NCERT Solutions Class 12 Maths
Chapter 5: Continuity and Differentiability
Miscellaneous Exercise on Chapter 5

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 5 Exercise misc, students learn advanced differentiation techniques including composite functions, trigonometric functions, and inverse trigonometric functions. This exercise covers chain rule applications, product rule, quotient rule, and implicit differentiation which are essential for CBSE board exams and competitive entrance tests.

Key Takeaways:

- Master chain rule for composite functions like (d)/(dx)[f(g(x))] = f'(g(x)) · g'(x)
- Apply differentiation formulas for inverse trigonometric functions such as (d)/(dx)[\sin^-1x] = (1)/(√1-x^2)
- Understand Mean Value Theorem and Rolle's Theorem applications for proving continuity and differentiability
- Practice complex differentiation problems that frequently appear in CBSE Class 12 board exams

Complete Solutions

Question 1

QUESTION

Differentiate w.r.t. x the function (3x^2-9x+5)^9.

SOLUTION

We are asked to differentiate the function with respect to .

This problem involves the chain rule, which states that if we have a composite function , its derivative is .

Step 1: Identify the outer and inner functions

Here, the outer function is , and the inner function is .

Step 2: Differentiate the outer function

The derivative of with respect to is:

Step 3: Differentiate the inner function

The derivative of with respect to is:

We can factor out a 3:

Step 4: Apply the chain rule

The derivative of the composite function is:

Final Answer:

The derivative of with respect to is .

ANSWER

27(3x^2-9x+5)^8(2x-3)

Question 2

QUESTION

Differentiate w.r.t. x the function \sin^3 x+\cos^6 x.

SOLUTION

We are asked to differentiate the function with respect to .

Step 1: Differentiate each term separately

We will use the chain rule to differentiate each term. Recall that the chain rule states .

For the first term, , we have:

For the second term, , we have:

Step 2: Combine the derivatives

Now, we add the derivatives of the two terms to find the derivative of the entire function:

Step 3: Factor out common terms

We can factor out from both terms:

Final Answer:

The derivative of with respect to is .

Conclusion:

By applying the chain rule and factoring, we found the derivative of the given function. Remember to differentiate each term separately and then combine them.

ANSWER

3\sin x\cos x\,(\sin x-2\cos^4 x)

Question 3

QUESTION

Differentiate w.r.t. x the function (5x)^3\cos 2x.

SOLUTION

This question requires us to differentiate a function of the form with respect to . We will use logarithmic differentiation to solve this problem.

Step 1: Define the function

Let .

Step 2: Take the natural logarithm of both sides

Taking the natural logarithm (ln) of both sides, we get:

Using the property of logarithms, , we have:

Step 3: Differentiate both sides with respect to

Differentiating both sides with respect to , we use the chain rule on the left side and the product rule on the right side:

Step 4: Calculate the derivatives

We have:

Substituting these into the equation, we get:

Step 5: Solve for

Multiply both sides by :

Substitute :

Final Answer:

ANSWER

(5x)^3\cos 2x\left[(3\cos 2x)/(x)-6\sin 2x\,\log(5x)\right]

Question 4

QUESTION

Differentiate w.r.t. x the function \sin^-1(x√x), for 0\le x\le 1.

SOLUTION

We are asked to differentiate the function with respect to , given the domain .

Step 1: Rewrite the function

First, rewrite the function to make it easier to differentiate:

Step 2: Apply the chain rule

We will use the chain rule, which states that if , then . In our case, and .

The derivative of is , and the derivative of is .

Step 3: Differentiate

Applying the chain rule:

Step 4: Simplify

Combine the terms:

Final Answer:

The derivative of with respect to is .

ANSWER

(3)/(2)√(x)/(1-x^3)

Question 5

QUESTION

Differentiate w.r.t. x the function \cos^-1(x/2)√2x+7, for -2<x<2.

