NCERT Solutions Class 12 Maths
Chapter 5: Continuity and Differentiability
Exercise 5.4

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 5 Exercise 5.4, students learn logarithmic differentiation techniques for complex functions involving exponential, trigonometric, and inverse trigonometric combinations. This exercise covers advanced differentiation methods including chain rule applications and composite function derivatives, which are essential for CBSE Class 12 board exams and competitive entrance tests.

Key Takeaways:

- Master logarithmic differentiation for functions like (e^x)/(\sin x) using the formula (d)/(dx)[\ln f(x)] = (f'(x))/(f(x))
- Apply chain rule for composite functions such as e^\sin^-1x and e^x^3 with careful attention to inner and outer derivatives
- Differentiate inverse trigonometric functions combined with exponentials like \sin(\tan^-1x) using standard derivative formulas
- Solve logarithmic functions involving trigonometric expressions such as \log(\cos e^x) by combining logarithmic and trigonometric differentiation rules

Complete Solutions

Question 1

QUESTION

Differentiate (e^x)/(\sin x) with respect to x.

SOLUTION

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

This requires the application of the quotient rule.

Step 1: Recall the quotient rule

The quotient rule states that if we have a function , then its derivative with respect to is given by:

Step 2: Identify and

In our case, and .

Step 3: Find the derivatives of and

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

The derivative of with respect to is , so .

Step 4: Apply the quotient rule

Substituting these values into the quotient rule formula, we get:

Step 5: Simplify the expression

We can factor out from the numerator:

Step 6: State the final answer with the domain restriction

The derivative of with respect to is , where , because cannot be zero.

ANSWER

(e^x(\sin x-\cos x))/(\sin^2 x), x \ne nπ,\; n\in \mathbbZ.

Question 2

QUESTION

Differentiate e^\sin^-1x with respect to x.

SOLUTION

We are asked to find the derivative of with respect to .

Step 1: Define the function

Let . We want to find .

Step 2: Apply the chain rule

The chain rule states that if , then .

In our case, and . Therefore, .

Step 3: Find the derivatives of the individual functions

The derivative of with respect to is .

The derivative of with respect to is , for .

Step 4: Apply the chain rule formula

Using the chain rule, we have:

Step 5: Simplify the expression

Final Answer:

The derivative of with respect to is , .

ANSWER

e^\sin^-1x√1-x^2, x\in(-1,1).

Question 3

QUESTION

Differentiate e^x^3 with respect to x.

SOLUTION

We are asked to find the derivative of the function with respect to . This requires applying the chain rule.

Step 1: Identify the outer and inner functions

Here, the outer function is and the inner function is . We can think of as a composite function where and .

Step 2: Apply the chain rule

The chain rule states that if , then . In our case, , so we need to find and .

Step 3: Differentiate the outer function

The derivative of with respect to is . So, .

Step 4: Differentiate the inner function

The derivative of with respect to is . So, . This uses the power rule: .

Step 5: Combine the derivatives using the chain rule

Now, we multiply the derivative of the outer function by the derivative of the inner function:

Step 6: Substitute back the inner function

Since , we substitute it back into the expression:

Step 7: Rearrange the terms

We can rewrite this as:

Final Answer: The derivative of with respect to is .

ANSWER

3x^2e^x^3.

Question 4

QUESTION

Differentiate \sin\big(\tan^-1(e^-x)\big) with respect to x.

SOLUTION

We need to find the derivative of with respect to . This requires applying the chain rule multiple times.

Step 1: Define the composite function

Let . We will differentiate this with respect to .

Step 2: Apply the chain rule - outer function

First, differentiate the outermost function, which is sine:

Step 3: Apply the chain rule - middle function

Now, differentiate with respect to . Recall that . Here, :

Step 4: Apply the chain rule - inner function

Differentiate with respect to . Recall that . Here, :

Step 5: Combine the derivatives

Substitute the results back into the expression for :

Step 6: Simplify

Final Answer:

ANSWER

-e^-x\cos\big(\tan^-1(e^-x)\big)1+e^-2x.

Question 5

QUESTION

Differentiate \log(\cos e^x) with respect to x.

SOLUTION

We are asked to differentiate the function with respect to . This requires applying the chain rule multiple times.

Step 1: Identify the composite functions

The given function is a composition of three functions: the logarithm function, the cosine function, and the exponential function. Specifically, we have:

, where , and .

Step 2: Apply the chain rule

The chain rule states that .

Step 3: Differentiate each part

First, differentiate with respect to :

Next, differentiate with respect to :

Finally, differentiate with respect to :

Step 4: Combine the derivatives

Now, multiply the derivatives together:

Step 5: Simplify the expression

We can rewrite the expression using the tangent function, since :

Step 6: State the condition

The tangent function is undefined when the cosine function is zero. Therefore, we must specify that , where .

Final Answer:

The derivative of with respect to is , .

ANSWER

-e^x\tan(e^x), e^x\ne(2n+1)(π)/(2),\; n\in\mathbbN.

Question 6

QUESTION

Differentiate e^x + e^x^2 + ·s + e^x^5 with respect to x.

SOLUTION

We are asked to differentiate the sum of exponential functions with respect to .

Step 1: Define the function

Let .

Step 2: Differentiate each term separately

We will use the chain rule, which states that if , then .

Step 3: Differentiate

The derivative of with respect to is simply .

Step 4: Differentiate

Using the chain rule, the derivative of with respect to is .

Step 5: Differentiate

Using the chain rule, the derivative of with respect to is .

Step 6: Differentiate

Using the chain rule, the derivative of with respect to is .

Step 7: Differentiate

Using the chain rule, the derivative of with respect to is .

Step 8: Sum the derivatives

Final Answer:

The derivative of with respect to is .

