Given the set

$$\left\{-3\,x^{3} + 2\,x^{2} + 2\,x + 3, -x^{3} + x^{2} + x + 1, -2\,x^{3} + 2\,x^{2} + x, 4\,x^{3} - x^{2} - 2\,x - 6\right\}$$

write a statement involving the solutions to a polynomial equation that's equivalent to each claim below.

- The set of polynomials is linearly **independent**.
- The set of polynomials is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8 Polynomial and matrix spaces

(a) Given the set

$$\left\{ \begin{bmatrix} -3 & -2 \\ -2 & -4 \end{bmatrix}, \begin{bmatrix} -3 & -2 \\ -2 & -4 \end{bmatrix}, \begin{bmatrix} -1 & -3 \\ -1 & -3 \end{bmatrix}, \begin{bmatrix} 3 & 2 \\ 2 & 4 \end{bmatrix}, \begin{bmatrix} 11 & 12 \\ 8 & 18 \end{bmatrix} \right\}$$

write a statement involving the solutions to a matrix equation that's equivalent to each claim below.

- The set of matrices **spans** $\mathrm{M}_{2,2}$
- The set of matrices does **not** span $\mathrm{M}_{2,2}$

(b) Explain how to determine which of these statements is true.

VS8
Polynomial and matrix spaces

(a) Given the set

$$\left\{ \begin{bmatrix} -2 & -4 \\ 3 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} 3 & 4 \\ -5 & 2 \end{bmatrix}, \begin{bmatrix} 6 & 13 \\ -9 & -1 \end{bmatrix} \right\}$$

write a statement involving the solutions to a matrix equation that's equivalent to each claim below.

- The set of matrices is linearly **independent**.
- The set of matrices is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS8
Polynomial and matrix spaces

(a) Given the set

$$\left\{ \begin{bmatrix} 1 & -1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 2 & -1 \\ 0 & -3 \end{bmatrix}, \begin{bmatrix} 4 & -3 \\ 1 & -3 \end{bmatrix}, \begin{bmatrix} -2 & 3 \\ -4 & -2 \end{bmatrix} \right\}$$

write a statement involving the solutions to a matrix equation that's equivalent to each claim below.

- The set of matrices is linearly **independent**.
- The set of matrices is linearly **dependent**.

(b) Explain how to determine which of these statements is true.

VS9
Homogeneous systems

Consider the following homogeneous system of equations.

$$\begin{array}{rcrcrcr} x_1 & + & 4\,x_2 & - & 2\,x_3 & = & 0 \\ & & x_2 & & & = & 0 \\ & & 2\,x_2 & & & = & 0 \\ x_1 & + & 5\,x_2 & - & 2\,x_3 & = & 0 \\ & - & 3\,x_2 & & & = & 0 \end{array}$$

(a) Find the solution space of this system.

(b) Find a basis of the solution space.

VS9
Homogeneous systems

Consider the following homogeneous system of equations.

$$\begin{array}{rcrcrcl} & - & x_2 & - & x_3 & = & 0 \\ x_1 & + & 5\,x_2 & + & 7\,x_3 & = & 0 \\ -x_1 & - & 4\,x_2 & - & 6\,x_3 & = & 0 \\ -2\,x_1 & - & 4\,x_2 & - & 8\,x_3 & = & 0 \\ x_1 & + & 2\,x_2 & + & 4\,x_3 & = & 0 \end{array}$$

(a) Find the solution space of this system.

(b) Find a basis of the solution space.

VS9
Homogeneous systems

Consider the following homogeneous system of equations.

$$\begin{array}{rcrcrcr} -x_1 & - & x_2 & + & 3\,x_3 & = & 0 \\ & & & & x_3 & = & 0 \\ -x_1 & - & x_2 & - & 3\,x_3 & = & 0 \\ -x_1 & - & x_2 & - & 5\,x_3 & = & 0 \\ x_1 & + & x_2 & + & x_3 & = & 0 \end{array}$$

(a) Find the solution space of this system.

(b) Find a basis of the solution space.

VS9
Homogeneous systems

Consider the following homogeneous system of equations.

$$\begin{array}{rcrcrcl} -3\,x_1 & - & 4\,x_2 & - & 2\,x_3 & = & 0 \\ -x_1 & - & 3\,x_2 & - & 4\,x_3 & = & 0 \\ -x_1 & & & + & 2\,x_3 & = & 0 \\ 2\,x_1 & + & 4\,x_2 & + & 4\,x_3 & = & 0 \\ x_1 & & & - & 2\,x_3 & = & 0 \end{array}$$

(a) Find the solution space of this system.