SOLUTION

We need to differentiate the function with respect to . This problem involves the quotient rule and chain rule of differentiation.

Step 1: Define the function

Let .

Step 2: Apply the quotient rule

The quotient rule states that if , then . Here, and .

Step 3: Find

. Using the chain rule, we have:

Step 4: Find

. Using the chain rule, we have:

Step 5: Apply the quotient rule formula

Step 6: Simplify the expression

Final Answer:

ANSWER

-\left[(1)/(√4-x^2)\,√2x+7+\cos^-1(x/2)(2x+7)^3/2\right]

Question 6

QUESTION

Differentiate w.r.t. x the function \cot^-1\left[√1+\sin x+√1-\sin x√1+\sin x-√1-\sin x\right], for 0<x<(π)/(2).

SOLUTION

We need to differentiate the function with respect to , where .

Step 1: Simplify the expression inside the function

We can simplify the expression by rationalizing the denominator. Multiply both the numerator and denominator by :

Since , , so .

Step 2: Further simplification using trigonometric identities

We can use the identities and .

Step 3: Substitute back into the original function

Now we have:

Step 4: Differentiate with respect to

Final Answer:

ANSWER

(1)/(2)

Question 7

QUESTION

Differentiate w.r.t. x the function (\log x)^\log x, for x>1.

SOLUTION

We are asked to differentiate the function with respect to , where .

Step 1: Define the function

Let .

Step 2: Apply logarithms to both sides

Taking the natural logarithm of both sides, we get:

Using the property of logarithms, , we have:

Step 3: Differentiate both sides with respect to

Differentiating both sides with respect to , we use the product rule on the right side. The product rule states that .

So,

Step 4: Calculate the derivatives

We know that . Also, using the chain rule:

Substituting these derivatives into our equation:

Step 5: Solve for

Multiply both sides by :

Step 6: Substitute the value of

Since , we have:

Final Answer:

ANSWER

(\log x)^\log x\left[(1)/(x)+(\log(\log x))/(x)\right]

Question 8

QUESTION

Differentiate w.r.t. x the function \cos(a\cos x+b\sin x), where a and b are constants.

SOLUTION

We need to find the derivative of with respect to , where and are constants. This problem involves the chain rule of differentiation.

Step 1: Define the function

Let .

Step 2: Apply the chain rule

We will use the chain rule: , where .

Step 3: Find

Since , we have . Therefore, .

Step 4: Find

We have . Differentiating with respect to :

Since and , we get:

.

We can also write this as .

Step 5: Combine the derivatives

Now, we multiply and to find :

Final Answer:

ANSWER

(a\sin x-b\cos x)\,\sin(a\cos x+b\sin x)

Question 9

QUESTION

Differentiate w.r.t. x the function (\sin x-\cos x)^(\sin x-\cos x), for (π)/(4)<x<(3π)/(4).

SOLUTION

We are asked to differentiate the function with respect to , given that .

Step 1: Define the function and apply logarithms

Let . To differentiate this, we'll use logarithms. Taking the natural logarithm of both sides:

Step 2: Differentiate both sides with respect to

Differentiating both sides with respect to using the chain rule and product rule:

Step 3: Calculate the derivatives

We have:

Substituting these into our equation:

Step 4: Simplify the expression

Step 5: Solve for

Multiply both sides by :

Substitute :

Final Answer:

ANSWER

(\sin x-\cos x)^(\sin x-\cos x)(\cos x+\sin x)\left(1+\log(\sin x-\cos x)\right)

Question 10

QUESTION

Differentiate w.r.t. x the function x^x+x^a+a^x+a^a, where a>0 is fixed and x>0.

SOLUTION

We need to differentiate the function with respect to , where is a fixed constant and .

Step 1: Differentiate each term separately

Let . Then, we can differentiate each term individually.

