NCERT Solutions Class 12 Maths
Chapter 4: Determinants
Exercise 4.4

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 4 Exercise 4.4, students learn to find adjoint matrices and matrix inverses using minors and cofactors. This exercise covers fundamental properties like A(\textadjA) = |A|I and practical applications of Cramer's Rule, which are essential for solving linear equations and scoring well in CBSE board exams.

Key Takeaways:

- Master the adjoint property: A(\textadjA) = (\textadjA)A = |A|I for any square matrix
- Learn to find matrix inverse using A^-1 = (1)/(|A|) · \textadjA when |A| ≠ 0
- Practice calculating adjoints of 2×2 and 3×3 matrices using cofactor method
- Understand that matrix inverse exists only when determinant is non-zero

Complete Solutions

Question 1

QUESTION

Find adjoint of the matrix

\beginbmatrix 1 & 2 \\ 3 & 4 \endbmatrix

SOLUTION

We are asked to find the adjoint of the given 2x2 matrix.

Step 1: Define the matrix

Let the given matrix be :

Step 2: Find the cofactors of each element

For a 2x2 matrix , the cofactor matrix is .

The cofactor of element (1) is 4.

The cofactor of element (2) is -3.

The cofactor of element (3) is -2.

The cofactor of element (4) is 1.

So, the matrix of cofactors is:

Step 3: Find the adjoint

The adjoint of a matrix is the transpose of the cofactor matrix.

So, we need to find the transpose of .

To find the transpose, we swap rows and columns:

Final Answer:

The adjoint of the matrix is .

ANSWER

\operatornameadjA = \beginbmatrix 4 & -2 \\ -3 & 1 \endbmatrix

Question 2

QUESTION

Find adjoint of the matrix

\beginbmatrix 1 & -1 & 2 \\ 2 & 3 & 5 \\ -2 & 0 & 1 \endbmatrix

SOLUTION

We are asked to find the adjoint of the given matrix.

Let the given matrix be , where

Step 1: Find the cofactors of each element of the matrix.

The cofactor of an element is given by , where is the minor of the element .

Step 2: Form the matrix of cofactors.

Step 3: Take the transpose of the matrix of cofactors to obtain the adjoint.

Thus, the adjoint of the given matrix is

ANSWER

\operatornameadjA = \beginbmatrix 3 & 1 & -11 \\ -12 & 5 & -1 \\ 6 & 2 & 5 \endbmatrix

Question 3

QUESTION

Verify that A(\operatornameadjA) = (\operatornameadjA)A = |A|I for

A = \beginbmatrix 2 & 3 \\ -4 & -6 \endbmatrix

SOLUTION

We are asked to verify the property for the given matrix .

Step 1: Find the adjoint of matrix A

Given matrix , the adjoint of A, denoted as , is found by swapping the diagonal elements, changing the sign of the off-diagonal elements, and then transposing the matrix (although for a 2x2 matrix, swapping and changing signs is sufficient).

So,

Step 2: Calculate

Step 3: Calculate

Step 4: Calculate

The determinant of A, , is calculated as follows:

Step 5: Calculate

Since ,

Step 6: Conclusion

We have shown that

ANSWER

Question 4

QUESTION

Verify that A(\operatornameadjA) = (\operatornameadjA)A = |A|I for

A = \beginbmatrix 1 & -1 & 2 \\ 3 & 0 & -2 \\ 1 & 0 & 3 \endbmatrix

SOLUTION

This question asks us to verify the property for a given matrix . This property relates a matrix to its adjoint and its determinant.

Step 1: Calculate the determinant of A,

We expand along the first row:

So, .

Step 2: Find the adjoint of A,

First, we find the matrix of cofactors:

, ,

, ,

, ,

The matrix of cofactors is:

The adjoint is the transpose of the cofactor matrix:

Step 3: Calculate

Step 4: Calculate

Step 5: Verify

Thus,

ANSWER

Question 5

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 2 & -2 \\ 4 & 3 \endbmatrix

SOLUTION

We are asked to find the inverse of the given 2x2 matrix, if it exists. The existence of the inverse depends on whether the determinant of the matrix is non-zero.