ANSWER

e^x + 2xe^x^2 + 3x^2e^x^3 + 4x^3e^x^4 + 5x^4e^x^5.

Question 7

QUESTION

Differentiate √e^√x with respect to x, where x>0.

SOLUTION

This question requires us to differentiate a composite function involving exponential and square root functions. We will use the chain rule repeatedly to find the derivative with respect to .

Step 1: Define the function

Let . We can rewrite this as .

Step 2: Apply the chain rule - first layer

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

Step 3: Apply the chain rule - second layer

Now we need to differentiate with respect to . Again, using the chain rule:

Step 4: Differentiate the innermost function

We know that

Step 5: Combine all the derivatives

Substituting back into our expression for :

Step 6: Simplify the expression

Since , we can write:

Final Answer: The derivative of with respect to is or , .

ANSWER

e^√x4√xe^√x, x>0.

Question 8

QUESTION

Differentiate \log(\log x) with respect to x, where x>1.

SOLUTION

We are asked to find the derivative of with respect to . This problem tests our understanding of the chain rule in differentiation.

Step 1: Define the function

Let . We want to find .

Step 2: Apply the chain rule

The chain rule states that if , then . In our case, and .

Step 3: Find the derivative of the outer function

The derivative of with respect to is . Therefore, .

Step 4: Find the derivative of the inner function

The derivative of with respect to is .

Step 5: Combine the derivatives using the chain rule

Step 6: Simplify the expression

Final Answer: , .

Conclusion: We successfully found the derivative of using the chain rule. It's crucial to remember the derivative of and to apply the chain rule systematically by differentiating the outer function first and then multiplying by the derivative of the inner function.

ANSWER

(1)/(x\log x), x>1.

Question 9

QUESTION

Differentiate (\cos x)/(\log x) with respect to x, where x>0.

SOLUTION

We need to find the derivative of the function with respect to .

Step 1: Identify the rule to apply

Since we have a function divided by another function, we will use the quotient rule. The quotient rule states that if we have a function , then its derivative is given by:

Step 2: Define and

In our case, let and .

Step 3: Find the derivatives of and

The derivative of is .

The derivative of is .

Step 4: Apply the quotient rule

Now, we substitute these into the quotient rule formula:

Step 5: Simplify the expression

We can simplify the numerator by multiplying the second term by to get a common denominator:

Now, we can simplify further by dividing by :

We can factor out a negative sign to get:

Final Answer: The derivative of with respect to is , .

ANSWER

-(x\sin x·\log x+\cos x)/(x(\log x)^2), x>0.

Question 10

QUESTION

Differentiate \cos(\log x + e^x) with respect to x, where x>0.

SOLUTION

We need to find the derivative of with respect to .

This problem involves the chain rule of differentiation.

Step 1: Define the composite function

Let . We can consider this as a composite function where the outer function is cosine and the inner function is .

Step 2: Apply the chain rule

The chain rule states that if , then .

In our case, and .

Step 3: Find the derivatives of the outer and inner functions

The derivative of the outer function is:

The derivative of the inner function is:

Step 4: Apply the chain rule formula

Now, we substitute these derivatives back into the chain rule formula:

Step 5: Simplify the expression

Therefore, the derivative of with respect to is .

Final Answer:

ANSWER

-(1)/(x)+e^x\sin(\log x+e^x), x>0.

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Key Formulas

Important Formulas for Exercise 5.4

Formula / Concept	Description
Logarithmic Properties	Properties used to simplify expressions before differentiation.
$\ln(ab) = \ln(a) + \ln(b)$	Product Rule for Logarithms.
$\ln\left(\frac{a}{b}\right) = \ln(a) - \ln(b)$	Quotient Rule for Logarithms.
$\ln(a^b) = b \ln(a)$	Power Rule for Logarithms.
Derivatives of Exponential Functions	Rules for differentiating exponential functions.
$\frac{d}{dx} (e^x) = e^x$	The derivative of the natural exponential function is itself.
$\frac{d}{dx} (a^x) = a^x \ln(a)$	The derivative of an exponential function with a base 'a'.
Derivatives of Logarithmic Functions	Rules for differentiating logarithmic functions.
$\frac{d}{dx} (\ln x) = \frac{1}{x}$	The derivative of the natural logarithmic function.
$\frac{d}{dx} (\log_a x) = \frac{1}{x \ln a}$	The derivative of a logarithmic function with a base 'a'.
Logarithmic Differentiation	A technique for differentiating complex functions, especially of the form $y = [f(x)]^{g(x)}$.
If $y = f(x)$, the process involves: 1. Take the natural logarithm: $\ln y = \ln(f(x))$ 2. Differentiate implicitly w.r.t. x: $\frac{1}{y} \frac{dy}{dx} = \frac{d}{dx} (\ln(f(x)))$ 3. Solve for $\frac{dy}{dx}$: $\frac{dy}{dx} = y \cdot \frac{d}{dx} (\ln(f(x)))$	Steps to apply logarithmic differentiation.
Rolle's Theorem	A theorem stating conditions under which a function must have a point with a horizontal tangent.
If a function f is: 1. Continuous on the closed interval [a, b]	The conditions and conclusion for Rolle's Theorem.

Formula / Concept	Description
2. Differentiable on the open interval (a, b) 3. f(a) = f(b) Then there exists some c in (a, b) such that f'(c) = 0.	
Mean Value Theorem (MVT)	A theorem that guarantees the existence of a point where the instantaneous rate of change equals the average rate of change.
If a function f is: 1. Continuous on the closed interval [a, b] 2. Differentiable on the open interval (a, b) Then there exists some c in (a, b) such that: f'(c) = (f(b) - f(a))/(b - a)	The conditions and conclusion for Lagrange's Mean Value Theorem.

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