(b) Find a basis of the solution space.

VS9
Homogeneous systems

Consider the following homogeneous system of equations.

$$\begin{array}{rcrcrcrcr}
x_1 & - & 2\,x_2 & - & x_3 & & & = & 0 \\
-2\,x_1 & + & 4\,x_2 & + & 3\,x_3 & + & 4\,x_4 & = & 0 \\
-3\,x_1 & + & 6\,x_2 & + & 2\,x_3 & - & 3\,x_4 & = & 0 \\
-3\,x_1 & + & 6\,x_2 & + & 2\,x_3 & - & 2\,x_4 & = & 0
\end{array}$$

(a) Find the solution space of this system.

(b) Find a basis of the solution space.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = 2\,h\,(x) - 2\,h'\,(4) \quad \text{and} \quad T(h(x)) = 2\,h\left(x^3\right) - 4$$

Explain why one these maps is a linear transformation and why the other map is not.

Version 0186

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(g(x)) = 3\,g\,(x)^2 - 2\,g'\,(-4) \quad \text{and} \quad T(g(x)) = g\,(-4) + 4\,g\left(x^3\right)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = -4\,h\,(-1) - h\left(x^3\right) \quad \text{and} \quad T(h(x)) = -3\,h\,(x)^2 - 4\,h\,(x)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(f(x)) = -2\,f\,(-4) + 5\,f'\,(x) \quad \text{and} \quad T(f(x)) = -f\,(x)^2 - 4\,f\,(x)$$

Explain why one these maps is a linear transformation and why the other map is not.

Version 0038

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(f(x)) = -f\left(x\right)^{2} + 2\,f\left(x^{3}\right) \quad \text{and} \quad T(f(x)) = 5\,x^{3} f\left(x\right) - 4\,f'\left(-4\right)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = -3\,h\left(x^3\right) - 5\,h'\left(x\right) \quad \text{and} \quad T(h(x)) = -2\,h\left(x\right)^2 - h'\left(3\right)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(g(x)) = g'(x) + 1 \quad \text{and} \quad T(g(x)) = -5\,g(4) + 3\,g'(-1)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = -5\,h\,(-4) + 5\,h'\,(x) \quad \text{and} \quad T(h(x)) = 4\,x^2 - xh\,(x)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = -3\,h\,(x)^2 + h\,(5) \quad \text{and} \quad T(h(x)) = 2\,h\left(x^2\right) - h'\,(-3)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT1
Linear maps

Consider the following maps of polynomials $S : \mathcal{P} \to \mathcal{P}$ and $T : \mathcal{P} \to \mathcal{P}$ defined by

$$S(h(x)) = -2\,x - 2\,h\,(-5) \quad \text{and} \quad T(h(x)) = x^3 h\,(x) + 5\,h\left(x^2\right)$$

Explain why one these maps is a linear transformation and why the other map is not.

AT2
Standard matrices

(a) Find the standard matrix for the linear transformation $S : \mathbb{R}^4 \to \mathbb{R}^3$ given by

$$S\left(\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}\right) = \begin{bmatrix} -2\,x - 3\,y - 5\,z - 6\,w \\ y + 4\,z - w \\ x + y + 4\,w \end{bmatrix}.$$

(b) Let $T : \mathbb{R}^3 \to \mathbb{R}^3$ be the linear transformation given by the standard matrix

$$\begin{bmatrix} -2 & -1 & 4 \\ 3 & 1 & -7 \\ -5 & -4 & 8 \end{bmatrix}.$$

Compute $T\left(\begin{bmatrix} -4 \\ -3 \\ 0 \end{bmatrix}\right)$.