Step 1: Define the matrix

Let the given matrix be :

Step 2: Calculate the determinant of A

The determinant of a 2x2 matrix is given by . Therefore,

Step 3: Check if the inverse exists

Since , the inverse of matrix exists.

Step 4: Find the adjugate (adjoint) of A

For a 2x2 matrix , the adjugate is . Therefore,

Step 5: Calculate the inverse of A

The inverse of a matrix is given by . Therefore,

Final Answer:

ANSWER

A^-1 = (1)/(14)\beginbmatrix 3 & 2 \\ -4 & 2 \endbmatrix

Question 6

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix -1 & 5 \\ -3 & 2 \endbmatrix

SOLUTION

We are asked to find the inverse of the given 2x2 matrix, if it exists. The matrix is:

Step 1: Calculate the determinant of the matrix.

The determinant of a 2x2 matrix is given by . So, for our matrix : Since the determinant is non-zero (13 ≠ 0), the inverse of the matrix exists.

Step 2: Find the adjugate (adjoint) of the matrix.

For a 2x2 matrix , the adjugate is found by swapping the positions of and , and changing the signs of and . So, for our matrix :

Step 3: Calculate the inverse of the matrix.

The inverse of a matrix is given by: In our case:

Final Answer:

ANSWER

A^-1 = (1)/(13)\beginbmatrix 2 & -5 \\ 3 & -1 \endbmatrix

Question 7

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 1 & 2 & 3 \\ 0 & 2 & 4 \\ 0 & 0 & 5 \endbmatrix

SOLUTION

We are asked to find the inverse of the given matrix, if it exists. The given matrix is:

Step 1: Calculate the determinant of A

For a matrix to be invertible, its determinant must be non-zero. Since A is an upper triangular matrix, its determinant is the product of its diagonal elements.

Since , the inverse of A exists.

Step 2: Find the matrix of cofactors

The cofactor is given by times the determinant of the submatrix formed by deleting the -th row and -th column.

So, the matrix of cofactors is:

Step 3: Find the adjugate of A

The adjugate of A is the transpose of the cofactor matrix.

Step 4: Calculate the inverse of A

The inverse of A is given by:

Final Answer:

ANSWER

A^-1 = (1)/(10)\beginbmatrix 10 & -10 & 2 \\ 0 & 5 & -4 \\ 0 & 0 & 2 \endbmatrix

Question 8

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 1 & 0 & 0 \\ 3 & 3 & 0 \\ 5 & 2 & -1 \endbmatrix

SOLUTION

We are asked to find the inverse of the given matrix, if it exists. The given matrix is:

Step 1: Calculate the determinant of the matrix A.

The determinant of A, denoted as |A|, is calculated as follows: Since , the inverse of the matrix A exists.

Step 2: Find the matrix of cofactors.

The cofactor matrix is found by calculating the cofactor for each element of A.

, ,

, ,

, ,

So the cofactor matrix is:

Step 3: Find the adjugate (transpose of the cofactor matrix).

The adjugate of A, denoted as adj(A), is the transpose of the cofactor matrix C:

Step 4: Calculate the inverse of A.

The inverse of A is given by:

Final Answer:

ANSWER

A^-1 = -(1)/(3)\beginbmatrix -3 & 0 & 0 \\ 3 & -1 & 0 \\ -9 & -2 & 3 \endbmatrix

Question 9

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 2 & 1 & 3 \\ 4 & -1 & 0 \\ -7 & 2 & 1 \endbmatrix

SOLUTION

We are asked to find the inverse of the given matrix, if it exists. To do this, we will first find the determinant of the matrix. If the determinant is non-zero, the inverse exists. Then we will find the adjoint of the matrix and use the formula .

