# NCERT Solutions Class 12 Maths
# Chapter 4: Determinants
# Miscellaneous Exercise on Chapter 4

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**Quick Summary:** In NCERT Solutions Class 12 Maths Chapter 4 Exercise misc, students learn advanced determinant evaluation techniques and their applications through challenging problems involving trigonometric functions and matrix properties. This exercise covers properties of determinants, Cramer's rule, and relationships between determinants, adjoints, and inverse matrices which are essential for CBSE board exams and competitive entrance tests.

**Key Takeaways:**

- Master determinant properties like |kA| = k^n|A| for n×n matrices and row/column operations
- Apply Cramer's rule x = (|A_x|)/(|A|) to solve systems of linear equations efficiently
- Understand the relationship |adj(A)| = |A|^n-1 and A · adj(A) = |A| · I for matrix calculations
- Evaluate complex determinants involving trigonometric functions using substitution and algebraic manipulation techniques

## Complete Solutions

### Question 1

QUESTION

Prove that the determinant

\left| \beginmatrix x & \sinθ & \cosθ \\ -\sinθ & -x & 1 \\ \cosθ & 1 & x \endmatrix \right|

is independent of θ.

SOLUTION

We need to prove that the given determinant is independent of , which means that when we expand the determinant, the terms should cancel out, leaving a constant value or an expression that does not involve .

**Step 1: Expand the determinant**

Let's expand the determinant along the first row:

**Step 2: Evaluate the 2x2 determinants**

Now, we evaluate each of the 2x2 determinants:

**Step 3: Substitute back into the expression**

Substitute these values back into the expanded determinant:

**Step 4: Simplify the expression**

**Step 5: Use the trigonometric identity**

Since , we have:

**Final Answer:**

The determinant simplifies to , which is independent of .

ANSWER

## Question 2

### QUESTION

Evaluate

\left| \beginmatrix \cosα\cosβ & \cosα\sinβ & -\sinα \\ -\sinβ & \cosβ & 0 \\ \sinα\cosβ & \sinα\sinβ & \cosα \endmatrix \right|

### SOLUTION

We are asked to evaluate the determinant of a 3x3 matrix involving trigonometric functions.

**Step 1: Write down the determinant**

The given determinant is:

**Step 2: Expand the determinant along the first row**

Expanding along the first row, we get:

**Step 3: Evaluate the 2x2 determinants**

**Step 4: Simplify the expression**

Since , we have:

**Final Answer:**

The value of the determinant is 1.

### ANSWER

1

## Question 3

QUESTION

If

A^-1 = \beginbmatrix 3 & -1 & 1 \\ -15 & 6 & -5 \\ 5 & -2 & 2 \endbmatrix \quad \textand \quad B = \beginbmatrix 1 & 2 & -2 \\ -1 & 3 & 0 \\ 0 & -2 & 1 \endbmatrix,

find (AB)^-1.

SOLUTION

We are given the inverse of matrix and matrix , and we need to find the inverse of the product , which is .

**Step 1: Recall the property of inverse of product of matrices**

The inverse of the product of two matrices is the product of their inverses in the reverse order. That is:

**Step 2: Find the inverse of matrix B**

We are given . To find , we first find the determinant of .

Since , the inverse exists.

Now, we find the adjugate of . The cofactors are:

So, the adjugate of is:

Then,

**Step 3: Calculate**

We have and .

**Final Answer:**

ANSWER

(AB)^-1 = \beginbmatrix 9 & -3 & 5 \\ -2 & 1 & 0 \\ 1 & 0 & 2 \endbmatrix

## Question 4

QUESTION

Let

A = \beginbmatrix 1 & 2 & 1 \\ 2 & 3 & 1 \\ 1 & 1 & 5 \endbmatrix.

Verify that

(i) [\operatornameadjA]^-1 = \operatornameadj(A^-1)

(ii) (A^-1)^-1 = A

SOLUTION

This question requires us to verify two properties related to the adjoint and inverse of a matrix . Specifically, we need to show that the inverse of the adjoint of is equal to the adjoint of the inverse of , and that the inverse of the inverse of is equal to itself.

**(i) Verify**

**Step 1: Calculate the adjoint of , denoted as .**

First, we find the matrix of cofactors of :

Then, , the transpose of the cofactor matrix:

**Step 2: Calculate .**

**Step 3: Calculate .**

**Step 4: Calculate .**

**Step 5: Calculate .**

Since , the first property is verified.

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**(ii) Verify**

**Step 1: Recall the formula for the inverse of a matrix.**

**Step 2: Find the inverse of .**

**Step 3: Simplify using properties of determinants and adjoints.**

We know that and . Also,

Therefore,

Thus, is verified.

ANSWER

## Question 5

### QUESTION

Evaluate

\left| \beginmatrix x & y & x+y \\ y & x+y & x \\ x+y & x & y \endmatrix \right|

### SOLUTION

We are asked to evaluate the determinant of a 3x3 matrix. This requires applying properties of determinants to simplify the expression and then expanding to find the final value.

**Step 1: Apply column operation**

Adding the second and third columns to the first column, we get:

**Step 2: Factor out from the first column**

We can factor out from the first column:

**Step 3: Apply row operations and**

Subtracting the first row from the second and third rows, we get:

**Step 4: Expand the determinant along the first column**

Expanding along the first column, we have:

**Step 5: Simplify the expression**

Recall the identity . Therefore,

**Final Answer:**

### ANSWER

$-2(x^3 + y^3)$

## Question 6

QUESTION

Evaluate

\left| \beginmatrix 1 & x & y \\ 1 & x+y & y \\ 1 & x & x+y \endmatrix \right|

SOLUTION

We are asked to evaluate the determinant of the given 3x3 matrix.