AT2
Standard matrices

(a) Find the standard matrix for the linear transformation $S : \mathbb{R}^3 \to \mathbb{R}^4$ given by

$$S\left(\begin{bmatrix} x \\ y \\ z \end{bmatrix}\right) = \begin{bmatrix} -2\,x + 2\,y + 6\,z \\ x + 6\,y + 8\,z \\ x + 2\,y + z \\ x + y \end{bmatrix}.$$

(b) Let $T : \mathbb{R}^3 \to \mathbb{R}^2$ be the linear transformation given by the standard matrix

$$\begin{bmatrix} -4 & 1 & 7 \\ -5 & 1 & 8 \end{bmatrix}.$$

Compute $T\left(\begin{bmatrix} -8 \\ -1 \\ -6 \end{bmatrix}\right)$.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}\right) = \begin{bmatrix} -x + y - 2\,z + 2\,w \\ x - y + z - 2\,w \\ -3\,x + 3\,y + 2\,z + 6\,w \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\left[\begin{array}{c} x \\ y \\ z \\ w \end{array}\right]\right) = \left[\begin{array}{c} -y - 4\,z - 7\,w \\ x - y - 2\,w \\ -y - 3\,z - 6\,w \end{array}\right].$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}\right) = \begin{bmatrix} x_1 - x_2 + x_3 - 5\,x_4 \\ x_2 + x_3 + 2\,x_4 \\ x_1 - x_2 + 2\,x_3 - 6\,x_4 \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}\right) = \begin{bmatrix} x + 2\,y - 7\,w \\ -2\,x - 3\,y + 2\,z + 7\,w \\ x - y - 5\,z + 12\,w \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}\right) = \begin{bmatrix} -x_1 + 2\,x_2 + 2\,x_4 \\ x_1 - 2\,x_2 - 4\,x_3 + 6\,x_4 \\ -2\,x_1 + 4\,x_2 + 5\,x_3 - 6\,x_4 \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}\right) = \begin{bmatrix} x + y + z + 3\,w \\ z + w \\ -x - y - 5\,z - 7\,w \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT3
Image and kernel

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by

$$T\left(\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}\right) = \begin{bmatrix} x - 2\,y - 3\,z + 4\,w \\ 2\,x - 4\,y - 5\,z + 6\,w \\ x - 2\,y + 2\,z - 6\,w \end{bmatrix}.$$

(a) Explain how to find the image of T and the kernel of T.

(b) Explain how to find a basis of the image of T and a basis of the kernel of T.

(c) Explain how to find the rank and nullity of T, and why the rank-nullity theorem holds for T.

AT4
Injectivity and surjectivity

Let $T : \mathbb{R}^3 \to \mathbb{R}^5$ be the linear transformation given by the standard matrix $\begin{bmatrix} 0 & 0 & 3 \\ 0 & 1 & 5 \\ 3 & -3 & -5 \\ -1 & 1 & 5 \\ 1 & -1 & 2 \end{bmatrix}$.

(a) Explain why T is or is not injective.

(b) Explain why T is or is not surjective.

AT4
Injectivity and surjectivity

Let $T : \mathbb{R}^4 \to \mathbb{R}^5$ be the linear transformation given by the standard matrix $\begin{bmatrix} 1 & 0 & 2 & 2 \\ 0 & 1 & 3 & 0 \\ -1 & 0 & -1 & -2 \\ 0 & 1 & 3 & 0 \\ 0 & -1 & -4 & 0 \end{bmatrix}$.

(a) Explain why T is or is not injective.

(b) Explain why T is or is not surjective.

AT4
Injectivity and surjectivity

Let $T : \mathbb{R}^3 \to \mathbb{R}^3$ be the linear transformation given by the standard matrix $\begin{bmatrix} -1 & 1 & 1 \\ -1 & 0 & -2 \\ 2 & 0 & 5 \end{bmatrix}$.

(a) Explain why T is or is not injective.

(b) Explain why T is or is not surjective.

AT4
Injectivity and surjectivity

Let $T : \mathbb{R}^4 \to \mathbb{R}^3$ be the linear transformation given by the standard matrix $\begin{bmatrix} 1 & 1 & 1 & -2 \\ 4 & 5 & 1 & -6 \\ -3 & -4 & 1 & 3 \end{bmatrix}$.

(a) Explain why T is or is not injective.

(b) Explain why T is or is not surjective.

AT4
Injectivity and surjectivity

Let $T : \mathbb{R}^4 \to \mathbb{R}^4$ be the linear transformation given by the standard matrix $\begin{bmatrix} -3 & 2 & 1 & 4 \\ 4 & -3 & 0 & -6 \\ 4 & -4 & 5 & -9 \\ 0 & 2 & -4 & 0 \end{bmatrix}$.