Step 2: Differentiate

Let . Taking the natural logarithm of both sides, we get . Differentiating both sides with respect to , we have:

Therefore,

Step 3: Differentiate

Let . Using the power rule, we have

Step 4: Differentiate

Let . We know that the derivative of with respect to is . So,

Step 5: Differentiate

Since is a constant, is also a constant. The derivative of a constant is 0. Therefore, the derivative of with respect to is 0.

Step 6: Combine the derivatives

Now, we add the derivatives of each term to find the derivative of with respect to :

Final Answer:

The derivative of with respect to is .

ANSWER

x^x(1+\log x)+a\,x^a-1+a^x\log a

Question 11

QUESTION

Differentiate w.r.t. x the function x^x^2-3+(x-3)^x^2, for x>3.

SOLUTION

This question requires us to differentiate a function that is a sum of two terms, each involving variable exponents. We will use logarithmic differentiation to handle the variable exponents.

Step 1: Define the function and split it into two parts

Let . We can write this as , where and .

Therefore, .

Step 2: Differentiate using logarithmic differentiation

Taking the natural logarithm of both sides, we get:

Differentiating both sides with respect to , we have:

Step 3: Differentiate using logarithmic differentiation

Taking the natural logarithm of both sides, we get:

Differentiating both sides with respect to , we have:

Step 4: Combine the results

Final Answer:

ANSWER

x^x^2-3\left[(x^2-3)/(x)+2x\log x\right]+(x-3)^x^2\left[(x^2)/(x-3)+2x\log(x-3)\right]

Question 12

QUESTION

Find (dy)/(dx), if y=12(1-\cos t), x=10(t-\sin t), -(π)/(2)<t<(π)/(2).

SOLUTION

We are asked to find given and are functions of . This is a problem of finding the derivative of a parametric function.

Step 1: Find

We have . Differentiating with respect to , we get:

Step 2: Find

We have . Differentiating with respect to , we get:

Step 3: Find using the chain rule

We know that . Therefore:

Step 4: Simplify the expression

We can simplify the expression using trigonometric identities. Recall that:

Substituting these identities into our expression for , we get:

Simplifying further:

Final Answer:

ANSWER

(6)/(5)\cot(t)/(2)

Question 13

QUESTION

Find (dy)/(dx), if y=\sin^-1x+\sin^-1√1-x^2, 0<x<1.

SOLUTION

We are asked to find the derivative of the function with respect to , given that .

Step 1: Differentiate both sides with respect to x

We need to find . Differentiating both sides of the equation with respect to , we get:

Step 2: Apply the chain rule

We know that . For the second term, we use the chain rule:

Since , , so

Step 3: Combine the derivatives

Now, substitute these results back into the expression for :

Step 4: Simplify

Final Answer:

ANSWER

0

Question 14

QUESTION

If x√1+y+y√1+x=0, for -1<x<1, prove that (dy)/(dx)=-(1)/((1+x)^2).

SOLUTION

This question requires us to find the derivative given an implicit relation between and . We will use implicit differentiation and algebraic manipulation to arrive at the desired result.

Step 1: Rewrite the given equation

We are given . Let's rewrite it as:

Step 2: Square both sides

Squaring both sides of the equation eliminates the square roots:

Step 3: Expand and rearrange

Expanding both sides gives:

Rearranging the terms, we get:

Step 4: Factor the equation

We can factor the difference of squares and factor out a common term from the last two terms:

Now, factor out the common factor :

Step 5: Solve for y

This gives us two possibilities: or . If , then . Substituting into the original equation gives , which simplifies to . This implies or . Since , we consider the other possibility:

Step 6: Differentiate with respect to x

Now, differentiate with respect to :

Final Answer:

Question 15

QUESTION

If (x-a)^2+(y-b)^2=c^2, for some c>0, prove that

(\left[1+\left(dy)/(dx)\right)^2\right]^3/2(d^2y)/(dx^2) is a constant independent of a and b.

SOLUTION

We are given the equation of a circle and asked to prove that the expression is a constant independent of and .

