NCERT Solutions Class 12 Maths
Chapter 4: Determinants
Exercise 4.5

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 4 Exercise 4.5, students learn to examine the consistency of systems of linear equations using determinants, adjoint matrices, and inverse matrices. This exercise covers advanced applications of Cramer's Rule and properties of determinants which are essential for solving complex algebraic problems in CBSE Class 12 board exams and competitive entrance tests.

Key Takeaways:

- Understanding system consistency: A system AX = B is consistent if |A| ≠ 0, giving unique solution X = A^-1B
- Cramer's Rule application: For consistent systems, solutions are found using x_i = (|A_i|)/(|A|) where A_i is the matrix with i-th column replaced by constants
- Adjoint matrix properties: A^-1 = (adj(A))/(|A|) and A · adj(A) = |A| · I for finding inverse matrices
- Critical exam skill: Analyzing inconsistent systems when |A| = 0 and determining conditions for infinitely many solutions

Complete Solutions

Question 1

QUESTION

Examine the consistency of the system of equations:

x + 2y = 2

2x + 3y = 3

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form.

The given system of equations is:

We can represent this system in matrix form as , where:

, , and

Step 2: Calculate the determinant of matrix A.

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

Step 3: Check if the determinant is non-zero.

Since , the matrix is non-singular, which means the system of equations has a unique solution.

Step 4: Determine the consistency of the system.

A system of linear equations is considered consistent if it has at least one solution (either a unique solution or infinitely many solutions). Since , the system has a unique solution. Therefore, the system is consistent.

Final Answer:

Consistent

ANSWER

Consistent

Question 2

QUESTION

Examine the consistency of the system of equations:

$2x - y = 5$

$x + y = 4$

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form

The given system of equations is:

We can write this in matrix form as , where:

, , and

Step 2: Calculate the determinant of matrix A

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

Step 3: Check if the determinant is non-zero

Since , the matrix is invertible, and the system of equations has a unique solution.

Step 4: Determine the consistency of the system

Because the determinant of is non-zero, the system of equations is consistent. A consistent system has at least one solution (in this case, a unique solution).

Final Answer: Consistent

The system of equations is consistent because the determinant of the coefficient matrix is non-zero, indicating a unique solution exists.

ANSWER

Consistent

Question 3

QUESTION

Examine the consistency of the system of equations:

x + 3y = 5

2x + 6y = 8

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form

The given system of equations is:

We can represent this system in matrix form as , where:

, , and

Step 2: Calculate the determinant of matrix A

The determinant of matrix A, denoted as , is calculated as follows:

Since , the matrix A is singular.

Step 3: Calculate the adjoint of matrix A

The adjoint of matrix A, denoted as , is found by swapping the diagonal elements and changing the signs of the off-diagonal elements:

Step 4: Calculate

Step 5: Check for consistency

Since and , the system of equations is inconsistent.

Final Answer: Inconsistent

ANSWER

Inconsistent

Question 4

QUESTION

Examine the consistency of the system of equations:

x + y + z = 1

2x + 3y + 2z = 2

ax + ay + 2az = 4

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form

The given system of equations can be written in the matrix form , where:

, , and

Step 2: Calculate the determinant of matrix A

Expanding the determinant along the first row:

Step 3: Analyze the determinant for consistency

For the system to be consistent, must be non-zero, i.e., . If , we need to check the adjoint and determinant to confirm consistency.

If , the system is consistent and has a unique solution.

If , the equations become:

, which is impossible. Thus, the system is inconsistent when .

However, the question does not specify any value for 'a'. Therefore, we assume .

Step 4: Conclusion

Assuming , the system of equations is consistent.

ANSWER

Consistent

Question 5

QUESTION

Examine the consistency of the system of equations:

3x - y - 2z = 2

2y - z = -1

3x - 5y = 3

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form

The given system of equations is:

We can write this in matrix form as , where:

, , and

Step 2: Calculate the determinant of matrix A

Expanding along the first row:

Since , we need to check the adjoint of A times B.

Step 3: Find the adjoint of A

The matrix of cofactors is:

The adjoint of A is the transpose of the cofactor matrix:

Step 4: Calculate

Since , the system is inconsistent.

Final Answer:

Inconsistent

ANSWER

Inconsistent

Question 6

QUESTION

Examine the consistency of the system of equations:

5x - y + 4z = 5

2x + 3y + 5z = 2

5x - 2y + 6z = -1

SOLUTION

We are asked to examine the consistency of the given system of linear equations.

Step 1: Write the system of equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of matrix A

Expanding along the first row:

Since , the system is consistent and has a unique solution.

Step 3: Conclusion

Since the determinant of the coefficient matrix is non-zero, the system of equations is consistent.

Final Answer: Consistent

ANSWER

Consistent

Question 7

QUESTION

Solve the system of linear equations, using matrix method:

5x + 2y = 4

7x + 3y = 5

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Express the system of equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of matrix A

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

Since , the matrix is invertible, and a unique solution exists.