(a) Explain why T is or is not injective.

(b) Explain why T is or is not surjective.

MX1
Multiplying matrices

Of the following three matrices, only two may be multiplied.

$$A = \begin{bmatrix} 1 & 3 \\ 1 & 4 \\ -1 & -4 \\ 0 & -5 \end{bmatrix} \quad B = \begin{bmatrix} -1 & 2 & -4 \\ 0 & 1 & 3 \\ 0 & -2 & -5 \\ 1 & -1 & 4 \end{bmatrix} \quad C = \begin{bmatrix} 1 & -4 \\ 3 & -5 \\ 0 & 1 \end{bmatrix}$$

Explain which two can be multiplied and why. Then show how to find their product.

MX1
Multiplying matrices

Of the following three matrices, only two may be multiplied.

$$A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \\ 0 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 1 \\ 1 & -2 \\ -1 & -2 \\ -1 & 2 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 & -2 & 3 \\ -3 & 1 & 2 & -5 \\ 1 & -1 & 3 & -2 \end{bmatrix}$$

Explain which two can be multiplied and why. Then show how to find their product.

MX1
Multiplying matrices

Of the following three matrices, only two may be multiplied.

$$A = \begin{bmatrix} 1 & 0 & 1 & -3 \\ -1 & 1 & -1 & 6 \\ -2 & 1 & -1 & 6 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 \\ 5 & 1 \\ -3 & -5 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 1 & -3 & -5 \\ -1 & 0 & 1 & 2 \end{bmatrix}$$

Explain which two can be multiplied and why. Then show how to find their product.

MX1
Multiplying matrices

Of the following three matrices, only two may be multiplied.

$$A = \begin{bmatrix} -3 & 1 & -2 \\ -4 & 1 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 & 0 \\ -5 & 1 & -3 \\ 5 & 1 & -2 \\ 5 & -1 & 0 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 1 & 6 & -2 \\ 0 & 1 & 4 & -1 \end{bmatrix}$$

Explain which two can be multiplied and why. Then show how to find their product.

MX1
Multiplying matrices

Of the following three matrices, only two may be multiplied.

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 2 & 1 & 1 & 0 \\ 4 & -1 & 6 & 2 \end{bmatrix} \quad B = \begin{bmatrix} -1 & 2 & -5 & -1 \\ -1 & 1 & -2 & 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & -6 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Explain which two can be multiplied and why. Then show how to find their product.

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix Q that may be used to perform the row operation $R_2 - 5R_4 \to R_2$.

(b) Give a 4×4 matrix N that may be used to perform the row operation $5R_2 \to R_2$.

(c) Use matrix multiplication to describe the matrix obtained by applying $5R_2 \to R_2$ and then $R_2 - 5R_4 \to R_2$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix B that may be used to perform the row operation $R_4 \leftrightarrow R_2$.

(b) Give a 4×4 matrix N that may be used to perform the row operation $5R_4 \to R_4$.

(c) Use matrix multiplication to describe the matrix obtained by applying $5R_4 \to R_4$ and then $R_4 \leftrightarrow R_2$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix P that may be used to perform the row operation $R_3 + 4R_2 \to R_3$.

(b) Give a 4×4 matrix N that may be used to perform the row operation $2R_3 \to R_3$.

(c) Use matrix multiplication to describe the matrix obtained by applying $2R_3 \to R_3$ and then $R_3 + 4R_2 \to R_3$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix Q that may be used to perform the row operation $-5R_1 \to R_1$.

(b) Give a 4×4 matrix B that may be used to perform the row operation $R_1 - 4R_3 \to R_1$.

(c) Use matrix multiplication to describe the matrix obtained by applying $-5R_1 \to R_1$ and then $R_1 - 4R_3 \to R_1$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix M that may be used to perform the row operation $R_3 \leftrightarrow R_1$.

(b) Give a 4×4 matrix Q that may be used to perform the row operation $3R_3 \to R_3$.

(c) Use matrix multiplication to describe the matrix obtained by applying $R_3 \leftrightarrow R_1$ and then $3R_3 \to R_3$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix N that may be used to perform the row operation $R_4 - 2R_1 \to R_4$.

(b) Give a 4×4 matrix C that may be used to perform the row operation $R_2 \leftrightarrow R_4$.