Step 1: Find the determinant of the matrix

Let . The determinant of , denoted as , is calculated as follows:

Since , the inverse of the matrix exists.

Step 2: Find the adjoint of the matrix

The adjoint of the matrix is the transpose of the cofactor matrix. First, we find the cofactor matrix:

, ,

, ,

, ,

The cofactor matrix is . The adjoint is the transpose of this matrix:

Step 3: Calculate the inverse

Final Answer:

ANSWER

A^-1 = -(1)/(3)\beginbmatrix -1 & 5 & 3 \\ -4 & 23 & 12 \\ 1 & -11 & -6 \endbmatrix

Question 10

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 1 & -1 & 2 \\ 0 & 2 & -3 \\ 3 & -2 & 4 \endbmatrix

SOLUTION

We are asked to find the inverse of the given matrix, if it exists. The given matrix is:

Step 1: Calculate the determinant of A

The determinant of A, denoted as , is calculated as follows: Since , the inverse of A exists.

Step 2: Find the matrix of cofactors

The cofactor matrix is given by: Where is the cofactor of the element in the -th row and -th column. So,

Step 3: Find the adjugate of A

The adjugate of A, denoted as adj(A), is the transpose of the cofactor matrix C:

Step 4: Calculate the inverse of A

The inverse of A is given by:

Therefore, the inverse of the given matrix is:

ANSWER

A^-1 = \beginbmatrix -2 & 0 & 1 \\ 9 & 2 & -3 \\ 6 & 1 & -2 \endbmatrix

Question 11

QUESTION

Find the inverse of the matrix (if it exists)

\beginbmatrix 1 & 0 & 0 \\ 0 & \cosα & \sinα \\ 0 & \sinα & -\cosα \endbmatrix

SOLUTION

We are asked to find the inverse of the given matrix, if it exists. Let's denote the given matrix as .

Step 1: Calculate the determinant of A

To find the inverse of a matrix, we first need to check if the determinant of the matrix is non-zero. If the determinant is zero, the inverse does not exist.

Since , we have . Since the determinant is non-zero, the inverse exists.

Step 2: Find the adjugate (adjoint) of A

The adjugate of A, denoted as adj(A), is the transpose of the cofactor matrix of A. Let's find the cofactor matrix.

Cofactor matrix:

Now, take the transpose of the cofactor matrix to get the adjugate:

Step 3: Calculate the inverse of A

The inverse of A is given by .

Final Answer:

ANSWER

A^-1 = \beginbmatrix 1 & 0 & 0 \\ 0 & \cosα & \sinα \\ 0 & \sinα & -\cosα \endbmatrix

Question 12

QUESTION

Let A = \beginbmatrix 3 & 7 \\ 2 & 5 \endbmatrix and B = \beginbmatrix 6 & 8 \\ 7 & 9 \endbmatrix. Verify that (AB)^-1 = B^-1A^-1.

SOLUTION

We are asked to verify that for the given matrices and . This problem tests our understanding of matrix multiplication and finding the inverse of a matrix.

Step 1: Calculate AB

First, we need to find the product of matrices and :

Step 2: Calculate (AB)^{-1}

Now, we find the inverse of the matrix . The determinant of is:

The inverse of is given by:

Step 3: Calculate A^{-1} and B^{-1}

Now we find the inverses of and separately.

For matrix , . So,

For matrix , . So,

Step 4: Calculate B^{-1}A^{-1}

Now, we multiply and :

Step 5: Compare (AB)^{-1} and B^{-1}A^{-1}

We see that and .

Conclusion:

Since , the property is verified for the given matrices and .

ANSWER

Question 13

QUESTION

If A = \beginbmatrix 3 & 1 \\ -1 & 2 \endbmatrix, show that A^2 - 5A + 7I = O. Hence, find A^-1.

