NCERT Solutions Class 12 Maths
Chapter 5: Continuity and Differentiability
Exercise 5.3

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 5 Exercise 5.3, students learn advanced differentiation techniques for exponential and logarithmic functions through implicit differentiation and parametric forms. This exercise covers Mean Value Theorem and Rolle's Theorem applications alongside complex derivative calculations using chain rule and logarithmic differentiation, which are essential for CBSE Board exams and competitive entrance tests.

Key Takeaways:

- Master implicit differentiation for finding (dy)/(dx) when functions involve exponential and logarithmic expressions
- Apply logarithmic differentiation technique for complex functions of the form y = [f(x)]^g(x)
- Understand Mean Value Theorem: If f is continuous on [a,b] and differentiable on (a,b), then f'(c) = (f(b)-f(a))/(b-a) for some c \in (a,b)
- Practice Rolle's Theorem applications where f'(c) = 0 exists when f(a) = f(b) and function satisfies continuity conditions

Complete Solutions

Question 1

QUESTION

Find (dy)/(dx) if 2x+3y=\sin x.

SOLUTION

We are asked to find the derivative for the equation . This requires us to use implicit differentiation.

Step 1: Differentiate both sides with respect to

We differentiate both sides of the equation with respect to :

Step 2: Apply the sum rule and constant multiple rule

Using the sum rule of differentiation, we have:

Applying the constant multiple rule:

Step 3: Differentiate each term

We know that and . Also, we need to use the chain rule to differentiate with respect to , so . Thus, we have:

Step 4: Isolate

Subtract 2 from both sides:

Divide both sides by 3:

Final Answer:

ANSWER

(dy)/(dx)=(\cos x-2)/(3)

Question 2

QUESTION

Find $(dy)/(dx)$ if $2x+3y=\sin y$.

SOLUTION

We are asked to find the derivative for the equation . This requires implicit differentiation since is not explicitly defined as a function of .

Step 1: Differentiate both sides with respect to

We differentiate both sides of the equation with respect to :

Step 2: Apply the differentiation rules

Using the sum rule and constant multiple rule, we get:

Since , we have:

Step 3: Isolate terms

We want to isolate on one side of the equation. Subtract from both sides:

Step 4: Factor out

Factor out from the right side:

Step 5: Solve for

Divide both sides by to solve for :

Final Answer:

ANSWER

$(dy)/(dx)=(2)/(\cos y-3)$

Question 3

QUESTION

Find (dy)/(dx) if ax+by^2=\cos y.

SOLUTION

We need to find for the equation . This requires implicit differentiation.

Step 1: Differentiate both sides with respect to

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

Step 2: Apply the differentiation rules

Using the sum rule and constant multiple rule, we have:

Applying the chain rule, we get:

So, we have:

Step 3: Isolate terms

Rearrange the equation to isolate the terms containing :

Step 4: Factor out

Factor out from the left side:

Step 5: Solve for

Divide both sides by to solve for :

Final Answer:

ANSWER

(dy)/(dx)=-(a)/(2by+\sin y)

Question 4

QUESTION

Find (dy)/(dx) if xy+y^2=\tan x+y.

SOLUTION

We are asked to find the derivative for the given equation . This requires implicit differentiation.

Step 1: Differentiate both sides with respect to

We differentiate both sides of the equation with respect to .

Step 2: Apply the product rule and chain rule

For the term , we use the product rule: .

For the term , we use the chain rule: .

For the term , we know that .

For the term , we have .

So, the equation becomes:

Step 3: Collect terms with

We rearrange the equation to group all terms containing on one side:

Step 4: Factor out

We factor out from the left side:

Step 5: Solve for

We divide both sides by to isolate :

Final Answer:

ANSWER

(dy)/(dx)=(\sec^2 x-y)/(x+2y-1)

Question 5

QUESTION

Find (dy)/(dx) if x^2+xy+y^2=100.

SOLUTION

We are asked to find the derivative for the given implicit function .

Step 1: Differentiate both sides with respect to x

We will differentiate both sides of the equation with respect to . Remember that is a function of , so we'll need to use the chain rule when differentiating terms involving .

Step 2: Apply the differentiation rules

Applying the power rule and product rule, we get:

Step 3: Collect terms with

Now, we group the terms containing on one side and move the other terms to the other side of the equation:

Step 4: Factor out

Factor out from the left side of the equation:

Step 5: Solve for

Divide both sides by to isolate :

Final Answer:

ANSWER

(dy)/(dx)=-(2x+y)/(x+2y)

Question 6

QUESTION

Find (dy)/(dx) if x^3+x^2y+xy^2+y^3=81.

SOLUTION

We are asked to find the derivative of the given implicit function .

Step 1: Differentiate both sides with respect to

We need to differentiate the entire equation with respect to .

Step 2: Apply the sum/difference rule and constant rule

Step 3: Apply the product rule and chain rule where necessary

Remember that is a function of , so we need to use the chain rule when differentiating terms involving .