(c) Use matrix multiplication to describe the matrix obtained by applying $R_2 \leftrightarrow R_4$ and then $R_4 - 2R_1 \to R_4$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix B that may be used to perform the row operation $4R_4 \to R_4$.

(b) Give a 4×4 matrix M that may be used to perform the row operation $R_4 + 2R_1 \to R_4$.

(c) Use matrix multiplication to describe the matrix obtained by applying $4R_4 \to R_4$ and then $R_4 + 2R_1 \to R_4$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix M that may be used to perform the row operation $R_1 \leftrightarrow R_3$.

(b) Give a 4×4 matrix C that may be used to perform the row operation $-4R_1 \to R_1$.

(c) Use matrix multiplication to describe the matrix obtained by applying $-4R_1 \to R_1$ and then $R_1 \leftrightarrow R_3$ to A (note the order).

MX2
Row operations as matrix multiplication

Let A be a 4×4 matrix.

(a) Give a 4×4 matrix B that may be used to perform the row operation $R_4 \leftrightarrow R_2$.

(b) Give a 4×4 matrix N that may be used to perform the row operation $R_2 - 2R_1 \rightarrow R_2$.

(c) Use matrix multiplication to describe the matrix obtained by applying $R_4 \leftrightarrow R_2$ and then $R_2 - 2R_1 \rightarrow R_2$ to A (note the order).

MX3
The inverse of a matrix

Explain why each of the following matrices is or is not invertible by disussing its corresponding linear transformation. If the matrix is invertible, explain how to find its inverse.

$$B = \begin{bmatrix} 1 & -2 & -3 & 1 \\ 3 & -5 & -6 & 4 \\ 0 & -2 & -6 & -2 \\ 0 & 3 & 9 & 3 \end{bmatrix} \qquad C = \begin{bmatrix} -5 & 3 & 5 & -1 \\ -2 & 1 & 2 & -1 \\ -2 & -1 & 3 & -4 \\ 0 & 0 & -1 & -2 \end{bmatrix}$$

Version 0169

MX3
The inverse of a matrix

Explain why each of the following matrices is or is not invertible by disussing its corresponding linear transformation. If the matrix is invertible, explain how to find its inverse.

$$Q = \begin{bmatrix} 3 & -4 & 2 & -12 \\ 1 & -1 & 0 & -3 \\ -3 & 4 & -2 & 12 \\ -2 & 4 & -4 & 12 \end{bmatrix} \qquad L = \begin{bmatrix} 0 & -1 & 1 & 0 \\ 1 & -3 & 0 & -3 \\ 0 & 4 & -3 & 0 \\ 0 & -1 & -4 & 1 \end{bmatrix}$$

Version 0160

MX3
The inverse of a matrix

Explain why each of the following matrices is or is not invertible by disussing its corresponding linear transformation. If the matrix is invertible, explain how to find its inverse.

$$A = \begin{bmatrix} 1 & 1 & -2 & -4 \\ 0 & 1 & 0 & 0 \\ 0 & -1 & 1 & 4 \\ 0 & 5 & -1 & -3 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 1 & 0 & 3 \\ 1 & 2 & -1 & 6 \\ 2 & -3 & 5 & -9 \\ -4 & 0 & -4 & 0 \end{bmatrix}$$

MX3
The inverse of a matrix

Explain why each of the following matrices is or is not invertible by disussing its corresponding linear transformation. If the matrix is invertible, explain how to find its inverse.

$$D = \begin{bmatrix} -1 & 1 & 1 & -1 \\ -2 & 2 & 1 & -4 \\ 2 & -2 & -3 & 1 \\ 1 & -1 & 1 & 1 \end{bmatrix} \qquad A = \begin{bmatrix} -3 & 1 & 1 & 1 \\ 4 & -3 & 0 & -3 \\ -4 & 2 & 1 & 3 \\ -4 & 3 & 0 & 4 \end{bmatrix}$$

MX3
The inverse of a matrix

Explain why each of the following matrices is or is not invertible by disussing its corresponding linear transformation. If the matrix is invertible, explain how to find its inverse.

$$M = \begin{bmatrix} 0 & -1 & -2 & 2 \\ 0 & 1 & 1 & -4 \\ 1 & 0 & -3 & 1 \\ 1 & 0 & -3 & 2 \end{bmatrix} \qquad N = \begin{bmatrix} 0 & 0 & 0 & 0 \\ -1 & -4 & 1 & 8 \\ 1 & 5 & -2 & -10 \\ -1 & -3 & 0 & 6 \end{bmatrix}$$

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -4.

