

MA 242 LINEAR ALGEBRA C1, Solutions to Second Midterm Exam

Prof. Nikola Popovic, November 9, 2006, 09:30am - 10:50am

Problem 1 (15 points).

Let the matrix A be given by

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

- (a) Find the inverse A^{-1} of A , if it exists.
- (b) Based on your answer in (a), determine whether the columns of A span \mathbb{R}^3 . (Justify your answer!)

Solution.

(a) To check whether A is invertible, we row reduce the augmented matrix $[A \ I_3]$:

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

Since the last row in the echelon form of A contains only zeros, A is not row equivalent to I_3 . Hence, A is not invertible, and A^{-1} does not exist.

(b) Since A is not invertible by (a), the Invertible Matrix Theorem says that the columns of A cannot span \mathbb{R}^3 .

Problem 2 (15 points).

Let the vectors $\mathbf{b}_1, \dots, \mathbf{b}_4$ be defined by

$$\mathbf{b}_1 = \begin{pmatrix} 3 \\ 5 \\ -2 \\ -4 \end{pmatrix}, \quad \mathbf{b}_2 = \begin{pmatrix} 2 \\ -1 \\ -5 \\ 7 \end{pmatrix}, \quad \mathbf{b}_3 = \begin{pmatrix} -1 \\ 1 \\ 3 \\ 0 \end{pmatrix}, \quad \text{and} \quad \mathbf{b}_4 = \begin{pmatrix} 0 \\ 0 \\ 0 \\ -3 \end{pmatrix}.$$

- (a) Determine if the set $\mathcal{B} = \{\mathbf{b}_1, \mathbf{b}_2, \mathbf{b}_3, \mathbf{b}_4\}$ is linearly independent by computing the determinant of the matrix $B = [\mathbf{b}_1 \ \mathbf{b}_2 \ \mathbf{b}_3 \ \mathbf{b}_4]$.
- (b) Using your answer in (a), determine if \mathcal{B} is a basis for \mathbb{R}^4 . (Justify your answer!)

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Wolfgang Guggemos



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