Step 4: Substitute the derivatives back into the equation

Step 5: Group the terms with

Step 6: Solve for

Final Answer:

ANSWER

(dy)/(dx)=-(3x^2+2xy+y^2)/(x^2+2xy+3y^2)

Question 7

QUESTION

Find $\frac{dy}{dx}$ if $\sin^2 y+\cos(xy)=k$.

SOLUTION

We need to find for the implicitly defined function , where is a constant.

Step 1: Differentiate both sides with respect to

We will use the chain rule and product rule as needed. Differentiating both sides of the equation with respect to , we get:

Step 2: Apply the chain rule to

Using the chain rule, we have:

Step 3: Apply the chain rule and product rule to

Using the chain rule and product rule, we have:

Step 4: Substitute the derivatives back into the equation

Substituting these results back into the original differentiated equation, we get:

Step 5: Isolate

Now, we isolate :

Final Answer:

Therefore,

ANSWER

$\frac{dy}{dx}=\frac{y\sin(xy)}{\sin(2y)-x\sin(xy)}$

Question 8

QUESTION

Find (dy)/(dx) if \sin^2 x+\cos^2 y=1.

SOLUTION

We are asked to find the derivative for the given equation . This problem involves implicit differentiation.

Step 1: Differentiate both sides with respect to

We differentiate both sides of the equation with respect to :

This gives us:

Step 2: Apply the chain rule

Using the chain rule, we have:

Step 3: Simplify using trigonometric identities

We know that and . Therefore:

Step 4: Isolate

Rearrange the equation to solve for :

Final Answer:

ANSWER

(dy)/(dx)=(\sin 2x)/(\sin 2y)

Question 9

QUESTION

Find (dy)/(dx) if y=\sin^-1\!\left((2x)/(1+x^2)\right).

SOLUTION

We need to find the derivative of with respect to .

Step 1: Recognize the trigonometric substitution

The expression inside the inverse sine function suggests a trigonometric substitution. Let's try substituting . This is a common technique when dealing with expressions of the form or inside inverse trigonometric functions.

Step 2: Perform the substitution

Let . Then, . Substituting into the expression for , we get:

Step 3: Simplify using trigonometric identities

Recall the double angle formula for sine: . Therefore,

Step 4: Simplify further

Assuming , we have:

Step 5: Substitute back for

Since , we have:

Step 6: Differentiate with respect to

Now, differentiate with respect to . We know that the derivative of is . Therefore:

Final Answer:

ANSWER

(dy)/(dx)=(2)/(1+x^2)

Question 10

QUESTION

Find (dy)/(dx) if y=\tan^-1\!\left((3x-x^3)/(1-3x^2)\right), for -(1)/(√3)<x<(1)/(√3).

SOLUTION

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

Step 1: Recognize the trigonometric identity

The expression inside the inverse tangent function, , resembles the triple angle formula for tangent:

Step 2: Substitute

Let . Then, . The given condition implies that . Therefore, , which is within the principal branch of the inverse tangent function.

Substituting into the expression for , we get:

Step 3: Simplify using the triple angle formula

Using the triple angle formula, we have:

Since , we can simplify this to:

Step 4: Substitute back for

Recall that . Substituting this back into the equation for , we get:

Step 5: Differentiate with respect to

Now, we differentiate with respect to :

Using the derivative of the inverse tangent function, , we have:

Final Answer:

ANSWER

(dy)/(dx)=(3)/(1+x^2)

Question 11

QUESTION

Find $\frac{dy}{dx}$ if $y=\cos^{-1}\!\left(\frac{1-x^2}{1+x^2}\right)$, for $0<x<1$.

SOLUTION

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

Step 1: Recognize the trigonometric substitution

The expression inside the inverse cosine function suggests a trigonometric substitution. Let's try . Since , we have .

Step 2: Substitute and simplify

Substituting into the expression for , we get:

Recall the trigonometric identity: . Therefore,

Step 3: Simplify further using the range of

Since , we have . In this interval, . Therefore, .

Step 4: Substitute back for

Since , we have . Substituting this back into the expression for , we get:

Step 5: Differentiate with respect to

Now, we differentiate with respect to :

Using the derivative of the inverse tangent function, , we get:

Final Answer:

ANSWER

$\frac{dy}{dx}=\frac{2}{1+x^2}$

Question 12

QUESTION

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

SOLUTION

This question asks us to find the derivative of an inverse trigonometric function. We will use trigonometric substitution to simplify the expression before differentiating.

Step 1: Trigonometric Substitution

Let . Since , we have . This substitution is helpful because it allows us to simplify the expression inside the inverse sine function.

Then, .

Step 2: Simplify using Trigonometric Identities

Recall the trigonometric identity: . Therefore, we can rewrite as:

.

Also, recall that . So,

.

Since , , and thus . Therefore, we can simplify further:

.

Step 3: Substitute back for

Since , we have . Substituting this back into the expression for , we get:

.