(a) Let C be the matrix obtained from A by applying the row operation $R_2 \leftrightarrow R_3$. What is $\det C$?

(b) Let B be the matrix obtained from A by applying the row operation $-4R_1 \rightarrow R_1$. What is $\det B$?

(c) Let M be the matrix obtained from A by applying the row operation $R_4 + 4R_3 \rightarrow R_4$. What is $\det M$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant 2.

(a) Let P be the matrix obtained from A by applying the row operation $-3R_1 \to R_1$. What is $\det P$?

(b) Let M be the matrix obtained from A by applying the row operation $R_4 + 2R_1 \to R_4$. What is $\det M$?

(c) Let N be the matrix obtained from A by applying the row operation $R_3 \leftrightarrow R_1$. What is $\det N$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -7.

(a) Let B be the matrix obtained from A by applying the row operation $R_3 \leftrightarrow R_4$. What is $\det B$?

(b) Let M be the matrix obtained from A by applying the row operation $R_1 + 4R_4 \rightarrow R_1$. What is $\det M$?

(c) Let C be the matrix obtained from A by applying the row operation $-4R_3 \rightarrow R_3$. What is $\det C$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -7.

(a) Let C be the matrix obtained from A by applying the row operation $2R_3 \to R_3$. What is $\det C$?

(b) Let P be the matrix obtained from A by applying the row operation $R_1 \leftrightarrow R_3$. What is $\det P$?

(c) Let B be the matrix obtained from A by applying the row operation $R_3 + 2R_2 \to R_3$. What is $\det B$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -7.

(a) Let M be the matrix obtained from A by applying the row operation $2R_3 \to R_3$. What is $\det M$?

(b) Let Q be the matrix obtained from A by applying the row operation $R_1 \leftrightarrow R_2$. What is $\det Q$?

(c) Let B be the matrix obtained from A by applying the row operation $R_4 + 5R_1 \to R_4$. What is $\det B$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -5.

(a) Let N be the matrix obtained from A by applying the row operation $-5R_1 \to R_1$. What is $\det N$?

(b) Let P be the matrix obtained from A by applying the row operation $R_4 + 2R_1 \to R_4$. What is $\det P$?

(c) Let C be the matrix obtained from A by applying the row operation $R_3 \leftrightarrow R_4$. What is $\det C$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -4.

(a) Let B be the matrix obtained from A by applying the row operation $-5R_2 \to R_2$. What is $\det B$?

(b) Let C be the matrix obtained from A by applying the row operation $R_2 \leftrightarrow R_3$. What is $\det C$?

(c) Let P be the matrix obtained from A by applying the row operation $R_4 + 2R_1 \to R_4$. What is $\det P$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant 5.

(a) Let P be the matrix obtained from A by applying the row operation $R_4 \leftrightarrow R_1$. What is $\det P$?

(b) Let B be the matrix obtained from A by applying the row operation $R_4 - 5R_1 \to R_4$. What is $\det B$?

(c) Let M be the matrix obtained from A by applying the row operation $4R_3 \to R_3$. What is $\det M$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant -2.

(a) Let C be the matrix obtained from A by applying the row operation $R_2 + 2R_3 \to R_2$. What is $\det C$?

(b) Let P be the matrix obtained from A by applying the row operation $-5R_3 \to R_3$. What is $\det P$?

(c) Let N be the matrix obtained from A by applying the row operation $R_4 \leftrightarrow R_3$. What is $\det N$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant 4.

(a) Let Q be the matrix obtained from A by applying the row operation $R_1 \leftrightarrow R_3$. What is $\det Q$?

(b) Let M be the matrix obtained from A by applying the row operation $-4R_1 \to R_1$. What is $\det M$?

(c) Let B be the matrix obtained from A by applying the row operation $R_2 - 2R_3 \to R_2$. What is $\det B$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant 2.

(a) Let Q be the matrix obtained from A by applying the row operation $R_1 \leftrightarrow R_2$. What is $\det Q$?

(b) Let M be the matrix obtained from A by applying the row operation $-5R_4 \to R_4$. What is $\det M$?