**Step 1: Apply row operations to simplify the determinant**

We can use row operations to simplify the determinant without changing its value. Let's apply the following operations:

and

This gives us:

**Step 2: Evaluate the determinant of the simplified matrix**

Now we have an upper triangular matrix, and the determinant is simply the product of the diagonal elements.

So, the determinant is:

**Step 3: State the final answer**

Therefore, the value of the determinant is .

**Final Answer:**

ANSWER

xy

## Question 7

### QUESTION

Solve the system of equations:

(2)/(x) + (3)/(y) + (10)/(z) = 4

(4)/(x) - (6)/(y) + (5)/(z) = 1

(6)/(x) + (9)/(y) - (20)/(z) = 2

### SOLUTION

We are given a system of three equations with three variables , , and in the denominators. We need to solve for , , and .

**Step 1: Substitution**

Let , , and . The system of equations becomes:

**Step 2: Elimination**

Multiply the first equation by 2:

Add this to the second equation:

...(4)

Multiply the first equation by 3:

Subtract the third equation from this:

**Step 3: Solve for a**

Substitute into equation (4):

**Step 4: Solve for b**

Substitute and into the first equation:

**Step 5: Find x, y, and z**

Since , , and :

**Final Answer:**

### ANSWER

x = 2,\; y = 3,\; z = 5

## Question 8

QUESTION

Choose the correct answer.

If x, y, z are nonzero real numbers, then the inverse of matrix

A = \beginbmatrix x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \endbmatrix

is

SOLUTION

We are asked to find the inverse of a diagonal matrix , where the diagonal elements are non-zero real numbers , , and .

**Step 1: Define the matrix**

The given matrix is: where are non-zero real numbers.

**Step 2: Recall the condition for the inverse of a matrix**

If is a matrix, its inverse exists if and only if , where is the identity matrix.

**Step 3: Assume a general form for the inverse matrix**

Let's assume the inverse matrix is also a diagonal matrix of the form: where are real numbers.

**Step 4: Multiply and and set it equal to the identity matrix**

We need to find such that . We want this to be equal to the identity matrix: This gives us the equations: , , and .

**Step 5: Solve for**

From the equations above, we get: , , and .

**Step 6: Write the inverse matrix**

Therefore, the inverse matrix is:

**Final Answer:** The inverse of the given matrix is

ANSWER

0

## Question 9

QUESTION

Let

A = \beginbmatrix 1 & \sinθ & 1 \\ -\sinθ & 1 & \sinθ \\ -1 & -\sinθ & 1 \endbmatrix, \quad 0 \le θ \le 2π.

Then

SOLUTION

This question asks us to find the value of the determinant of the given matrix , where the elements of the matrix involve trigonometric functions.

**Step 1: Write down the matrix**

The given matrix is:

**Step 2: Calculate the determinant of A**

We can calculate the determinant of by expanding along the first row:

**Step 3: Evaluate the 2x2 determinants**

**Step 4: Find the range of the determinant**

Since , we know that . Therefore, .

So,

The question asks for the number 3. This seems to be asking if 3 is in the range of possible values for the determinant. Since , 3 is a possible value.

**Final Answer:** 3

ANSWER
3



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# Key Formulas

## Important Formulas for Exercise misc

| Formula / Concept | Description |
|---|---|
| Reflection Property: $|A'| = |A|$ | The determinant of a matrix remains unchanged if its rows and columns are interchanged. Here, A' is the transpose of matrix A. |
| Switching Property | If any two rows or columns of a determinant are interchanged, then the sign of the determinant changes. |
| Zero Property | If any two rows or columns of a determinant are identical or proportional, then the value of the determinant is zero. |
| Scalar Multiple Property | If the elements of a row or column are multiplied by a constant k, then the value of the new determinant is k times the value of the original determinant. |
| Property of Invariance: $R_i \to R_i + kR_j$ or $C_i \to C_i + kC_j$ | If we add a multiple of one row (or column) to another row (or column), the value of the determinant remains the same. |
| Sum Property | If some or all elements of a row or column are expressed as the sum of two or more terms, then the determinant can be expressed as the sum of two or more determinants. |
| Product Property: $|AB| = |A| |B|$ | The determinant of the product of two square matrices of the same order is equal to the product of their individual determinants. |
| Power Property: $|A^n| = |A|^n$ | The determinant of a matrix raised to a power is the determinant raised to that power. |
| Scalar Multiplication: $|kA| = k^n |A|$ | If A is a square matrix of order n, then the determinant of kA is $k^n$ times the determinant of A. |
| Adjoint Property: $|\text{adj}(A)| = |A|^{n-1}$ | For a square matrix A of order n, the determinant of its adjoint is equal to the determinant of A raised to the power of n-1. |
| Cramer's Rule (System of 3 Linear Equations) | A method for solving a system of linear equations using determinants, provided the determinant of the coefficient matrix is non-zero. |
| $\begin{aligned} a_1x + b_1y + c_1z &= d_1 \\ a_2x + b_2y + c_2z &= d_2 \\ a_3x + b_3y + c_3z &= d_3 \end{aligned}$ | A system of three linear equations in three variables. |
| | The determinant of the coefficient matrix. |

| Formula / Concept | Description |
|---|---|
| D = \beginvmatrix a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \endvmatrix | |
| x = (D_x)/(D), \quad y = (D_y)/(D), \quad z = (D_z)/(D) | Solution for the variables x, y, and z, where $D \neq 0$. |
| Conditions for Consistency | • If $D \neq 0$, the system has a unique solution.<br>• If $D = 0$ and $D_x = D_y = D_z = 0$, the system has infinitely many solutions.<br>• If $D = 0$ and at least one of $D_x$, $D_y$, $D_z$ is non-zero, the system has no solution (inconsistent). |

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