Step 4: Differentiate with respect to

Now, we differentiate with respect to :

.

The derivative of a constant is 0, and the derivative of is . Therefore,

.

Final Answer:

ANSWER

(dy)/(dx)=-(2)/(1+x^2)

Question 13

QUESTION

Find (dy)/(dx) if y=\cos^-1\!\left((2x)/(1+x^2)\right), for -1<x<1.

SOLUTION

This question asks us to find the derivative of an inverse trigonometric function. We'll use a trigonometric substitution to simplify the expression before differentiating.

Step 1: Trigonometric Substitution

Let . Since , we have . This substitution simplifies the expression inside the inverse cosine function.

Step 2: Substitute and Simplify

Substitute into the expression for :

Recall the trigonometric identity: . Therefore,

Step 3: Further Simplification

We can rewrite as . So,

Since , we have , and thus . However, we need to ensure that lies within the range of the inverse cosine function, which is . In our case, it does.

Therefore,

Step 4: Differentiate with Respect to

First, express in terms of : . Then,

Now, differentiate both sides with respect to :

Final Answer:

ANSWER

(dy)/(dx)=-(2)/(1+x^2)

Question 14

QUESTION

Find $\frac{dy}{dx}$ if $y=\sin^{-1}\!\left(2x\sqrt{1-x^2}\right)$, for $-\frac{1}{\sqrt{2}}<x<\frac{1}{\sqrt{2}}$.

SOLUTION

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

Step 1: Trigonometric Substitution

Let's use the substitution . This is a common technique when dealing with expressions of the form . Since , we have .

Then, (since , is positive).

Step 2: Simplify the expression for y

Substituting into the expression for , we get:

Using the trigonometric identity , we have:

Since , we have . Therefore, .

So, .

Step 3: Express y in terms of x

Since , we have . Therefore,

.

Step 4: Differentiate y with respect to x

Now, we differentiate with respect to :

We know that .

Therefore, .

Final Answer:

ANSWER

$\frac{dy}{dx}=\frac{2}{\sqrt{1-x^2}}$

Question 15

QUESTION

Find $\frac{dy}{dx}$ if $y=\sec^{-1}\!\left(\frac{1}{2x^2-1}\right)$, for $0<x<\frac{1}{\sqrt{2}}$.

SOLUTION

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

Step 1: Simplify the expression using trigonometric identities

Recall the identity . Let . Then, we have:

Step 2: Determine the range of

Since and , we have . This implies that . Therefore, .

Step 3: Simplify based on the range of

Since , lies in the second quadrant. In this quadrant, is not directly true. However, we can use the property . Thus, . Since the range of is excluding , we need to find an equivalent angle in that range. However, since simplifies to in our case, we can proceed with .

Therefore, .

Step 4: Differentiate with respect to

We have . Differentiating with respect to , we get:

Final Answer:

ANSWER

$\frac{dy}{dx}=-\frac{2}{\sqrt{1-x^2}}$

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Key Formulas

Important Formulas for Exercise 5.3

Formula / Concept	Description
Implicit Functions	An implicit function is one where the dependent variable is not explicitly isolated on one side of the equation. For example, $x^2 + y^2 = 1$ is an implicit function.
Differentiation of Implicit Functions	To find the derivative of an implicit function, differentiate both sides of the equation with respect to x, treating y as a function of x, and then solve for $\frac{dy}{dx}$. This process often involves the chain rule.
Chain Rule	If y is a function of u, and u is a function of x, then the derivative of y with respect to x is given by $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$.
Derivatives of Inverse Trigonometric Functions	Formulas for the derivatives of the inverse trigonometric functions.
$\frac{d}{dx}(\sin^{-1}x)$	$\frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}(\cos^{-1}x)$	$-\frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}(\tan^{-1}x)$	$\frac{1}{1+x^2}$
$\frac{d}{dx}(\cot^{-1}x)$	$-\frac{1}{1+x^2}$
$\frac{d}{dx}(\sec^{-1}x)$	$\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$
$\frac{d}{dx}(\csc^{-1}x)$	$-\frac{1}{\lvert x\rvert\sqrt{x^2-1}}$
Derivatives of Exponential Functions	Formulas for the derivatives of exponential functions.
$\frac{d}{dx}(e^x)$	e^x
$\frac{d}{dx}(a^x)$	$a^x \ln a$
Derivatives of Logarithmic Functions	Formulas for the derivatives of logarithmic functions.
$\frac{d}{dx}(\ln x)$	$\frac{1}{x}$
$\frac{d}{dx}(\log_a x)$	$\frac{1}{x \ln a}$
Rolle's Theorem	If a function f is continuous on the closed interval [a, b], differentiable on the open interval (a, b), and f(a) = f(b), then there exists at least one number c in (a, b) such that f'(c) = 0.

Formula / Concept	Description
Mean Value Theorem (Lagrange's)	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 (a, b) such that $f'(c) = (f(b) - f(a))/(b - a)$.

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