(c) Let C be the matrix obtained from A by applying the row operation $R_3 - 3R_4 \to R_3$. What is $\det C$?

GT1
Row operations and determinants

Let A be a 4×4 matrix with determinant 5.

(a) Let C be the matrix obtained from A by applying the row operation $R_2 \leftrightarrow R_1$. What is $\det C$?

(b) Let N be the matrix obtained from A by applying the row operation $R_1 + 2R_4 \to R_1$. What is $\det N$?

(c) Let Q be the matrix obtained from A by applying the row operation $-3R_2 \to R_2$. What is $\det Q$?

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} -3 & 1 & 5 & 4 \\ -2 & 5 & 5 & -1 \\ 5 & 0 & 2 & -3 \\ 2 & 1 & 0 & 0 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 3 & 0 & -1 & 2 \\ 5 & 0 & 0 & 2 \\ 3 & 3 & -1 & 5 \\ 3 & 1 & 5 & 4 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} -5 & -4 & -3 & -1 \\ 1 & 0 & 1 & 4 \\ 3 & 0 & -1 & 0 \\ -5 & 3 & -1 & 1 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 1 & -2 & -3 & 4 \\ -3 & 5 & 4 & -2 \\ 2 & 1 & 0 & 0 \\ 1 & 5 & 2 & -2 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 5 & 2 & 3 & 0 \\ -3 & -4 & 1 & -1 \\ 0 & -1 & 0 & -3 \\ 3 & -4 & -1 & -4 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} -5 & -4 & 4 & 4 \\ 3 & 0 & -1 & 0 \\ -2 & 2 & -4 & 4 \\ -2 & -2 & 0 & 1 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 2 & 5 & 0 & 0 \\ 4 & 4 & 4 & -2 \\ 3 & 3 & -4 & 0 \\ -3 & -4 & -4 & -1 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 3 & 4 & 0 & -5 \\ -5 & 2 & -2 & -5 \\ -4 & 1 & -1 & 4 \\ -5 & 3 & 0 & 4 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 2 & 3 & 5 & -4 \\ -2 & 1 & 3 & -3 \\ -5 & 2 & -1 & -2 \\ 0 & 1 & 0 & 0 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} -5 & 0 & -5 & -4 \\ 5 & -2 & -1 & -5 \\ 0 & 2 & 0 & -1 \\ -5 & 2 & -3 & 5 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 3 & 0 & 1 & -2 \\ 2 & 4 & -5 & -1 \\ -4 & 4 & -5 & 0 \\ -3 & -3 & 3 & 0 \end{bmatrix}.$$

GT2
Determinants

Show how to compute the determinant of the matrix

$$A = \begin{bmatrix} 3 & 0 & -4 & 0 \\ 3 & -1 & -1 & -1 \\ 5 & 0 & 3 & -2 \\ 3 & -2 & 2 & 4 \end{bmatrix}.$$

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 2 \\ 5 & 2 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\left[\begin{array}{cc} 8 & 2 \\ -14 & -8 \end{array}\right]$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 1 \\ -2 & -4 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 5 & 2 \\ -9 & -6 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 1 \\ -2 & -4 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -3 & 1 \\ 6 & 2 \end{bmatrix}$.

Version 0209

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 1 \\ -8 & -7 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 10 & 2 \\ -21 & -3 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 9 & 1 \\ -15 & 1 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 5 & 1 \\ -2 & 2 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 0 & 1 \\ 9 & 0 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 2 \\ 6 & 3 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -3 & 1 \\ 6 & 2 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -2 & 2 \\ -4 & -8 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 5 & 2 \\ -9 & -6 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 12 & 2 \\ -51 & -11 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} -1 & 2 \\ 6 & -2 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 3 & 2 \\ -15 & -8 \end{bmatrix}$.

GT3
Eigenvalues

Explain how to find the eigenvalues of the matrix $\begin{bmatrix} 5 & 1 \\ -11 & -7 \end{bmatrix}$.