Step 1: Differentiate the given equation with respect to x

Given:

Differentiating both sides with respect to , we get:

Simplifying:

Rearranging to solve for :

Step 2: Differentiate again with respect to x to find the second derivative

Differentiating with respect to , we use the quotient rule:

Substitute into the equation:

Since , we have:

Step 3: Calculate

Step 4: Calculate

Final Answer:

The expression , which is a constant independent of and .

Question 16

QUESTION

If \cos y=x\cos(a+y), with \cos a≠ ± 1, prove that (dy)/(dx)=(\cos^2(a+y))/(\sin a).

SOLUTION

We are given the equation and asked to prove that , given that .

Step 1: Express in terms of

From the given equation, we can express as:

Step 2: Differentiate with respect to

We will differentiate both sides of the equation with respect to :

Using the quotient rule, , we have:

Step 3: Simplify using trigonometric identity

Recall the trigonometric identity: . Applying this to the numerator, we get:

Step 4: Find

Since , we can find by taking the reciprocal:

Final Answer:

Therefore, we have proven that .

Question 17

QUESTION

If x=a(\cos t+t\sin t) and y=a(\sin t-t\cos t), find (d^2y)/(dx^2).

SOLUTION

This question requires us to find the second derivative given parametric equations for and in terms of . We will use the chain rule and quotient rule to solve this problem.

Step 1: Find and

Given , we differentiate with respect to :

Given , we differentiate with respect to :

Step 2: Find

Using the chain rule, :

Step 3: Find

We need to differentiate with respect to . Using the chain rule:

We know , so .

Also, , so .

Therefore,

Final Answer:

,

ANSWER

(\sec^3 t)/(a t), 0<t<(π)/(2)

Question 18

QUESTION

If f(x)=|x|^3, show that f''(x) exists for all real x and find it.

SOLUTION

We are given the function and asked to show that its second derivative, , exists for all real and to find it.

Step 1: Rewrite the function using the definition of absolute value.

The absolute value function is defined as:

Therefore, we can rewrite as:

Step 2: Find the first derivative, .

Differentiating each case separately:

For , .

For , .

Thus, we have:

We can also write this as .

Step 3: Find the second derivative, .

Differentiating again:

For , .

For , .

Thus, we have:

We can also write this as .

Step 4: Check the existence of at .

We need to check if the left-hand limit and right-hand limit of are equal at .

Since both limits are equal to 0, .

Step 5: Conclude.

Since exists for all and is given by , we have shown that exists for all real .

Final Answer:

Question 19

QUESTION

Using the fact that \sin(A+B)=\sin A\cos B+\cos A\sin B and the differentiation, obtain the sum formula for cosines.

SOLUTION

We are asked to derive the sum formula for cosine, i.e., , using the given sine sum formula and differentiation.

Step 1: Write down the given sine sum formula

We are given that:

Step 2: Differentiate both sides with respect to A

Differentiating both sides of the equation with respect to , we get:

Step 3: Apply the chain rule and differentiation rules

Using the chain rule on the left side and the sum/product rules on the right side, we have:

Since , we get:

Step 4: State the sum formula for cosines

Therefore, the sum formula for cosines is:

Final Answer:

Question 20

QUESTION

Does there exist a function which is continuous everywhere but not differentiable at exactly two points? Justify your answer.

SOLUTION

This question explores the relationship between continuity and differentiability of a function. We need to determine if a function can be continuous everywhere but fail to be differentiable at exactly two points.

Step 1: Recall the relationship between continuity and differentiability

If a function is differentiable at a point, it must also be continuous at that point. However, the converse is not necessarily true. A function can be continuous at a point but not differentiable there. This typically happens at sharp corners or cusps.

Step 2: Consider examples of non-differentiable points

The absolute value function, , is a classic example. It is continuous everywhere, but not differentiable at because of the sharp corner. The left-hand derivative and right-hand derivative at are different.

