

MTH 309T LINEAR ALGEBRA EXAM 1

October 3, 2019

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Matthew Cho

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Instructions:

- Textbooks, calculators and any other electronic devices are not permitted. You may use one sheet of notes.
- For full credit solve each problem fully, showing all relevant work.

1	2	3	4	5	6	7	TOTAL	GRADE

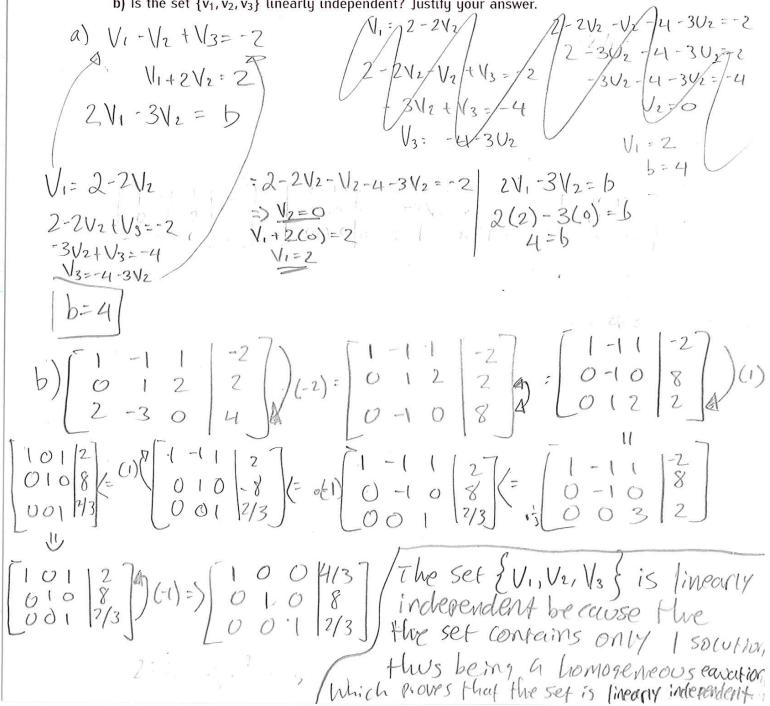
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1. (20 points) Consider the following vectors in \mathbb{R}^3 :

$$\mathbf{v}_1 = \left[\begin{array}{c} 1 \\ 0 \\ 2 \end{array} \right], \quad \mathbf{v}_2 = \left[\begin{array}{c} -1 \\ 1 \\ -3 \end{array} \right], \quad \mathbf{v}_3 = \left[\begin{array}{c} 1 \\ 2 \\ 0 \end{array} \right], \quad \mathbf{w} = \left[\begin{array}{c} -2 \\ 2 \\ b \end{array} \right]$$

- a) Find all values of b such that $w \in \text{Span}(v_1, v_2, v_3)$.
- b) Is the set $\{v_1, v_2, v_3\}$ linearly independent? Justify your answer.





2. (10 points) Consider the following matrix:

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

Compute A^{-1} .

$$\begin{bmatrix}
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0 & 1 & 0 & 0 & 0
\end{bmatrix}$$

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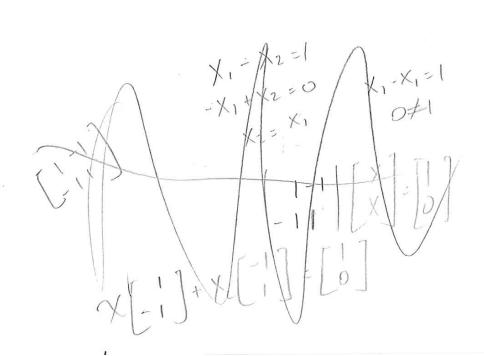
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3. (10 points) Let A be the same matrix as in Problem 2, and let

$$B = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 4 \\ 3 & 2 & 1 \end{bmatrix}$$

Find a matrix C such that $A^TC = B$ (where A^T is the transpose of A).

$$A: \begin{bmatrix} 1 & -1 & 2 \\ 1 & 0 & 1 \end{bmatrix}$$

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

$$A = \begin{bmatrix} A & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

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4. (20 points) Let $T: \mathbb{R}^2 \to \mathbb{R}^3$ be a linear transformation given by

$$T\left(\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right) = \begin{bmatrix} x_1 - 2x_2 \\ x_1 + x_2 \\ x_1 - 3x_2 \end{bmatrix}$$

