

LECTURES IN MATH III: LINEAR ALGEBRA

Lecture 1. The Inverse of a matrix

The inverse of a matrix plays a very significant role in solving certain system of linear equations. There are 3 ways in finding the inverse of a matrix

1. By definition of inverse of a matrix. If A is an $n \times n$ matrix, then the inverse of A is the matrix A^{-1} , such that

$$AA^{-1} = I_n \quad \text{or} \quad A^{-1}A = I_n.$$

- ✓ If there exists a matrix A^{-1} , then A is called nonsingular or invertible.
- ✓ If there exists no such matrix A^{-1} , then A is called singular or noninvertible.

1. For any 2×2 matrix,

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

its inverse can be determined by the formula

$$A^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}.$$

3. Gauss-Jordan Reduction for finding the inverse of a matrix.

Let A be an $n \times n$ matrix.

a. Adjoin the identity $n \times n$ matrix I_n to A to form the matrix $[A : I_n]$.

b. Compute the reduced row echelon form of $[A : I_n]$

- ✓ If the reduced row echelon form is of type $[I_n : A^{-1}]$, then A^{-1} is the inverse of A .
- ✓ If the reduced row echelon form is not of the type $[I_n : A^{-1}]$, in that the first $n \times n$ submatrix is not I_n , then A has no inverse.

Properties of Matrix Inverse

Let A and B be invertible matrices and r be a nonzero scalar.

1. $(A^{-1})^{-1} = A$
2. $(rA)^{-1} = (1/r) A^{-1}$
3. $(AB)^{-1} = B^{-1} A^{-1}$
4. $(A^T)^{-1} = (A^{-1})^T$
5. $(A^{-T})^{-1} = (A^{-1})^T$

Note: Proofs of these properties will be left to students as exercises.

Example 1: Find the inverse of A , if

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

Solution 1: By definition of inverse of a matrix, using either $AA^{-1} = I_n$ or

$$\text{Let } A^{-1} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

Math 111 Logic And Linear Algebra

Arthur Cayley



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Table of Contents Math 111 Logic And Linear Algebra

1. Understanding the eBook Math 111 Logic And Linear Algebra
 - The Rise of Digital Reading Math 111 Logic And Linear Algebra
 - Advantages of eBooks Over Traditional Books
2. Identifying Math 111 Logic And Linear Algebra
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an eBook Math 111 Logic And Linear Algebra
 - User-Friendly Interface
4. Exploring eBook Recommendations from Math 111 Logic And Linear Algebra
 - Personalized Recommendations
 - Math 111 Logic And Linear Algebra User Reviews and Ratings
 - Math 111 Logic And Linear Algebra and Bestseller Lists

5. Accessing Math 111 Logic And Linear Algebra Free and Paid eBooks
 - Math 111 Logic And Linear Algebra Public Domain eBooks
 - Math 111 Logic And Linear Algebra eBook Subscription Services
 - Math 111 Logic And Linear Algebra Budget-Friendly Options
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 - Math 111 Logic And Linear Algebra Enhanced eBook Features
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 - Adjustable Fonts and Text Sizes of Math 111 Logic And Linear Algebra
 - Highlighting and Note-Taking Math 111 Logic And Linear Algebra
 - Interactive Elements Math 111 Logic And Linear Algebra
8. Staying Engaged with Math 111 Logic And Linear Algebra
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Math 111 Logic And Linear Algebra
9. Balancing eBooks and Physical Books Math 111 Logic And Linear Algebra
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Math 111 Logic And Linear Algebra
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Math 111 Logic And Linear Algebra
 - Setting Reading Goals Math 111 Logic And Linear Algebra
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Math 111 Logic And Linear Algebra
 - Fact-Checking eBook Content of Math 111 Logic And Linear Algebra
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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