Step 3: Construct a function with two non-differentiable points

We can extend the absolute value function concept. Consider the function , where and are distinct real numbers. This function is continuous everywhere. The points where it might not be differentiable are and .

Step 4: Analyze the differentiability at and

At , the term is not differentiable, creating a corner. Similarly, at , the term is not differentiable. Everywhere else, the function is a linear combination of linear functions and is therefore differentiable.

Step 5: Conclude

Yes, such a function exists. For example, is continuous everywhere but not differentiable at and . The graph of this function will have corners at these two points.

Question 21

QUESTION

If y=\beginvmatrix f(x) & g(x) & h(x) \\ l & m & n \\ a & b & c \endvmatrix, prove that

(dy)/(dx)=\beginvmatrix f'(x) & g'(x) & h'(x) \\ l & m & n \\ a & b & c \endvmatrix.

SOLUTION

This question tests our understanding of how to differentiate a determinant where the elements are functions of .

Step 1: Expand the determinant

Let's expand the determinant along the first row:

Now, evaluate the 2x2 determinants:

Step 2: Differentiate with respect to

Differentiate both sides of the equation with respect to . Remember that are constants, so their derivatives are zero.

Apply the derivative to each term:

Step 3: Rewrite as a determinant

Now, we want to express this result as a determinant. Notice the similarity to the expansion we did in Step 1.

This is the expansion of the following determinant along the first row:

Final Answer:

Therefore, we have proven that .

Question 22

QUESTION

If y=e^a\cos^-1x, -1\le x\le 1, show that (1-x^2)(d^2y)/(dx^2)-x(dy)/(dx)-a^2y=0.

SOLUTION

We are given the function and asked to prove that .

Step 1: Find the first derivative,

Using the chain rule, we have:

Step 2: Find the second derivative,

First, rewrite the first derivative as:

Differentiate both sides with respect to using the product rule and chain rule:

Multiply both sides by :

Substitute into the right side:

Step 3: Rearrange the equation

Move all terms to the left side:

Final Answer: We have shown that .

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📐 Key Formulas

Important Formulas for Exercise misc

Formula / Concept	Description
Rolle's Theorem	A special case of the Mean Value Theorem. It states that if a function f is continuous on the closed interval [a, b], differentiable on the open interval (a, b),

Formula / Concept	Description
	and f(a) = f(b), then there exists at least one number c in the open interval (a, b) such that f'(c) = 0.
Conditions for Rolle's Theorem	For Rolle's Theorem to be applicable, three conditions must be met: 1. The function f(x) must be continuous on the closed interval [a, b]. 2. The function f(x) must be differentiable on the open interval (a, b). 3. The values of the function at the endpoints must be equal, i.e., f(a) = f(b).
Geometrical Interpretation of Rolle's Theorem	Geometrically, Rolle's Theorem implies that if a continuous and differentiable curve has the same height at two points, then there must be at least one point between them where the tangent to the curve is horizontal (parallel to the x-axis).
Mean Value Theorem (Lagrange's Mean Value Theorem)	This theorem states that if a function f is continuous on the closed interval [a, b] and differentiable on the open interval (a, b), then there exists at least one number c in the open interval (a, b) such that: f'(c) = (f(b) - f(a))/(b - a)
Conditions for Mean Value Theorem	For the Mean Value Theorem to be applicable, two conditions must be satisfied: 1. The function f(x) must be continuous on the closed interval [a, b]. 2. The function f(x) must be differentiable on the open interval (a, b).
Geometrical Interpretation of Mean Value Theorem	Geometrically, the Mean Value Theorem states that for a continuous and differentiable curve between two points, there is at least one point on the curve where the tangent line is parallel to the secant line connecting the two endpoints. The slope of the secant line is (f(b) - f(a))/(b - a), and the slope of the tangent line at point c is f'(c).

📚 More Exercises

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Miscellaneous Exercise on Chapter 5 ✓ →

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