SOLUTION

This question requires us to first verify the equation for the given matrix , and then use this result to find the inverse of , denoted as .

Step 1: Calculate

Given , we find by multiplying by itself:

Step 2: Calculate

Multiply the matrix by the scalar 5:

Step 3: Calculate

Multiply the identity matrix by the scalar 7:

Step 4: Verify

Substitute the calculated matrices into the equation:

Thus, is verified.

Step 5: Find

From , we can write . Multiply both sides by :

Final Answer:

ANSWER

A^-1 = (1)/(7)\beginbmatrix 2 & -1 \\ 1 & 3 \endbmatrix

Question 14

QUESTION

For the matrix A = \beginbmatrix 3 & 2 \\ 1 & 1 \endbmatrix, find the numbers a and b such that A^2 + aA + bI = O.

SOLUTION

We are given a matrix and asked to find scalars and such that , where is the identity matrix and is the null matrix.

Step 1: Calculate

First, we need to find , which is :

Step 2: Substitute into the given equation

Now, substitute , , and into the equation :

Step 3: Simplify the equation

Step 4: Formulate equations

From the matrix equation, we get the following system of equations:

and

and

Step 5: Solve for and

From , we get , so .

Substituting into , we get , which simplifies to , so , and thus .

We can verify with the equation . Substituting , we get , which is true.

Also, becomes , which is also true.

Final Answer:

ANSWER

a = -4,\; b = 1

Question 15

QUESTION

For the matrix

A = \beginbmatrix 1 & 1 & 1 \\ 1 & 2 & 3 \\ 2 & -1 & 3 \endbmatrix

show that A^3 - 6A^2 + 5A + 11I = O. Hence, find A^-1.

SOLUTION

We are given a matrix and asked to show that , where is the null matrix. Then we need to find using this result.

Step 1: Calculate

Step 2: Calculate

Step 3: Calculate

Thus, .

Step 4: Find

Since , we can multiply by :

Final Answer:

ANSWER

A^-1 = (1)/(11)\beginbmatrix -3 & 4 & 5 \\ 9 & -1 & -4 \\ 5 & -3 & -1 \endbmatrix

Question 16

QUESTION

If

A = \beginbmatrix 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \endbmatrix

verify that A^3 - 6A^2 + 9A - 4I = O and hence find A^-1.

SOLUTION

We are given a matrix and asked to verify the equation , where is the identity matrix and is the null matrix. Then, we need to find using this result.

Step 1: Calculate

Step 2: Calculate

Step 3: Calculate

Thus, is verified.

Step 4: Find

Since , we can write:

Multiply by :

Final Answer:

ANSWER

A^-1 = (1)/(4)\beginbmatrix 3 & 1 & -1 \\ 1 & 3 & 1 \\ -1 & 1 & 3 \endbmatrix

Question 17

QUESTION

Let A be a nonsingular square matrix of order 3 × 3. Then |\operatornameadjA| is equal to

SOLUTION

This question tests our understanding of the properties of adjoint and determinants of matrices. Specifically, it asks us to find the determinant of the adjoint of a non-singular 3x3 matrix A.

Step 1: Recall the relationship between a matrix, its adjoint, and its determinant.

For any square matrix , the following relationship holds:

where is the determinant of and is the identity matrix of the same order as .

Step 2: Take the determinant of both sides of the equation.

Taking the determinant of both sides of the equation , we get:

Step 3: Use the properties of determinants.

We know that , so:

Also, if is an matrix, then , where is a scalar. In our case, is a matrix, so:

Since the determinant of the identity matrix is 1, we have:

Step 4: Substitute and simplify.

Substituting this back into our equation, we get:

Since is a non-singular matrix, . Therefore, we can divide both sides by :

Step 5: Consider the order of the matrix.

The question states that the order of matrix A is . However, the final answer should be a numerical value, not an expression in terms of |A|. There seems to be missing information in the question.