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -1 in the matrix

$$\begin{bmatrix} 2 & 4 & -1 & -5 \\ 0 & 0 & -3 & -9 \\ 1 & 1 & 0 & 2 \\ -2 & -2 & 3 & 5 \end{bmatrix}.$$

Version 0000

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 2 in the matrix

$$\begin{bmatrix} 0 & -4 & 4 & 2 \\ -2 & -2 & 4 & 2 \\ 0 & 0 & 2 & 0 \\ -3 & -6 & 6 & 5 \end{bmatrix}.$$

Version 0204

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -4 in the matrix

$$\begin{bmatrix} -3 & -1 & -3 & 3 \\ 2 & -5 & -2 & -2 \\ 2 & -2 & -9 & 4 \\ 0 & 0 & 0 & -4 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -2 in the matrix

$$\begin{bmatrix} -1 & 4 & 10 & 1 \\ 3 & -7 & -21 & 3 \\ 0 & -3 & -11 & 0 \\ 0 & 2 & 6 & -2 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -2 in the matrix

$$\begin{bmatrix} 2 & -4 & 4 & 12 \\ -1 & -1 & -1 & -3 \\ -4 & 4 & -6 & -12 \\ -4 & 4 & -4 & -14 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 2 in the matrix

$$\begin{bmatrix} 2 & 0 & -4 & -12 \\ 1 & 1 & -4 & -13 \\ 0 & 0 & 3 & 3 \\ 1 & -1 & -1 & -2 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 2 in the matrix

$$\begin{bmatrix} 3 & 1 & 0 & 1 \\ -1 & 2 & 2 & -2 \\ 3 & 0 & -3 & 5 \\ -5 & -2 & 2 & -2 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -2 in the matrix

$$\begin{bmatrix} -1 & -4 & -11 & 1 \\ -1 & -1 & 5 & -5 \\ -1 & -4 & -7 & -4 \\ 0 & 4 & 8 & 2 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -3 in the matrix

$$\begin{bmatrix} -3 & 0 & -1 & -2 \\ 1 & -6 & -3 & -18 \\ 1 & -4 & -7 & -23 \\ 0 & -1 & -1 & -8 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -2 in the matrix

$$\begin{bmatrix} -2 & -1 & 2 & 1 \\ 1 & -3 & 4 & -1 \\ 3 & -2 & 8 & -4 \\ -2 & 5 & -14 & -3 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 3 in the matrix

$$\begin{bmatrix} -1 & 8 & -12 & -4 \\ 2 & -1 & 6 & 2 \\ -5 & 10 & -12 & -5 \\ -3 & 6 & -9 & 0 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -3 in the matrix

$$\begin{bmatrix} -4 & -2 & 2 & -3 \\ -4 & -11 & 8 & -12 \\ -1 & -2 & -1 & -3 \\ -3 & -6 & 6 & -12 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -2 in the matrix

$$\begin{bmatrix} -1 & 1 & -2 & -1 \\ 5 & 3 & -10 & -5 \\ -4 & -4 & 6 & 4 \\ 5 & 5 & -10 & -7 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 2 in the matrix

$$\begin{bmatrix} 3 & -2 & 2 & -1 \\ 5 & -8 & 10 & -5 \\ 4 & -8 & 10 & -4 \\ -2 & 4 & -4 & 4 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 2 in the matrix

$$\begin{bmatrix} 3 & -1 & 2 & 1 \\ 0 & 2 & 0 & 0 \\ 4 & -4 & 10 & 4 \\ 2 & -2 & 4 & 4 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue -4 in the matrix

$$\begin{bmatrix} -1 & 2 & -5 & 3 \\ 1 & -3 & -4 & 2 \\ 1 & 1 & -7 & 2 \\ 2 & 0 & -3 & -6 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 3 in the matrix

$$\begin{bmatrix} 4 & 0 & 3 & -2 \\ 1 & 3 & 3 & -3 \\ 0 & 1 & 5 & -4 \\ 5 & -3 & 9 & 8 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 3 in the matrix

$$\begin{bmatrix} 6 & -9 & 9 & -3 \\ -4 & 15 & -12 & 4 \\ 2 & -6 & 9 & -2 \\ 0 & 0 & 0 & 3 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 1 in the matrix

$$\begin{bmatrix} 2 & 3 & 1 & 2 \\ -2 & -5 & -2 & -4 \\ 3 & 9 & 4 & 6 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

GT4
Eigenvectors

Explain how to find a basis for the eigenspace associated to the eigenvalue 3 in the matrix

$$\begin{bmatrix} 5 & -2 & -5 & -4 \\ -1 & 4 & 5 & 7 \\ -2 & 2 & 7 & 2 \\ -1 & 1 & 1 & 2 \end{bmatrix}.$$