- a) Find the standard matrix of \mathcal{T} .
- b) Find all vectors u satisfying $T(u) = \begin{bmatrix} 1 \\ 10 \\ -2 \end{bmatrix}$.

$$T(u+v) = Tu + Tv$$

$$T(u) = \begin{cases} U_1 + U_1 \\ U_1 + U_2 \\ U_1 + U_2 \end{cases}$$

$$U_1 + U_2 = \begin{cases} U_1 + V_1 - 2U_2 - 2V_2 \\ U_1 + V_1 + U_2 + V_2 \\ U_1 + V_2 \end{cases}$$

$$T(v) = \begin{cases} V_1 - 2V_2 \\ V_1 + V_2 \\ V_2 - 3V_2 \end{cases}$$

$$= \begin{cases} (U_1 + V_1) - 2 (U_2 + V_2) \\ (U_1 + V_1) + (U_2 + V_2) \end{cases}$$

$$Standard matrix$$

$$A(T(e_1) T(e_2)) = \begin{cases} T(e_1) - 2 \\ 1 \\ 1 \end{cases}$$

$$T(e_2) = \begin{cases} T(e_1) - 2 \\ 1 \\ 1 \end{cases}$$

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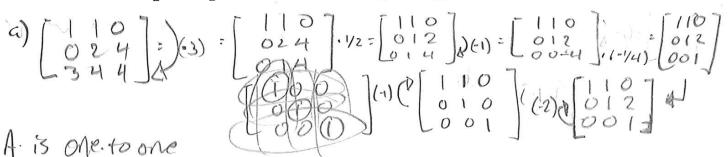
$$T(e_1) = \begin{cases} T(e_$$



5. (20 points) For each matrix A given below determine if the matrix transformation $T_A \colon \mathbb{R}^3 \to \mathbb{R}^3$ given by $T_A(v) = Av$ is one-to one or not. If T_A is not one-to-one, find two vectors \mathbf{v}_1 and \mathbf{v}_2 such that $T_A(\mathbf{v}_1) = T_A(\mathbf{v}_2)$.

a)
$$A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 2 & 4 \\ 3 & 4 & 4 \end{bmatrix}$$
 b) $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 2 & 4 \\ 3 & 4 & 2 \end{bmatrix}$

b)
$$A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 2 & 4 \\ 3 & 4 & 2 \end{bmatrix}$$



A. is one to one

because every column has a pivot position and the marrix is a homogeneous carerton

$$b) \left(\begin{array}{c} 0 & 2 & 4 \\ 3 & 4 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 2 & 4 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 & 1 & 2 \\ 0 & 1 & 2 \end{array} \right) \left(\begin{array}{c} 0 &$$

A's one to one because every column has a fivot position and the matrix is a homogeneous ravation.



6. (10 points) For each of the statements given below decide if it is true or false. If it is true explain why. If it is false give a counterexample.

a) If u, v, w are vectors in \mathbb{R}^3 such that $w + u \in \text{Span}(u, v)$ then $w \in \text{Span}(u, v)$.

Vi= (g) Vi= [6]; · U; [2], w= [6] V, + Our = 1 DV. + V2 = 2 01/1+01,=0

V, +0U2: 4 OU.+V2 =6 / DU, +OU = 0

Utw: [&]

V. +OV2= 4 OV, + V2 = 8 OV1+0U2=0

b) If u, v, w are vectors in \mathbb{R}^3 such that the set $\{u, v, w\}$ is linearly independent then the set {u, v} must be linearly independent.

The because in order for a set to be Inearly independent they Muss have socution (Homogeneous carafter) 50 that means that IL, U, W all only have I squition which thems that the Set & U, UZ is imeasty independent



7. (10 points) For each of the statements given below decide if it is true or false. If it is true explain why. If it is false give a counterexample.

a) If A is a 2×2 matrix and u, v are vectors in \mathbb{R}^2 such that Au, Av are linearly dependent then u, v also must be linearly dependent.

TMC

b) If $T: \mathbb{R}^2 \to \mathbb{R}^2$ is a linear transformation and $u, v, w \in \mathbb{R}^2$ are vectors such that u is in Span(v, w) then T(u) must be in Span(T(v), T(w)).

This is the