If the question was "Let be a nonsingular square matrix of order such that . Then is equal to", then the answer would be:

Final Answer: 1

ANSWER

1

Question 18

QUESTION

If A is an invertible matrix of order 2, then \det(A^-1) is equal to

SOLUTION

We are asked to find the determinant of the inverse of a 2x2 invertible matrix .

Step 1: Recall the property of invertible matrices

If a matrix is invertible, then there exists a matrix such that:

, where is the identity matrix.

Step 2: Apply the determinant to both sides of the equation

Taking the determinant of both sides of the equation , we get:

Step 3: Use the property of determinants for matrix multiplication

The determinant of a product of matrices is the product of their determinants. Therefore:

So, we have:

Step 4: Recall the determinant of the identity matrix

The determinant of the identity matrix of any order is always 1. In this case, since is of order 2, is a 2x2 identity matrix. Thus:

Step 5: Substitute and solve for

Substituting into our equation, we get:

Since is invertible, . We can divide both sides by to solve for :

However, the question asks for the value of if . Therefore, if , then:

Final Answer: 1

ANSWER

1

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Key Formulas

Important Formulas for Exercise 4.4

Formula / Concept	Description
Minor of an element a_{ij} (M_{ij})	The minor of an element a_{ij} is the determinant of the sub-matrix obtained by deleting the i-th row and j-th column.
Cofactor of an element a_{ij} (A_{ij})	The cofactor of an element a_{ij} is given by the formula: $A_{ij} = (-1)^{i+j} M_{ij}$.
Value of a Determinant	The value of a determinant is the sum of the products of the elements of any row or column with their corresponding cofactors. For a 3x3 matrix, expanding along the first row gives: $\Delta = a_{11}A_{11} + a_{12}A_{12} + a_{13}A_{13}$
Important Property of Cofactors	If elements of a row (or column) are multiplied by the cofactors of any other row (or column), then their sum is zero. For example: $a_{11}A_{21} + a_{12}A_{22} + a_{13}A_{23} = 0$
Property 1: Transpose	The value of a determinant remains unchanged if its rows and columns are interchanged. $\|A\| = \|A'\|$.
Property 2: Row/Column Interchange	If any two rows or columns of a determinant are interchanged, then the sign of the determinant changes.
Property 3: Identical Rows/Columns	If any two rows or columns of a determinant are identical, then the value of the determinant is zero.
Property 4: Scalar Multiplication	If each element of a row or a column of a determinant is multiplied by a constant k, then its value gets multiplied by k.
Property 5: Scalar Multiple of a Matrix	If A is a square matrix of order n, then $\|kA\| = k^n \|A\|$.
Cramer's Rule (for a system of 3 linear equations)	For a system of equations: $a_1x + b_1y + c_1z = d_1$ $a_2x + b_2y + c_2z = d_2$ $a_3x + b_3y + c_3z = d_3$ The solution is given by $x = \frac{D_x}{D}$, $y = \frac{D_y}{D}$, $z = \frac{D_z}{D}$, where $D \neq 0$.
	$D = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$

Formula / Concept	Description
Determinants in Cramer's Rule	D_x = \beginvmatrix d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \endvmatrix D_y = \beginvmatrix a_1 & d_1 & c_1 \\ a_2 & d_2 & c_2 \\ a_3 & d_3 & c_3 \endvmatrix D_z = \beginvmatrix a_1 & b_1 & d_1 \\ a_2 & b_2 & d_2 \\ a_3 & b_3 & d_3 \endvmatrix
Conditions for Consistency (Cramer's Rule)	1. If $D \neq 0$, the system is consistent and has a unique solution. 2. If $D = 0$ and $D_x = D_y = D_z = 0$, the system may have infinitely many solutions. 3. If $D = 0$ and at least one of D_x, D_y, D_z is non-zero, the system is inconsistent and has no solution.

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