Step 3: Find the adjoint of matrix A

The adjoint of , denoted as , is the transpose of the cofactor matrix of . For a 2x2 matrix, it's found by swapping the diagonal elements and changing the sign of the off-diagonal elements:

Step 4: Calculate the inverse of matrix A

The inverse of , denoted as , is given by:

Since , we have:

Step 5: Find the solution matrix X

The solution is given by :

Step 6: State the solution

Therefore, and .

ANSWER

x = 2,\; y = -3

Question 8

QUESTION

Solve the system of linear equations, using matrix method:

2x - y = -2

3x + 4y = 3

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Express the system of equations in matrix form

The given system of equations is:

We can write this in matrix form as , where:

, , and

Step 2: Find the determinant of matrix A

The determinant of A, denoted as , is calculated as follows:

Since , the matrix A is invertible, and a unique solution exists.

Step 3: Find the adjoint of matrix A

The adjoint of A, denoted as , is found by swapping the diagonal elements and changing the signs of the off-diagonal elements:

Step 4: Find the inverse of matrix A

The inverse of A, denoted as , is calculated as:

Step 5: Calculate the solution

Step 6: State the solution

Therefore, and .

ANSWER

x = -(5)/(11),\; y = (12)/(11)

Question 9

QUESTION

Solve the system of linear equations, using matrix method:

4x - 3y = 3

3x - 5y = 7

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Express the system of equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of matrix A

The determinant of is given by:

Since , the matrix is invertible, and a unique solution exists.

Step 3: Find the adjoint of matrix A

The adjoint of matrix is obtained by swapping the diagonal elements and changing the signs of the off-diagonal elements:

Step 4: Calculate the inverse of matrix A

The inverse of matrix is given by:

Step 5: Find the solution X

The solution is given by :

Therefore, and .

Final Answer:

ANSWER

x = -(6)/(11),\; y = -(19)/(11)

Question 10

QUESTION

Solve the system of linear equations, using matrix method:

$5x + 2y = 3$

$3x + 2y = 5$

SOLUTION

This question asks us to solve a system of linear equations using the matrix method. This involves representing the equations in matrix form, finding the inverse of the coefficient matrix, and then solving for the variables.

Step 1: Express the system of equations in matrix form.

The given system of equations is:

We can write this in matrix form as , where:

, , and

Step 2: Find the determinant of matrix A.

The determinant of A, denoted as , is calculated as:

Since , the matrix A is invertible, and a unique solution exists.

Step 3: Find the adjoint of matrix A.

The adjoint of A, denoted as , is found by swapping the diagonal elements and changing the signs of the off-diagonal elements:

Step 4: Find the inverse of matrix A.

The inverse of A, denoted as , is calculated as:

Step 5: Solve for X using the formula .

Step 6: State the solution.

Therefore, and .

Final Answer:

ANSWER

x = -1,\; y = 4

Question 11

QUESTION

Solve the system of linear equations, using matrix method:

2x + y + z = 1

x - 2y - z = (3)/(2)

3y - 5z = 9

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Write the equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Find the determinant of matrix A

Since , the system has a unique solution.

Step 3: Find the adjoint of matrix A

First, find the matrix of cofactors:

Then, find the adjoint by taking the transpose of the cofactor matrix:

Step 4: Find the inverse of matrix A

Step 5: Calculate the solution

Therefore, , , and .

Final Answer:

ANSWER

x = 1,\; y = (1)/(2),\; z = -(3)/(2)

Question 12

QUESTION

Solve the system of linear equations, using matrix method:

$x - y + z = 4$

$2x + y - 3z = 0$

$x + y + z = 2$

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Express the system of equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of matrix A

Since , the system has a unique solution.

Step 3: Find the adjoint of matrix A

The cofactors of A are:

The adjoint of A is the transpose of the cofactor matrix:

Step 4: Calculate the inverse of matrix A

Step 5: Find the solution X

Therefore, .

Final Answer:

ANSWER

x = 2,\; y = -1,\; z = 1

Question 13

QUESTION

Solve the system of linear equations, using matrix method:

2x + 3y + 3z = 5

x - 2y + z = -4

3x - y - 2z = 3

SOLUTION

We are asked to solve the given system of linear equations using the matrix method.

Step 1: Write the equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of A

Since , the system has a unique solution.

Step 3: Find the adjoint of A

First, find the matrix of cofactors:

Then, take the transpose to find the adjoint:

Step 4: Calculate the inverse of A

Step 5: Find the solution X

Therefore, , , and .

Final Answer:

ANSWER

x = 1,\; y = 2,\; z = -1

Question 14

QUESTION

Solve the system of linear equations, using matrix method:

x - y + 2z = 7

3x + 4y - 5z = -5

2x - y + 3z = 12

SOLUTION

We are asked to solve a system of three linear equations using the matrix method. This involves expressing the equations in matrix form, finding the inverse of the coefficient matrix, and then solving for the variables.

Step 1: Express the system of equations in matrix form

The given system of equations can be written in the form , where:

, , and

Step 2: Calculate the determinant of matrix A

Since , the matrix A is invertible, and the system has a unique solution.

Step 3: Find the adjoint of matrix A

First, find the matrix of cofactors:

Then, find the adjoint by taking the transpose of the cofactor matrix:

Step 4: Calculate the inverse of matrix A

Step 5: Solve for X

Step 6: Find the values of x, y, and z

Therefore, , , and .

Final Answer:

ANSWER

x = 2,\; y = 1,\; z = 3

Question 15

QUESTION

If

A = \beginbmatrix 2 & -3 & 5 \\ 3 & 2 & -4 \\ 1 & 1 & -2 \endbmatrix

find A^-1. Using A^-1 solve the system of equations

2x - 3y + 5z = 11

3x + 2y - 4z = -5

x + y - 2z = -3

SOLUTION

We are asked to find the inverse of matrix and then use it to solve a system of linear equations.

Step 1: Find the determinant of A

Expanding along the first row:

Step 2: Find the matrix of cofactors

Step 3: Find the adjoint of A

Step 4: Find the inverse of A

Step 5: Solve the system of equations

The system of equations can be written as , where

Then

Therefore, .

Final Answer: ,

ANSWER

A^-1 = \beginbmatrix 0 & 1 & -2 \\ -2 & 9 & -23 \\ -1 & 5 & -13 \endbmatrix, x = 1,\; y = 2,\; z = 3

Question 16

QUESTION

The cost of 4 kg onion, 3 kg wheat and 2 kg rice is \text₹60. The cost of 2 kg onion, 4 kg wheat and 6 kg rice is \text₹90. The cost of 6 kg onion 2 kg wheat and 3 kg rice is \text₹70. Find cost of each item per kg by matrix method.

SOLUTION

This question requires us to find the cost per kg of onion, wheat, and rice using the matrix method. We will first form a system of linear equations from the given information and then solve it using matrices.

Step 1: Formulate the linear equations

Let the cost per kg of onion, wheat, and rice be , , and respectively. From the given information, we can write the following equations:

Step 2: Express the equations in matrix form

We can represent the system of equations in matrix form as , where:

, , and

Step 3: Find the determinant of matrix A

Step 4: Find the adjoint of matrix A

First, find the matrix of cofactors:

Then, find the adjoint by taking the transpose of the cofactor matrix:

Step 5: Calculate the inverse of matrix A

Step 6: Solve for X

Final Answer:

Cost of onions per kg =

Cost of wheat per kg =

Cost of rice per kg =

ANSWER

Cost of onions per kg = \text₹5

Cost of wheat per kg = \text₹8

Cost of rice per kg = \text₹8

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Key Formulas

Important Formulas for Exercise 4.5

Formula / Concept	Description
Adjoint of a Matrix	The adjoint of a square matrix A is the transpose of its cofactor matrix. It is denoted by adj(A).
$\text{adj}(A) = [C_{ij}]^T$	Where C_{ij} is the cofactor of the element a_{ij}. The adjoint is found by taking the transpose of the cofactor matrix.
Singular Matrix	A square matrix A is called singular if its determinant is zero, i.e., $\|A\| = 0$.
Non-Singular Matrix	A square matrix A is called non-singular if its determinant is not zero, i.e., $\|A\| \neq 0$. A matrix has an inverse if and only if it is non-singular.
Inverse of a Matrix	For a non-singular square matrix A, its inverse is denoted by A^{-1} and is given by the formula: $A^{-1} = \frac{1}{\|A\|} \text{adj}(A)$
Theorem 1: $A(\text{adj } A) = (\text{adj } A)A = \|A\|I$	For any square matrix A of order n, the product of the matrix and its adjoint is the determinant of A multiplied by the identity matrix I of the same order.
$\|A^{-1}\| = \frac{1}{\|A\|}$	The determinant of the inverse of a matrix is the reciprocal of the determinant of the matrix.
$(AB)^{-1} = B^{-1}A^{-1}$	The inverse of the product of two invertible matrices is the product of their inverses in the reverse order.
$(A^T)^{-1} = (A^{-1})^T$	The inverse of the transpose of a matrix is the transpose of its inverse.
System of Linear Equations	A system of linear equations can be written in matrix form as AX = B. If $\|A\| \neq 0$, the system has a unique solution given by $X = A^{-1}B$.
Consistency of a System	• If $\|A\| \neq 0$, the system is consistent and has a unique solution. • If $\|A\| = 0$ and $(\text{adj } A)B \neq O$, the system is inconsistent (no solution).

Formula / Concept	Description
	• If |A| = 0 and (\textadj A)B = O, the system may be consistent (infinitely many solutions) or inconsistent.

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